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The Modern General Dentist: A Global Narrative Review of Contemporary Clinical Practice, from Foundational to Advanced Procedures, and Future Directions

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ABSTRACT

General dentistry has changed substantially over the past decade. Biological, risk-based care, digital workflows, evidence-based clinical guidelines, artificial intelligence (AI) and remote care now shape what the general dentist is expected to deliver, yet the evidence is scattered across specialties. To synthesise current international evidence and guidelines on contemporary clinical practice for the general dentist, from foundational to advanced procedures, and to outline emerging directions. A narrative review was undertaken in October 2026. Targeted searches of PubMed and PubMed Central, publisher sites and professional society repositories prioritised clinical practice guidelines, consensus reports and systematic reviews, with supporting primary literature where needed. Six themes emerged. First, caries, pulp and restorative care have moved toward prevention, selective caries removal and vital pulp preservation. Second, periodontal and peri-implant care is structured by the 2017 classification and stepwise S3 guidelines. Third, implants show high medium- to long-term survival, with peri-implant disease as the main biological burden. Fourth, digital workflows (intraoral scanning, cone beam computed tomography, CAD/CAM, guided surgery, 3D printing) are mainstream, although clinical evidence for printed definitive restorations remains limited. Fifth, AI-assisted caries detection shows promising accuracy but marked heterogeneity and a need for external validation. Sixth, teledentistry offers caries diagnosis comparable to clinical examination in many settings, with weaker performance for early lesions and posterior teeth. A global perspective runs through the review: resource-adapted care, regional disease patterns, differences in law and regulation, language and culture, cross-border care and international governance of technology. The review also provides discipline-by-discipline guidance on the recognition and management of complications, with advice on when to treat and when to refer, and covers licensing, international standards, professional ethics, informed consent, and the ethical and lawful management of fees, billing and the practice as a business, continuing professional development and postgraduate education, vital pulp therapy, combined endodontic procedures, coronectomy and step-by-step core clinical procedures, dental materials and the complications of root canal treatment. Quick-reference tables, a five-phase care framework and applied clinical vignettes are included. Further sections address oral surgery in medically complex patients, anaesthesia and sedation, medical emergencies, paediatric care and dental trauma, removable prostheses, tooth wear, temporomandibular disorders prevention in practice, mucosal disease, safeguarding, oral hygiene, prescribing, dental anxiety, sleep-disordered breathing, radiography, antimicrobial stewardship, older and pregnant patients, access to care, consent and medico-legal practice, and practitioner wellbeing. The modern general dentist is best served by a biologically driven, guideline-informed and technology-literate approach, with clear recognition of the limits of personal scope and of the evidence. Priorities for the future include robust validation of AI tools, long-term trials of digital materials and equitable access.

1. Introduction

General dentistry has changed substantially over the past decade. Biological, risk-based care, digital workflows, evidence-based clinical guidelines, artificial intelligence (AI) and remote care now shape what the general dentist is expected to deliver, yet the

evidence is scattered across specialties. To synthesise current international evidence and guidelines on contemporary clinical practice for the general dentist, from foundational to advanced procedures, and to outline emerging directions. A narrative review was undertaken in October 2026. Targeted searches of PubMed and PubMed Central, publisher sites and professional society repositories prioritised clinical practice guidelines, consensus reports and systematic reviews, with supporting primary literature where needed. Six themes emerged. First, caries, pulp and restorative care have moved toward prevention, selective caries removal and vital pulp preservation. Second, periodontal and peri-implant care is structured by the 2017 classification and stepwise S3 guidelines. Third, implants show high medium- to long-term survival, with peri-implant disease as the main biological burden. Fourth, digital workflows (intraoral scanning, cone beam computed tomography, CAD/CAM, guided surgery, 3D printing) are mainstream, although clinical evidence for printed definitive restorations remains limited. Fifth, AI-assisted caries detection shows promising accuracy but marked heterogeneity and a need for external validation. Sixth, teledentistry offers caries diagnosis comparable to clinical examination in many settings, with weaker performance for early lesions and posterior teeth. A global perspective runs through the review: resource-adapted care, regional disease patterns, differences in law and regulation, language and culture, cross-border care and international governance of technology. The review also provides discipline-by-discipline guidance on the recognition and management of complications, with advice on when to treat and when to refer, and covers licensing, international standards, professional ethics, informed consent, and the ethical and lawful management of fees, billing and the practice as a business, continuing professional development and postgraduate education, vital pulp therapy, combined endodontic procedures, coronectomy and step-by-step core clinical procedures, dental materials and the complications of root canal treatment. Quick-reference tables, a five-phase care framework and applied clinical vignettes are included. Further sections address oral surgery in medically complex patients, anaesthesia and sedation, medical emergencies, paediatric care and dental trauma, removable prostheses, tooth wear, temporomandibular disorders prevention in practice, mucosal disease, safeguarding, oral hygiene, prescribing, dental anxiety, sleep-disordered breathing, radiography, antimicrobial stewardship, older and pregnant patients, access to care, consent and medico-legal practice, and practitioner wellbeing. The modern general dentist is best served by a biologically driven, guideline-informed and technology-literate approach, with clear recognition of the limits of personal scope and of the evidence. Priorities for the future include robust validation of AI tools, long-term trials of digital materials and equitable access.
Keywords: general dentistry; minimally invasive dentistry; digital dentistry; artificial intelligence; global oral health; teledentistry

1. Introduction

Oral diseases remain among the most widespread health conditions worldwide. The World Health Organization estimates that almost 3.5 billion people are affected by oral diseases, most of them in low- and middle-income settings [1]. Untreated caries in permanent teeth is the most common condition in the Global Burden of Disease analyses [2], and the burden of oral disease is closely tied to wider public health challenges such as sugar consumption, tobacco use and unequal access to care [3]. The general dentist is the first and often the only point of contact for this burden.

The problem is global but unevenly distributed. Untreated caries and severe periodontitis affect populations in every region [4,5], while access to services, the workforce and the regulatory environment vary widely between and within countries [6]. The World Health Assembly adopted a resolution on oral health in 2021 [7] and endorsed a global strategy and action plan for 2023–2030 [8], which makes the question of what a general dentist can and should deliver an international one.

Over the past decade the scope and expectations of general practice have shifted in several directions at once. Disease management has moved from a restorative, surgical model toward a biological, risk-based and minimally invasive model. Rigorous guideline development, including S3-level guidelines in periodontology and endodontics, has replaced much expert opinion with graded evidence [9,10]. Digital technologies, from intraoral scanning and cone beam computed tomography (CBCT) to computer-aided design and manufacturing (CAD/CAM) and three-dimensional (3D) printing, have entered everyday practice. Artificial intelligence (AI) and teledentistry are beginning to change diagnosis and access to care.

These developments create a practical problem. The relevant evidence is published in specialty journals, guideline documents and technology reviews that are rarely read together, and the general dentist must decide what is established, what is promising and what remains unproven. A single, clinically oriented synthesis that runs from basic preventive care to advanced procedures, and that looks ahead, is not readily available.

Objective. This review aims to summarise current evidence and guidance on contemporary clinical practice for the general dentist across the full clinical spectrum and in diverse health-system and resource settings worldwide, from foundational procedures to advanced care, to identify where the evidence is strong or limited, and to outline likely future directions.

2. Materials and Methods

Study design. This is a narrative review. It was not registered, and it is not a systematic review or meta-analysis. Its structure was guided by the criteria of the Scale for the Assessment of Narrative Review Articles (SANRA) [11]: a justified aim, a described literature search, appropriate referencing, scientific reasoning and appropriate presentation of data.

Information sources and search. Searches were run in October 2026 through PubMed and PubMed Central, publisher websites and the repositories of professional societies and international bodies (for example the European Federation of Periodontology, the European Society of Endodontology, the American Dental Association, the International Association of Paediatric Dentistry and the World Health Organization). Search terms combined clinical domains (caries, minimally invasive dentistry, endodontics, periodontitis, dental implants, restorative materials, orthodontic aligners, oral cancer, infection control, oral surgery, anaesthesia and sedation, medical emergencies, paediatric dentistry, dental trauma) with technology terms (digital dentistry, intraoral scanning, CBCT, CAD/CAM, 3D printing, artificial intelligence, teledentistry).

Selection. Priority was given to, in order: clinical practice guidelines and consensus reports; systematic reviews and meta-analyses; and key primary studies where higher-level evidence was missing. Recent sources (roughly the last ten years) were preferred, with

earlier landmark guidelines retained where they remain current. Publications were included when they addressed procedures or decisions within the realistic scope of general dental practice, or the interface with specialist referral. To support an international readership, global and regional sources (World Health Organization documents, Global Burden of Disease analyses, and legislation and case law from several jurisdictions) were included. Regulatory examples are illustrative, not exhaustive, and local law prevails. Synthesis. Findings were synthesised narratively by clinical domain. Formal risk-of-bias assessment of individual studies was not performed; where a source reported its own limitations (for example heterogeneity or risk of bias), these are stated. Quantitative figures are quoted from the source publications and are not re-analysed.
Ethics. This review used published literature only and involved no patients, patient data or animals. Ethical approval and informed consent were therefore not required.

3. Results and Discussion

The evidence is presented by clinical domain, moving from foundational care (assessment, prevention, restorative dentistry) through advanced procedures (endodontics, periodontics, implants, digital prosthodontics, orthodontics) to emerging technologies and future directions. The later subsections extend the review to global context, resource-adapted care, regional disease patterns, dental anxiety, sleep-disordered breathing, radiography, antimicrobial stewardship, prescribing, special patient groups, safeguarding, law and data across jurisdictions, language and culture, cross-border care, practitioner wellbeing, quality improvement, appraisal of evidence, the integration of these elements into daily care, applied clinical vignettes, and, in the sections on complications, referral, licensing, standards, ethics and consent, a systematic treatment of what can go wrong and how to respond, and a section on the practice as a business that covers fees, billing, fraud prevention and legal compliance, and a section on lifelong learning that covers continuing professional development, postgraduate education and personal development planning. It also gives dedicated treatment to vital pulp therapy, combined endodontic-periodontal lesions, combination and multidisciplinary endodontic approaches, and coronectomy, together with a section of step-by-step clinical procedures (scaling and polishing, root surface debridement, surgical extraction, dentures, crowns and bridges, and other common procedures), an integrated dental materials guide covering every procedure, and an expanded treatment of the complications of root canal treatment and their management. Original schematic figures illustrate key anatomy, procedures and decision pathways. Quick-reference tables cover pulpal and apical diagnosis (Table 1), periodontal staging (Table 5), resource adaptation (Table 7), international regulatory differences (Table 8), practice readiness (Table 9), acute presentations (Table 10), medical risks (Table 11), common pitfalls (Table 12), complications by discipline (Tables 9 to 19), referral (Table 39), licensing (Table 40), international standards (Table 41) consent (Table 42), fees and billing (Table 43), billing problems (Table 44), compliance (Table 45) practice indicators (Table 46), learning activities (Table 47), postgraduate pathways (Table 48) career-stage learning priorities (Table 49), vital pulp therapy (Table 2), endodontic-periodontal lesions (Table 3), combined endodontic approaches (Table 4) coronectomy (Table 6), the procedural sequences for scaling (Table 19), root surface debridement (Table 20), surgical extraction (Table 21), dentures (Table 22), crowns (Table 23), bridges (Table 24) and other procedures (Table 25), materials (Tables 13 to 18), root canal treatment complications (Table 29) and options for persistent disease (Table 30), and Table 50 near the end of this section summarises the main positions.

3.1 Global context: burden, inequality and policy

Oral conditions are among the most widespread health problems in every region. Global Burden of Disease analyses show that untreated caries in permanent teeth and severe periodontitis affect large populations across all regions [4,5], with caries and periodontal disease patterns shaped by sugar availability, tobacco use, access to fluoride and the organisation of health services [12]. A recurring theme in international commentary is that oral health has been neglected within global health, that most disease is preventable, and that actions on diet, tobacco and alcohol are as important as clinical services [6]. Policy is catching up with these arguments. The World Health Assembly adopted a resolution on oral health in 2021 [7] and a global strategy and action plan for 2023–2030, which locate oral health within universal health coverage and the wider noncommunicable disease agenda, emphasise prevention and integration with primary care, and support the phase-down of dental amalgam in line with the Minamata Convention [8,13]. The FDI World Dental Federation's Vision 2030 sets out the profession's role in delivering optimal oral health for all [14].
For the general dentist, this global context has practical consequences. The standard of care described in this review (risk-based, preventive, minimally invasive and ethically sound) is universal, but its delivery must be adapted to the equipment, workforce, regulation, culture and patient needs of each setting. The sections that follow therefore pair each domain's evidence with notes on adaptation, and later sections address resource settings, regional disease patterns, regulatory differences, language and culture, and cross-border care.

3.2 Assessment, diagnosis and risk-based care

Contemporary care begins with a structured assessment: medical and medication history, extraoral and intraoral examination with mucosal screening, periodontal charting, occlusal and tooth-wear assessment, and caries risk assessment. Consensus terminology now frames caries as a dynamic disease managed at both patient and lesion level, so that lesion detection, lesion activity and patient risk together determine the plan, rather than the mere presence of a cavity [15].
Imaging should be justified case by case. CBCT delivers a higher radiation dose than conventional intraoral radiography, and the European evidence-based guidelines advise that it be used only when conventional imaging cannot answer the clinical question and that clinicians be trained in justification, acquisition and interpretation [16]. For the general dentist, intraoral radiographs remain the workhorse for caries and periapical assessment, with CBCT reserved for defined indications such as implant planning, complex endodontic problems and surgical assessment.
Caries assessment is most reproducible when it uses a validated, structured system. The International Caries Detection and Assessment System (ICDAS) scores lesions on a seven-point scale from sound surfaces to extensive cavitation, which allows early

non-cavitated lesions to be separated from cavitated ones [17]. The International Caries Classification and Management System (ICCMS) builds on ICDAS and adds patient-level risk assessment and a four-step cycle of determining risk, deciding on a plan, doing the care and detecting (monitoring) the result [18]. Using one system consistently in the records makes progression, arrest and treatment outcomes traceable over time, and it supports a risk-based recall interval rather than a fixed six-month routine.

3.3 Prevention and non-invasive caries management

Prevention is the foundation of modern practice. Fluoride toothpaste prevents caries in children and adolescents with a dose-dependent effect [19], and resin sealants reduce occlusal caries in the permanent molars of children and adolescents compared with no sealant [20]. For lesions that have already cavitated, non-restorative arrest is now a guideline-supported option: the American Dental Association guideline recommends 38% silver diamine fluoride (SDF) to arrest cavitated lesions on the coronal surfaces of primary and permanent teeth, applied twice a year [21]. A network meta-analysis of non-restorative treatments supports the effectiveness of agents such as SDF [22].

Minimally invasive options now include fluoride varnish, SDF, resin sealants, resin infiltration, chemomechanical caries removal and atraumatic restorative treatment, each with defined indications and limitations [23]. Black discolouration of arrested lesions is a recognised trade-off of SDF and must be discussed with patients and carers before use [23]. In primary molars, preformed metal crowns placed with the Hall technique show lower failure than conventional fillings in the Cochrane evidence base [24]. In practical terms, caries arrest, remineralisation and monitoring are legitimate treatment outcomes, not failures to treat.

Diet counsellingis a clinical intervention in its own right. The World Health Organization recommends that free sugars supply less than 10% of total energy intake, with a further reduction below 5% suggested for additional benefit [25]. In practice, the dental team can turn this into specific advice on the frequency of sugar exposure, sugar-containing drinks (including at night in children), and substitutions the patient can realistically adopt.

Clinical trial evidence supports professionally applied silver diamine fluoride for arresting caries in children [26], and general-practice trials of the Hall technique found it acceptable to children, parents and dentists, with favourable outcomes at 23 months [27]. Both are valuable tools for children who cannot cooperate with conventional restorations, provided that the parent or carer is told about staining and about the review schedule.

3.4 Restorative dentistry

In deep lesions, consensus recommendations favour selective carious tissue removal to soft dentine over non-selective removal to hard dentine, to protect pulp vitality [28]. Direct composite resin is the standard direct material, and meta-analytic evidence shows that direct class II composite restorations can achieve clinically acceptable longevity, with failure influenced by patient caries risk, operator and technique [29]. International policy is also reshaping material choice: the Minamata Convention on Mercury commits its parties to phase down the use of dental amalgam [13], which makes high-quality adhesive posterior dentistry an essential general-practice skill.

For indirect restorations, early veneered zirconia crowns suffered technical complications, principally chipping of the veneering ceramic [30], which has encouraged the shift to monolithic designs. Lithium disilicate single crowns show high survival in the medium term [31]. Both materials are suitable for single-unit restorations when preparation design, bonding or cementation protocol and occlusal scheme are matched to the material.

Adhesive technique determines the success of direct restorations. A systematic review of clinical trials of contemporary adhesives found that multi-step etch-and-rinse and two-step self-etch systems generally performed more reliably than one-step self-etch products, particularly in non-carious cervical lesions [32]. Bulk-fill and conventional composites show similar clinical performance in posterior teeth in meta-analysis, so bulk-fill materials can shorten chair time without an obvious loss of longevity [33]. Isolation matters: a Cochrane review of rubber dam isolation for restorative treatment found only low-certainty evidence and could not show a clear difference in restoration survival compared with cotton roll isolation [34], but the dam remains important for moisture control, operator and patient safety, and it is strongly recommended in endodontics [35]. A practical sequence is: shade selection before isolation, isolation, a conservative preparation, matrix and wedge adaptation, adhesive protocol strictly as specified by the manufacturer, incremental or bulk placement as the material allows, light-curing with a checked and adequately powered light, and finishing with occlusal checks.

3.5 Endodontics

Endodontic care has been reframed around tooth preservation. The first S3-level guideline of the European Society of Endodontology (ESE) set out 34 key clinical recommendations, ten expert-based and 24 evidence-based, for pulpitis and apical periodontitis [10,35]. For restorable teeth with pulpitis, either vital pulp treatment or root canal treatment with an appropriate restoration is preferred to extraction [35]. Vital pulp therapy rests on selective caries removal, or pulp capping and pulpotomy with hydraulic calcium silicate cement under aseptic conditions [36]. For pulpitis with spontaneous pain, the guideline suggests that either root canal treatment or full pulpotomy can be effective, although the certainty of evidence for many vital pulp comparisons is low or very low [35]. See Figure 1.

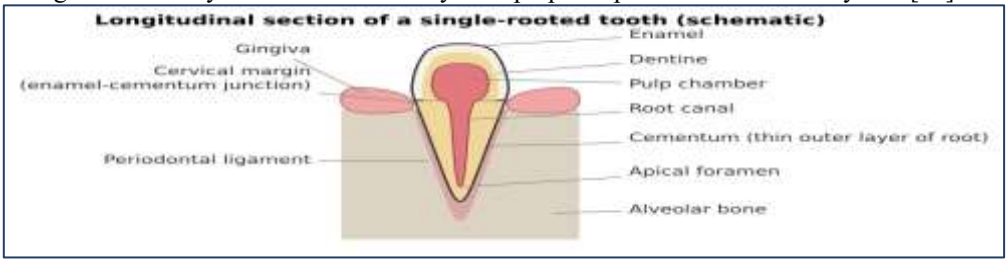

Figure 1. Longitudinal section of a single-rooted tooth showing the structures referred to in the endodontic, periodontal and restorative sections. Original schematic illustration, not to scale.

The guideline places the fundamentals first: a meticulous aseptic technique with dental dam, good light and magnification [35]. For non-surgical treatment of apical periodontitis it suggests contemporary engine-driven nickel-titanium instrumentation, notes that sodium hypochlorite (1–5.25%) followed by EDTA may be considered, strongly recommends a single-visit approach without inter-appointment calcium hydroxide when adequate procedures have been performed, and suggests against adjuncts such as photoactivated disinfection, laser, ozone or passive ultrasonic activation in addition to conventional syringe irrigation [35]. Periapical radiography is recommended for routine diagnosis of apical periodontitis, with CBCT considered when the diagnosis remains in doubt [35]. For emergency management of symptomatic pulpitis or apical periodontitis in a restorable tooth, local treatment is appropriate and systemic antibiotics are not [35,37].

Apical periodontitis is highly prevalent worldwide [38], so competent basic endodontics is a core general-practice skill. For immature teeth with pulp necrosis, an apical plug or revitalisation may be considered, whereas revitalisation is not suggested in mature teeth [35,39]. Complex retreatment and surgical management of apical periodontitis are areas where further postgraduate training is beneficial and specialist referral is appropriate [35].

Diagnosis deserves equal attention. The guideline suggests cold testing, possibly supplemented by electric pulp testing, to assess pulp vitality, and suggests combining pain history with clinical findings (pulp exposure, tenderness to percussion and pain on heat) to assess pulpal condition. Whether inflammatory biomarkers can predict pulp status is not yet known [35]. The guideline also carries an important caveat for interpretation: most eligible studies were carried out in dental schools and universities, so they measured efficacy rather than the effectiveness expected in everyday practice, and tooth survival was ranked as the most critical outcome [35].

Several details of technique influence outcomes beyond the guideline summary. Irrigation is central to disinfection: sodium hypochlorite remains the principal irrigant for tissue dissolution and antimicrobial action, and chelators such as EDTA remove the smear layer, with the choice of concentration, volume, contact time and delivery all affecting the result [40]. In a prospective cohort, periapical healing after non-surgical root canal treatment depended on factors including the preoperative periapical status, the length and quality of the root filling and the avoidance of procedural complications [41]. The coronal seal is also decisive: a systematic review and meta-analysis found that the quality of the coronal restoration was associated with the outcome of root canal treatment to a degree comparable with the quality of the root filling [42]. A definitive coronal restoration should therefore be placed promptly and planned before endodontic treatment begins.

Accurate diagnosis depends on consistent terminology, and the findings must be read together, because individual sensibility tests and radiographs each have limitations [35]. Table 1 summarises widely used pulpal and apical diagnostic categories [43] with the usual direction of management in the light of the guideline [10,35].

Table 1. Pulpal and apical diagnostic categories and the usual direction of management.

Diagnosis	Typical history and findings	Usual direction of management
Normal pulp	No symptoms; normal response to cold; no tenderness	No endodontic treatment
Reversible pulpitis	Short, sharp pain to cold or sweet that settles quickly	Remove the cause; selective caries removal and a well-sealed restoration [28]
Symptomatic irreversible pulpitis	Lingering or spontaneous pain; may be poorly localised	Vital pulp treatment or root canal treatment; extraction only if unrestorable [10,35]
Asymptomatic irreversible pulpitis	Deep caries or trauma with exposure and no symptoms	As above, according to restorability and exposure [10,35]
Pulp necrosis	No response to cold; may be asymptomatic	Root canal treatment, or revitalisation in selected immature teeth [35,39]
Symptomatic apical periodontitis	Pain on biting or percussion; widened ligament space	Root canal treatment or retreatment; extraction if unrestorable [35]
Asymptomatic apical periodontitis	Periapical radiolucency without symptoms	Root canal treatment or retreatment [35]
Acute apical abscess	Rapid onset swelling and pain; possible systemic signs	Drainage and source control; antibiotics only with spreading infection or systemic involvement [37]
Chronic apical abscess	Sinus tract with intermittent drainage	Root canal treatment; trace the sinus to its source [35]

3.6 Vital pulp therapy: preserving the pulp in carious and traumatised teeth

Vital pulp therapy (VPT) is a group of procedures that aim to keep all or part of the pulp alive and functioning after exposure by caries, trauma or restorative preparation. It is the endodontic expression of the minimally invasive philosophy that runs through this review: the pulp is the tooth's defence and repair system, and preserving it retains proprioception, immune function and, in immature teeth, continued root development. Current guidelines treat selective caries removal, indirect pulp treatment, pulp capping, partial pulpotomy and full pulpotomy as a graded sequence, chosen by the depth and extent of caries, the pulpal diagnosis and the ability to control bleeding, with root canal treatment reserved for when vitality cannot be preserved [10,36,44]. See Figure 2.

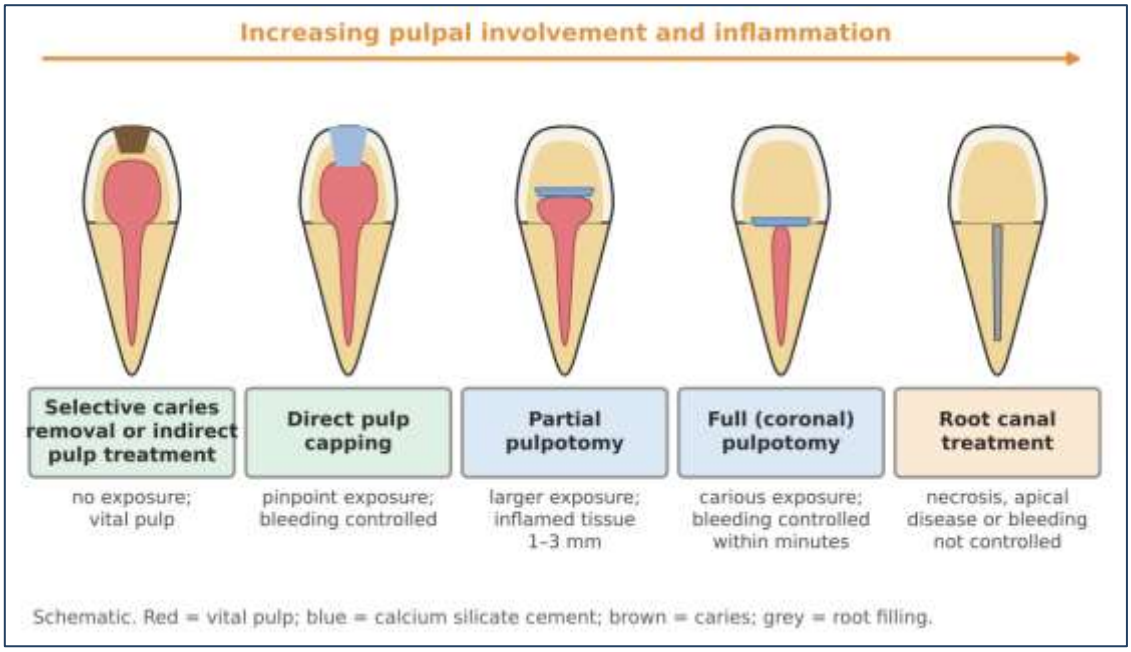

Figure 2. Vital pulp therapy as a graded sequence, from selective caries removal to root canal treatment, according to pulpal involvement. Original schematic illustration.

The biological case has strengthened. The older assumption that symptoms of irreversible pulpitis always mean a pulp that cannot recover has been questioned, because the correlation between clinical symptoms and histological status is imperfect [45]. Hydraulic calcium silicate cements stimulate dentine bridge formation, seal well and are biocompatible, and have largely replaced calcium hydroxide as the capping material of choice [36,46]. Systematic reviews report high short- to medium-term success for direct pulp capping and for pulpotomy in permanent teeth with carious exposures, including some teeth with symptoms of irreversible pulpitis, although the certainty of the evidence is generally low to moderate and long-term data are limited [47–49]. Randomised and cohort studies of full pulpotomy in mature molars with irreversible pulpitis report outcomes comparable to those of root canal treatment over one to five years [50,51], and the ESE guideline suggests that either full pulpotomy or root canal treatment may be offered for selected cases [10]. Clinicians should view this as an evolving area in which patient selection and technique determine success [52].

Table 2. Vital pulp therapy options: indications, key steps and cautions.

Procedure	Typical indication	Key steps	Cautions and pitfalls
Selective caries removal and indirect pulp treatment	Deep caries without pulp exposure, vital pulp, no spontaneous pain or signs of apical disease	Remove soft peripheral carious tissue to sound dentine, leave firm or leathery dentine over the pulp, seal with a durable restoration	Diagnose carefully; inadequate seal or missed symptoms of irreversible pulpitis [28]
Direct pulp capping	Small, pinpoint exposure (often traumatic or mechanical) in a vital pulp, bleeding controllable	Rubber dam, disinfect the cavity, control bleeding with sodium hypochlorite, apply calcium silicate cement, seal immediately	Contaminated exposure, uncontrolled bleeding and poor coronal seal increase failure [47,53]
Partial (Cvek) pulpotomy	Larger exposure, particularly in immature teeth and trauma, pulp vital with controllable bleeding	Remove inflamed superficial pulp (1 to 3 mm) with a sterile bur, control bleeding, place cement, restore	Preserves coronal pulp; technique-sensitive; follow-up needed
Full (coronal) pulpotomy	Carious exposure in permanent teeth, including selected cases with symptoms of irreversible pulpitis, bleeding controlled within a few minutes	Remove the whole coronal pulp to canal orifices, control bleeding, place calcium silicate cement, restore with a permanent restoration at once or after a short interval	Failure to control bleeding indicates more extensive inflammation, so convert to root canal treatment; avoid in teeth with necrosis or apical periodontitis [49,50]
Root canal treatment	Necrotic pulp, apical periodontitis, uncontrollable bleeding, or restorative need	See Table 1 and the endodontics section	Standard care when vitality cannot be preserved [10]
Regenerative endodontic procedures	Immature teeth with necrotic pulp	Disinfection, evoked bleeding, scaffold, coronal seal	Specialist or experienced-clinician procedure [39]

A reliable VPT protocol rests on a few non-negotiable elements. Rubber dam isolation and a disinfected field are essential [34]. Magnification is strongly advisable. The decision to proceed depends on a pre-operative diagnosis (see Table 1), radiographic assessment of the periapical region, and, most importantly, the intra-operative assessment of bleeding: haemostasis within a few minutes using sodium hypochlorite on a sterile pellet indicates a pulp that may be preserved at that level [36]. The capping material must be placed against healthy pulp tissue and covered by a well-sealed definitive restoration, since coronal leakage is a main cause

of failure. Success is judged clinically (no pain, swelling or sinus tract; normal response to cold) and radiographically (no apical radiolucency, continued root development in immature teeth) at six and twelve months and annually, and the patient must understand that further treatment may be needed. Cuspal coverage may be considered for heavily broken-down teeth [54].

Practice or refer? A general dentist with training, magnification and rubber dam can provide indirect pulp treatment, direct pulp capping and pulpotomy for suitable cases, and should convert to root canal treatment or refer if bleeding cannot be controlled, if there are signs of apical disease, or if the tooth is restorable only with difficulty. Immature teeth with trauma or necrosis (apexification and regeneration), complex cases and teeth with failed VPT are often best referred to an endodontist or paediatric specialist (Tables 24 and 1).

3.7 Combined endodontic-periodontal lesions

The pulp and the periodontium communicate through the apical foramen, accessory and lateral canals, dentinal tubules, and, when damaged, through perforations and fractures. Disease in one compartment can therefore involve the other, a relationship described over fifty years ago and still central to diagnosis [55,56]. Correct diagnosis matters because the treatment, the sequence and the prognosis differ, and mistakes lead to unnecessary extractions, repeated treatment and patient frustration. See Figure 3.

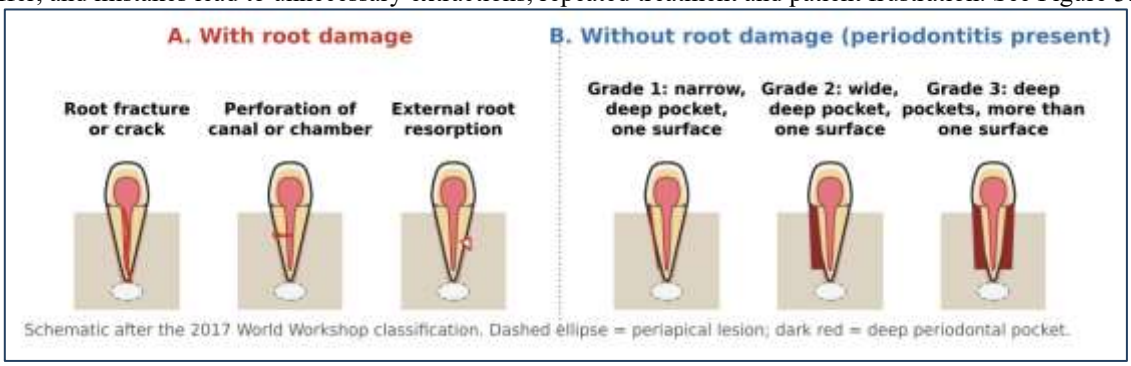

Figure 3. Endodontic-periodontal lesions with and without root damage, following the 2017 World Workshop classification. Original schematic illustration.

The 2017 World Workshop classification groups these as endodontic-periodontal lesions, distinguished by whether there is root damage [57]. Lesions with root damage arise from root fracture or cracking, perforation of the root canal or pulp chamber, or external root resorption. Lesions without root damage occur in the context of periodontitis and are graded according to the pattern of pocketing: grade 1 is a narrow, deep pocket on one tooth surface, grade 2 a wide, deep pocket on one surface, and grade 3 deep pockets on more than one surface [57]. Traditional descriptions (primary endodontic, primary endodontic with secondary periodontal involvement, primary periodontal, primary periodontal with secondary endodontic involvement, and true combined) remain useful for thinking about causality [55,56].

Diagnosis combines pulp sensibility testing, percussion, palpation, mobility, full-mouth periodontal charting with probing at six sites, a sinus tract traced with a gutta-percha cone, periapical and bitewing radiographs, and, where justified, limited-field cone beam computed tomography to visualise root fractures, resorption and perforations [16,58]. A narrow, isolated, deep probing defect on one surface suggests a root fracture or an endodontic sinus draining through the sulcus, whereas generalised bone loss and pocketing in several teeth suggests periodontitis. Vertical root fracture is a common cause of unexplained, isolated defects in root-filled teeth, and often carries a hopeless prognosis [59,60].

Table 3. Combined endodontic-periodontal lesions: diagnosis, sequence of care and prognosis.

Scenario	Clues	Management sequence	Prognosis and referral
Primary endodontic lesion draining through the sulcus	Non-vital pulp; narrow sinus-like defect; periapical or furcation radiolucency; periodontal support elsewhere good	Root canal treatment first; reassess periodontal defect after healing (often about 2 to 3 months) before any periodontal surgery	Usually good if the pulp is the only cause; refer complex anatomy or retreatment [10,56]
Primary periodontal lesion	Vital pulp; generalised bone loss and pocketing; plaque and calculus	Periodontal treatment steps (Table 5 and the periodontology section); monitor pulp	Depends on stage, grade and patient compliance [9]
Combined (true) lesion	Non-vital pulp plus periodontitis with defect communicating with the periapical area	Endodontic treatment first, then periodontal therapy, then reassessment; consider regeneration or resection where suitable	Guarded; specialist input often needed [56,61]
Vertical root fracture or crack	Isolated deep narrow pocket, J-shaped radiolucency, prior root filling or post, sometimes a double sinus tract	Confirm with exploration, CBCT or flap; in most cases extraction (or root resection or hemisection in multi-rooted teeth) and replacement planning	Hopeless for single-rooted teeth with confirmed fracture [59,62]
Perforation or resorption communicating with the periodontium	Sudden bleeding, pain or bone loss, or a defect after post or endodontic treatment	Seal early with calcium silicate cement under dam; manage periodontal defect; refer if large or late	Early repair and small size give better outcomes [60]

The sequence of care is straightforward: stabilise pain and infection; establish the diagnosis and prognosis for the tooth; treat the endodontic component first, because infection from the root canal system will otherwise defeat periodontal therapy; reassess after a healing period; and then carry out periodontal therapy, with regenerative or resective procedures where indicated [56,61]. The evidence for the treatment of true combined lesions comes mostly from case series and small trials, and a systematic review found that outcomes are better when the endodontic cause is controlled and that regenerative approaches may add benefit in selected defects [61]. In multirooted teeth with severe furcation or single-root involvement, root resection, hemisection or extraction with implant or other replacement may be considered, noting the long-term outcomes of root-resected molars and of implants [62,63]. Prognosis must be discussed honestly, and keeping a hopeless tooth is not in the patient's interest.

3.8 Combination and multidisciplinary endodontic approaches

Many endodontic problems are not solved by a single technique, and the best outcomes come from combining modalities in a planned sequence. The aim is to select the least invasive combination that gives the tooth a good chance of long-term function, and to compare it honestly with extraction and replacement [63].

Table 4. Combined approaches in endodontics and when to consider them.

Combination	When to consider	Notes
Non-surgical retreatment followed by endodontic microsurgery	Persistent or recurrent apical periodontitis; retreatment not possible or unsuccessful	Both approaches have good outcomes in selected cases; surgery with magnification and modern root-end filling materials has improved success [64,65]
Endodontics with periodontal therapy, including regeneration or root resection	Combined lesions; furcation involvement	Endodontic cause first; reassess; refer for regeneration or resection [61,62]
Vital pulp therapy then definitive restoration, followed by long-term monitoring	Deep caries or exposure in vital teeth	Immediate definitive seal; recall for pulp status and apical health [36]
Endodontic treatment with cuspal coverage, post or core build-up	Heavily restored or weakened teeth; molars and premolars	Coronal restoration quality is as important as root filling [41,54]
Revitalisation or regeneration plus long-term follow-up in immature necrotic teeth	Young permanent teeth with necrotic pulp and open apex	Consider specialist; compare with apexification [39]
Endodontics with limited-field CBCT, magnification and ultrasonics	Complex anatomy, missed canals, perforation, resorption, retreatment	Use CBCT only when it changes management [58]
Intentional replantation	Selected cases when conventional surgery is not feasible (for example, difficult access) and the tooth would otherwise be lost	Specialist technique; careful selection [66]
Endodontics with planned orthodontic or prosthodontic care	Teeth that are to be moved, crowned or used as abutments	Establish periapical health before prosthetic or orthodontic loading; communicate across the team
Extraction with replacement	Non-restorable tooth, hopeless prognosis, patient preference	Present as an equally valid, sometimes better, option [63]

Combination strategies demand clear communication with the patient: what is the plan, what are the steps and costs of each phase, what outcomes can be expected, and what happens if a step fails. The decision framework in Table 39 helps identify when to refer. Coordinated care between general dentist and specialists, with shared records and imaging, reduces delay and duplicated treatment. A written treatment plan, with consent for each phase and an agreed recall schedule, protects the patient and the dentist.

3.9 Periodontology

Periodontal diagnosis now follows the 2017 World Workshop classification, which defines periodontal health for intact and reduced periodontia and stages periodontitis from I to IV by severity and complexity and grades it from A to C by risk of progression [67,68]. Staging and grading give the clinician a structure for treatment planning and for monitoring response to therapy [67,68]. See Figure 4.

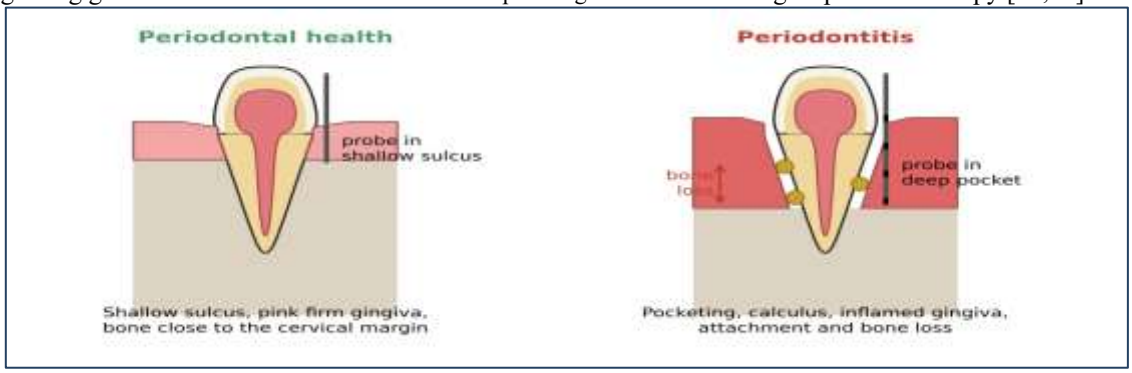

Figure 4. Periodontal health compared with periodontitis, showing probing depth, gingival inflammation, calculus and bone loss. Original schematic illustration, not to scale.

Treatment of stage I–III periodontitis follows the stepwise approach of the European Federation of Periodontology (EFP) S3 guideline [9]. Step 1 addresses behaviour change, supragingival biofilm and risk factor control. Step 2 is subgingival instrumentation. Step 3 provides additional treatment for sites that do not respond. Step 4 is supportive periodontal care [9]. The approach is described as personalised and minimally invasive [69]. Consensus reports describe associations between periodontitis and both diabetes [70] and cardiovascular disease [71], which supports collaboration with physicians and makes periodontal assessment part of the dentist's wider health role.

The case definitions behind these stages are practical. In the 2017 classification, periodontal health and gingivitis on an intact or reduced periodontium are defined by the proportion of sites that bleed on probing and by probing depths, with bleeding at fewer than 10% of sites and no loss of attachment compatible with periodontal health [72]. Staging reflects severity and complexity (clinical attachment loss, radiographic bone loss, tooth loss and extent), while grading estimates the rate of progression using direct or indirect evidence of progression, together with risk factors such as smoking and diabetes [73]. Recording full-mouth probing depths, bleeding, recession, mobility and furcation involvement at baseline, and again after active therapy, is what turns these definitions into a usable monitoring system. Smoking cessation and glycaemic control are part of periodontal treatment, not optional extras [9,70].

The 2017 staging and grading system can be summarised in a few practical criteria (Table 5). Stage describes severity and complexity, and grade describes the rate of progression and the risk profile [73].

Table 5. Summary criteria for staging periodontitis [73].

Stage	Interdental clinical attachment loss	Radiographic bone loss	Tooth loss due to periodontitis	Complexity
I	1–2 mm	Coronal third (<15%)	None	Maximum probing depth ≤4 mm; mostly horizontal bone loss
II	3–4 mm	Coronal third (15–33%)	None	Maximum probing depth ≤5 mm; mostly horizontal bone loss
III	≥5 mm	Extending to the middle third or beyond	≤4 teeth	Probing depth ≥6 mm; vertical bone loss ≥3 mm; furcation class II–III; moderate ridge defects
IV	≥5 mm	Extending to the middle third or beyond	≥5 teeth	Stage III features plus the need for complex rehabilitation, for example masticatory dysfunction, secondary occlusal trauma, bite collapse or fewer than 20 remaining teeth

Grade A indicates slow progression (no evidence of loss over five years, a ratio of percentage bone loss to age below 0.25, heavy biofilm with low destruction, a non-smoker who is normoglycaemic). Grade B indicates moderate progression (less than 2 mm of loss over five years, a ratio of 0.25 to 1.0, a smoker of fewer than 10 cigarettes per day, or diabetes with HbA1c below 7.0%). Grade C indicates rapid progression (2 mm or more over five years, a ratio above 1.0, destruction that exceeds what the biofilm would predict, a smoker of 10 or more cigarettes per day, or diabetes with HbA1c of 7.0% or more) [73]. A grade can be modified upward when risk factors are present, so smoking status and glycaemic control belong in the periodontal record.

3.10 Implant dentistry

Implant therapy is well established. A systematic review of 23 longitudinal studies (7,711 implants, mean follow-up 13.4 years) reported cumulative mean survival of 94.6% and mean marginal bone loss of 1.3 mm [74]. A later systematic review of prospective studies of contemporary implants reported 10-year survival of 96.4% (95% CI 95.2–97.5%), but a sensitivity meta-analysis that accounted for loss to follow-up gave 93.2% and suggested lower survival in patients aged 65 years or older [75]. Survival figures should therefore be communicated to patients as estimates with a range, not as guarantees.

The main biological burden is peri-implant disease. The 2017 classification distinguishes peri-implant health, peri-implant mucositis, peri-implantitis and soft and hard tissue deficiencies [76]. A systematic review of epidemiology estimated that around 43% of subjects have peri-implant mucositis and around 22% have peri-implantitis [77]. Prevention depends on patient selection, prosthesis designs that permit cleaning and supportive maintenance, which the EFP S3 guideline on peri-implant diseases addresses [78].

Static computer-assisted implant surgery improves predictability, but it is not exact: a meta-analysis reported mean deviations of approximately 1.2 mm at the entry point, 1.4 mm at the apex and 3.5 degrees in angulation [79]. Safety margins around vital structures therefore remain necessary. Implant placement by the general dentist requires specific training, justified CBCT imaging [16] and a low threshold for referral in cases needing complex augmentation.

Planning and timing decisions matter as much as surgical skill. In the anterior maxilla, immediate and early implant placement can give high survival, but mid-facial soft tissue recession is a recognised aesthetic risk, so patient selection, tissue biotype, three-dimensional implant position and the method of provisionalisation are critical [80]. A five-year follow-up study found that peri-implant disease was more frequent in patients who did not attend regular preventive maintenance than in those who did [81], which supports building a maintenance recall into every implant treatment plan and into the consent discussion. A prosthetically driven plan, based on the final restoration, adequate bone and soft tissue volume, and a design that the patient can clean, should precede any decision to place a fixture.

Risk indicators for peri-implant disease identified in consensus include a history of severe periodontitis, poor plaque control and the absence of regular maintenance care after implant therapy, whereas the evidence for smoking and diabetes as risk indicators is less consistent, although both matter for healing and general health [76]. Before placing an implant, a sensible checklist includes the following. Is the patient's periodontal disease controlled? Is plaque control adequate and is the patient willing to attend maintenance? Is there adequate bone and soft tissue volume, and what additional procedures would be needed? Is the planned prosthesis cleansable and retrievable? Has the patient understood the complications, which include infection, nerve injury, sinus involvement, screw loosening, ceramic chipping and peri-implant disease? Screw-retained designs ease retrieval and avoid cement-related complications, which is an advantage in long-term maintenance, but design must still follow the clinical situation.

3.11 Digital workflows and prosthodontics

The intraoral scanner is the entry point to the digital workflow. Its accuracy is clinically acceptable for many indications, but it depends on the scanner, software, operator, scanning strategy and the oral structures being scanned [82]. A systematic review of the complete digital workflow in fixed prosthodontics found it feasible for tooth-supported single crowns and short-span prostheses, with short-term outcomes comparable to conventional workflows, although long-term data were limited [83]. Digital impressions also allow files to be shared with the laboratory and the surgeon, which supports team-based treatment planning.

Three-dimensional printing is advancing quickly, but the evidence does not yet match the enthusiasm. Vat polymerisation is the dominant technology, and the mechanical properties of printed resins have improved. The main unresolved problems for permanent restorations are colour stability, water sorption, solubility and anisotropy, and their biological behaviour and clinical performance remain largely unexplored [84]. Printing is therefore well supported for models, surgical guides, splints and provisional restorations, whereas printed definitive restorations should be treated as an area of active research until long-term clinical data are available [84].

In practice, a reliable digital workflow depends on a few habits: isolating and drying the field before scanning, capturing margins fully and checking the scan before the patient leaves, communicating clearly with the laboratory through annotated prescriptions or shared files, and keeping a documented backup of scan and design files in line with the data protection requirements discussed later [82,83]. Digital tools improve efficiency, but they do not remove the need to understand preparation design, occlusion and material selection, which remain the determinants of long-term success.

3.12 Orthodontic aligners and occlusion

Clear aligner therapy is now commonly requested in general practice. A systematic review of clinical effectiveness found evidence of limited quality, and tooth movement is less predictable for some movement types [85]. Careful case selection, a clear treatment plan, informed consent about limits and planned retention are essential, and complex malocclusions are better referred. For bruxism, international consensus describes repetitive masticatory muscle activity that is not necessarily pathological, so the clinical task is to identify consequences such as tooth wear, restoration failure or pain and to manage those, rather than to treat the behaviour in isolation [86].

Retention after orthodontic treatment is as important as the active phase. A Cochrane review of retention procedures found little high-quality evidence to favour one retention regimen over another, so the choice of fixed or removable retainers should be individualised and long-term retention discussed from the outset [87].

3.13 Oral medicine, medical safety and infection control

Systematic extraoral and intraoral mucosal examination belongs in every comprehensive examination. Reviews of oral potentially malignant disorders emphasise that clinicians must recognise these lesions and arrange biopsy or specialist assessment of suspicious areas [88]. Antibiotic prophylaxis against infective endocarditis is restricted to patients at highest risk of an adverse outcome, for procedures that manipulate gingival tissue or the periapical region or perforate the oral mucosa [89]. Standard precautions, instrument reprocessing and dental unit waterline management are set out in infection control guidelines for dental settings [90]. Together with the guideline position on antibiotics in endodontic emergencies [37], these principles support antibiotic stewardship in everyday practice.

Oral cancer is a significant cause of morbidity. Global estimates for 2020 indicate roughly 380,000 new cases of lip and oral cavity cancer and about 180,000 deaths worldwide [91]. A Cochrane diagnostic review of clinical assessment for detecting oral cavity cancer and potentially malignant disorders in apparently healthy adults could not recommend adjunctive tests such as toluidine blue or autofluorescence in place of specialist assessment and histopathology [92]. In practice, any ulcer, red or white patch or lump that does not resolve within two to three weeks after removal of local causes should be documented with measurements and photographs where possible, and referred for biopsy or specialist opinion, without waiting for adjunctive tests to supply reassurance.

3.14 Common oral mucosal conditions

Beyond screening for malignancy, general dentists regularly meet benign mucosal disease. Oral lichen planus is a chronic immune-mediated condition with reticular and erosive forms, usually diagnosed from the clinical picture and confirmed by biopsy when atypical; topical corticosteroids are commonly used for symptomatic disease, and follow-up is advised because a small proportion of lesions may undergo malignant change [93]. Oral candidiasis is common in people using inhaled corticosteroids, wearing dentures, with xerostomia, diabetes or immunosuppression, and treatment combines identification and correction of the predisposing factor with a topical antifungal for mild disease and systemic therapy such as fluconazole for moderate to severe disease, generally for 7 to 14 days [94]. Denture stomatitis is managed first by denture hygiene, leaving the denture out at night and treating any candidal overgrowth.

Recurrent aphthous stomatitis is common and usually self-limiting; topical corticosteroid preparations and antiseptic or anaesthetic rinses give symptomatic relief, and frequent or severe episodes should prompt screening for underlying haematinic deficiency or systemic disease [95]. Any lesion that does not heal as expected should be re-evaluated and, if in doubt, biopsied or referred [88,92].

3.15 Artificial intelligence in diagnosis

AI, particularly deep learning applied to radiographs, is the technology closest to routine clinical use. Reviews describe potential in image analysis but also real challenges in data quality, generalisability, transparency and bias [96]. In a bitewing test set, a deep learning model detected caries lesions with higher sensitivity than dentists [97]. A recent systematic review and meta-analysis of AI for caries detection on radiographs included 21 studies, 14 of them in the meta-analysis, and reported a pooled specificity of approximately 88% with very high heterogeneity (I^2 around 96%) [98].

The practical reading is that AI is best used as a second reader that flags lesions for the dentist to confirm. Responsibility for the diagnosis stays with the clinician. Before relying on a tool, the dentist should look for prospective external validation in populations like their own, understand its regulatory status, and meet data protection obligations for patient images.

AI tools are developed and trained mainly on data from high-income populations, so their performance in other populations, radiographic systems and disease patterns must be shown before use. Governance is evolving: the WHO has issued ethics and governance principles for AI in health, emphasising transparency, accountability, inclusiveness and protection of autonomy [99], the European Union has legislated for medical devices and artificial intelligence [100,101], and other regulators have their own pathways. Dentists outside these jurisdictions should still ask for evidence of regulatory approval and local validation.

3.16 Teledentistry

Teledentistry can extend access, particularly where patients are remote or underserved. A systematic review of 19 in-vivo studies found sensitivity of 48–98.3% and specificity of 83–100% for caries diagnosis from photographs, with 17 of the 19 studies reporting accuracy comparable to clinical examination [102]. Patient selection was a source of bias in most studies, performance was weaker for early lesions and posterior teeth, all studies used store-and-forward methods and this approach is not recommended for emergencies [102]. Earlier systematic reviews found effectiveness unclear and generalisation difficult [102,103]. Teledentistry is therefore a useful tool for triage, screening and follow-up, not a substitute for in-person examination when a definitive diagnosis or treatment is required.

Teledentistry and digital health are particularly relevant where distances are large and specialists are scarce. The WHO global strategy on digital health promotes the safe, equitable and ethical use of digital technologies, with attention to infrastructure, data governance and workforce skills [104]. In practice, store-and-forward teledentistry using smartphone photographs can support triage and referral in remote regions, subject to consent, secure transmission and compliance with local privacy law.

3.17 Oral surgery and medically complex patients

Extraction remains the most common surgical procedure in general practice, and decisions about it are increasingly individualised. For asymptomatic, disease-free impacted third molars, a Cochrane review found insufficient evidence either to support or to refute routine prophylactic removal, so the decision should rest on symptoms, pathology and risk rather than on routine [105].

The medical history changes surgical risk. In patients continuing anticoagulants, a meta-analysis of eight studies (539 patients on direct oral anticoagulants and 574 on vitamin K antagonists) found a lower post-extraction bleeding risk with direct oral anticoagulants (RR 0.68, 95% CI 0.49–0.95), although data on individual agents are scarce [106]. Local haemostatic measures and liaison with the prescribing physician are sensible, and any change to anticoagulant therapy is a decision for the physician. Patients taking antiresorptive medication need particular care. The 2022 position paper of the American Association of Oral and Maxillofacial Surgeons prioritises prevention of medication-related osteonecrosis of the jaw while allowing cancer and osteoporosis treatment to continue, now regards surgical management as a viable option at all disease stages, and could not reach consensus on drug holidays [107]. The general dentist should identify these patients at history-taking, avoid unnecessary extractions, document the risk discussion and refer established disease.

For acute postoperative dental pain, combining ibuprofen with paracetamol (acetaminophen) provides effective analgesia and is an opioid-sparing strategy [108].

Technique and planning determine the safety of extractions. General principles include a thorough assessment of the tooth and surrounding structures with appropriate radiographs, a flap design that preserves blood supply and allows closure over sound bone, controlled bone removal and sectioning of multirooted or difficult teeth to reduce force, copious irrigation, careful debridement of the socket and secure haemostasis. Written post-operative instructions on bleeding, swelling, analgesia, diet, oral hygiene and warning signs reduce avoidable calls and complications. Common complications include alveolar osteitis, post-operative infection, bleeding, nerve injury, oroantral communication and root displacement; prophylactic antibiotics lower the risk of infection and alveolar osteitis in healthy patients but offer only a small absolute benefit [109]. A realistic assessment of difficulty, with early referral of deeply impacted teeth, teeth close to the inferior alveolar canal or sinus, and patients with complex medical histories, is a mark of safe practice [105–107].

3.18 Coronectomy and the management of high-risk mandibular third molars

Removal of lower third molars carries a recognised risk of injury to the inferior alveolar nerve, with consequences ranging from transient numbness to permanent altered sensation or pain, and a smaller risk of lingual nerve injury [110]. When imaging shows that the roots are intimately related to the inferior alveolar canal, the choice is between complete removal, coronectomy (intentional partial odontectomy), or leaving the tooth under observation if asymptomatic and disease-free [105]. See Figure 5.

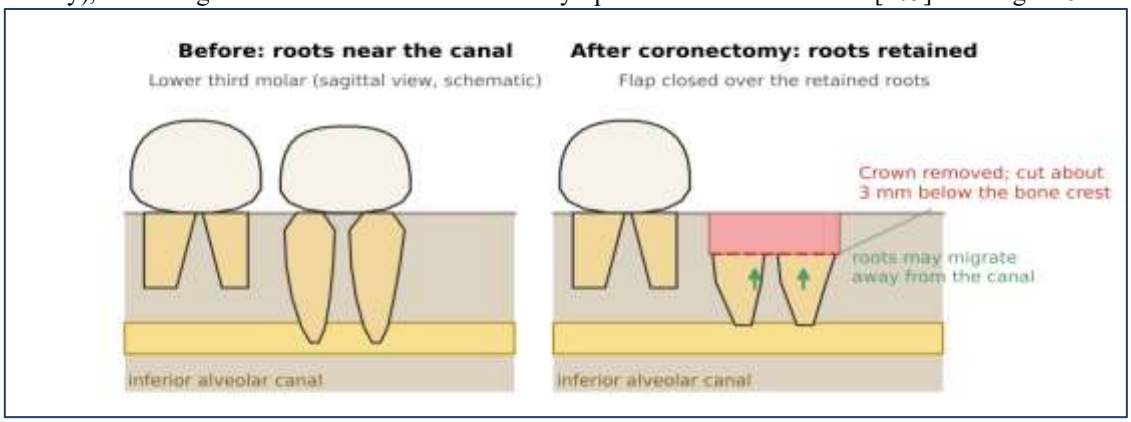

Figure 5. Coronectomy of a lower third molar whose roots lie close to the inferior alveolar canal: the crown is removed below the bone crest and the roots are left in place. Original schematic illustration, not to scale.

Coronectomy removes the crown of the tooth and leaves the roots in situ, to avoid mobilising them against the nerve. It was described as a technique to protect the inferior alveolar nerve, and the roots are expected to migrate away from the canal over time in many patients [111]. Randomised trials and systematic reviews show a lower incidence of inferior alveolar nerve injury after coronectomy than after total removal, with the trade-offs being the possibility of root migration, infection, pain, dry socket and the need for a second operation to remove retained roots in a minority of cases [112–115].

Selection is based on imaging. Panoramic radiographic signs such as darkening of the root, deflection of the root, narrowing of the root, loss of the white line of the canal, and a diversion or narrowing of the canal indicate a close relationship with the nerve and a higher risk [116]. When these signs are present, limited-field cone beam computed tomography can help to define the relationship and the position of the canal, but should only be used when it will alter management [16,117].

Table 6. Coronectomy: indications, contraindications, technique and follow-up.

Aspect	Guidance
Indications	Lower third molar with symptoms or disease and radiographic evidence of a high risk to the inferior alveolar nerve; patient has been told of the alternatives, including no treatment and complete removal [112,116]
Contraindications	Mobile tooth, active infection around the tooth or periapical infection, horizontal impaction with the roots lying across the canal in a way that makes safe sectioning impossible, a pulp already infected or necrotic, a tooth that would be split by the cutting, medical conditions that predispose to serious infection, and patient unable to attend follow-up
Technique	Raise a flap and protect the lingual tissue; remove the crown with a bur and copious irrigation, cutting to at least about 3 mm below the bone crest on the buccal and lingual sides; do not instrument or remove the roots or fill the canals; smooth the cut surface; close primarily [111,113]
Postoperative care	Analgesia and routine instructions; antibiotics only when indicated (see the stewardship section); review at one to two weeks
Follow-up	Clinical and radiographic review at 6 and 12 months and thereafter if symptomatic; document root migration or complications [114,115]
Complications	Pain, infection, dry socket, root mobilisation or exposure, root migration into the mouth, and need for re-operation; nerve injury is less likely than after total removal but not abolished [114,115]
Consent	Explain the nerve risk of each option; the possibility of retained roots, infection, delayed eruption of root pieces, further surgery and long follow-up; document the discussion (Table 42)

Who should perform coronectomy? Because the clinical decision involves imaging interpretation, nerve-risk assessment and surgical technique, coronectomy should be done by a dentist with relevant training and experience in third molar surgery, and referral to an oral and maxillofacial surgeon is appropriate when the relationship to the canal is intimate, the anatomy is complex, the patient has medical risk factors, or the dentist has not been trained in the procedure (Table 39). Patients who elect no treatment should be told the signs of disease and monitored; those who choose complete removal after a full discussion of the risk should have the nerve risk documented and, where appropriate, be referred. As always, the decision follows the patient's values after balanced information.

3.19 Local anaesthesia, sedation and pain control

Profound local anaesthesia underpins almost every procedure. In symptomatic irreversible pulpitis, systematic review evidence suggests that the advantage of 4% articaine over 2% lidocaine lies mainly with infiltration rather than with the inferior alveolar nerve block [118]. A mini systematic review found no conclusive evidence that 4% articaine causes more nerve injury than 2% lidocaine when used for inferior alveolar nerve block, although the authors advised caution until better studies are available [119].

Nitrous oxide inhalation sedation is widely used for anxiety and behaviour management. A health technology assessment rated the certainty of evidence as low to very low and found no study showing nitrous oxide to be more effective than placebo or midazolam, but adverse-event data suggested that it is safe and useful for anxious children, adolescents and adults [120]. Sedation beyond minimal levels requires specific training, monitoring equipment and facilities, and referral is appropriate where these are not available.

Dosing and technique safety deserve explicit attention. Maximum recommended doses for local anaesthetic are weight-based and differ between agents and vasoconstrictor combinations, and they should be checked against the product label and standard references for each patient, with extra caution in children, older adults and patients with hepatic or cardiac disease [121]. Aspiration before injection, slow injection and watching for early signs of toxicity (perioral numbness, tinnitus, agitation, drowsiness) reduce the risk of intravascular injection and systemic toxicity. For acute dental pain more broadly, an overview of systematic reviews found that non-steroidal anti-inflammatory drugs, alone or combined with paracetamol, were generally preferred over opioid-containing regimens, which carried more adverse effects and little additional benefit [122]. Opioid prescribing for dental pain should therefore be rare and reasoned.

3.20 Medical emergencies

Managing medical emergencies is a requisite skill for every dentist, yet a scoping review found a widespread lack of preparedness despite universal recognition of its importance [123]. Sensible measures include a written emergency protocol, oxygen, an automated external defibrillator and emergency drugs that are checked regularly, current basic life support training for all clinical staff, and regular team rehearsal of the most likely scenarios.

Standards for general dental practice set out the equipment and drugs that should be available and the training expected of the whole team [124]. The commonly listed emergency drugs are oxygen, adrenaline (epinephrine) for anaphylaxis, salbutamol for bronchospasm, glyceryl trinitrate and aspirin for suspected cardiac ischaemia, oral glucose and glucagon for hypoglycaemia, and a benzodiazepine for prolonged seizures, together with an automated external defibrillator and airway equipment [124]. For

anaphylaxis, intramuscular adrenaline is the first-line treatment and should not be delayed; the dose and route should follow the written protocol and local guidance. The most common events in practice are syncope, hypoglycaemia, angina, asthma exacerbation and seizures, so scenario training should cover these first. Every event should be documented and reviewed afterwards as a learning exercise.

3.21 Paediatric dentistry and dental trauma

Early childhood caries is defined as one or more decayed, missing or filled tooth surfaces in a child under six years of age [125]. Professionally applied fluoride varnish prevents caries in children and adolescents [126], and micro-invasive approaches such as resin infiltration and sealing can reduce the progression of non-cavitated proximal lesions compared with non-operative care [127]. The Hall technique and silver diamine fluoride, discussed above [21,24], are central to managing young or uncooperative children.

Dental trauma is a time-critical emergency. The International Association of Dental Traumatology (IADT) guidelines are intended for the immediate or urgent care of traumatic dental injuries, with follow-up by specialists where needed [128]. Avulsion is among the most serious dental injuries, seen in 0.5–16% of all dental injuries, and prompt, correct emergency management at the place of injury and immediately afterwards is essential for the best outcome [129]. Injuries to primary teeth often need very different management from those in the permanent dentition [130]. Having the IADT algorithms in the practice, and being able to give clear telephone advice to a parent or teacher, are practical priorities.

Two further paediatric topics deserve mention. Molar incisor hypomineralisation (MIH) presents with demarcated enamel defects, post-eruptive breakdown and hypersensitivity in first permanent molars and incisors, and best-practice guidance emphasises early identification, caries prevention, hypersensitivity control, appropriate restorative management and timely referral for complex cases [131]. For primary teeth with deep caries, professional guidance describes indirect pulp treatment, pulpotomy and pulpectomy according to the pulpal diagnosis, with calcium silicate materials increasingly used as medicaments [132].

3.22 Safeguarding and vulnerable patients

Dental professionals are well placed to notice injuries and neglect, because many injuries involve the head, face and mouth and because children attend regularly. Signs that should raise concern include unexplained or inconsistent injuries of the face, mouth or neck, torn frenula, patterns of bruising, untreated disease despite available care (dental neglect), repeated missed appointments, and a carer's account that does not fit the injury. Studies show that dental professionals often feel under-trained in child protection [133]. Reporting duties are defined by local law; in South Africa the Children's Act places duties on listed professionals, which include dentists, to report suspected abuse or neglect [134]. Practical steps are to document findings objectively (descriptions, measurements, photographs with consent where appropriate), avoid leading questions, know the local reporting pathway before it is needed, and seek advice early. The same vigilance applies to older and vulnerable adults and to patients disclosing domestic violence.

3.23 Removable prosthodontics and oral rehabilitation

Conventional complete and partial dentures remain essential, particularly for patients who cannot or do not wish to have implants. For the edentulous mandible, the McGill consensus statement states that a two-implant overdenture should be the first-choice standard of care [135]. Digital denture workflows are emerging, but were not assessed systematically in this review.

Several principles from restorative and prosthodontic literature help to deliver predictable removable care. A critical review argues that complete dentures will remain necessary for decades despite the growth of implant therapy, especially where cost or health limits access to implants [136]. The shortened dental arch concept holds that dentitions reduced to premolar occlusion can provide adequate function for many patients, so replacing every missing molar is not always necessary [137]. For removable partial dentures, a sound design (rest seats, guide planes, direct and indirect retention, and tissue support), careful mouth preparation and a recall for maintenance are the main determinants of success [138]. Patients should be taught how to clean and store dentures, to leave them out at night where appropriate, and to report sore spots early, and they should be reviewed soon after delivery.

3.24 Tooth wear, aesthetics and temporomandibular disorders

A European consensus statement on severe tooth wear emphasises prevention, early diagnosis and monitoring, with minimally invasive adhesive restorative management when intervention is needed [139]. A systematic review of vital tooth bleaching found that both at-home and in-office approaches are effective, with tooth sensitivity the main adverse effect and more common with in-office techniques [140]. For temporomandibular disorders, the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) provide standardised criteria for diagnosis in clinical and research settings [141], and, as noted above, bruxism is best managed by identifying and treating its consequences [86].

Practical tools exist to quantify wear. The Basic Erosive Wear Examination (BEWE) scores each sextant from 0 to 3 for the most severely affected surface and sums the scores into a cumulative value that guides risk level and management, from routine observation to active prevention and restoration [142]. Baseline photographs, study casts or intraoral scans allow later comparison, which separates active wear from historical wear. For temporomandibular disorders, systematic reviews support conservative and reversible management (education, self-care, jaw exercises and physical therapy, and a stabilisation appliance for selected pain patients), whereas irreversible occlusal treatments are not supported as a treatment for TMD [143].

3.25 Prevention in practice: tobacco and lifestyle risk factors

The dental team sees patients regularly and is well placed to address shared risk factors. Systematic review evidence supports delivering tobacco cessation interventions in the dental setting [144]. Brief advice on tobacco, sugar intake and alcohol, together with mucosal screening [88], turns every examination into a preventive health encounter.

3.26 Oral hygiene and self-care

Home care is the greatest single determinant of the long-term success of every treatment described in this review. Effective advice is individualised and demonstrated rather than simply stated. Twice-daily brushing with fluoride toothpaste, with spitting out but not rinsing, is the cornerstone of caries prevention [19]. For children, guidance suggests a smear of toothpaste with at least 1,000 ppm fluoride before the age of three, and a pea-sized amount of 1,350 to 1,500 ppm from the age of three, with an adult supervising brushing [145]. A Cochrane review found that powered toothbrushes, particularly those with an oscillating-rotating action, reduce plaque and gingivitis slightly more than manual brushes, although the clinical importance of the difference is uncertain [146]. For interdental cleaning, a Cochrane review found low-certainty evidence that adding floss to toothbrushing reduces gingivitis, and that interdental brushes may reduce plaque more than floss, without reliable evidence of an effect on caries [147]. The practical conclusion is to recommend a device the patient will actually use correctly, matched to their interdental space, with periodic review of technique, and with dietary advice on sugar frequency [25].

3.27 Dental anxiety and behaviour management

Dental anxiety is common, causes avoidance, delays care and makes treatment harder for patient and clinician alike. A review of management approaches recommends first identifying anxiety (using a short validated questionnaire or direct questions) and its triggers, then applying psychological strategies such as clear explanation, a sense of control through agreed stop signals, graded exposure, relaxation and cognitive behavioural techniques, with pharmacological support as an adjunct rather than the first line [148]. For children, professional guidance distinguishes basic behaviour guidance (communication, tell–show–do, positive reinforcement, distraction) from advanced techniques (sedation, protective stabilisation and general anaesthesia) that require specific training, informed parental consent and, often, referral [149]. Where sedation is used, standards for conscious sedation set out the training, monitoring, staffing and emergency equipment required, and the operator–sedationist arrangement for different levels of sedation [150]. A calm, unhurried first visit, short appointments and early successful experiences often reduce the need for any sedation.

3.28 Sleep-disordered breathing and oral appliance therapy

Dentists see snoring, tooth wear, a scalloped tongue, a narrow airway and daytime tiredness in the same patients. The joint American Academy of Sleep Medicine and American Academy of Dental Sleep Medicine guideline suggests that, for adults with snoring and obstructive sleep apnoea who request treatment or do not tolerate continuous positive airway pressure, a custom-made, titratable oral appliance is preferred to a non-custom device, and that appliances should be provided by a qualified dentist after the patient has been assessed and diagnosed by a physician [151]. Regular follow-up is recommended to monitor symptoms, appliance wear and dental side effects such as occlusal change and temporomandibular discomfort [151]. For the general dentist, the realistic role is screening, appropriate referral for medical assessment, and, with suitable training, appliance provision and monitoring.

3.29 Dental radiography and radiation protection

Radiographs are central to diagnosis, but every exposure should be justified by the individual patient's clinical need rather than by a fixed schedule. The American Dental Association and US Food and Drug Administration recommendations advise selecting radiographs on the basis of history, clinical findings and caries risk, and using longer bitewing intervals in patients at low risk and shorter intervals in those at high risk [152]. This principle sits alongside the European evidence-based guidance on CBCT, which limits its use to cases where conventional imaging cannot answer the clinical question [16]. In practice this means: using the lowest dose that is diagnostically adequate; using rectangular collimation, fast receptors and, where relevant, thyroid protection according to local rules; recording the justification and a report for each image; and reserving CBCT for defined indications such as implant planning, complex impactions, suspected root fractures or resorption, and unresolved endodontic diagnoses [16,152]. Local regulations on equipment licensing, quality assurance and operator training apply and must be checked by each practice.

3.30 Antimicrobial stewardship in dental practice

Dentists prescribe a considerable share of outpatient antibiotics, and a large proportion of these are unnecessary. In a United States claims analysis, about four in five antibiotic prophylaxis prescriptions given before dental procedures were judged inappropriate [153], which is consistent with the narrow indications described in the American Heart Association statement [89]. For acute dental infection the guiding principle is source control: drainage, pulp removal or extraction comes first, and systemic antibiotics are reserved for spreading infection, systemic involvement or medical compromise, as set out by the European Society of Endodontology [37]. For the prevention of complications after tooth extraction, a Cochrane review found that prophylactic antibiotics reduce the risk of infection and alveolar osteitis in otherwise healthy patients, but the absolute benefit is small and must be balanced against adverse effects and antimicrobial resistance [109]. A practical stewardship approach is to document the indication, choose the narrowest effective agent, use the shortest effective course, and review any prescription that does not follow these rules.

Antimicrobial resistance is a global threat, and the World Health Organization's global action plan calls on all prescribers to optimise antimicrobial use [154]. A global analysis estimated that bacterial antimicrobial resistance was directly responsible for around 1.27 million deaths in 2019 and associated with several million more [155]. Dentists contribute to the problem when they prescribe antibiotics without clear indication. In some countries antibiotics can be obtained without prescription, so patient education about not self-medicating, not sharing antibiotics and finishing only the prescribed course supports stewardship wherever the dentist practises.

3.31 Prescribing and national clinical guidance in primary care

Prescribing is a daily clinical act with real risks. Practical national guidance for dental practice covers analgesics, antibiotics, antifungals and other drugs, with attention to dose, duration, contraindications and interactions [156]. For acute dental pain, the combination studied in the evidence base paired ibuprofen 400 mg with paracetamol 1,000 mg [108], and non-steroidal anti-inflammatory drugs must be avoided or used with caution in patients with asthma, peptic ulceration, renal impairment, anticoagulant

therapy or in late pregnancy. Interactions that general dentists should remember include metronidazole, macrolides and miconazole with warfarin, which may raise the international normalised ratio, and the interactions of macrolides with some other drugs; the medication list and the prescriber's reference should be checked before every prescription [156]. Two further national guidance documents give pathway-based advice that fits general practice: one on the oral health management of patients at risk of medication-related osteonecrosis of the jaw, which sets out risk identification, preventive care before and after starting antiresorptives and the management of extractions [157], and one on the prevention and treatment of periodontal diseases in primary care [158]. Using such guidance alongside the S3 documents gives the dentist a ready-made structure for record keeping and referral.

3.32 Older adults, xerostomia and pregnancy

Population ageing and polypharmacy increase the number of patients with dry mouth, root caries, medical complexity and reduced manual dexterity. Xerostomia and hyposalivation are frequently medication-related and raise caries and candidiasis risk; management combines identification of the cause, saliva substitutes or stimulation, and intensified topical fluoride prevention [159]. People with dementia carry a high burden of poor oral hygiene, caries and periodontal disease, so care plans should involve caregivers, simplify regimens and prioritise comfort, function and the prevention of pain and infection [160]. Simplified and preventive treatment plans, with early attention to denture hygiene and nutrition, usually serve frail patients better than complex reconstruction.

Pregnancy is not a reason to defer necessary dental care. Reviews of care during pregnancy support routine hygiene and preventive care, timely treatment of active disease and emergency treatment at any stage, with elective procedures most conveniently scheduled in the second trimester, and careful positioning to avoid supine hypotension in late pregnancy [161]. Radiographs that are clinically justified can be taken with appropriate collimation and protection, and the medication choice should be reviewed for each prescription.

Oral health also affects general health in frail people. A systematic review found that professional oral hygiene care reduced the risk of pneumonia and respiratory infection in elderly people in hospitals and nursing homes, although the methodological quality of the trials was variable [162]. For patients in residential care, a written oral care plan, staff training and regular dental review are practical ways to apply this evidence.

3.33 Adapting contemporary care to different resource settings

The WHO-linked Basic Package of Oral Care describes a minimum, evidence-based package for low-resource settings: urgent oral care (relief of pain and first-aid for infections and trauma), affordable fluoride toothpaste, and atraumatic restorative treatment [163]. This package, and its extensions, show that high-quality care need not depend on high technology. Table 7, an authored synthesis of the evidence cited in this review, shows how the same clinical principles can be delivered in well-resourced and resource-limited settings. Adaptation never lowers the standard for consent, infection control, medical-risk assessment or safe referral.

Table 7. Adapting contemporary care across resource settings (authored synthesis).

Domain	Well-resourced setting	Limited-resource adaptation	Evidence anchor
Caries management	Risk-based care, varnish, sealants, SDF, adhesive composite, selective removal	Fluoride toothpaste, SDF, atraumatic restorative treatment with high-viscosity glass ionomer, Hall technique	[19,21,26,27,164]
Endodontics	Vital pulp treatment, root canal treatment under dental dam with magnification	Vital pulp therapy where feasible; single-visit treatment under dam if equipment allows; extraction when safe endodontic care is not possible	[35]
Vital pulp therapy	Graded sequence from selective caries removal to capping and pulpotomy under dam; convert to root canal treatment if bleeding is not controlled	Guidelines and systematic reviews [44,47,49]	
Combined endodontic-periodontal lesions	Diagnose with probing, sensibility tests and imaging; treat the endodontic cause first, reassess, then manage the periodontal defect; consider fracture	Classification and systematic review [56,61]	
Coronectomy	Option for symptomatic or diseased lower third molars at high risk to the inferior alveolar nerve; document risks and follow up	Randomised trials and reviews [112,114,115]	
Core procedures	Follow a defined sequence for scaling, root surface debridement, extraction, dentures, crowns and bridges; match the procedure to diagnosis, consent and competence	Textbooks, systematic reviews and guidelines [165–168]	
Dental materials	Choose materials for the site, load, moisture control and the clinician's technique; know sensitisers, standards and regulatory limits (for example, amalgam phase-down)	Reviews, standards and regulations [169–173]	
Root canal treatment complications	Prevent through dam, anatomy, working length and irrigation safety; manage perforation, fracture, hypochlorite accident and flare-up; refer early	Reviews and guidelines [174–177]	

Domain	Well-resourced setting	Limited-resource adaptation	Evidence anchor
Periodontal care	Stepwise S3 care with instrumentation and supportive care	Steps 1 and 2 (behaviour change, supragingival and subgingival hand instrumentation) are low-technology; refer residual disease	[9]
Imaging	Digital bitewing and periapical radiographs; CBCT for defined indications	Clinical examination and selected periapical films where available; CBCT rarely available	[16,152]
Anaesthesia and analgesia	Articaine or lidocaine; sedation where trained	Lidocaine with epinephrine; ibuprofen with paracetamol	[108,122]
Prosthodontics	Digital workflows, implants	Conventional removable prostheses, immediate dentures	[135,136]
Prevention	Chairside counselling and recall	Community and school programmes, access to fluoride toothpaste, sugar and tobacco policy	[19,25,144]
Emergencies	Defibrillator, emergency drugs, trained team	Basic life support, oxygen if possible, adrenaline, airway skills and written protocol	[123,124]

3.34 Regional patterns of oral disease and risk

Some conditions are concentrated in particular regions, and the general dentist who treats a mobile or diverse population will meet them. Fluoride exposure. Water fluoridation reduces caries in children, although the effect is smaller now that fluoride toothpaste is widely available, and it increases the frequency of dental fluorosis, which was of aesthetic concern in roughly one in eight people at the fluoride concentrations studied [178]. At the other end, groundwater with naturally high fluoride concentrations in several regions causes endemic fluorosis, so the dentist should know the local water fluoride level before advising on supplements or toothpaste for children. Areca nut and smokeless tobacco. Betel quid and areca nut are chewed by many millions of people in South and Southeast Asia, the Pacific and migrant communities elsewhere, and areca nut is classified as carcinogenic to humans [179]. Oral submucous fibrosis, a potentially malignant fibrosing disorder presenting with a burning sensation, blanching, fibrous bands and progressive limitation of mouth opening, is strongly associated with this habit, and early detection depends on asking about quid use and examining the mucosa and mouth opening [88,180]. Tobacco control under the WHO Framework Convention on Tobacco Control includes cessation support, and dental teams can contribute to it [144,181].

Noma. Noma is a rapidly progressive necrotising disease of the face that mainly affects young, malnourished children in poor regions, especially sub-Saharan Africa, and carries a very high mortality when untreated; it was recognised by the WHO as a neglected tropical disease in 2023 [182]. Dentists in affected regions should recognise acute necrotising gingival disease in a malnourished child as an emergency for urgent medical referral and nutritional and antimicrobial management.

Periodontitis and caries burden. The burden of severe periodontitis exceeds one billion prevalent cases worldwide [5], and untreated caries is concentrated in less affluent groups in every country [1,3]. Population-level strategies for sugar, tobacco and fluoride access therefore complement chairside care.

3.35 Access, task-sharing and the South African context

Because the burden of oral disease is greatest where resources are fewest [1,3], general dentists in many countries work in settings where equipment, electricity or specialist referral are limited. South Africa illustrates the challenge: the oral health workforce is unevenly distributed between the private and public sectors and between provinces, leaving large populations dependent on a small public-sector workforce [183]. In such settings low-technology, biologically sound approaches are especially valuable. The atraumatic restorative treatment (ART) approach uses hand instruments and adhesive restorations to remove softened tissue and restore cavities without rotary equipment or a power supply, and it has been used for more than two decades in community and school programmes [164]. Together with fluoride varnish, silver diamine fluoride, sealants and the Hall technique [20–22,24,126], ART forms a toolkit that private practitioners can also deploy in outreach, school and community work. Task-sharing with oral hygienists, dental therapists and community health workers, supported by clear referral pathways, extends prevention and early care to more people.

3.36 Consent, records and the medico-legal framework

Informed consent is both an ethical duty and a legal requirement. In South African law, the principle that a practitioner must disclose the material risks of a proposed treatment, judged from the perspective of a reasonable patient, was set out in Castell v De Greef [184], and a similar material-risk standard applies in the United Kingdom after Montgomery v Lanarkshire Health Board [185]. The Health Professions Council of South Africa (HPCSA) guidance on seeking informed consent describes the information to be provided, the need for the patient to understand it, and the documentation required [186]. The National Health Act also requires that users of health services be informed of their health status, the treatment options, and the benefits, risks and costs of each [187]. Good consent for a modern general practice therefore includes the diagnosis, the options (including no treatment and referral), the material risks (for example nerve injury, peri-implant disease, the lifespan of restorations and the need for maintenance), costs, and the patient's questions and decision, all documented contemporaneously.

Clinical records support continuity of care and defence of care. The HPCSA record-keeping guideline sets out what must be recorded and for how long records must be retained [188]. Digital images, scans, CBCT volumes and AI outputs are part of the clinical record and, since health information is special personal information, their storage, sharing and cross-border transfer fall under the Protection

of Personal Information Act [189]. Practices using cloud-based scanners, teledentistry platforms or AI services should confirm where data are stored, who can access them and under what contract. Professional indemnity cover, scope-of-practice limits and the practitioner's own competence should guide which advanced procedures are offered.

Shared decision-making turns consent from a form into a conversation. Models of shared decision-making describe three steps: telling patients that reasonable options exist, describing those options and their benefits and harms, and exploring the patient's preferences before reaching a decision together [190]. Decision aids such as photographs, models and simple written summaries make complex trade-offs (for example crown versus implant, or monitoring versus restoring a lesion) more understandable, and the discussion and the choice should be recorded.

3.37 Regulation, law and data across jurisdictions

Practising internationally, treating patients who have moved between countries, or reading guidance written elsewhere, requires awareness of how law and regulation differ. Table 8 gives illustrative examples, not an exhaustive or authoritative statement of the law, which changes and must be checked locally.

Table 8. Illustrative international differences that affect general practice.

Aspect	Illustrative examples
Professional regulation	United Kingdom: General Dental Council. South Africa: Health Professions Council of South Africa [186]. Australia: Dental Board of Australia. Canada: provincial regulatory colleges. United States: state dental boards. India: Dental Council of India. European Union: mutual recognition of qualifications under Directive 2005/36/EC [191]
Standard of disclosure for consent	United Kingdom: material-risk test from Montgomery [185]. South Africa: Castell v De Greef and HPCSA guidance [184,186]. Australia: Rogers v Whitaker [192]. Canada: Reibl v Hughes [193]. United States: varies by state, with the patient-centred approach in Canterbury v Spence influential [194]
Data protection	European Union: General Data Protection Regulation [195]. South Africa: Protection of Personal Information Act [189]. United States: Health Insurance Portability and Accountability Act [196]
Radiation protection	European Union: Directive 2013/59/Euratom [197]. United States: federal recommendations and state rules [152]. Many countries require equipment registration, quality assurance and trained operators
Mercury and amalgam	Minamata Convention on Mercury [13]. European Union: Regulation 2017/852 on mercury and later amendments phasing out dental amalgam, with limited exceptions [198]
Devices and artificial intelligence	European Union: Medical Device Regulation [100] and the Artificial Intelligence Act [101]. WHO ethics and governance guidance for AI in health [99]

The practical rules are the same everywhere: practise within the law of the jurisdiction where care is delivered, within the limits of competence, with documented informed consent, secure records and lawful handling of data. When patients, laboratories or cloud services cross borders, check where data are stored and which law applies, and take advice from the regulator, indemnifier or professional body when unsure.

3.38 Language, culture and religion in a diverse patient population

Increasing migration and diverse populations make cultural and linguistic competence a clinical skill. A practical framework describes cultural competence as understanding the patient's social and cultural context, exploring beliefs and expectations, and adapting communication and care accordingly, in order to reduce disparities [199]. Language is the most obvious barrier. A systematic review found that professional interpreters improve communication, patient satisfaction and clinical outcomes compared with no interpreter or with ad hoc interpreters such as family members, who are more likely to make errors of omission and substitution [200]. Informed consent obtained through an untrained interpreter is not reliable, so professional or telephone interpreting services should be used for consent discussions.

Religious and cultural considerations affect scheduling, materials and advice, and they are best handled by asking rather than assuming. Patients who fast, for example during Ramadan, may prefer appointments after the fast is broken, and views differ on whether particular procedures or medicines affect the fast, so the clinician's role is to ask, respect the patient's own understanding and arrange flexible timing. Some patients wish to know the source of materials: bone grafts, collagen membranes, gelatin-based haemostats and some medications may be of bovine, porcine or other animal origin, and alcohol is present in some mouthrinses, so disclosing the source and offering alternatives where available is part of informed consent. Some patients prefer a clinician or chaperone of the same gender, appointments around prayer times, or specific arrangements for modesty. Traditional oral hygiene methods, such as chewing sticks, and traditional remedies are used in many regions; asking about them is respectful and safer than assuming, and they can be combined with fluoride toothpaste and good technique. Dietary advice should take account of cultural patterns such as sugar-rich drinks and sweets consumed at festivals or when breaking a fast [25].

3.39 International mobility, dental tourism and continuity of care

Patients travel for dental care, often for implants, crowns and aesthetic treatment, and they may return with complications and incomplete records. Medical tourism raises issues of quality assurance, regulatory oversight and follow-up that are well described in the health services literature [201]. When a patient presents after treatment abroad, a useful approach is to establish what was done and when (request records, radiographs, implant system and component details), examine and image them with justification, assess and record the problem objectively, discuss options and limits without criticising the previous clinician, and clarify the responsibilities of each party. Complications such as peri-implant mucositis and loosening are managed according to the same guideline-based principles as in any patient [76–78]. For patients planning treatment abroad, a pre-travel check-up, advice to obtain

complete written records and component details, and a plan for local follow-up reduce later difficulty. The same principles apply to patients who relocate: portable records and radiographs support safe continuity of care.

3.40 Practitioner wellbeing and ergonomics

The clinician is part of the clinical system. Systematic review evidence shows a high prevalence of musculoskeletal disorders among dental professionals, particularly in the neck, shoulder and back, with reported prevalence in the range of roughly two thirds to more than nine tenths across studies [202]. Surveys of dentists also report substantial levels of stress and burnout [203]. Practical measures include magnification and good lighting, neutral working postures, four-handed dentistry with correct patient positioning, scheduled breaks and varied appointment lengths, regular physical conditioning, and attention to workload, peer support and mental health. These measures protect long-term clinical capacity and therefore patient safety.

3.41 Quality, audit and team-based care

Good outcomes depend on systems as much as on individual skill. Clinical audit, in which a practice measures one aspect of care against a standard, changes it and measures again, is a practical way to improve quality. Suitable audit topics include the justification and quality of radiographs [152], antibiotic prescribing [109,153], completeness of records and consent documentation [186,188], infection control processes [90] and emergency readiness [123,124]. Team-based care means delegating within the scope of each registered team member, with clear protocols, regular meetings and shared learning from incidents and near misses. Table 7 lists a minimum standard of practice readiness.

Table 9. Practice readiness checklist.

Area	Minimum standard	Supporting sources
Infection control	Standard precautions; validated sterilisation with logs; dental unit waterline management	[90]
Emergency readiness	Written protocol; oxygen, defibrillator and emergency drugs checked regularly; team training and rehearsal	[123,124]
Radiography	Justification, quality assurance and reports; dose optimisation; CBCT only for defined indications	[16,152]
Medical history	Updated at each course of care; flags for anticoagulants, antiresorptives and cardiac risk	[89,106,107]
Consent and records	Contemporaneous consent with options and risks; complete records; data protection	[184,186,188,189]
Prescribing	Antibiotics only for defined indications; interaction checks	[37,153,156]
Referral	Written criteria and a directory of specialists	[35,107]
Staff wellbeing	Ergonomics, workload and support	[202,203]

3.42 Appraising evidence and guidelines

The review has used the language of evidence throughout, so a short note on how to read it is useful. Evidence-based practice means integrating the best available research evidence with clinical expertise and the patient's values [204]. The GRADE approach rates the certainty of a body of evidence as high, moderate, low or very low, starting randomised trials at a higher level and observational studies at a lower level, and moving the rating down for risk of bias, inconsistency, indirectness, imprecision or publication bias, or up for large effects or dose-response gradients; it then separates the certainty of the evidence from the strength of a recommendation, which also depends on balance of benefits and harms, values and resources [205]. Many recommendations in the guidelines cited above rest on low-certainty evidence, as the endodontic guideline states explicitly [35]. Practical questions when reading a study are: Were the patients and setting like mine? Was the comparison clinically meaningful? Were outcomes that matter to patients, such as tooth survival, function and symptoms, measured, rather than surrogate outcomes? Who funded the study? Was follow-up long enough? Asking these questions, and reading guidelines and systematic reviews before single studies or manufacturer claims, protects against both over-adoption of new technology and reflexive attachment to old habits.

3.43 Integrating care: a practical approach to the patient

The evidence reviewed above is most useful when it is organised into a consistent sequence of care. A widely used structure moves through five phases (Figure 6).

- Assess. Take a medical, medication, dental and social history; assess caries, periodontal, occlusal, mucosal and risk status; select justified imaging [15,16,152].
- Control. Relieve pain, control infection and manage urgent problems, using source control first and antibiotics only for defined indications [37,89].
- Stabilise and prevent. Start risk-based prevention: fluoride, diet and tobacco advice, plaque control, stepwise periodontal therapy, and non-restorative caries management [9,21,144].
- Restore and rehabilitate. Provide definitive care in the least invasive way that meets the patient's needs, with direct, indirect, endodontic, prosthodontic and implant treatment within the limits of competence [10,28,30,74].
- Maintain. Recall at a risk-based interval, monitor restorations, implants and periodontal status, and re-evaluate the plan as the patient's circumstances change [9,78].

Table 10. Quick reference for common acute presentations in general practice.

Presentation	Key points	Practical approach	Escalate or refer when
Pain with reversible pulpitis features	Short, sharp pain provoked by cold or sweet and settling on removal of the stimulus	Selective caries removal and a well-sealed restoration, with pulp protection in deep lesions [28,36]	Symptoms progress to lingering or spontaneous pain
Irreversible pulpitis	Lingering or spontaneous pain; often poorly localised	Vital pulp treatment or root canal treatment under dental dam, or extraction; ibuprofen with paracetamol; antibiotics not indicated [10,37,108]	Complex anatomy, retreatment or an uncertain diagnosis
Acute apical abscess	Swelling, pain on biting, possible fever	Drain and remove the source; antibiotics only if there is spreading infection or systemic involvement [37]	Trismus, floor-of-mouth swelling, difficulty swallowing or breathing, or systemic compromise: urgent hospital referral
Avulsed permanent tooth	Time out of the mouth and storage medium determine outcome	Replant immediately if possible, splint and follow IADT guidance [129]	Complex associated injuries
Mucosal lesion persisting beyond two to three weeks	Red, white or ulcerated lesion without a clear cause	Remove local irritants, review, and biopsy or refer if it persists [88]	Any suspicion of malignancy: urgent referral
Bleeding after extraction	Establish medication and medical history	Local pressure, haemostatic agents and sutures; avoid unnecessary interruption of anticoagulants [106]	Uncontrolled bleeding or suspected coagulopathy
Medical emergency in the chair	Early recognition is critical	Follow the written protocol, call emergency services and support airway, breathing and circulation [123]	All serious events

Table 11. Medical conditions with practical dental implications.

Condition or exposure	Why it matters	Practical action
Anticoagulants	Increased bleeding risk after surgery	Identify the agent and indication; use local haemostasis; coordinate with the physician only when needed [106]
Antiresorptive drugs (bisphosphonates, denosumab)	Risk of medication-related osteonecrosis of the jaw	Check history before surgery; optimise oral health first; follow the position paper [107]
High-risk cardiac conditions	Endocarditis risk	Antibiotic prophylaxis only for the highest-risk groups before relevant procedures [89]
Diabetes	Two-way relationship with periodontitis	Periodontal treatment as part of diabetes care; check glycaemic control before elective surgery [70]
Cardiovascular disease	Association with periodontitis	Treat periodontitis according to guidelines and give general risk-factor advice [71]
Xerostomia and polypharmacy	Caries, candidiasis and denture problems	Review medicines with the prescriber, saliva substitutes, high-fluoride products [159]
Pregnancy	Gingival changes and positioning issues	Continue preventive and necessary care; time elective care sensibly [161]
Tobacco use	Periodontitis, implant failure, oral cancer	Brief advice and referral for cessation support [144]

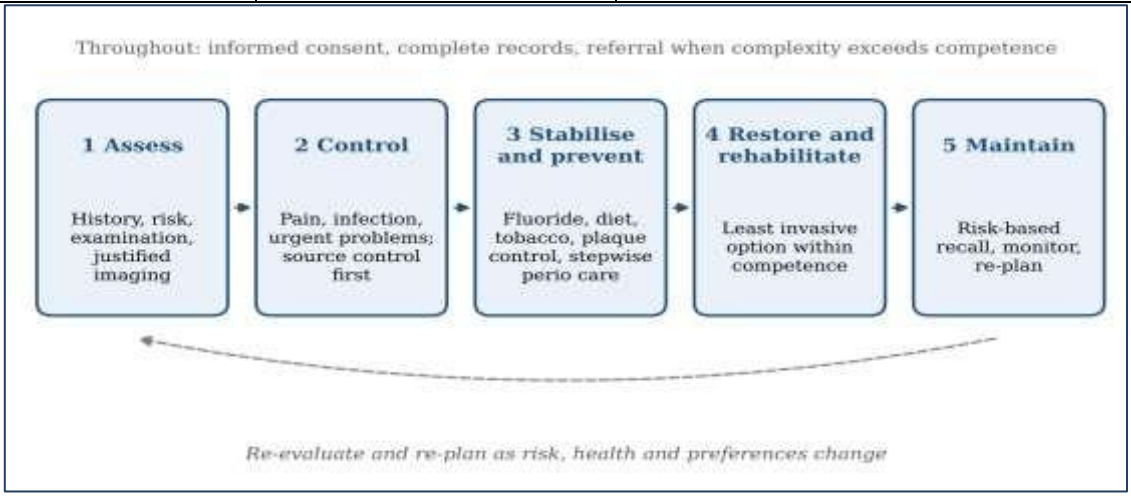

Figure 6. A five-phase framework for organising contemporary general dental care. Consent, records and referral apply throughout, and the cycle returns to reassessment as the patient's risk, health and preferences change.

Table 12. Common pitfalls in contemporary general practice and how to avoid them.

Pitfall	Why it matters	How to avoid it
Treating the lesion, not the risk	Restorations fail when disease drivers remain	Record caries risk, diet and fluoride exposure, and use a risk-based recall [18]
Routine radiographs without justification	Unnecessary radiation and over-diagnosis	Select imaging by clinical need and risk [16,152]
Missing the medical history	Bleeding, infection and drug-related complications	Update the history and medication list at every course of care; identify anticoagulant and antiresorptive use [106,107]
Antibiotics for pain	Resistance and adverse events without benefit	Drain, treat the source and prescribe only for defined indications [37,153]
Weak coronal seal after endodontics	Reinfection and failure	Plan and place the final restoration promptly [42]
Implants without a maintenance plan	Higher peri-implant disease risk	Build maintenance into the plan and consent [81]
Over-reliance on technology outputs	Unvalidated AI or printed definitive restorations may mislead	Treat as adjuncts; confirm clinically [84,96]
Incomplete consent or records	Medico-legal and ethical exposure	Document options, risks, costs and the patient's choice [184,186]
Delayed referral	Worse outcomes for complex disease	Refer early when complexity exceeds competence [35,107]

3.44 Dental materials: an integrated guide to selection, handling and safety

Every procedure in this review depends on materials, and the same procedure can succeed or fail according to the material chosen and how it is handled. A general dentist uses materials from at least eight families in a normal week: restorative materials, adhesives and cements, indirect restorative and prosthetic materials, endodontic materials, preventive and aesthetic agents, impression and laboratory materials, surgical, periodontal and implant materials, and infection-control chemicals. This section integrates them into one framework and then maps them to the procedures described throughout the review.

Four principles guide material choice. First, biocompatibility and safety: materials must be tested to recognised standards, and clinicians should know the common sensitisers (methacrylates, nickel, latex, eugenol, some preservatives) and ask about allergies [206–208]. Second, fitness for purpose: strength, wear, aesthetics, handling, radiopacity, bonding and the ability to survive the oral environment must match the site and load, and standards such as ISO 4049 define minimum requirements for polymer-based restorative materials [209]. Third, technique sensitivity: most failures arise from moisture contamination, incorrect mixing, inadequate curing or poor cementation, and not from the material itself, so the best material is the one that the clinician can handle well in the conditions available (for example, with or without rubber dam) [34]. Fourth, regulatory and environmental duties: devices must be authorised under the national regulator (for example, the European Medical Device Regulation) [100], mercury use is restricted internationally by the Minamata Convention and, in the European Union, dental amalgam is being phased out under a revised mercury regulation, with separators required where amalgam is used [13,173,198,210].

Table 13. Direct restorative materials: properties, uses and cautions.

Material	Typical uses	Strengths	Limitations and cautions
Resin composite (including nanohybrid and bulk-fill)	Anterior and posterior restorations, repairs, cores, minimally invasive cavities	Adhesion to tooth, aesthetics, conservative preparation; good longevity in posterior teeth when well placed	Technique sensitive; polymerisation shrinkage; needs dry field and adequate curing; some risk of secondary caries and fracture [33,169,170]
Dental amalgam	Posterior restorations where moisture control is difficult, in settings where it is still permitted	Durable, tolerant of moisture, low cost	Mercury concerns; phase-down under the Minamata Convention and national rules; requires retentive preparation; amalgam separators needed [13,173]
Conventional glass-ionomer cement	Class III and V cavities, atraumatic restorative treatment, root caries, temporary and primary teeth	Chemical adhesion, fluoride release, hydrophilic, biocompatible	Lower strength and wear resistance; sensitive to early moisture and dryness [211]
Resin-modified glass-ionomer and glass hybrid	Cervical, root-surface and primary teeth lesions; liners and bases; some posterior use	Fluoride release with improved strength and handling	Water sorption; shrinkage; shorter service in high-load sites [211]
Compomer	Primary teeth and low-load restorations	Easy handling	Limited indications; less fluoride release than glass-ionomer
Calcium silicate cements (MTA and similar)	Pulp capping, pulpotomy, perforation repair, root-end filling, apexification	Bioactive, seal well, support dentine bridge formation	Discolouration with some products; cost; handling; follow current guidelines for use [36,46]
Calcium hydroxide liners	Indirect capping, thin liners	Low cost, established	Dissolves over time; poor seal; largely replaced by calcium silicates

Material	Typical uses	Strengths	Limitations and cautions
Temporary restorative materials (zinc oxide eugenol, glass-ionomer, resin-based)	Interim fillings and endodontic access seals	Easy placement and removal	Eugenol interferes with resin bonding; temporary seals leak over time

Composite is now the default direct restorative material in most countries, and the Cochrane evidence on composite versus amalgam shows that composite is a reasonable alternative with greater technique demands and a higher risk of secondary caries in some trials [170,171]. Curing is a frequent weak point: the light output of the unit, the distance to the restoration, the exposure time and the shade and thickness of each increment determine the degree of conversion, and the output of curing lights should be checked regularly with a radiometer and the light tip kept clean [212].

Table 14. Adhesives and cements: choice by purpose.

Material	Typical uses	Strengths	Limitations and cautions
Etch-and-rinse adhesive	Direct composite; adhesive cementation; sealants	Strong, long-established enamel bond	Over-drying or over-wetting dentine; technique sensitive [213]
Self-etch adhesive	Direct composite in dentine; reduced post-operative sensitivity	Simplified steps	Weaker enamel etch unless selective enamel etching is added [213]
Universal adhesive	Flexible use in etch-and-rinse, self-etch or selective-etch modes; repair and indirect work	Versatile, fewer products	Follow manufacturer's instructions; shelf life and solvent evaporation [213]
Zinc phosphate cement	Metal and metal-ceramic crowns, posts	Long clinical record	Needs retentive preparation; no chemical bonding; mixing is technique dependent [167]
Glass-ionomer and resin-modified cements	Metal and metal-ceramic crowns, bridges, orthodontic bands	Fluoride release; some adhesion	Solubility in early period; post-operative sensitivity in some products [211]
Resin cement (adhesive, self-adhesive, dual-cure)	All-ceramic crowns, veneers, resin-bonded bridges, inlays and onlays, posts	Strong bonding to tooth and restoration; aesthetics	Needs moisture control and correct surface conditioning of restoration and tooth; excess removal [167,214]
Temporary cement (non-eugenol or eugenol)	Provisional crowns and trial cementation	Easy removal	Eugenol can inhibit resin cure if not cleaned off
Pit and fissure sealants (resin or glass-ionomer)	Preventing occlusal caries	Effective caries prevention in children and adults at risk	Need dry isolation, review and repair [20]

Table 15. Indirect restorative and prosthetic materials.

Material	Typical uses	Strengths	Limitations and cautions
Gold and high-noble alloys	Crowns, onlays, inlays, frameworks	Excellent fit, durability, minimal reduction	Cost; appearance; fewer practitioners provide
Base-metal alloys (nickel-chromium, cobalt-chromium)	Frameworks of partial dentures, metal-ceramic substructures	Strength, low cost	Nickel allergy risk; technique-sensitive casting or milling [206]
Metal-ceramic (porcelain fused to metal)	Crowns and bridges	Long clinical record; strong	Chipping of porcelain; metal margin; reduction needed [30]
Glass-ceramic (feldspathic, leucite, lithium disilicate)	Veneers, inlays, onlays, anterior and posterior crowns	Aesthetics and adhesion; lithium disilicate is strong	Technique sensitivity; adhesive cementation preferred; fracture in thin sections [31,215]
Zirconia (monolithic and layered)	Crowns, bridges, implant frameworks	High strength, minimal reduction	Wear of opposing teeth if poorly polished; veneered types may chip; bonding protocol differs [172,215]
CAD/CAM resin composite and hybrid ceramics	Inlays, onlays, crowns, provisional restorations	Chairside milling; easy repair; shock absorbing	Wear and staining over time; limited long-term data
Polymethyl methacrylate (acrylic)	Denture bases and teeth, provisionals, splints	Cheap, repairable, easy to adjust	Water sorption, staining, fracture, residual monomer; allergy is uncommon but possible [216]
3D-printed resins	Models, surgical guides, provisionals, splints, some definitive restorations	Digital workflow; rapid	Material certification and post-curing essential; evidence for definitive use is evolving [84]
Soft liners and tissue conditioners	Dentures: relines, healing	Comfort	Short lifespan; harbour Candida; hygiene needed [217]

Table 16. Endodontic materials: function, examples and cautions.

Category	Examples	Function	Cautions
Irrigants	Sodium hypochlorite; chlorhexidine (selected cases); saline	Dissolve tissue and disinfect	Hypochlorite extrusion and tissue damage; never mix with chlorhexidine; use side-vented needles and low pressure [40,218]
Chelating agents	EDTA	Remove smear layer; help negotiate calcified canals	Over-use erodes dentine; keep sodium hypochlorite and EDTA sequence in mind [40]
Intracanal medicaments	Calcium hydroxide	Reduce bacteria between visits	Needs complete removal before obturation; not required for all cases [219]
Files and instruments	Stainless steel hand files; nickel-titanium rotary and reciprocating files	Shape the canal	Instrument fracture; follow single-use or limited-use rules; use correct motor settings [220,221]
Root canal sealers	Epoxy resin; calcium silicate; zinc oxide eugenol; others	Seal the space between gutta-percha and dentine	Extrusion; solubility; interactions with irrigants [222]
Core filling material	Gutta-percha (cold, warm vertical, single-cone with bioceramic sealer)	Fill the shaped canal	Voids and over-extension; technique-specific [222]
Repair and regenerative materials	MTA; calcium silicate cements; blood clot with scaffold	Perforation repair, pulp capping, root-end filling, revitalisation	Discolouration with some materials [46,223]
Coronal seal	Resin composite; glass-ionomer base; definitive restoration	Prevent re-contamination	Delayed restoration allows leakage and failure [54]

Table 17. Preventive, aesthetic, impression, surgical, periodontal and implant materials.

Family	Examples	Typical uses	Notes
Fluoride products	Toothpaste, varnish, gel, silver diamine fluoride	Caries prevention and arrest	Varnish and silver diamine fluoride are core professional agents; silver diamine fluoride stains lesions black [26,126]
Bleaching agents	Carbamide and hydrogen peroxide	Tooth whitening	Observe national limits and supervision; counsel on sensitivity [140,224]
Impression materials	Alginate (irreversible hydrocolloid), polyvinyl siloxane, polyether, zinc oxide eugenol; intraoral scanning	Study casts, final impressions, dentures, crowns	Disinfect impressions; polyvinyl siloxane for fixed work, alginate for study casts and primary impressions; digital scanning reduces material use [225,226]
Gypsum products and waxes	Plaster, stone, die stone, bite registration wax	Casts and records	Handle and disinfect correctly
Suture materials	Resorbable (polyglactin, gut), non-resorbable (silk, nylon, polypropylene)	Wound closure after extraction, surgery and biopsy	Choose by site and healing; remove non-resorbable sutures in about a week [166]
Haemostatic agents	Oxidised cellulose, gelatin sponge, collagen, tranexamic acid mouthwash, pressure	Control bleeding after extraction	Particularly helpful for anticoagulated patients [227]
Bone grafts and membranes	Autograft, allograft, xenograft, alloplast; collagen and non-resorbable membranes	Socket preservation, ridge augmentation, regeneration	Selection depends on defect, biology and the surgeon's experience [228,229]
Implant materials	Titanium and titanium alloys; zirconia	Implants, abutments and frameworks	Titanium has the longest evidence base; zirconia is an alternative with shorter-term data [230]
Periodontal materials	Chlorhexidine, local antimicrobials, enamel matrix derivative	Adjuncts to periodontal therapy	Not routine; reserved for defined indications [9]
Infection-control chemicals	Alcohol-based hand rub; chlorhexidine; chlorine-based disinfectants; sterilant-grade products	Hand hygiene, surface disinfection, instrument reprocessing	Follow manufacturer contact times; use compatible products [90]
Local anaesthetics	Lidocaine, articaine, mepivacaine, prilocaine, bupivacaine	Pain control	See the anaesthesia section for doses and cautions

Table 18. Materials mapped to procedures: a quick reference.

Procedure	Typical materials	Key handling points
Caries prevention	Fluoride varnish, toothpaste, silver diamine fluoride, sealants	Dry field for sealants; correct fluoride regimens
Direct restoration	Adhesive, composite, glass-ionomer, matrices, wedges	Rubber dam; incremental placement; curing check

Procedure	Typical materials	Key handling points
Pulp capping and pulpotomy	Calcium silicate cement, sodium hypochlorite, definitive restoration	Control bleeding; seal at once
Root canal treatment	Irrigants, files, medicament, sealer, gutta-percha, coronal seal	Rubber dam; sodium hypochlorite safety; prompt coronal restoration
Scaling and root debridement	Ultrasonic tips, curettes, air-polishing powders, polishing paste	Use least abrasive option; infection-control precautions
Extraction and surgery	Local anaesthetic, sutures, haemostatic agents, bone graft where indicated	Atraumatic technique; follow anticoagulant guidance
Crown and bridge	Impression or scan, provisional resin, cement, ceramic or metal	Margin, moisture control, bonding protocol, cement removal
Complete and partial denture	Impression materials, acrylic, metal framework, soft liner, denture adhesive	Border moulding; hygiene instructions
Implant	Titanium or zirconia fixture, abutment, graft, membrane, suture	Sterile technique; torque and prosthetic protocols
Periodontal therapy	Instruments, adjuncts as indicated	Adjuncts are exceptions, not routine
Bleaching	Carbamide or hydrogen peroxide, desensitising agents	Respect limits; evaluate cause first
Orthodontic aligners and retainers	Thermoplastic sheets, composite attachments, bonded wire retainers	Hygiene and retention counselling
Children and trauma	Stainless steel crowns, glass-ionomer, calcium silicate, splint materials	Behaviour management; see paediatric section

Material safety and stewardship extend beyond clinical use. Store materials as directed, check expiry dates and rotate stock, keep safety data sheets accessible, record batch numbers for implants, bone grafts and other implantable items to allow traceability, and report adverse reactions to the manufacturer and the regulator. Ask all patients about allergies to latex, metals, acrylic, eugenol and local anaesthetics, and use alternatives where needed. Dispose of mercury-containing waste, sharps, chemicals and radiographic waste through licensed streams, and consider environmental impact when selecting disposables and packaging (see the ISO environmental standard in the standards section).

3.45 Core clinical procedures step by step

The preceding sections describe what contemporary evidence recommends. This section turns the recommendations into the sequences of clinical steps that a general dentist performs every day: scaling and polishing, root surface debridement (root planing), simple and surgical extraction, complete and partial dentures, crowns and bridges, and a range of other common procedures. The steps are authored syntheses of standard teaching in the cited textbooks, guidelines and reviews, not a substitute for supervised training or local protocols. Each procedure shares a common frame: confirm the indication and the diagnosis; review the medical history and consent; prepare the operatory, instruments, isolation and anaesthesia; perform the procedure in a defined sequence; give clear after-care; document; and arrange review. The complication tables in the later sections explain what to do when a procedure does not go to plan.

3.46 Scaling, polishing and professional plaque control

Scaling removes plaque, calculus and stain from the tooth surfaces above and below the gingival margin. Polishing smooths the enamel surface and removes extrinsic stain. Professional mechanical plaque removal reduces gingival inflammation and is a core element of the treatment of gingivitis and of supportive care in periodontitis [9,231]. Evidence that a routine scale and polish, given at fixed intervals to every adult regardless of risk, improves long-term periodontal outcomes is limited, and a Cochrane review found little or no difference in outcomes between routine scale and polish and no scale and polish, which supports individualising frequency to risk and need rather than providing it by habit [232]. Polishing is mainly cosmetic, and removes stain more than it improves health, and repeated polishing of exposed dentine or resin restorations may cause unnecessary wear [233].

Scaling can be done with ultrasonic and sonic instruments, hand instruments (sickle scalers and curettes), or both. Machine-driven and manual instrumentation give comparable clinical results, and ultrasonic devices are faster and less tiring for the operator [234]. Air polishing with low-abrasive powders (for example glycine or erythritol) removes biofilm and stain effectively, can reach subgingival sites and is well tolerated, but should be used with technique appropriate to the powder to avoid tissue and dentine damage [233].

Table 19. Scaling and polishing: sequence, key points and cautions.

Step	What to do	Key points and cautions
1. Assess	Review medical history, medications and infection risk; examine soft tissues; chart plaque, bleeding on probing and probing depths; update radiographs as indicated	Diagnose gingivitis or periodontitis first; scaling alone is not periodontal treatment [9]
2. Prepare	Consent; protective equipment for patient and team; pre-procedural rinse is optional; high-volume suction; check ultrasonic device compatibility	Pacemakers and implantable devices: follow the manufacturer's current advice and the device clinic; modern devices are usually safe, but caution is reasonable [90]

Step	What to do	Key points and cautions
3. Disclose and instruct	Show the patient plaque (disclosing agent) and teach brushing and interdental cleaning	Behaviour change is the main driver of lasting benefit [231]
4. Supragingival scaling	Remove calculus with ultrasonic tip or hand scaler, working systematically by sextant with light lateral pressure	Keep tip moving and water on; avoid prolonged contact with one site
5. Subgingival debridement (if needed)	Use fine ultrasonic tips or curettes with anaesthesia as needed; see root surface debridement	This is periodontal therapy and needs diagnosis and a review plan
6. Remove stain and biofilm	Air polishing or rubber cup with a low-abrasive paste; avoid exposed dentine, cervical lesions and resin where possible	Do not routinely polish for its own sake; use the least abrasive option [233]
7. Interdental cleaning and fluoride	Floss or interdental brushes; apply fluoride varnish in patients at caries risk	Fluoride varnish is a core preventive step (see the prevention section) [126]
8. After-care and recall	Explain bleeding and sensitivity; review hygiene technique; set a recall interval by risk	Interval from three months to a year or more according to risk [232]

Contraindications and cautions for air polishing include respiratory conditions such as asthma and chronic obstructive disease, sodium-restricted diets (sodium bicarbonate powders), known allergies to powder components, and certain infectious risks; ultrasonic and air-polishing generate aerosol, so infection-control precautions must be followed (see the infection control section). Patients with a bleeding tendency, those taking anticoagulants and those with severe immunosuppression need case-by-case planning, but most can be scaled safely with local measures.

3.47 Root surface debridement (root planing)

Subgingival instrumentation, formerly called scaling and root planing, is the cause-related step of periodontal therapy. Its aim is to disrupt and remove subgingival biofilm and calculus from the root surface, with minimal removal of cementum, to allow the periodontal tissues to heal and the pocket to shrink [165,235]. Evidence shows that nonsurgical subgingival instrumentation reduces probing depth, improves attachment levels and reduces bleeding, and that the choice between hand and ultrasonic devices, or between full-mouth and quadrant-by-quadrant approaches, makes little difference to outcomes [165,234]. The 2020 EFP guideline specifies a stepwise approach: step one is behaviour change and supragingival control, step two is subgingival instrumentation, step three is for persisting pockets, and step four is supportive periodontal care [9]. See Figure 7.

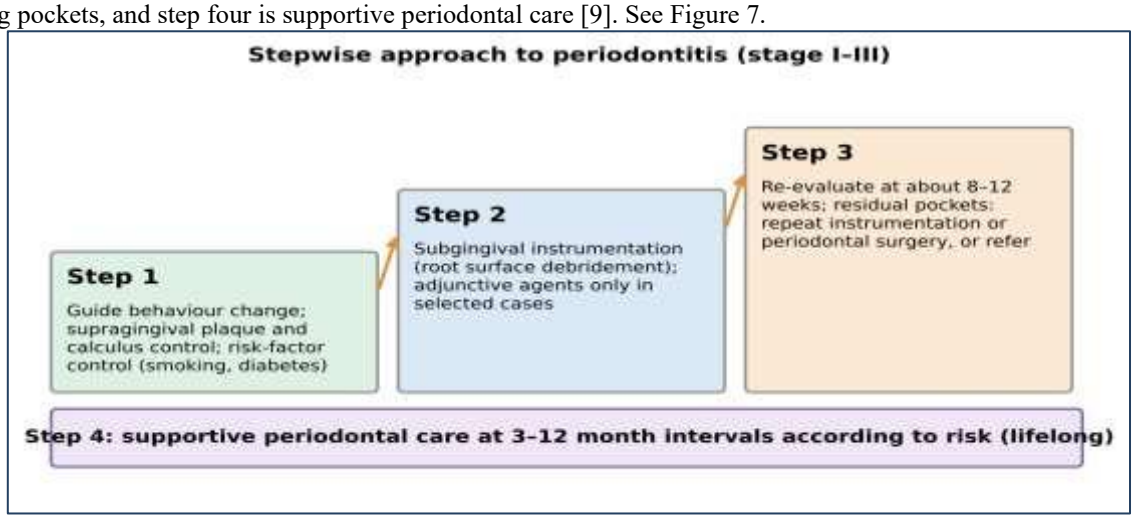

Figure 7. Stepwise approach to the treatment of periodontitis (stage I to III), following the structure of the European Federation of Periodontology S3 guideline. Original schematic illustration.

Table 20. Root surface debridement: sequence and endpoints.

Stage	Actions	Endpoints and cautions
Before	Diagnosis (stage and grade), full-mouth charting, radiographs, risk factors (smoking, diabetes), oral hygiene instruction, supragingival cleaning	Patient understands the long-term nature of treatment and the cost [68]
Anaesthesia	Infiltration or block; topical or intrapocket anaesthetic gel for comfort in selected patients	Treat by quadrant or sextant to ensure comfort and thoroughness
Instrumentation	Ultrasonic or sonic device with a slim subgingival tip, followed by curettes (Gracey or universal) with controlled, overlapping strokes, working apically to coronally	Aim for a smooth, hard, calculus-free root; avoid over-instrumentation of cementum and damage to soft tissue [235]
Furcations and deep pockets	Use fine tips and mini-bladed curettes; accept limits of access in deep pockets, narrow defects and furcations	Refer or plan surgical access when instrumentation is inadequate [165]
Adjuncts	Do not use systemic antibiotics or local antimicrobials routinely; consider only in defined cases and per guideline	Systemic antibiotics are reserved for specific, selected situations (see stewardship) [9,236]

Stage	Actions	Endpoints and cautions
After-care	Analgesia if needed; explain sensitivity, bleeding and recession; reinforce interdental cleaning	Recession may reveal root surfaces and cause sensitivity
Re-evaluation	Re-chart at about 8 to 12 weeks; if pockets of 4 mm or more with bleeding or 6 mm or more remain, re-instrument or progress to the next step	Residual deep pockets and furcations: refer for periodontal surgery or regeneration [9]
Supportive care	Recall at 3 to 12 months by risk: re-chart, remove biofilm, re-instrument residual sites, reinforce behaviour	Stable patients can be recalled less often; unstable ones more often [9]

3.48 Surgical removal of teeth

Simple extraction removes a tooth that is fully erupted using elevators and forceps. Surgical extraction is required when the tooth cannot be removed intact by these means, for example when the crown is broken down or the roots are curved, divergent, ankylosed or hypercementosed, or when the tooth is impacted or partly erupted. The principles of controlled force, adequate access and early sectioning minimise the risk of fracture, damage to adjacent structures and complications [166]. See Figure 8.

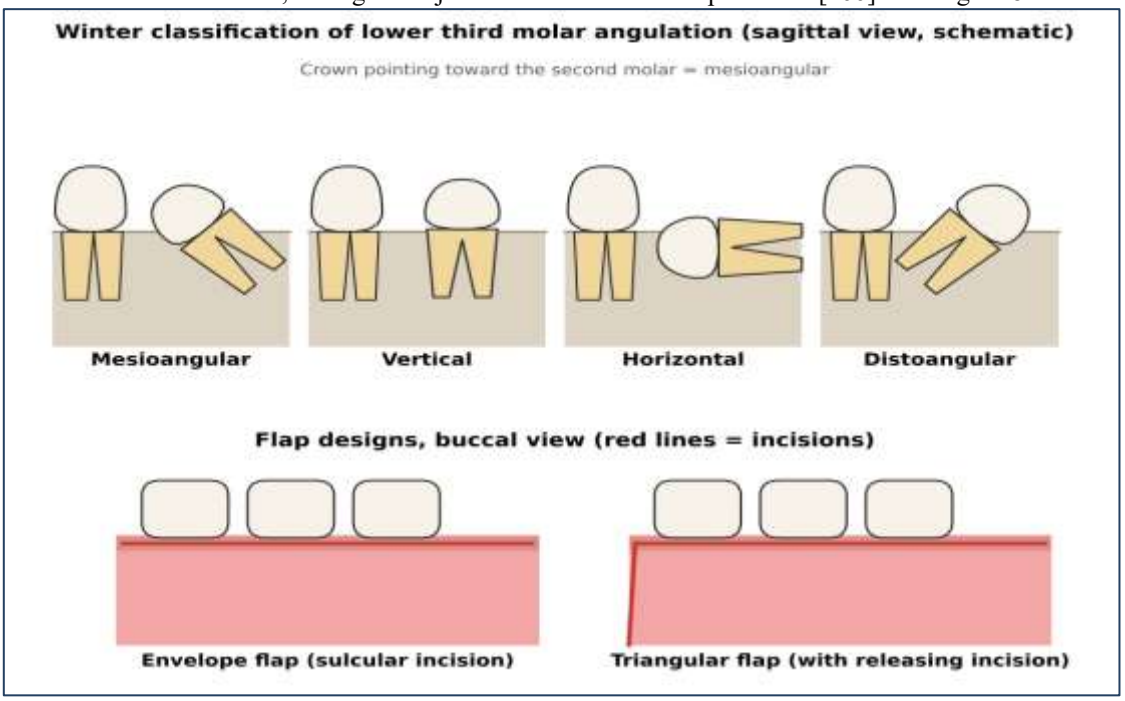

Figure 8. Winter classification of lower third molar angulation (upper row) and envelope and triangular flap designs for surgical extraction (lower row). Original schematic illustration.

Planning starts with the history, the indication for extraction, the medical status and the imaging. Systemic factors to address before surgery include anticoagulant and antiplatelet drugs (most patients can be treated without stopping them, using local haemostatic measures; see national guidance) [106,227], current or past antiresorptive or antiangiogenic therapy and head and neck radiotherapy (risk of osteonecrosis, refer according to guidelines) [107], and cardiac, endocrine and immune conditions that alter risk (see the medical section). For lower third molars, difficulty and risk are assessed with the classification of position and depth, the Winter and Pell and Gregory systems [237,238], and with radiographic signs of nerve proximity (see the section on coronectomy). Antibiotics are not routinely required for healthy patients undergoing extraction [109].

Table 21. Surgical extraction: standard sequence.

Step	Actions	Key points
1. Consent and preparation	Explain diagnosis, options (including no treatment, retention or coronectomy), risks (pain, swelling, bleeding, infection, dry socket, nerve injury, sinus communication, fracture of root or jaw), and after-care; record consent	Use the material-risk framework (see consent in depth) [186]
2. Anaesthesia	Regional block or infiltration (for example, articaine buccal infiltration in mandibular teeth is an option in adults); consider sedation	Test anaesthesia before starting; avoid injury to the lingual and inferior alveolar nerves [110]
3. Flap	Envelope or triangular flap, full-thickness mucoperiosteal, with a base wider than the apex, designed to be sutured over bone; retract and protect the lingual tissue	Flap design affects swelling, pain and dry socket; envelope flaps may give less morbidity in some comparisons [239]
4. Bone removal	Remove only the bone needed for access using a surgical handpiece and copious irrigation; avoid air-driven handpieces	Avoid air-rotor instruments that can cause emphysema; keep irrigation continuous [166]

Step	Actions	Key points
5. Sectioning	Section multirooted teeth into single-rooted pieces, separate the crown from roots where needed, create space to deliver pieces	Cut part-way and fracture the remainder with an elevator to avoid damage to adjacent tissue
6. Luxation and delivery	Elevate with controlled, directed force; avoid levering against adjacent teeth; deliver the tooth or pieces; remove the follicle where indicated	Stop and re-assess if resistance persists
7. Socket care	Inspect the tooth for completeness; curette granulation tissue; irrigate and remove bone and tooth debris; compress buccal and lingual plates; place a haemostatic agent where indicated	Consider socket preservation for aesthetic sites where an implant is planned [229]
8. Closure	Replace the flap; place resorbable sutures; apply pressure with gauze for 20 to 30 minutes	Primary closure is optional in simple sockets
9. After-care	Written instructions; analgesia (for example combined ibuprofen and paracetamol if appropriate) [108]; cold compress; soft diet; no rinsing for the first 24 hours; smoking cessation advice; contact numbers	Warn about dry socket, bleeding and infection [240]
10. Review	Check healing and remove non-resorbable sutures at about 7 days; record outcome	Review sooner for anyone with complications (see the complications section)

Common difficulties include root fracture (retrieve if feasible and safe, or leave a small, non-infected, deeply seated tip after informing the patient and recording it, with review), displacement of a tooth or root into the sinus or soft tissue (stop and refer if it cannot be retrieved easily), oroantral communication (immediate closure if small, referral if large or infected), and uncontrolled haemorrhage (local pressure, sutures, haemostatic agents, and urgent referral if it persists). A dentist should refer, rather than proceed, when imaging shows close nerve or sinus relationship, when anatomy or medical status raises the risk beyond training, or when the procedure is not within the dentist's competence (Table 39).

3.49 Complete and partial dentures

For many patients, particularly older adults and those without access to implants, removable dentures remain the principal means of replacing missing teeth. Well-made dentures restore function, appearance and comfort, but they succeed only if the clinician pays attention to the oral tissues, the support, retention and stability of the prosthesis, the occlusion and the patient's expectations and ability to adapt [136,168]. Implant-retained overdentures, particularly two implants in the mandible, are widely recommended as a first-choice treatment for edentulous patients with problems with conventional lower dentures [135]. See Figure 9.

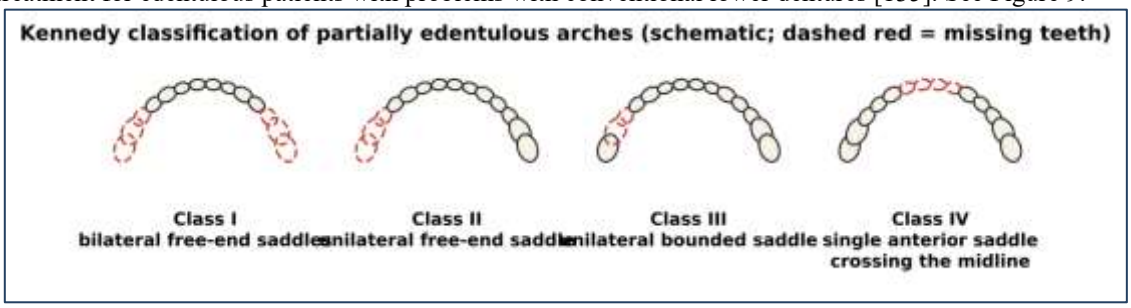

Figure 9. Kennedy classification of partially edentulous arches. Dashed red outlines mark missing teeth. Original schematic illustration.

Table 22. Clinical sequence for a complete denture and a partial denture.

Stage	Complete denture	Partial denture
Assessment	History, expectations, existing dentures, tissue health, ridge form, saliva, occlusal vertical dimension, medical status; radiographs if indicated	Assess remaining teeth: caries, periodontal status, endodontic status, mobility, occlusion; decide which teeth are retainable; classify the arch (Kennedy)
Treatment plan	Options: new dentures, immediate dentures, implant overdentures; preprosthetic surgery if needed; consent and costs	Options: tooth-supported or mixed-support denture, fixed bridge, implants; stabilise the mouth first (disease control) [138]
Mouth preparation	Treat denture stomatitis and infection; recondition tissues; surgical correction of undercuts, tori or flabby ridges	Complete restorative and periodontal care; guide planes, rest seats and contour adjustments to design
Preliminary impressions	Stock or custom trays in alginate or similar for primary casts	Alginate impressions for study casts and diagnosis
Design and special tray	Special trays made on the primary cast	Survey the cast; design clasp, rest, major and minor connector, and indirect retention; write a laboratory prescription
Final impressions	Border-moulded, functional impressions (for example, with silicone or zinc oxide eugenol)	Master impressions after mouth preparation

Stage	Complete denture	Partial denture
Jaw relations	Record occlusal vertical dimension and centric relation with occlusal rims; select tooth shade, shape and size; mark the midline and smile line	Record occlusion where needed with wax or bite registration; select teeth
Try-in	Waxed trial dentures: check aesthetics, phonetics, occlusal vertical dimension and occlusion; patient approval	Try the metal framework and trial teeth
Fit and delivery	Check fit, retention, stability, occlusion and borders; adjust pressure spots; give instructions on insertion, eating, speech, hygiene and night-time removal [241]	As for complete denture, with attention to clasp function and insertion path; check the occlusion on the natural teeth and the saddles
Review	Review at 24 to 48 hours and again after a week or two; adjust sore spots; reline when ridge changes; recall at least annually	Review to adjust and to check on the abutment teeth; maintain periodontal health [138]

Several principles guide success. Support, stability and retention come from the maximum tissue coverage, accurate borders, a well-balanced occlusion and neutral-zone muscle control. A partial denture should be designed to preserve and protect the remaining teeth, using rest seats, bracing and reciprocation, with minimal gingival coverage, and the patient must be able to clean it [138]. Denture hygiene is essential: dentures should be removed at night, cleaned daily with a soft brush and a non-abrasive denture cleanser, and kept in water, and stomatitis managed by improving hygiene, treating infection and correcting fit [217,241]. Immediate dentures replace teeth at the time of extraction and require early relining as the tissues remodel. Patients should be told that adaptation takes weeks, that tissues change, and that replacement or relining is needed over time. Refer to a prosthodontist when there is severe ridge resorption, complex occlusal rehabilitation, maxillofacial defects, or implant treatment beyond the dentist's competence (Table 39).

3.50 Crowns and bridges: fixed prosthodontics

A crown restores a tooth that cannot be reliably restored with a direct restoration: large loss of structure, cusp fracture risk, endodontically treated posterior teeth, severe wear, or aesthetic demands. A bridge replaces one or more missing teeth by joining a pontic to retainers attached to adjacent teeth, or to implants. The minimally invasive principle favours the most conservative option: for example, onlays or partial coverage restorations, adhesive bridges, or implant-supported restorations, rather than full-coverage crowns on healthy abutments [30,167]. See Figure 10.

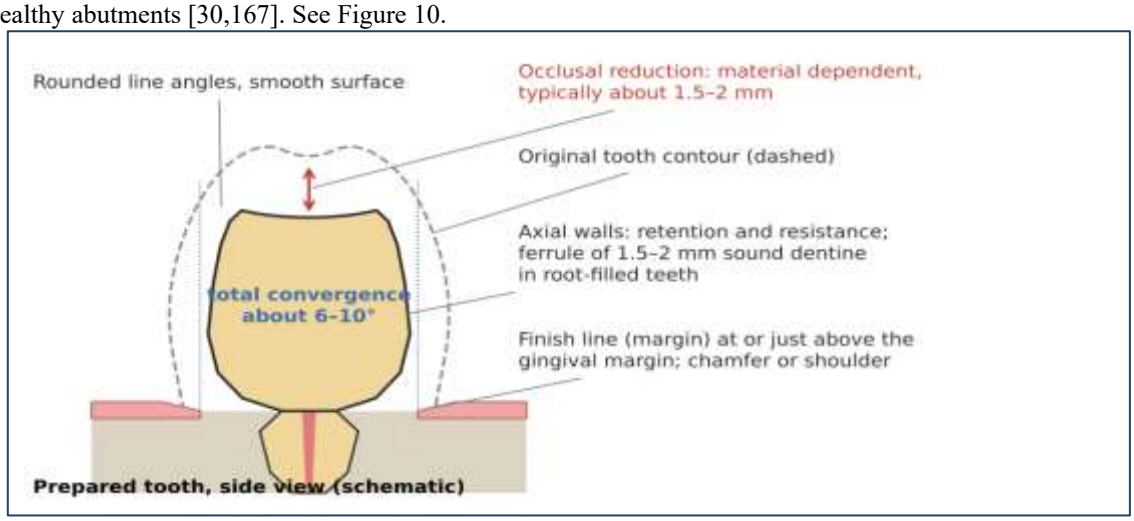

Figure 10. Principles of crown preparation: occlusal reduction, near-parallel axial walls, margin position and ferrule. Values are typical teaching figures and vary by material. Original schematic illustration, not to scale.

Preparation follows biomechanical principles: preserve tooth structure, provide retention and resistance (adequate height and near-parallel walls with a total convergence angle commonly cited as about 6 to 10 degrees), allow adequate thickness of material for strength and aesthetics, finish the margin on sound tooth structure with the margin design matching the material (for example, a chamfer or shoulder for ceramic), and preserve the periodontium by respecting biologic width and placing margins at or just above the gingival margin where possible [167,242]. Endodontically treated teeth need an adequate ferrule (about 1.5 to 2 mm of sound tooth structure above the margin) and, only when necessary, a post for retention of the core, because posts do not strengthen the tooth [243,244].

Table 23. Single crown: clinical sequence.

Step	Actions	Key points
1. Diagnosis and plan	Confirm pulp and periodontal health, caries control, restorability, occlusion and aesthetics; shade and material selection; consent	Control disease before prosthodontics; review radiographs for periapical health [41]
2. Anaesthesia and isolation	Local anaesthesia; cheek and tongue retraction; gingival retraction cord or other method	Protect pulp and soft tissue from heat; keep the margin dry
3. Preparation	Reduce the occlusal and axial surfaces according to the material: guidance varies by manufacturer (for example, about 1.5 to 2 mm occlusal reduction for metal-ceramic and lithium disilicate, and less for monolithic zirconia and gold)	Use water spray and light touch; keep taper, round line angles and a smooth, continuous margin [242]

Step	Actions	Key points
4. Core build-up if needed	Build up core with adhesive restorative material; place post only when needed	Protect remaining tooth structure; maintain ferrule [243]
5. Impression or scan	Digital scan or polyvinyl siloxane impression; record opposing arch and bite; shade	Digital and conventional impressions can give comparable accuracy [226]
6. Provisional	Fit a well-contoured provisional crown with good margins and occlusion; cement with a weak temporary cement	Protect the periodontium and pulp; provisional should not leave open margins
7. Laboratory	Send clear prescription with photographs, shade, material, margin and occlusion requirements	Communicate directly with the technician
8. Try-in and cementation	Remove provisional; check contacts, margins, occlusion and shade; clean and cement according to the material (adhesive resin cement for glass-ceramic and some others; glass-ionomer or resin-modified cements for others)	Follow the manufacturer's bonding protocol; remove excess cement completely because retained cement causes inflammation [167]
9. Final checks	Occlusal adjustment and polishing; hygiene instruction; photographs and records	Warn about sensitivity and that crowns can fail; set a recall

Materials should be chosen according to the location, the occlusal load, the available space, the opposing dentition and the aesthetic demand: gold or monolithic zirconia for strength and minimal reduction, lithium disilicate for aesthetics and moderate loads, and metal-ceramic where strength and aesthetics are needed. Systematic reviews report high medium-term survival of single crowns, with failures mostly from caries, loss of retention, endodontic complications and fracture, and with all-ceramic and metal-ceramic crowns showing broadly comparable survival [30].

Table 24. Bridge options: indications, advantages and limitations.

Type	Indication	Advantages	Limitations
Conventional fixed-fixed bridge	Short span, abutments with good periodontal support and heavy restorations or need for crowns	Predictable and durable	Requires preparation of abutments; risk of caries, endodontic and retention problems [30]
Cantilever bridge	Single missing premolar or lateral incisor with a strong abutment	Fewer abutments	Lever forces; limited indications
Resin-bonded (adhesive) bridge	Missing anterior or premolar teeth with sound abutments and adequate enamel	Minimally invasive; reversible; good survival with careful design [214]	Debonding risk; requires enamel and good bonding technique
Implant-supported single crown or bridge	Healthy abutments are to be preserved; adequate bone	Conserves adjacent teeth; high survival	Surgical phase, cost, biological complications (see the implant section) [230]
Removable partial denture	Multiple missing teeth, long spans, financial or medical limits	Reversible; adaptable	Needs hygiene and adjustment (Table 22)
No replacement	Short dental arch or shortened arches may be adequate; patient's preference	Avoids treatment	Consider function, aesthetics and risks [63]

Bridge planning considers the span, the number and quality of abutments, their periodontal support and root surface area (the traditional rule that the abutments' combined root surface should at least equal that of the missing teeth), the occlusion and parafunction, the position of the pontic and the patient's ability to clean beneath it. Patients must be shown how to clean the bridge using floss threaders, super-floss and interdental brushes, and the periodontal health of the abutments must be maintained [167]. Veneers and partial coverage restorations offer minimally invasive solutions for aesthetic problems in selected teeth, with good long-term survival when bonded to enamel and used appropriately [245]. See Figure 11.

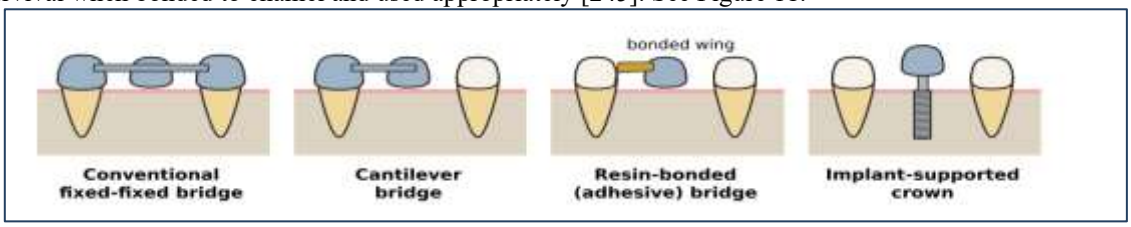

Figure 11. Types of bridge and implant-supported replacement for a missing tooth. Original schematic illustration.

3.51 Other common procedures: a quick-reference guide

Several other procedures are within the scope of most general dentists. The table below gives key steps and cautions; it is a prompt, not a replacement for training. For each, the level (P = perform in general practice if trained, R = refer in complex or high-risk cases) follows the convention used in the complications section.

Table 25. Other common procedures: key steps, cautions and level.

Procedure	Key steps	Cautions and tips	Level
Direct composite restoration	Diagnosis; anaesthesia; isolation with rubber dam; selective caries removal and cavity preparation; matrix	Dam and moisture control determine success [34]	P

Procedure	Key steps	Cautions and tips	Level
	and wedge; adhesive protocol; incremental placement; light-cure; finish and polish; occlusion check		
Fissure sealant	Clean, isolate, etch or use self-etch, apply sealant, light-cure, check occlusion and retention	Dry field essential; review and repair as needed [20]	P
Fluoride varnish	Dry teeth; apply varnish; instruct not to eat hard food for a few hours	Core preventive step in children and adults at risk [126]	P
Vital and non-vital tooth whitening	Assess cause of discolouration; exclude caries and defects; protect gingivae; apply regulated hydrogen or carbamide peroxide; review	Follow national limits (for example, in the European Union up to 6% hydrogen peroxide, under supervision of a dentist) [224]; counsel on sensitivity and realistic outcomes [140,246]	P
Veneer	Plan with mock-up; minimal preparation in enamel; scan or impression; provisional; try-in; adhesive cementation	Enamel bonding gives the best long-term outcomes [245]	P (R for complex cases)
Post and core	Confirm adequate remaining tooth structure and root filling; prepare post space with minimal removal; bond post and core	Posts do not strengthen the tooth; ferrule matters more [243,244]	P
Incision and drainage of a localised abscess	Anaesthesia (note reduced effect in infection); incise at the most dependent point; open the cavity; irrigate; place a drain if needed; address the cause (extraction or root canal treatment)	Antibiotics only if systemic involvement or spreading infection; refer for airway threat, deep neck space infection or toxicity [109,247]	P (R if spreading)
Biopsy of an oral lesion	Photograph and measure; explain; anaesthetise around the lesion; take a representative incisional biopsy or complete excisional biopsy for small benign-appearing lesions; fix in formalin; label; request pathology; follow up result	Lesions that persist for more than 2 to 3 weeks without a clear cause should be biopsied or referred; do not delay suspected cancer [92,248]	P for small lesions; R if suspicious or large
Frenectomy or simple soft tissue surgery	Anaesthesia; incise or use laser; dissect or excise; suture	Indications must be clear; refer for infants or complex cases [166]	P (R in complex cases)
Occlusal splint	Impressions; fabricate a hard stabilisation splint; adjust to even contacts; instruct to wear at night	Reversible; for bruxism and TMD pain, with counselling and self-care [249]	P
Suturing	Choose suture and needle; atraumatic handling; tension-free closure; simple interrupted or continuous; remove or allow to resorb	Avoid tension and strangulation of tissue	P
Emergency pulp care	Pain relief; pulpotomy or pulpectomy; temporary dressing	See the vital pulp therapy and endodontics sections [10]	P

Whatever the procedure, standard precautions, accurate records, appropriate consent and a plan for review apply. If the clinician is uncertain, the question to ask is the one used throughout this review: is this within my competence, is it indicated for this patient, has the patient had a balanced explanation, and what would I do if something went wrong?

3.52 Complications in general practice: principles of prevention, recognition and response

Every procedure in this review carries a risk of complications, and the quality of a practice is judged less by whether complications occur than by how well they are prevented, recognised and managed. Most complications are reduced by the same habits: a full medical and medication history, justified imaging, a clear diagnosis and plan, correct technique with appropriate isolation and magnification, informed consent that names the material risks, and early review. When a complication occurs, a consistent response protects the patient and the clinician. Stop and make the patient safe. Assess what has happened and whether it is progressing. Treat what is within competence. Explain honestly what occurred and what will happen next. Escalate or refer when the problem is beyond competence or equipment, or when delay would harm the patient. Document contemporaneously and review the event as a learning exercise. See Figure 12.

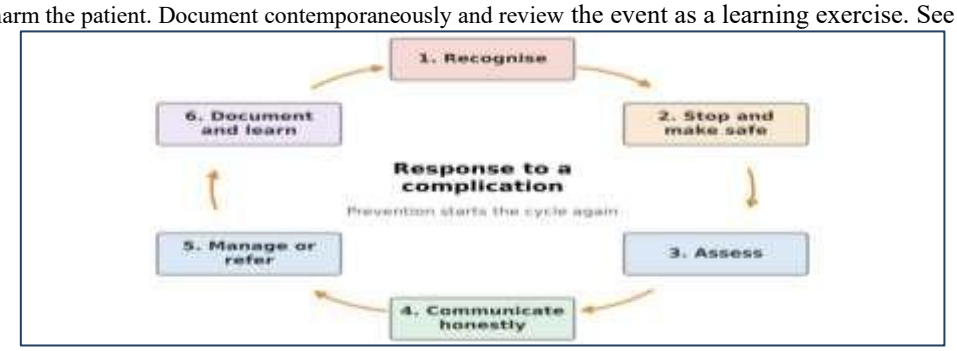

Figure 12. A six-step response to a complication: recognise, stop and make safe, assess, communicate honestly, manage or refer, and document and learn. Original schematic illustration.

The tables that follow use a three-level code in the final column. P means the general dentist can usually manage the problem in practice. R means refer, with the specialty and the usual urgency given in brackets. E means an emergency: stabilise, call emergency services or arrange immediate hospital transfer. These tables are authored syntheses of the sources cited and of widely taught clinical practice. They are not substitutes for local protocols, for specialist advice or for judgement about the individual patient, and doses and thresholds must be checked against current local guidance and product labelling.

3.53 Complications of local anaesthesia and sedation

Most injection complications are minor and self-limiting, but a few are serious. Persistent altered sensation after dental local anaesthesia is uncommon, and large series have reported that lingual and inferior alveolar nerve involvement is most often associated with inferior alveolar nerve block [119,250]. Local anaesthetic systemic toxicity is rare but life-threatening and is managed with airway support, seizure control, advanced life support and, in hospital, intravenous lipid emulsion [251]. Sedation complications are principally airway and respiratory events, which is why standards require appropriate training, monitoring and rescue skills [150,252].

Table 26. Complications of local anaesthesia and sedation.

Complication	Recognition	Management in practice	Level
Haematoma after posterior superior alveolar or other blocks	Rapidly developing facial swelling and later bruising	Apply pressure, reassure, advise that bruising resolves over one to two weeks; antibiotics not routinely required	P; R (oral surgeon, urgent) if expanding or airway concern
Trismus	Limited mouth opening after injection or procedure	Warm compresses, anti-inflammatory analgesia, gentle jaw exercises, review; exclude infection	P; R (oral surgeon or physiotherapist) if not improving over about two weeks or if infection suspected
Transient facial palsy after block reaching the parotid	Facial weakness, inability to close the eyelid	Reassure; protect the eye (lubricate, patch) until recovery as the anaesthetic wears off	P; R (physician) if it persists beyond the expected duration
Transient visual disturbance or diplopia	Blurred or double vision during or after injection	Reassure, cover the affected eye, delay discharge until resolved	P; R (urgent) if it persists
Persistent paraesthesia (lingual or inferior alveolar nerve)	Numbness, tingling or pain in the lip, chin or tongue beyond the expected duration	Document extent and time course, inform the patient, review at intervals, avoid repeat blocks; record neurosensory testing	R (oral and maxillofacial surgeon or neurosensory service; earlier referral gives better options)
Needle fracture	Broken needle in tissue	Keep the patient still with mouth open, retrieve if visible with forceps, do not explore blindly; obtain radiographs	R (oral surgeon, same day) if not retrieved
Allergic reaction or anaphylaxis	Urticaria, wheeze, swelling, hypotension	Stop the agent; intramuscular adrenaline, airway, oxygen, call for help [253]	E
Methaemoglobinaemia (rare; some agents)	Cyanosis unresponsive to oxygen, dyspnoea	Oxygen and call emergency services for specific treatment	E
Local anaesthetic systemic toxicity	Perioral tingling, tinnitus, agitation, seizures, arrhythmia	Stop injection, oxygen, airway, treat seizures, call emergency services; lipid emulsion in hospital [251]	E
Soft-tissue self-injury (lip or tongue biting)	Ulcer or swelling after a procedure, especially in children	Warn carers beforehand; treat ulcers with topical care and analgesia	P
Oversedation or respiratory depression	Reduced responsiveness, falling oxygen saturation, airway obstruction	Stimulate, open the airway, give oxygen, support ventilation, use reversal agent if trained and indicated, call emergency services [252]	E

3.54 Complications of restorative and fixed prosthodontic treatment

Restorative complications are usually biological (sensitivity, pulpitis, secondary caries) or mechanical (fracture, debonding, open margins). Systematic reviews of single crowns and fixed prostheses show that technical complications such as ceramic chipping and loss of retention, and biological complications such as caries and endodontic problems, accumulate over time [30,31], which supports maintenance recall and a frank discussion of lifespan at consent.

Table 27. Complications of direct and indirect restorations.

Complication	Recognition	Management in practice	Level
Post-operative sensitivity	Short sharp pain to cold, biting or sweet after restoration	Check occlusion and margins, desensitising agents, review; most settle	P; R (endodontic care) if spontaneous or lingering pain develops

Complication	Recognition	Management in practice	Level
Pulp exposure during caries removal	Bleeding point in the cavity floor	Control bleeding, vital pulp therapy with a hydraulic calcium silicate cement and a sealed restoration [36]	P; R (endodontist) if bleeding is uncontrolled or symptoms indicate necrosis
Overhang, open contact, food impaction	Bleeding papilla, food packing	Recontour or replace the restoration; restore the contact	P
Fractured restoration or cusp	Loss of material, sharp edge	Repair or replace; consider cuspal coverage	P; R (prosthodontist) for complex rehabilitation
Secondary caries	Marginal discolouration, radiographic change	Risk assessment and prevention; repair or replace	P
Crown debonding	Loose or lost crown	Check preparation form and cause; re-cement or remake	P
Veneering ceramic chipping	Visible chip or roughness	Polish or intraoral repair; replace if function or aesthetics are compromised	P; R if the chip is part of a wider failure
Pulpitis or necrosis after crown preparation	Persistent pain or sensitivity, apical change	Diagnose, endodontic access through the crown if suitable	P or R (endodontist), according to competence
Gingival recession or inflammation at margins	Exposed margin, bleeding	Improve hygiene, adjust margins, soft tissue management	P; R (periodontist) for progressive recession
Lichenoid or allergic reaction to a restorative material	Mucosal lesion adjacent to a restoration	Confirm by exclusion and biopsy if needed; replace material if clinically justified	R (oral medicine)

3.55 Complications in endodontics

Endodontic complications are best prevented by correct diagnosis, dental dam isolation, a straight-line access, an adequate working-length strategy and a controlled irrigation protocol, as set out in consensus quality guidelines and in the S3 guideline [10,254]. Instrument fracture, perforation and irrigant extrusion are the main procedural accidents. Decisions after instrument fracture depend on the stage of preparation, the canal anatomy and the presence of infection, and options include bypassing, removing or leaving the fragment and monitoring it, always with communication to the patient [221,255]. Accidental perforations are best sealed promptly with a calcium silicate cement, with prognosis depending on the location, the time elapsed and the quality of the seal [60]. A sodium hypochlorite accident is an emergency characterised by sudden severe pain, rapid swelling, ecchymosis and bleeding from the canal, managed by stopping irrigation, saline irrigation, analgesia and urgent hospital or specialist care [218].

Table 28. Complications in endodontic treatment.

Complication	Recognition	Management in practice	Level
Inter-appointment pain or flare-up	Pain and swelling after treatment	Check occlusion, analgesia, drain if fluctuant; antibiotics only for systemic involvement [37]	P; R (endodontist) if persistent
Ledge or blocked canal	Loss of working length, resistance	Pre-curve small files, chelator, patience; avoid forcing	P; R (endodontist) if not negotiable
Instrument separation	Fragment visible on radiograph	Assess position and infection, bypass, remove or monitor; inform and document [221,255]	R (endodontist, planned) when removal is indicated and beyond competence
Perforation (furcal, strip or apical)	Sudden bleeding, pain, radiographic confirmation	Seal promptly with calcium silicate cement under dam [60]	R (endodontist, early) for inaccessible or large defects
Sodium hypochlorite accident	Immediate severe pain, swelling, bruising, bleeding	Stop irrigation, irrigate with saline, analgesia, reassure, urgent assessment [218]	E; R (oral surgeon or hospital, same day)
Extrusion of sealer or filling material	Pain, radiographic overfill, possible neurosensory change	Analgesia and monitoring; review	R (oral surgeon, urgent) if nerve involvement is suspected
Missed canal or persistent apical periodontitis	Persisting symptoms or lesion	Retreatment with magnification, or surgical option	R (endodontist)
Vertical root fracture	Isolated deep probing defect, J-shaped lesion, sinus	Confirm diagnosis; extraction is usually indicated	P for extraction; R (surgeon) for complex removal
Coronal leakage or loss of restoration	Contamination of obturation	Restore promptly; assess need for retreatment [42]	P
Rubber dam related injury or aspiration	Lost clamp or dam fragments	Tie clamps with floss; if aspirated or swallowed, see Table 38	E if airway threatened

3.56 Root canal treatment: complications in depth, their management and when to refer

Root canal treatment has high success when it is carried out to a good standard, but outcome depends on the stage and quality of each step, and a systematic approach to the things that can go wrong is part of competent practice. Prospective studies show that the preoperative condition (especially apical periodontitis), the quality of the root filling and the quality of the coronal restoration all

influence outcome and tooth survival [41,254,256]. Many complications can be avoided by planning: a good-quality preoperative radiograph (with limited-field cone beam computed tomography only where it changes management) [58], careful assessment of anatomy, restorability and periodontal condition, rubber dam, magnification, a straight-line access, and a controlled irrigation protocol [10].

The earlier summary table of endodontic complications is expanded here by treatment stage. For every complication, the principles are the same: recognise it early, stop and assess before carrying on, communicate honestly with the patient, record what happened, make the tooth safe and comfortable, and decide whether to continue, to refer or to extract. See Figure 13.

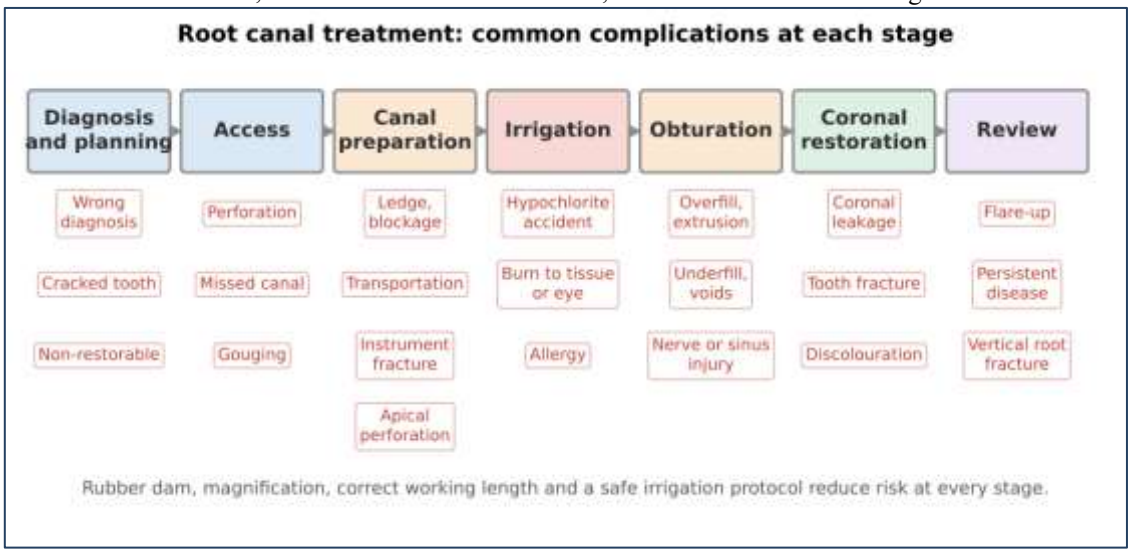

Figure 13. Common complications at each stage of root canal treatment, from diagnosis to review. Original schematic illustration.

Table 29. Complications of root canal treatment by stage: prevention, management and level (P = manage in practice, R = refer).

Stage and complication	Prevention	Management	Level
Diagnosis and access — wrong diagnosis (for example, non-endodontic pain, cracked tooth, periodontal origin)	Careful history, tests, imaging; consider other causes [10]	Stop; re-evaluate; refer for orofacial pain or periodontal specialist input where needed; a cracked tooth may need protection with a cuspal coverage restoration, with variable prognosis [257]	P; R if diagnosis uncertain
Access: perforation of crown or floor, gouging	Pre-operative radiographs; know the pulp chamber anatomy; use magnification [258]	Seal immediately with calcium silicate cement under dam; manage the periodontal consequences; review [60,259]	P for small and fresh; R (endodontist) for large, long-standing or furcal
Calcified or hidden canals, missed canal (for example, second mesiobuccal canal in upper molars)	Look for the canal under magnification; use ultrasonic tips; consider CBCT in retreatment	Search the pulp floor systematically; use troughing with care; refer if canals cannot be located [260]	P; R if not found
Rubber dam clamp failure, aspiration or ingestion of an instrument	Tie floss to clamps and instruments; check dam fit	Retrieve if visible; if swallowed, radiograph and refer; if aspirated, emergency [261]	E when airway threatened
Canal preparation — ledge, blockage, transportation	Pre-curve files, use lubricant and chelator, small files to length before larger ones, avoid forcing [220]	Re-negotiate with pre-curved small files and chelator; if not possible, disinfect as far as possible and refer or monitor	P; R if not negotiable
Loss of working length	As above; use an apex locator and radiographs	Re-establish with patency file; record true working length	P
Instrument fracture	Single-use or limited-use files; inspect before use; correct motor settings and technique [221]	Assess position and whether infection is present; bypass or remove with ultrasonic technique under magnification, or leave and monitor; inform the patient and document [174,255]	R (endodontist) when removal is indicated and beyond competence
Apical perforation or over-instrumentation	Accurate working length; avoid enlarging beyond constriction	Seal with calcium silicate cement if accessible; reassess	P for small; R for large
Strip perforation in a thin root	Avoid aggressive coronal flaring in curved roots	Early repair under magnification	R (endodontist)
Irrigation — sodium hypochlorite extrusion	Side-vented needle; short of working length; gentle pressure;	Stop at once; reassure; analgesia; consider irrigating with saline; ice then warm	E; R

Stage and complication	Prevention	Management	Level
	no binding; avoid in open apices and perforations [177,218]	compresses; high-dose corticosteroid or antibiotics at clinician's judgement; same-day referral to oral surgery or hospital, especially if airway involved; follow up daily [218]	
Chemical burn from irrigant to soft tissue or eye	Dam; patient protective eyewear; careful handling	Irrigate eye or tissue with water or saline; seek ophthalmic or medical care	E
Allergy (latex, medicament, anaesthetic)	History	Remove allergen; emergency care if anaphylaxis (see medical emergencies)	E if systemic
Obturation — overfill or extrusion of sealer or gutta-percha	Accurate length and apical control; avoid excess sealer; select technique to the case	Analgesia and monitoring; if near the inferior alveolar nerve or the sinus, urgent referral for possible removal; neurosensory change warrants early surgical advice [262,263]	R (oral surgeon, urgent) if nerve involved
Underfill, voids, poor density	Good shaping, cleaning, drying; correct technique	Retreat if symptomatic or apical disease persists	P; R
After treatment — post-operative pain or flare-up	Complete cleaning; occlusal reduction if painful; avoid over-instrumentation; manage anxiety [175,264]	Check occlusion, analgesia, drain if fluctuant, re-instrument and irrigate if needed; antibiotics only for systemic involvement or spreading infection [37]	P; R if persistent
Tooth discolouration	Remove pulp tissue and sealer from the chamber; avoid colouring materials such as some sealers and calcium silicates in anterior teeth	Internal bleaching, or restoration	P [223]
Coronal leakage, loss of temporary or permanent restoration	Immediate or early definitive restoration	Restore promptly; retreat if contaminated	P [54]
Vertical root fracture	Avoid excessive taper, post force and heavy lateral condensation; restore with cuspal protection	Confirm by examination and imaging; extraction in most cases; resection or hemisection in selected multirooted teeth [59]	P for extraction; R if complex
Persistent or new apical periodontitis	Technical quality; coronal seal	Retreatment, apical surgery or extraction according to restorability and patient preference [65,176]	R (endodontist)

Management of post-operative pain and flare-up. Pain after root canal treatment is common but usually mild and short lived; systematic reviews report that pain is highest in the first days and falls steadily, and that flare-ups (marked pain and swelling that need unscheduled care) affect a small proportion of patients [175,264]. A practical approach is to reassure the patient, advise regular non-steroidal anti-inflammatory drugs with paracetamol where there is no contraindication [108], and check the occlusion. If pain is severe or swelling is present, the tooth is reopened, drained through the canal or by incision, and re-irrigated, with antibiotics reserved for systemic involvement, spreading infection or immunocompromise [37]. A persistent pain after seemingly adequate treatment should prompt consideration of a missed canal, a root fracture, a non-odontogenic cause (neuropathic or myofascial pain, sinusitis) and referral. See Figure 14.

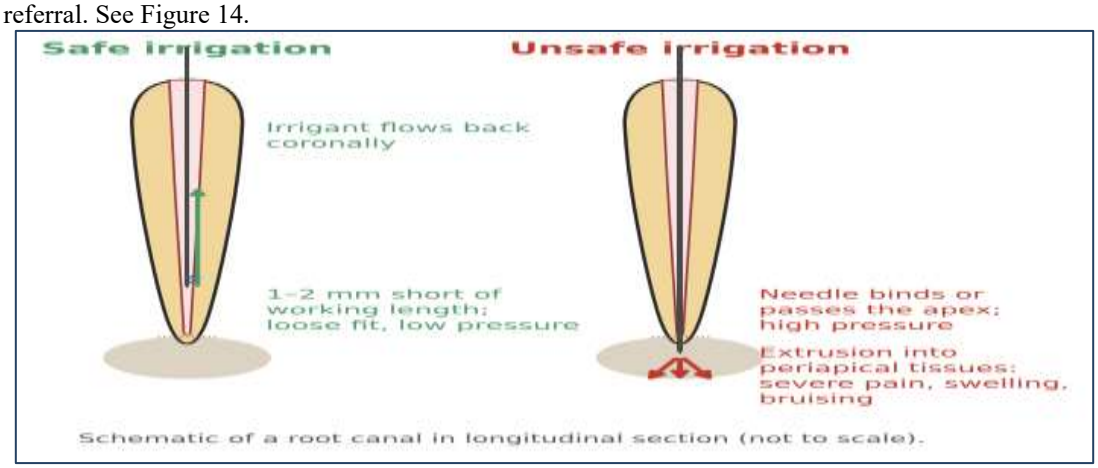

Figure 14. Safe and unsafe irrigation technique. A side-vented needle placed short of the working length with free backflow reduces the risk of extrusion of sodium hypochlorite beyond the apex. Original schematic illustration, not to scale.

Table 30. Options for a root-filled tooth with persistent or recurrent disease.

Option	When appropriate	Evidence and notes
Monitor	Asymptomatic, small or stable lesion, patient informed	Many periapical lesions heal slowly over years; follow with periapical radiographs [10]

Option	When appropriate	Evidence and notes
Non-surgical retreatment	Inadequate root filling, missed canals, coronal leakage, restorable tooth	Good outcomes, particularly where the original treatment was poor and the cause can be corrected [176,265]
Endodontic microsurgery	Retreatment not feasible or unsuccessful; surgical access; adequate bone	High success with magnification, ultrasonic tips and calcium silicate root-end filling [64,65]
Intentional replantation	Selected cases where surgery is not feasible	Specialist technique; careful selection [66]
Extraction and replacement	Non-restorable tooth, fracture, severe periodontal loss, patient choice	Compare honestly with preserving the tooth; implants and bridges have their own risks [63]

Communication, consent and documentation for endodontic complications. Patients should be told before treatment that root canal treatment is not always successful, that complications such as fracture of an instrument, perforation, flare-up and need for retreatment can occur, and what the alternatives are, including extraction and no treatment. When a complication occurs, tell the patient promptly and in plain language, explain what it means for the outcome and what options exist, record the event, the explanation, the management and the plan, and arrange follow-up. The principles of candour, apology and documentation apply (see the adverse events section) [266]. Referral is appropriate, and not a failure, for complex anatomy, calcified canals, retreatment with ledges or fractured instruments, large perforations, immature teeth with necrosis, teeth with combined lesions and any case where the dentist lacks the experience, magnification or equipment (see the referral table). Where the cause is a failure of treatment quality, honest discussion of the options, including whether fees should be adjusted or refunded, is part of ethical practice (see the section on practice management).

3.57 Complications in periodontal care

Table 31. Complications and acute conditions in periodontal care.

Complication	Recognition	Management in practice	Level
Post-instrumentation sensitivity or recession	Cold sensitivity, exposed roots	Desensitising agents, fluoride, hygiene advice, review	P
Periodontal abscess	Localised swelling, suppuration, deep pocket	Drainage, debridement, irrigation; antibiotics only with spreading infection or systemic involvement [57]	P; R (periodontist) if recurrent or involving furcation
Necrotising periodontal disease	Painful ulcerated, necrotic papillae, bleeding, halitosis	Gentle debridement, oral hygiene support, analgesia; systemic antimicrobial where systemic involvement; exclude HIV or other predisposing conditions [57]	P; R (physician or oral medicine) for systemic involvement or underlying disease
Endodontic-periodontal lesion	Deep pocket with pulp necrosis or sinus	Establish pulpal status; usually treat endodontic component first and reassess periodontal response [57]	R (endodontist or periodontist) if complex
Non-response to therapy	Persisting pockets and bleeding at re-evaluation	Check plaque control and risk factors, repeat instrumentation, then step 3 [9]	R (periodontist) for residual deep sites
Progressive mobility or furcation involvement	Increasing mobility, bone loss	Splinting, occlusal management, prognosis assessment	R (periodontist or prosthodontist)
Gingival enlargement	Overgrowth related to drugs or hormones	Hygiene, identify drug cause with physician, surgical correction when needed	R (periodontist) for surgery

3.58 Complications of tooth extraction and oral surgery

Alveolar osteitis (dry socket) presents with severe pain typically two to four days after extraction, with a partly or fully empty socket and halitosis, and management is symptomatic with irrigation, a medicated dressing if used locally, analgesia and review [240]. Post-extraction bleeding in patients taking anticoagulants is managed locally, and guidance generally favours continuing anticoagulants with local haemostatic measures and liaison with the prescriber [106,227]. Oroantral communication is managed according to size and timing: small communications may heal with blood clot protection and sinus precautions, while larger or persistent defects need surgical closure, usually with a buccal advancement flap or buccal fat pad [267]. Nerve injury must be recognised and documented early, as outcomes depend on timely assessment [110].

Table 32. Complications of extraction and minor oral surgery.

Complication	Recognition	Management in practice	Level
Alveolar osteitis	Severe pain 2–4 days after extraction, empty socket	Gentle irrigation, medicated dressing, analgesia, review [240]	P
Post-extraction haemorrhage	Persistent bleeding after the first hours	Remove clot, pressure with gauze or tranexamic acid-soaked gauze, local anaesthetic with vasoconstrictor, haemostatic agent and sutures; review medication [227]	P; E or R (hospital) for uncontrolled bleeding or suspected coagulopathy
Post-operative infection	Increasing pain, swelling, pus, trismus	Drainage and source control; antibiotics only for spreading or systemic infection	P; R or E (oral surgeon or hospital) with airway signs

Complication	Recognition	Management in practice	Level
Oroantral communication	Fluid from nose, air passage, altered voice	Small: clot protection, sinus precautions, review; moderate or large: refer for closure; avoid probing [267]	R (oral surgeon, within days; same day if root or tooth in sinus)
Root or tooth displaced into sinus or tissue space	Lost fragment	Stop, take radiographs, do not search blindly	R (oral surgeon, same day)
Fracture of maxillary tuberosity	Mobile bone segment with tooth	Stabilise; retain the segment where possible	R (oral surgeon, urgent)
Mandibular fracture	Pain, malocclusion, step, mobility	Support the jaw, radiographs, analgesia	R or E (oral surgeon, urgent)
Inferior alveolar or lingual nerve injury	Numbness, tingling, pain	Document, reassure, record sensory testing, early referral [110]	R (oral surgeon, early)
Temporomandibular joint dislocation	Open lock, inability to close	Manual reduction after analgesia; support, rest, soft diet	P; R if reduction fails
Surgical emphysema	Crepitus, rapid swelling after air-driven handpiece use	Stop, assess airway, antibiotic and observation per specialist advice	R or E (oral surgeon or hospital)
Damage to adjacent teeth or restorations	Chipped or loosened adjacent tooth	Inform the patient, repair, document	P
Retained root	Fragment on postoperative radiograph	Assess risk and benefit; remove or monitor with consent	P or R, according to difficulty

3.59 Complications in implant dentistry

Implant complications are usually classified as biological (mucositis, peri-implantitis, failure to integrate, nerve and sinus complications), technical (screw loosening, abutment or prosthesis fracture, ceramic chipping) and aesthetic. Systematic reviews of single crowns and fixed prostheses on implants show that technical and biological complications are common over five years even when survival is high [230,268], which is why consent and maintenance planning matter. Peri-implant mucositis and peri-implantitis follow the diagnostic definitions and treatment sequence of the consensus report and the EFP S3 guideline [76,78]. Haemorrhage into the floor of the mouth after perforation of the lingual cortex in the anterior mandible is a rare but potentially airway-threatening emergency [269].

Table 33. Complications of implant treatment.

Complication	Recognition	Management in practice	Level
Failure of osseointegration or early infection	Mobility, pain, suppuration	Remove the implant, debride, allow healing, reassess for re-treatment	R (implant surgeon) for re-treatment planning
Implant-related nerve injury	Numbness, tingling or pain after placement	Review imaging; an implant encroaching on the canal may need early repositioning or removal; document and refer urgently [110]	R (oral surgeon, urgent)
Floor-of-mouth haematoma	Rapid sublingual swelling, tongue elevation, airway compromise	Airway protection, pressure, call emergency services [269]	E
Sinus perforation or implant displaced into sinus	Epistaxis, sinusitis, radiographic finding	Stop, image, antibiotics and decongestants per specialist, retrieval	R (oral surgeon or ENT, urgent)
Wound dehiscence or exposed cover screw	Exposed implant or membrane	Chlorhexidine, hygiene, review; remove loose exposed material	P; R if graft loss
Screw loosening	Loose crown, bite changes	Tighten to manufacturer torque, check occlusion and fit, replace the screw if needed	P
Ceramic chipping or prosthetic fracture	Chip, fracture	Polish, repair or remake; review occlusion and parafunction	P; R (prosthodontist) for complex cases
Peri-implant mucositis	Bleeding, no bone loss	Mechanical debridement, hygiene instruction, review [78]	P
Peri-implantitis	Bleeding or pus with progressive bone loss	Non-surgical therapy first, then surgical therapy where indicated [78]	R (periodontist or implant surgeon)
Residual cement	Persistent inflammation	Remove cement; review prosthesis design	P
Aesthetic complication (recession, malposition)	Visible deficiency	Assess cause; soft-tissue or prosthetic correction	R (periodontist or prosthodontist)
Implant fracture	Sudden loss of function	Remove or retain according to situation and risk	R (implant surgeon)

3.60 Complications in removable prosthodontics, orthodontics and aligner therapy

Denture problems are usually mechanical or mucosal. Sore spots are relieved by selective adjustment of the fitting surface, ulceration is reviewed after relief, poor retention prompts assessment of the border seal, occlusion and tissue changes, and denture stomatitis is managed by hygiene, leaving the denture out at night and treating any candidal overgrowth [94,136]. Orthodontic and aligner

complications include gingival inflammation and recession, white-spot lesions, relapse and root resorption. A systematic review found that some apical root resorption is common after orthodontic tooth movement, that severe resorption is uncommon, and that the risk is related to treatment duration, force and individual susceptibility [270].

Table 34. Complications of removable prostheses, orthodontics and aligners.

Complication	Recognition	Management in practice	Level
Denture sore spot or ulcer	Localised pain, ulcer under the denture	Relieve the fitting surface, review in a few days; biopsy if the ulcer does not heal	P; R (oral medicine) if it persists beyond two to three weeks
Poor retention or instability	Loose denture	Check borders, extension, occlusion, tissue change; reline or remake	P; R (prosthodontist) for complex rehabilitation
Denture stomatitis	Erythema under the upper denture	Hygiene, remove at night, topical antifungal if candidal [94]	P
Denture fracture	Cracked or broken base	Repair or remake; assess occlusion and fit	P
Gingival inflammation with aligners or fixed appliances	Plaque, bleeding	Hygiene instruction, professional cleaning, pause if severe	P
White-spot lesions	Chalky demineralisation around attachments	Fluoride and remineralisation advice; monitor	P
Root resorption	Blunted roots on radiographs, mobility	Take radiographs when indicated, pause or stop if marked [270]	R (orthodontist)
Attachment loss or tracking problems	Aligners do not seat	Review stage, refinement or new impressions	P within competence; R (orthodontist) for complex cases
Relapse	Teeth drifting after treatment	Retention review and re-treatment plan	P or R (orthodontist)
Temporomandibular symptoms	Pain or clicking	Conservative management, pause treatment if needed [141]	P; R (orofacial pain service) if persistent

3.61 Complications in children, dental trauma and sedation

Paediatric complications include local anaesthetic overdose (weight-based limits), lip and cheek biting after anaesthesia, aspiration or swallowing of crowns or instruments, high occlusion after preformed crowns, failure of pulp treatment in primary teeth and complications of trauma. Pulpal necrosis, root resorption (replacement and inflammatory), ankylosis with infraocclusion and discolouration are the principal sequelae of luxation and avulsion, and the IADT guidelines specify follow-up and indications for intervention [128–130]. Sedation of children follows monitoring and rescue standards [252].

Table 35. Complications in children and after dental trauma.

Complication	Recognition	Management in practice	Level
Local anaesthetic overdose in a child	Agitation, drowsiness, seizures	Prevent by weight-based dosing; if suspected treat as systemic toxicity [251]	E
Self-inflicted lip or cheek injury	Ulcer or swelling hours later	Warn carers; soft diet, topical care, review	P
High occlusion after preformed crown	Premature contact, discomfort	Usually settles within days to weeks as teeth adapt; review	P
Failed pulpotomy in a primary tooth	Swelling, sinus, pain, radiolucency	Extract or pulpectomy according to tooth and cooperation [132]	P; R (paediatric dentist) for complex cases
Pulp necrosis after trauma	Greyish crown, sinus, radiolucency	Endodontic treatment according to IADT guidance	P or R (endodontist)
Replacement resorption and ankylosis	Infraocclusion, metallic percussion note	Monitor; plan for decoronation or prosthetic management in growing patients	R (paediatric dentist or oral surgeon)
Aspiration or swallowing of a crown or instrument	Coughing, choking, missing item	See Table 38	E when airway threatened
Suspected non-accidental injury	Inconsistent injuries, neglect	Document, follow reporting duty, seek advice	R (child protection services; see safeguarding section)

3.62 Spreading odontogenic infection and sepsis

Most dental infections remain localised, but a minority spread through fascial spaces and can threaten the airway or the central nervous system. A review of complications of odontogenic infection describes spread to the submandibular, sublingual and submental spaces (Ludwig's angina), the parapharyngeal and retropharyngeal spaces, the orbit and cavernous sinus, with possible mediastinitis, sepsis and airway obstruction [271]. Early recognition of red flags and immediate escalation are the mark of safe practice.

Table 36. Red flags in dental infection: recognise and escalate.

Red flag	Why it matters	Action
Difficulty swallowing or breathing, drooling, voice change, stridor	Airway compromise	E: call emergency services; keep the patient upright; oxygen
Floor-of-mouth swelling, raised tongue	Ludwig's angina	E: urgent hospital transfer for airway and surgical care
Trismus with fever and spreading swelling	Deep fascial space infection	E or R (oral surgeon or hospital, same day)
Periorbital swelling, visual change, severe headache	Orbital or intracranial spread	E: urgent hospital care
Fever, tachycardia, hypotension, confusion	Sepsis	E: emergency services; antibiotics per protocol
Neck swelling or chest pain after dental infection	Cervical or mediastinal spread	E
Immunocompromise or diabetes with infection	Higher risk of rapid spread	Low threshold to refer or admit

3.63 Medical emergencies in the dental chair: recognition and immediate response

A systematic approach (airway, breathing, circulation, disability, exposure) applies to every emergency, with a call for help early and an automated external defibrillator available. The European Resuscitation Council guidelines describe the chain of survival and basic life support [272], the World Allergy Organization guidance describes the recognition and treatment of anaphylaxis, with intramuscular adrenaline as the first-line treatment [253], and dental practice standards list the equipment and drugs recommended for primary dental care [124]. Doses and drugs in the table are typical, must follow local protocol and must be checked against current guidance.

Table 37. Medical emergencies: recognition and first response.

Emergency	Recognition	First response (follow local protocol)	Call emergency services
Syncope (faint)	Pallor, sweating, slow pulse, loss of consciousness	Lie flat and raise the legs, check airway and breathing, oxygen if needed	If no rapid recovery
Hypoglycaemia	Confusion, sweating, shakiness in a diabetic	Oral glucose if conscious; glucagon intramuscularly or intravenous glucose if unconscious	If no recovery or unconscious
Angina or myocardial infarction	Chest pain, breathlessness, sweating	Stop treatment, sit upright, glyceryl trinitrate spray, aspirin 300 mg chewed if suspected infarct, oxygen	Yes for suspected infarct or persisting pain
Asthma attack	Wheeze, difficulty speaking	Sit upright, salbutamol inhaler with spacer repeated as needed, oxygen	If severe, exhausted or not improving
Anaphylaxis	Urticaria, swelling, wheeze, hypotension	Intramuscular adrenaline (typically 500 micrograms for adults; lower weight- or age-based doses for children), lie flat with legs raised unless breathing is difficult, oxygen, repeat adrenaline after 5 minutes if needed [253]	Always
Epileptic seizure	Convulsion, loss of consciousness	Protect from injury, do not restrain, time the seizure, buccal or intranasal benzodiazepine if prolonged (more than five minutes)	If prolonged, repeated, or first seizure
Choking (airway obstruction)	Cannot speak, clutching throat	Encourage coughing, back blows, then abdominal thrusts if severe	If obstruction is not relieved
Stroke	Facial droop, arm weakness, speech disturbance	Note time of onset, call immediately	Always
Cardiac arrest	Unresponsive, not breathing normally	Call for help, begin chest compressions and ventilations, apply defibrillator [272]	Always
Acute adrenal insufficiency	Collapse in a patient on long-term steroids	Lay flat, call emergency services, hydrocortisone per protocol	Always
Hyperventilation	Anxiety, tingling, shortness of breath	Reassure, coach slow breathing; exclude other causes	If symptoms atypical

3.64 Occupational injuries, aspiration and ingestion

Sharps injuries expose the dental team to blood-borne virus risk. Immediate first aid (wash with soap and water, do not squeeze, rinse mucosa or eyes), prompt risk assessment of the source and the exposure, and, when indicated, post-exposure prophylaxis started as soon as possible are described in public health guidance [273]. Staff hepatitis B vaccination and documented immunity are basic safeguards [90]. Aspiration and ingestion of dental items, including crowns, files and burs, occur in practice, with most items swallowed and passing without harm but a minority aspirated into the airway, which can be an emergency [261].

Table 38. Occupational injury, aspiration and ingestion.

Event	Immediate action	Follow-up	Level
Needlestick or sharps injury	Wash, do not squeeze, rinse, record the incident, identify the source patient and exposure	Urgent risk assessment and post-exposure prophylaxis decision as soon as possible; testing and counselling [273]	R (occupational health or emergency department, same day)
Splash to eye or mouth	Irrigate copiously with water or saline	Assessment as for sharps; chemical splash (for example sodium hypochlorite) needs prolonged irrigation and eye assessment	R (urgent)
Swallowed item	Reassure, keep the patient calm, note the item	Chest and abdominal radiographs; most pass naturally, but sharp or large items need medical assessment [261]	R (emergency department, same day)
Aspirated item	Position the patient forward, encourage coughing; if airway obstruction, use back blows and abdominal thrusts	Chest radiograph, bronchoscopy if retained [261]	E
Chemical or thermal burn	Remove the agent, irrigate, cool	Wound care and review	P; R for extensive burns
Latex or glove allergy in staff or patients	Remove the allergen, treat symptoms	Latex-free environment	P; E if anaphylaxis

3.65 When to treat and when to refer: working within competence

Knowing the limits of one's competence is a professional duty and a safety measure. Referral is not failure; delayed or avoided referral is a leading contributor to avoidable harm. The decision to treat in practice or to refer depends on the complexity of the problem, the training, experience and equipment of the clinician, the patient's medical status and preferences, and the urgency. A useful self-check before starting any procedure asks four questions. Have I done this often enough, and recently enough, to be competent? Do I have the equipment and assistance needed, and a plan for the foreseeable complications? Have I explained the options, including referral, and obtained consent? Would an experienced colleague agree that this is within general practice? When the answer to any is no, referral, mentoring or further training is appropriate. See Figure 15.

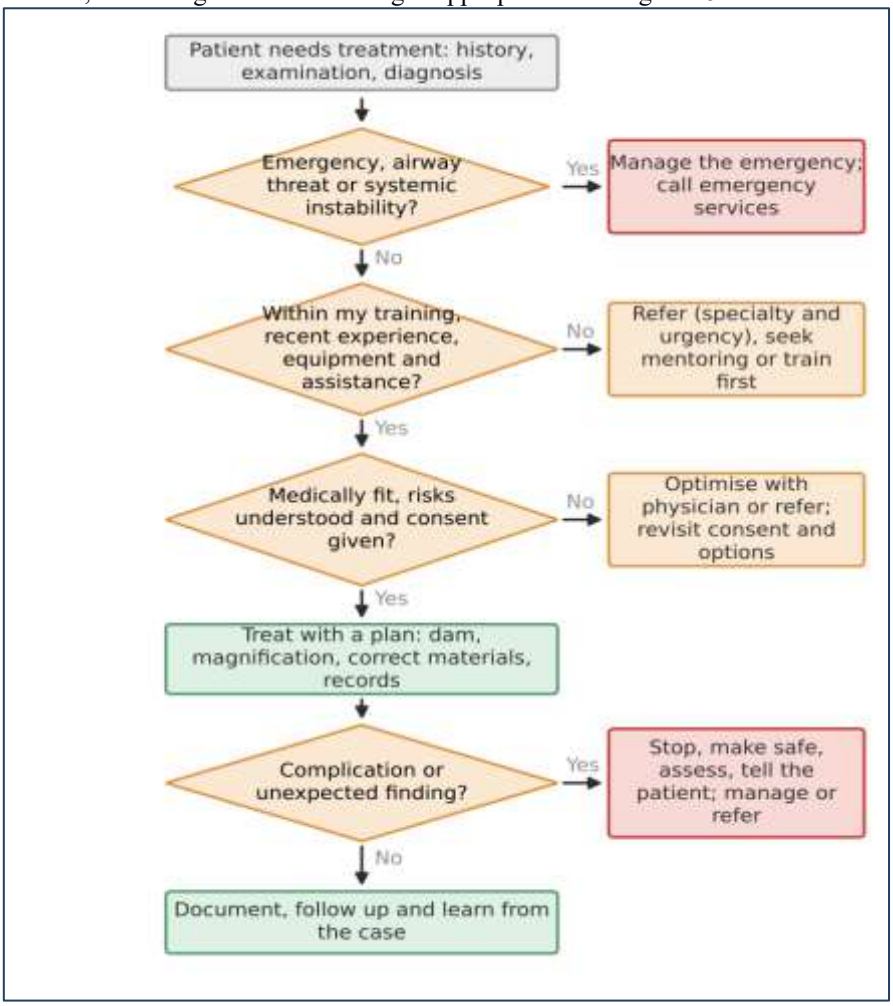

Figure 15. Decision pathway for treating in practice, referring or managing an emergency. Original schematic illustration.

Table 39. Typical indications for referral by specialty.

Specialty or service	Typical indications for referral	Usual urgency
Oral and maxillofacial surgery	Deeply impacted or ectopic teeth, surgery near the inferior alveolar canal or sinus, oroantral communication, facial trauma and fractures, cysts and tumours, spreading infection, nerve injury, complex implant and bone augmentation procedures, biting-force or orthognathic problems	Same day for airway threat, spreading infection, fracture or displaced root; otherwise planned
Endodontics	Calcified or complex canal anatomy, instrument separation, perforation repair, retreatment, apical surgery, resorption, trauma sequelae, uncertain diagnosis	Early for perforation or severe pain; otherwise planned
Periodontics	Stage III–IV periodontitis with non-response, furcation and mucogingival problems, peri-implantitis needing surgery, regenerative or soft-tissue surgery	Planned; urgent for necrotising disease with systemic involvement
Prosthodontics	Complex full-mouth rehabilitation, severe tooth wear, maxillofacial prosthetics, complex implant prostheses, aesthetic reconstruction	Planned
Orthodontics	Skeletal discrepancy, complex malocclusion, impacted canines, adults needing combined care, treatment outside aligner indications	Planned; earlier for interceptive needs
Paediatric dentistry	Very young or anxious children, medically complex children, developmental anomalies, complex trauma, behaviour management beyond competence	Planned; urgent for trauma and spreading infection
Oral medicine and oral pathology	Persistent mucosal lesions, suspected malignancy or potentially malignant disorders, immune-mediated disease, burning mouth, orofacial pain syndromes	Urgent (within about two weeks) for suspected malignancy
Special care dentistry	Patients with disabilities, dementia, severe anxiety, complex medical or social needs	Planned
Sedation or dental anaesthesia service	Patients needing sedation or general anaesthesia beyond the dentist's training or facilities	Planned
Physician or specialist doctor	Uncontrolled diabetes, hypertension, anticoagulation questions, cardiac risk, antiresorptive therapy, suspected systemic disease	As required by risk
Hospital emergency department	Airway compromise, uncontrolled bleeding, systemic sepsis, major trauma	Immediate

A good referral gives the receiving clinician what they need to act: the patient's identification and contact details, the reason for referral and the question being asked, the urgency, a concise history of the problem and treatment already provided, relevant medical history, medications and allergies, current radiographs or scans (shared securely and with consent), the patient's expectations and the consent given for the referral and information sharing, and the referring dentist's contact details. The referrer should record that the referral was made, confirm that the patient understands why and how to attend, track the outcome, and continue to provide general care. In an emergency the first communication should be by telephone, followed by written details.

3.66 Licensing, registration and the right to practise

The right to practise dentistry is conferred by a regulator and conditional on continued fitness to practise. Details differ between countries and change, so the points below are general, and each dentist must check current requirements with the relevant regulator. Typically, the right to practise depends on holding a recognised qualification, being registered with the regulatory body in the correct category (general dentist or specialist), being of good standing and good character, meeting language requirements where relevant, paying registration fees, completing continuing professional development, and holding appropriate professional indemnity. In South Africa, dentists register with the Health Professions Council of South Africa under the Health Professions Act, practise within the registered scope, and follow the council's ethical rules and guidelines [274–276]. Compliance with these rules covers matters such as professional conduct, advertising, fee transparency, record keeping, informed consent and the prohibition on improper financial arrangements.

Table 40. Illustrative routes to registration and requirements to maintain the right to practise (verify with each regulator).

Jurisdiction	Regulator	Typical elements of the pathway	Maintaining registration
South Africa	Health Professions Council of South Africa	Recognised dental degree, registration in the appropriate category; foreign-qualified dentists usually need evaluation or an examination; community service applies to South African graduates	Annual registration, continuing professional development, indemnity cover, ethical compliance [274]
United Kingdom	General Dental Council	Recognised UK qualification, or for others an approved examination route; registration with indemnity	Annual retention fee, verifiable continuing professional development cycle, compliance with Standards for the Dental Team [277]
European Union	National dental authorities	Automatic recognition of qualifications gained in member states under Directive 2005/36/EC; other qualifications assessed nationally [191]	National continuing education and registration rules
United States	State dental boards	Degree from an accredited programme (or advanced standing programme for foreign graduates), national	State renewal and continuing education

Jurisdiction	Regulator	Typical elements of the pathway	Maintaining registration
		board examination, state clinical or jurisprudence requirements	
Canada	Provincial regulatory colleges	Accredited degree or equivalency process, national examinations	Provincial renewal and continuing education
Australia	Dental Board of Australia	Accredited qualification or assessment pathway for overseas-qualified dentists, registration with indemnity	Annual renewal and continuing professional development
India	Dental Council of India and state councils	Recognised dental degree, state registration; screening for foreign graduates	State renewal rules

The right to practise also depends on licences and obligations beyond personal registration. These commonly include registration or licensing of the premises, a licence or notification for ionising radiation equipment, legal handling of medicines and controlled substances (with, in South Africa, a dispensing licence for dentists who dispense and compliance with medicines legislation [278]), regulated healthcare waste management, adherence to advertising and billing rules, professional indemnity cover and insurance, health and safety obligations, and data protection registration or officer duties where applicable. A dentist moving countries needs documents such as a certificate of good standing, verified qualifications and records of continuing education. Practising outside the scope of registration, or without current registration or indemnity, exposes patients to risk and the dentist to disciplinary, civil and sometimes criminal consequences. Offering advanced procedures, sedation, implants or orthodontics also requires evidence of training and competence, which regulators and indemnifiers may ask to see.

3.67 Standards, ISO and quality systems in dental practice

International standards are voluntary, consensus-based documents that specify characteristics of products, processes and management systems, unless law or a contract makes them binding. In dentistry they matter in three ways. They define the performance and safety of the materials, instruments and equipment the dentist buys, which in turn underlie regulatory approvals such as CE marking in Europe or clearance by regulators elsewhere. They set out management-system frameworks for quality, risk, information security, health and safety and the environment. They provide shared vocabulary and notation, such as the two-digit tooth designation system that standardises records [279]. Standards are revised regularly, so the current edition must be checked. ISO Technical Committee 106 (Dentistry) maintains the family of dental standards.

Table 41. Selected international standards relevant to dental practice.

Standard	Subject	Relevance to the general dentist
ISO 13485:2016 [280]	Quality management for medical devices	Required in many jurisdictions for manufacturers and many dental laboratories; reassures about device supply chains
ISO 14971:2019 [281]	Risk management for medical devices	Underlies device safety documentation; a model for practice risk assessment
ISO 10993-1:2018 [207] and ISO 7405:2018 [208]	Biological evaluation of medical devices and dental biocompatibility	Basis for assessing the biological safety of restorative materials and devices
ISO 4049:2019 [209]	Polymer-based restorative materials	Specifies properties of composite restoratives that influence clinical performance
ISO 14801:2016 [282]	Fatigue testing of endosseous dental implants	Helps compare implant mechanical behaviour
ISO 3950:2016 [279]	Tooth designation system	Standard notation for records and referral letters
ISO 17664-1:2021 [283]	Information from manufacturers for reprocessing of devices	Instructions for cleaning, disinfection and sterilisation of instruments and handpieces
ISO 11607-1:2019 [284]	Packaging for terminally sterilised devices	Sterile barrier systems for instrument pouches
ISO 11143:2008 [210]	Amalgam separators	Capture of mercury in dental wastewater, linked to the Minamata Convention
ISO 9001:2015 [285]	Quality management systems	Optional framework for practice quality and audit
ISO/IEC 27001:2022 [286]	Information security management	Framework for protecting digital records, scans and images
ISO 45001:2018 [287]	Occupational health and safety management	Framework for staff safety, ergonomics and injury prevention
ISO 14001:2015 [288]	Environmental management	Framework for waste, energy and sustainability

Standards translate into daily infection prevention practice. The core elements are standard precautions for every patient; hand hygiene at the key moments of care [289]; appropriate personal protective equipment; safe handling and disposal of sharps; validated reprocessing of instruments (pre-cleaning, inspection, packaging, sterilisation under steam pressure, storage and traceability records) in line with manufacturers' instructions [283,284]; sterilisation of handpieces between patients; management of dental unit waterlines; surface barriers and disinfection; and segregated healthcare and amalgam waste [210]. National and international guidance sets out these basics in detail, including CDC guidance and national technical memoranda [90,290,291]. A practice that audits these processes regularly, trains its team and keeps records can show regulators and patients that it takes safety seriously, whether or not it seeks formal certification. Small practices do not need to certify to ISO 9001 or ISO 27001 to benefit from the principles they contain.

3.68 Professional ethics

Ethics provides the reasons behind the rules. Four widely used principles guide biomedical ethics: respect for autonomy, beneficence, non-maleficence and justice [292]. The Declaration of Geneva commits physicians to the health and well-being of the patient as their first consideration, to respect for autonomy and dignity and to confidentiality [293], and its principles are widely adopted across the health professions. National codes, such as the Health Professions Council of South Africa's general ethical guidelines and the General Dental Council's standards, translate these principles into duties for dentists [275,277].

The principles become practical in recurring situations in general practice. Autonomy requires informed consent, respect for refusal and attention to capacity. Beneficence and non-maleficence require that treatment be indicated by the patient's need and not by commercial pressure; that new technologies be offered on evidence, not on marketing; and that overtreatment and undertreatment both be avoided. Justice requires fair access, non-discrimination (including toward patients with HIV or other infections, disability or low income) and honest, transparent fees. Related duties include confidentiality and its limits (for example, mandatory reporting of suspected child abuse [134]); honesty about outcomes, complications and errors; protecting patient privacy in images and on social media; truthful advertising; avoiding conflicts of interest from industry sponsorship, commissions or referral inducements; maintaining professional boundaries; not abandoning patients in mid-treatment; seeking second opinions or referral when appropriate; supporting colleagues and speaking up about unsafe practice; and attending to one's own health and fitness to practise.

When values conflict, a structured approach helps. One practical framework asks four questions: the medical indications (what is the problem and what would work), the patient's preferences, quality of life and wider contextual features such as family, finances, law and resources [294]. Writing down the analysis, discussing difficult cases with colleagues or an ethics service, and recording the reasoning reduce error and protect both patient and clinician. Ethical practice also includes the stewardship of shared resources (antibiotics, radiation, the environment) and of the profession's trust, which depends on honesty in all communication with patients and the public.

3.69 Informed consent in depth

Informed consent is a process, not a form. Valid consent requires that the patient has capacity to decide, receives adequate information in understandable language, understands that information, and decides voluntarily, without coercion. The legal standard for the information to be disclosed differs between jurisdictions, as shown earlier, but the common approach is to disclose the material risks, meaning those a reasonable patient would consider significant or that the particular patient would consider significant, together with alternatives, including no treatment [184–186]. In South Africa, the National Health Act also gives users of health services the right to be informed about their health status, options, benefits, risks and costs [187].

The following elements make consent robust. Allow enough time for questions and, for elective major treatment, a period for reflection. Offer written information and diagrams, models or photographs. Use a professional interpreter when the patient is not fluent in the language of care, because family members are unreliable interpreters [200]. Check understanding by asking the patient to explain the plan in their own words. Present the options in a balanced way, using shared decision-making [190]. Discuss costs, duration, maintenance needs and what happens if complications occur. Obtain separate consent for photographs, teaching, research, sharing of images and use of AI tools where patient data are processed by third parties. Record the discussion contemporaneously, with a signed form if used as a record rather than a substitute for the conversation. Revisit consent when the plan changes or complications arise, and respect the patient's right to withdraw consent at any time.

Special groups need careful attention. Children and adolescents: the law specifies who may consent and from what age. In the United Kingdom the Gillick decision recognises that a competent child may consent to treatment [295]. In South Africa, the Children's Act sets age-based rules for consent to medical treatment and surgical operations, and the provisions should be read for the current text [134]. Adults who lack capacity: capacity is decision-specific and time-specific; a dentist must assess it, support decision-making and, where it is lacking, act in the patient's best interests within the law, as the Mental Capacity Act 2005 sets out for England and Wales [296] and local law elsewhere. Emergencies: necessary treatment to prevent serious harm may proceed without consent when the patient cannot consent and delay would be dangerous, with the reason recorded. Refusal: a competent adult may refuse treatment, and the dentist should explain consequences, document the refusal and continue to offer care within appropriate limits.

Table 42. Examples of material risks and points to discuss, by procedure.

Procedure	Material risks and points to discuss
Local anaesthesia	Temporary numbness, bruising, trismus, rare prolonged or permanent altered sensation, allergy
Direct restoration	Sensitivity, need for later repair or replacement, possible pulp involvement, variation in longevity
Crown or bridge	Tooth reduction is irreversible, sensitivity, possible need for root canal treatment, chipping, debonding, recession, limited lifespan
Root canal treatment	Post-operative pain, instrument fracture, perforation, failure needing retreatment or extraction, need for a crown, rare irrigant accident
Extraction	Pain, swelling, bleeding, dry socket, infection, damage to adjacent teeth, nerve injury (for lower teeth), sinus communication (for upper teeth), root fragments, jaw fracture (rare)
Periodontal treatment	Recession, sensitivity, mobility, need for lifelong maintenance, continued risk if smoking or diabetes uncontrolled
Implants	Failure, infection, nerve or sinus injury, peri-implant disease, aesthetic compromise, need for bone or soft-tissue procedures, long-term maintenance and costs, material sources of grafts
Clear aligners or orthodontics	Limits of predictability, need for attachments and interproximal reduction, relapse and lifelong retention, gingival recession, root resorption, no guarantee of result
Bleaching	Sensitivity, gingival irritation, relapse, uneven result, no effect on restorations

Procedure	Material risks and points to discuss
Sedation	Over-sedation, airway events, amnesia, need for escort and fasting instructions, limits of the service
Dentures	Adaptation period, speech and eating changes, ongoing tissue change and relines, hygiene needs

3.70 Adverse events, candour, complaints and documentation

When something goes wrong, a transparent and structured response serves the patient and is usually the best protection for the clinician. Professional standards require dentists to be open and honest with patients when things go wrong, which includes saying so promptly, apologising where appropriate, explaining what happened and the likely consequences, offering remedial treatment or referral, and telling the patient what will be done to prevent recurrence [275,277]. Apology laws and the legal effect of expressions of regret differ between countries, so indemnifiers often advise on wording, but concealment is never acceptable. Notify the professional indemnity provider early. Record events factually and contemporaneously, with dates and times, what was said and done, and the patient's response, and never alter or backfill records, because late changes are detectable and damaging.

Practices benefit from a simple incident process: report events and near misses without blame, review them at team level, identify root causes (communication, equipment, training, process) and agree changes. Complaints should be acknowledged quickly, investigated fairly and answered in writing, with information on how to escalate. Clinicians involved in serious events often experience distress, sometimes called the second-victim phenomenon, and benefit from peer support [266]. Good documentation rests on a few habits: record the history, examination findings, diagnosis, options discussed and chosen, consent, treatment performed with materials and batch details where relevant, post-operative instructions and follow-up arrangements, and any referrals and communications, using standard tooth notation [279].

3.71 The practice as a business: why management matters clinically

A dental practice is simultaneously a clinical service and a small business. Sound management is not separate from good care: a practice that cannot meet its overheads is under pressure to over-treat, to shorten appointments, to defer sterilisation and maintenance, and to cut corners on staffing, whereas a financially stable practice can invest in training, equipment, infection control and unhurried care. The ethical difficulty arises because dentists are paid per item of treatment, so their income can be influenced by the very clinical judgements they must make in the patient's interest. This is widely recognised in professional codes, which require that clinical decisions be based on the patient's needs and not on financial gain [275–277]. The principle for the whole of this section is therefore simple: bill honestly, for what was actually done, at a fee the patient knew about beforehand, and keep records that prove it.

A practical way to see the business is as five linked functions. Clinical governance (competence, infection control, records, complaints) protects patients and defends the practice. Financial management (fees, billing, collections, cash flow, tax) keeps it viable. People management (employment, delegation, training, wellbeing) sustains the team. Legal and regulatory compliance (registration, privacy, consumer protection, waste, health and safety) keeps it lawful. Marketing and patient experience (honest advertising, access, communication) brings and retains patients. Each can fail independently, and each has direct clinical and ethical consequences.

3.72 Fees: setting, disclosing and agreeing them

Fees should be set on a transparent basis that reflects the time, skill, materials, laboratory costs, overheads and the dentist's experience, and should be reasonable in the circumstances. In South Africa, since the abolition of a national reference price list for health services, practitioners and medical schemes negotiate and publish their own tariffs, and the competition authority treats collective fixing of fees by competing practitioners as unlawful [297]. Dentists must therefore set their fees independently, and professional associations may publish guidance but not binding prices. Similar rules against price-fixing exist in most jurisdictions, whereas public systems (for example, state-funded dentistry in the United Kingdom) fix payment through contracts.

The ethical core of fee-setting is informed financial consent. Patients are entitled to know, before treatment, what is proposed, what alternatives exist, what each will cost, what portion a scheme or insurer is likely to pay, and what they will owe. Consumer protection law in many countries gives this a statutory footing: in South Africa the Consumer Protection Act requires fair, transparent and non-misleading pricing and gives consumers the right to clear information [298], and in the United Kingdom the Consumer Rights Act 2015 and the professional standards require clear information on costs and services [299]. A written treatment plan with a fee estimate, signed or otherwise acknowledged, is the best evidence that this was done. Where the plan changes (for example, a tooth needs root canal treatment instead of a filling, or an unforeseen complication occurs), the patient should be told about the change and the cost implication before proceeding, except in an emergency when delay would cause harm.

Further principles are widely accepted. Fees may differ for genuinely different services, but patients with identical needs should not be charged different amounts on irrelevant grounds. Discounts and free or reduced-fee care (including to colleagues, staff, family and those in financial need) are lawful and ethical when applied openly and consistently, but must not be used to disguise a falsified claim to a third party. Estimates should be honest ranges, with a note of what could change them. Fees for missed appointments or cancellations should be stated in advance, applied fairly and waived where the reason is genuine. Emergency treatment of pain, infection or trauma should never be withheld because of ability to pay at that moment, and arrangements can be made afterwards.

Table 43. Ethical and legal principles for fees, billing and collection in general dental practice.

Area	Good practice	Ethical or legal basis
Setting fees	Independent, cost-based, reasonable and non-discriminatory; no agreement with competitors on prices	Competition law; professional codes [275,276,297]
Estimates and treatment plans	Written plan with alternatives, risks, expected costs, scheme or insurer co-payment, and validity period; revised in writing if the plan changes	Consumer protection and informed consent law [186,298]

Area	Good practice	Ethical or legal basis
Billing	Bill only for treatment actually provided, on the date provided, by the practitioner who provided it, using the correct item and diagnostic codes	Professional codes; fraud law [276,300]
Third-party claims	Submit accurate claims that match the clinical record; collect the patient's portion unless a lawful, disclosed arrangement says otherwise; do not alter or add codes to obtain payment	Medical schemes and insurance law; anti-fraud law [301,302]
Discounts and waivers	Open and consistent; never waive a co-payment while billing the insurer the full amount	Fraud and professional misconduct rules [300]
Deposits and prepayment	Disclose terms, hold to treatment actually done, refund unused amounts, and itemise	Consumer protection law [298]
Payment plans and third-party finance	Disclose all costs and interest; do not accept commissions from lenders that influence advice	Consumer protection; conflict-of-interest rules [276,298]
Referral and laboratory fees	No fee-splitting, commissions or kickbacks for referrals; bill laboratory work honestly	Professional codes; corruption and anti-kickback law [276,302,303]
Collections	Send accurate statements, give notice, offer arrangements, respect privacy, and do not withhold emergency care or lawfully required records as leverage	Professional codes; privacy law; prescription of debts [189,276,304]
Records for billing	Contemporaneous, dated, signed clinical notes that justify every item billed; retained for the required period	Health and records rules [187,188]
Advertising	Truthful, not misleading, no inducements that compromise judgement; fees advertised only where permitted	Consumer protection; professional advertising rules [276,298]

3.73 Billing and coding: accuracy, fraud, waste and abuse

Third-party payment (medical schemes, insurance companies, government programmes) increases the importance of accuracy. Claims are statements of fact to a payer: that the patient was treated on a given date, by a given practitioner, with a given procedure, for a given reason, and that the fee is correct. Misstatement may be an honest error, a pattern of carelessness, or deliberate fraud, and the law and the regulator treat them very differently. Honest errors should be corrected promptly, with refund of any overpayment. Systematic errors indicate a system problem to be fixed by audit and training. Deliberate misrepresentation is dishonesty and can lead to loss of registration, civil recovery, fines and imprisonment.

In South Africa, medical schemes operate under the Medical Schemes Act, which regulates benefits, prescribed minimum benefits for emergencies and defined conditions, and the scheme-practitioner relationship [301]. The regulator's guidelines on over-servicing and perverse incentives define unethical commercial practices such as over-servicing, unbundling, upcoding and kickbacks [300]. In the United States, the False Claims Act imposes liability for submitting false claims to government programmes, and federal privacy rules require that patient information in claims be protected [302,305]. Equivalent regimes exist elsewhere, such as the fraud-prevention services of national health systems. The principles are the same internationally, even when the statutes differ.

Table 44. Common billing problems in dental practice, how to avoid them and potential consequences.

Problem	What it means	How to avoid it	Potential consequences
Upcoding	Billing a more expensive code than the service provided (for example, a surgical extraction when a simple one was done)	Choose the code from the clinical note and the code definition, not from the reimbursement	Refund, penalties, disciplinary action, criminal charges
Unbundling	Billing separately for components that belong in one procedure	Learn which items include others; follow payer code rules	As above
Phantom or inflated billing	Billing for services not provided, not completed, or for longer time than spent	Bill on completion; keep time and treatment records; never pre-bill for the plan	Fraud charges; loss of registration
Over-servicing	Treatment that is unnecessary, excessive or too frequent (for example, routine radiographs without indication, or replacement of sound restorations)	Evidence-based indications; patient-specific diagnosis; peer review	Disciplinary action; harm to patients
Waiving the co-payment	Telling the patient they owe nothing while billing the insurer in full	Collect or lawfully disclose any reduction; bill the true fee	Fraud on the insurer
Misreporting date, patient or provider	Claiming for another person's treatment, a different date, or by an unregistered or unsupervised provider	Accurate records; staff training; clear delegation rules	Fraud; unlawful practice
Kickbacks and commissions	Receiving payment for referrals or for using a particular product, laboratory or finance company	Refuse; disclose any legitimate arrangement; follow codes	Corruption offences; misconduct

Problem	What it means	How to avoid it	Potential consequences
Treatment for revenue	Recommending elective treatment mainly to meet targets	Decide on need; avoid production-based pressure on clinicians; consider salary or quality-based pay	Harm; complaints; negligence
Poor records	Billing without notes that justify the item	Contemporaneous notes before the claim; regular audits	Claims clawed back; weak defence

Systems reduce risk. These include a documented fee schedule; a code list with plain-language definitions; software checks that block unusual combinations; a rule that the treating clinician approves each claim; periodic internal audit of a sample of claims against the notes; prompt correction and refund of overpayments; training for reception and billing staff; and a clear route for staff to raise concerns without penalty. The practice owner remains responsible for claims made in the practice's name, including those submitted by staff.

3.74 Legal and regulatory compliance for the practice

Beyond billing, a dental business must comply with a range of laws. The details differ by jurisdiction; the headings below are those of a typical compliance register in South Africa, with international parallels.

Table 45. Core business and legal compliance areas for a dental practice (South African examples with international parallels).

Area	Typical requirements	Examples (check locally)
Professional registration and practice rights	Annual registration; practise only within scope; registered practice or business form where required; display of registration	Health Professions Act [274,275]
Indemnity and insurance	Professional indemnity; public liability; business interruption; cover for employed staff	Regulator and employer requirements [276]
Business structure and tax	Sole proprietor, partnership or company; registration for income tax, payroll taxes and, where applicable, value-added tax; accurate bookkeeping	Seek accountant and tax-authority advice
Employment	Written contracts; minimum conditions; fair dismissal and disciplinary procedures; unfair discrimination rules; training and delegation within scope	Basic Conditions of Employment and Labour Relations Acts [306,307]
Health and safety	Safe workplace; risk assessment; sharps, radiation and hazardous substance control; incident records	Occupational Health and Safety Act [308] and ISO 45001 [287]
Patient information	Lawful processing; security; breach notification; retention periods; access requests	Protection of Personal Information Act; National Health Act; HIPAA, GDPR and equivalents [187,189,305]
Consumer protection	Fair pricing, honest advertising, quotes, warranties and returns	Consumer Protection Act; Consumer Rights Act [298,299]
Medical waste and environment	Licensed collection and disposal; amalgam separators; sharps containers; records of waste	ISO 14001 and local waste regulations [288]
Radiation	Licence for X-ray equipment, quality assurance, shielding, dose records	National radiation regulator and standards
Facility and equipment	Fit-for-purpose premises; maintenance and calibration logs; sterilisation validation	ISO and device standards [280,283]
Complaints and adverse events	Documented procedure; candour; reporting to regulator or insurer where required	Professional codes [275,276]

3.75 Managing the practice financially and ethically

Financial management starts with understanding what the practice earns and spends. Production (the value of work provided) differs from collections (money actually received), and the gap is made up of discounts, write-offs, unpaid accounts and rejected claims. Overheads (rent, staff, materials, laboratory, equipment, indemnity, marketing, software, interest and depreciation) should be tracked, as should the dentist's own remuneration, kept separate from the business's profit. Regular review of simple indicators allows early correction. Cash flow, not profit, determines whether bills and salaries can be paid, and seasonal and payer-delay patterns should be anticipated.

Table 46. Practical indicators for monitoring a dental practice, and the questions they answer.

Indicator	What it shows	Questions to ask when it moves
Production and collections	Work done and money received	Are accounts being sent, followed up and corrected? Are claims rejected?
Overheads as a share of collections	Efficiency and sustainability	Which costs have risen? Are fees reviewed regularly?
Rejected or reversed claims	Billing accuracy	Are the causes coding errors, missing information or true non-cover?
Outstanding accounts (age analysis)	Credit risk	Are estimates and deposits clear? Is follow-up timely and respectful?

Indicator	What it shows	Questions to ask when it moves
Recall and retention	Continuity and prevention	Are risk-based recall intervals used? Are patients lost after treatment?
Failed and cancelled appointments	Access and capacity	Are reminders working? Are policies fair?
Treatment plan acceptance	Communication and affordability	Are options, phasing and finance explained? Is the plan realistic?
Redo and warranty work	Quality	What is the cause, and are patients charged fairly?
Complaints and adverse events	Safety and experience	Have they been recorded, analysed and acted upon?
Staff turnover and wellbeing	People and culture	Is workload sustainable? Is there support?

Several ethical safeguards protect the clinical-financial boundary. Pay clinicians in ways that do not reward unnecessary treatment (for example, by salary or by blended or quality-based schemes rather than pure production commission), and avoid targets for specific procedures. Separate clinical judgement from sales: treatment coordinators may explain costs and finance, but should not decide on clinical recommendations. Do not recommend unnecessary treatment to meet costs, and conversely do not withhold necessary care to avoid conflict. Disclose financial interests in products, laboratories, finance companies or referral arrangements. Be open about new investments (such as lasers, scanners or aligner franchises) so that patients are offered them on indications rather than to repay the equipment. Ensure that private-equity or corporate ownership, where present, does not override the clinician's duty to the patient: the registration of the clinician and the duty to the patient remain personal and cannot be delegated to a business [275–277]. Debt collection should be proportionate and respectful. Keep statements accurate and send them promptly. Offer payment arrangements before escalating. Observe privacy rules, since disclosing a debt or clinical information to third parties (for example, collectors or credit bureaus) may be restricted; share only what is necessary and lawful [189]. Know the period after which a debt becomes unenforceable in your jurisdiction (in South Africa, generally three years for ordinary debts under the Prescription Act, although the rules are technical) [304]. Do not threaten to withhold urgent treatment, and do not refuse to release a patient's records, or to transfer them to another practitioner, as leverage for payment; retention and release should follow the privacy and records rules [187–189]. Business decisions affect access and equity. Pricing, location, opening hours, language, accessibility and payment options determine who can use the service. Consider a sliding scale or community days where feasible, support for patients on public systems, partnerships with schools and charities, and referral pathways for those who cannot afford care. The ethical principle of justice is served when a practice of any size contributes some care to those in need, and it is also good for professional satisfaction and local reputation [292].

Finally, plan for continuity and exit. Succession, sale, closure or the dentist's illness raise ethical and legal duties: patients must be informed, records secured and accessible, and urgent treatment continued or transferred. Keep a business continuity plan covering power, data backup, equipment failure, cyber-attack, pandemic restrictions and the absence of key staff, and keep copies of key documents (registration, indemnity, leases, contracts, licences, policies) in a safe place.

3.76 Lifelong learning: continuing professional development and postgraduate education

Dentistry changes faster than any undergraduate curriculum can anticipate. Materials, digital workflows, minimally invasive concepts, artificial intelligence, new disease classifications and new regulation have all appeared within the working life of many practising dentists. The knowledge and skills of a graduate begin to age on the day of graduation, and the interval between graduation and retirement may be forty years. Continuing professional development (CPD) is therefore not an administrative burden but the mechanism by which every other section of this review stays true in the individual dentist's hands. It is also an ethical duty: professional codes require practitioners to keep their knowledge and skills up to date and to work within their competence [275–277], and the World Health Organization's workforce strategy treats continuous learning and the maintenance of competence as a basis of safe, universal health care [309]. Internationally, the profile of competences expected of a dentist emphasises not only technical skill but also professionalism, communication, evidence-based practice, safety and lifelong learning [310].

The aim of this section is to integrate education into the clinical framework developed throughout the review. Learning should follow the five phases of care (assess, control, stabilise and prevent, restore and rehabilitate, maintain) and the cross-cutting themes of consent, records and referral. It should also be planned against the dentist's own practice: what is done often, what is done rarely but carries high risk (medical emergencies, surgical complications, paediatric sedation), what is new, and what the dentist's audit and complaints data show to be weak.

3.77 What the regulators and professional bodies require

CPD obligations are set by regulators, and they differ in form but not in intent. In South Africa the Health Professions Council requires practitioners to accumulate continuing education units within a defined cycle, which must include ethics, human rights and health law, as a condition of annual registration, with accredited providers awarding the units [311]. In the United Kingdom the General Dental Council operates an enhanced CPD scheme with a fixed number of hours over a five-year cycle, of which a defined proportion must be verifiable, a personal development plan, and an annual statement, and with topics that include medical emergencies, infection control, radiography and safeguarding [312]. Other jurisdictions, such as Australia and New Zealand, the United States (state by state), Canada (province by province) and many European countries, have their own hours, categories and audit systems, and some link relicensure to evidence of CPD. The FDI World Dental Federation promotes CPD as a core professional responsibility and urges that it be relevant, evidence based and independent of commercial bias [313]. The specific number of hours or units changes periodically, so dentists should confirm the current rules with their regulator every year, keep certificates, and record reflection as well as attendance.

3.78 What works: evidence on the effectiveness of continuing education

Not all learning activities change practice. Systematic reviews of continuing medical education show that passive, didactic, one-off lectures have little effect on performance or patient outcomes, whereas interactive, multi-method, sequenced and repeated activities, particularly those that involve practice, feedback and a clear link to the learner's own work, are more likely to produce change [314,315]. A Cochrane review of continuing education meetings and workshops found small but meaningful average improvements in professional practice and smaller effects on patient outcomes, with larger effects for interactive formats and where the content was relevant to the learner and the barriers to change were addressed [316]. Audit and feedback, in which a clinician's own performance is measured and compared with a standard or with peers, produces modest average improvements and works best when feedback is repeated, given by a respected source, includes specific targets and action plans, and is not purely punitive [317]. Internet-based learning is as effective as traditional teaching on average and allows flexible scheduling, although engagement and completion are weaker without interaction or accountability [318]. Simulation-based education with deliberate practice and feedback improves procedural skill and is an efficient and safe way to learn rare or high-risk tasks, such as managing airway emergencies, before they arise in a patient [319,320].

Two conceptual frameworks help dentists plan their own learning. Miller's pyramid distinguishes knowing, knowing how, showing how and doing, and reminds us that attending a lecture develops the first level while competence in practice requires the upper levels, which need practice and observation [321]. Competence itself is broader than knowledge: it includes technical skill, clinical reasoning, communication, emotional intelligence and reflection, and must be assessed in context [322]. The concept of entrustable professional activities describes tasks that can be entrusted to a clinician once they have shown reliability, and is a useful way to think about when to start performing a new procedure unsupervised, such as surgical third molar removal, molar endodontics or implant placement [323].

Table 47. Learning activities used in continuing professional development, with evidence, strengths and cautions.

Activity	Typical use in dentistry	Strengths	Cautions
Lectures and conferences	Updates; exposure to new concepts and technology	Efficient; networking	Passive formats alone change practice little [314,316]
Interactive workshops and hands-on courses	Procedural skills (for example, rotary endodontics, composite layering, suturing)	Practice and feedback improve skill	Must be followed by supervised application; short courses alone do not confer competence
Simulation	Medical emergencies, basic life support, airway skills, surgery rehearsal, digital treatment planning	Safe repetition; assessment	Needs good design and debriefing [319]
Online courses and webinars	Theory, regulations, infection control, evidence updates	Flexible; scalable; low cost	Engagement and quality vary [318]
Reading, journal clubs and appraisal	Staying current; testing claims; applying guidelines	Builds critical thinking	Requires critical appraisal skills; avoid reliance on summaries and marketing [204]
Peer review, case discussion and mentoring	Treatment planning, complications, ethics	Contextual; tailored; supportive	Needs a safe, non-judgemental culture
Clinical audit and feedback	Radiograph quality, record keeping, infection control, restoration longevity	Targets the dentist's own practice	Needs follow-up and re-audit [317]
Study clubs and practice-based learning	Shared cases and local referral networks	Relevant; sustained	May reinforce local habits unless anchored in evidence
Teaching and supervision	Mentoring colleagues and students	Consolidates learning	Needs training and time
Reflective practice and significant event analysis	Learning from complications, complaints and near misses	Converts experience into learning	Needs honesty and structure; record it [320]

3.79 Postgraduate education and specialisation

Postgraduate education serves two different purposes: to deepen the competence of the general dentist (broadening or advancing a special interest), and to prepare for registration as a specialist. Pathways vary by country, and dentists should seek advice from the regulator and the awarding institution before enrolling.

Table 48. Typical postgraduate pathways for dentists (examples; availability, names and recognition vary by country and are subject to change).

Pathway	Typical examples	Outcome	Points to consider
Short courses and certificates	Implant, endodontic, orthodontic aligner, sedation, restorative or digital dentistry courses	Skills and certificates	Verify accreditation, mentoring, case supervision and independence from commercial interests [324]
Diplomas and postgraduate certificates	Postgraduate diplomas in dentistry, implantology, endodontics, conscious sedation, oral medicine or dental public health	Advanced general skill; some lead to a master's degree	Check hours of supervised clinical work and assessment
Membership and fellowship examinations	Royal College examinations (for example, in general dental surgery or dental faculty membership in the United Kingdom); fellowships of national colleges of dentistry	Peer-recognised standard of knowledge and practice	Examinations assess knowledge and clinical reasoning; they do not by themselves confer specialist registration

Pathway	Typical examples	Outcome	Points to consider
Master's degrees	Master of science or clinical dentistry in a discipline; research or taught	Advanced knowledge and research skills	Taught programmes vary in clinical content
Residency or advanced general dentistry programmes	General practice residency or advanced education in general dentistry (United States)	One to two years of structured, supervised, broad clinical experience	Competitive; often hospital based
Specialist training programmes	Orthodontics, periodontics, endodontics, prosthodontics, oral and maxillofacial surgery, paediatric dentistry, oral medicine and pathology, oral radiology, dental public health, special care dentistry	Registration as a specialist in the discipline, with a specialist title	Usually two to six years, full-time, with assessment, thesis or portfolio; registration with the regulator is required before using the title [274–276]
Doctoral degrees and research	Doctor of philosophy or clinical doctorate	Research career, academic teaching, leadership	Needs funding, supervision and time
Education and leadership qualifications	Certificates in clinical education, healthcare management, practice management and public health	Teaching, leadership, policy	Complement clinical qualifications

A general dentist can follow several routes. Some become the practice's lead in a domain such as endodontics, implantology, paediatric dentistry or sedation, completing structured mentored programmes while continuing in general practice and referring cases that exceed their competence (Table 39). Others enter specialist training and move to referral practice, teaching or hospital work. A growing number add research, public health, teaching or healthcare-management qualifications to broaden careers or to improve the systems in which they work. Whichever route is chosen, the safe principle is the same: the title, the skills and the registration must match what the dentist claims to offer, and it is the regulator's rules, not the course certificate, that define who may use a specialist title or practise in a protected domain [274–276].

It is also worth considering the quality of the course. Features of good programmes include clear learning outcomes; accredited or recognised providers; faculty with relevant clinical experience; supervised treatment of real patients with feedback, not just lectures and models; an assessment that tests competence rather than attendance; a graded progression from simple to complex cases; and transparency about commercial links. Short courses that promise rapid mastery of a complex discipline, or that tie training to the purchase of a product, require caution, because acquired confidence can outrun competence and patient harm may follow; the ethical response to commercial sponsorship is disclosure, independence of content, and critical evaluation of claims [275,277,324].

3.80 Building a personal development plan

A personal development plan turns CPD from collecting certificates into targeted improvement. The cycle has five steps. First, reflect and assess: review the practice's case mix, complications, complaints, referral patterns, audit results and feedback from patients and colleagues, and ask where confidence exceeds evidence of competence. Second, set objectives: choose a few specific, measurable aims linked to patient benefit and to the dentist's role, such as reducing endodontic retreatment rates, introducing risk-based recall, or improving the management of anxious patients. Third, choose activities from the range in Table 47, favouring interactive and practice-based formats and mixing knowledge, skill and attitude. Fourth, apply and evaluate: use the learning in practice with supervision where required, and measure whether anything has changed through audit, case logs and feedback. Fifth, record and revise: keep a log of activities, hours, reflections and outcomes that satisfies the regulator and can be used in appraisal or in a complaint, and update the plan annually. See Figure 16.

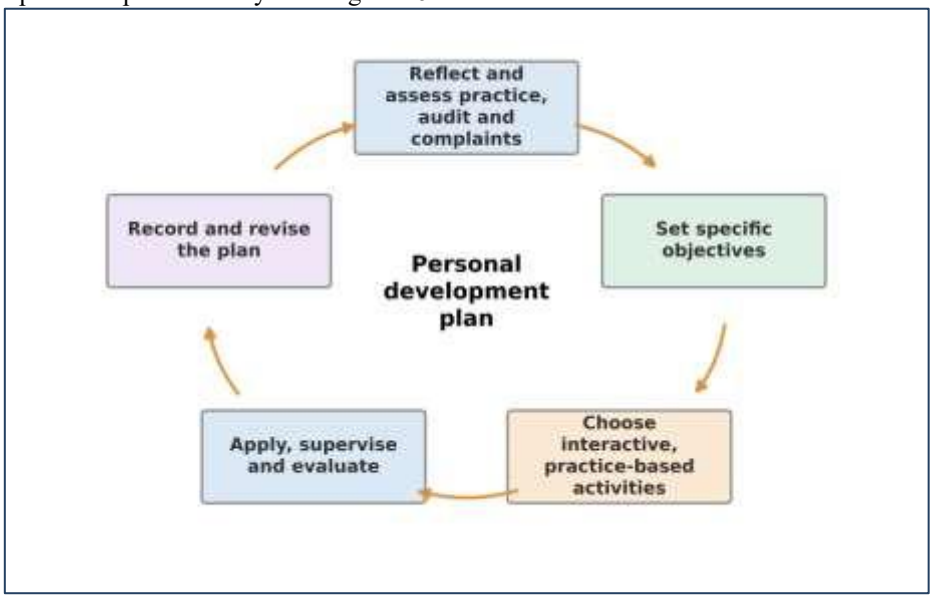

Figure 16. The personal development plan cycle used for continuing professional development. Original schematic illustration.

Table 49. Suggested learning priorities across career stages (a planning aid, not a requirement).

Career stage	Priorities	Suggested activities
Newly qualified	Consolidate fundamentals: diagnosis, treatment planning, records, local anaesthesia, rubber dam, simple extractions and endodontics, infection control, emergencies, consent	Supervised practice, mentoring, case discussion, hands-on courses, emergency simulation, audit of own records
Early career (a few years)	Expand scope in a structured way: molar endodontics, indirect restorations, periodontal therapy, paediatric dentistry, communication, practice management	Mentored case series, diplomas, study clubs, peer review, entrustment before starting new procedures [323]
Established general dentist	Focused advanced skills (for example, implants, aligners, sedation, digital workflow); complication management; leadership and teaching	Structured postgraduate programmes, simulation, audit and feedback, research or teaching, contributions to the community
Senior and late career	Keep current in evidence; mentor; adapt to age and health; plan succession and retirement	Journal reading and appraisal, mentoring and peer review, reduced or adapted scope, wellbeing support [203]
All stages	Emergencies and basic life support; ethics and consent; infection control; radiation protection; safeguarding; wellbeing	Annual refreshers and simulation; mandatory updates set by regulators [311,312]

Wellbeing and learning are linked. Chronic stress and burnout impair cognition, empathy and decision-making, and they reduce the capacity to learn [203]. CPD plans should therefore protect time for rest and for peer support, and learning should be planned as an enjoyable and sustainable part of professional life, not as an additional source of pressure. Dentists working in isolation, such as those in remote or small practices, can benefit from online communities, tele-mentoring, peer review across practices and regular meetings, while those in resource-limited settings may rely on open-access resources, public-sector and university partnerships, and international organisations that offer free education [309,313].

3.81 Integrating learning into daily practice and into the practice team

Education is most effective when it is integrated into routine work. Practical measures include a short weekly team meeting to discuss a case or a guideline; a monthly clinical audit with feedback; a shared library of protocols that are updated when guidance changes; a log of complications and near misses with brief learning notes; structured peer review of treatment plans; and brief refreshers on emergencies and infection control. Learning should include the whole team, because dental nurses, hygienists, therapists, technicians and receptionists contribute to safety, communication and billing accuracy, and many regulators require their CPD as well. Time and funding for learning should be built into the practice budget and into the annual leave and rota, and the cost can be framed as an investment that reduces complications, complaints, rework and staff turnover.

Practice-based research and quality improvement are a powerful form of integrated education. Even small practices can undertake simple projects, such as measuring restoration failure, post-extraction complications, recall adherence or the proportion of radiographs that meet quality standards, then implementing a change and re-measuring. Contributing to practice-based research networks, writing up case reports, and teaching colleagues or students all strengthen learning, and the skills developed (question formulation, critical appraisal, data handling) are the same skills needed to apply the evidence discussed throughout this review [204].

Finally, learning must be honest about uncertainty and open to unlearning. Many once-routine practices (for example, extensive caries removal, prophylactic removal of asymptomatic third molars, routine antibiotic prophylaxis and routine amalgam use) have been revised in light of evidence and regulation, and others currently widely marketed will be revised in the future. A dentist who keeps asking whether a procedure is needed, whether the evidence supports it, and whether the patient would choose it after hearing all the options, will find CPD and postgraduate study most valuable [204,320].

3.82 Clinical vignettes: applying the evidence

The following short cases illustrate how the positions in this review combine in daily decisions. They are composites for teaching, not real patients, and each decision must be adapted to the individual and to local regulation.

Case 1: lingering pain in a lower molar. A 27-year-old reports lingering cold-provoked pain in a lower molar. The bitewing shows deep distal caries close to the pulp, there is no swelling and there is no periapical radiolucency. This fits symptomatic irreversible pulpitis in a restorable tooth. Reasonable options are vital pulp treatment, such as pulpotomy with hydraulic calcium silicate under dental dam, or root canal treatment, with the choice guided by the exposure, bleeding control and patient preference [10,35,36]. Antibiotics are not indicated [37]. Ibuprofen with paracetamol provides analgesia [108]. A definitive, well-sealed coronal restoration should follow promptly [42], and the patient's caries risk, diet and fluoride use should be addressed [18].

Case 2: bleeding gums in a smoker with diabetes. A 58-year-old smoker with type 2 diabetes has generalised probing depths of 5 to 7 mm and bone loss to the middle third of the roots. This is at least stage III periodontitis, and smoking and diabetes point toward grade C [73]. Treatment follows the stepwise approach: motivation and biofilm control, smoking cessation advice and support [144], coordination with the physician on glycaemic control [70], subgingival instrumentation, re-evaluation and further treatment or referral for residual deep sites, then supportive periodontal care [9].

Case 3: extraction in a patient on an anticoagulant and an antiresorptive. A 74-year-old taking a direct oral anticoagulant for atrial fibrillation and oral alendronate for osteoporosis needs a hopeless molar removed. The dentist identifies both drugs, plans an atraumatic extraction with local haemostatic measures and does not stop the anticoagulant without the prescriber's advice; the bleeding risk is lower with direct oral anticoagulants than with vitamin K antagonists in the available meta-analysis, although individual-agent data are limited [106]. The risk of medication-related osteonecrosis of the jaw is low in oral bisphosphonate therapy for osteoporosis but not zero, so the risk is discussed, the discussion documented and the patient followed until healing is complete [107,157].

Case 4: avulsed central incisor. A parent telephones about an avulsed upper central incisor of a 9-year-old, lost 20 minutes earlier. Advice is to replant immediately if the tooth is clean and the child can cooperate, or otherwise to store the tooth in milk and come to the practice at once. In the chair the dentist follows the IADT algorithm: confirm the position, stabilise with a flexible splint for about two weeks, give tetanus and hygiene advice, consider antibiotics according to the guideline, and arrange follow-up including timely root canal treatment where the apex is closed [128,129].
Case 5: request for clear aligners. A 35-year-old with generalised gingivitis, heavily restored teeth and mild crowding wants aligners. The dentist first controls periodontal disease and caries, assesses the occlusion and the restorations, explains the limits of predictability, plans retention from the start and refers if the movements are beyond scope [72,85,87].
Case 6: a loose lower denture. A 66-year-old with an edentulous mandible and a poorly retained lower denture is offered a two-implant overdenture as the first-choice standard of care, with justified imaging [16,135]. The consent discussion includes the need for maintenance, the risk of peri-implant disease and the cost, and a maintenance recall is built into the plan [78,81].
Case 7: a white patch on the tongue. A 68-year-old has a white patch on the lateral border of the tongue present for four weeks. The patient is a long-term smoker. Local irritants are excluded, the lesion is measured and photographed, and the patient is referred for biopsy without waiting for adjunctive tests [88,92].

3.83 Global vignettes: applying the evidence across settings

These composite cases extend the earlier vignettes to settings that differ from a well-equipped urban practice. They illustrate principles, not individual patients.
Case 8: a rural clinic without electricity. A child presents with several cavitated molars and a gum abscess in a clinic with hand instruments, glass ionomer, silver diamine fluoride and fluoride toothpaste, but no power. The urgent problem is the abscess, managed by removal of the source and analgesia, with antibiotics only if there is systemic involvement [37,163]. Other cavitated lesions are managed by atraumatic restorative treatment with high-viscosity glass ionomer where accessible, or silver diamine fluoride for lesions in children who cannot cooperate, with the Hall technique for suitable primary molars if crowns are available [21,26,27,164]. Parents are told about staining and reviews, and a programme to supply fluoride toothpaste and reduce sugar frequency is arranged [19,25].
Case 9: a migrant patient who chews areca quid. A 45-year-old man who recently moved from South Asia and uses areca nut with tobacco has a burning mouth and difficulty opening wide. A professional interpreter is used for history and consent [200]. Examination shows blanching and fibrous bands of the cheeks and reduced mouth opening, consistent with oral submucous fibrosis. Cessation support is offered, mouth opening is measured and recorded, and the patient is referred for specialist assessment and biopsy of any red or white area because of malignant potential [88,92,180].
Case 10: complications after treatment abroad. A 52-year-old returns from overseas with a loose implant crown, bleeding around the implant and no records. The dentist requests the clinic's records, identifies the implant system by radiograph and any available documentation, takes justified imaging, diagnoses peri-implant mucositis versus peri-implantitis, manages it according to the guidelines and documents the discussion, including the limits of what can be known without records [76–78,201].
Case 11: a fasting patient with a broken filling. A patient during Ramadan wishes to have a restoration replaced. The dentist offers a time after the fast is broken, discusses options and does not assume which procedures the patient regards as acceptable during the fast. Advice about sugar-containing drinks at the evening meal is included [25].
Case 12: a malnourished child with facial necrosis. In a region where noma occurs, a malnourished child presents with painful, rapidly progressing gingival necrosis and facial swelling. This is treated as an emergency: urgent referral for nutritional support, antimicrobial therapy and wound care, with early recognition being the most important determinant of outcome [182].

3.84 Future directions

Several trends are likely to shape the next decade of general practice. These are informed projections drawn from the evidence above, not established facts.

- Validated, integrated AI. The priority is prospective, externally validated studies and transparent reporting, so that AI moves from promising accuracy figures to demonstrated patient benefit [96,98].
- Biology-led pulp and periodontal care. Vital pulp preservation is expanding, yet the guideline still lists the value of endodontic tissue engineering as unknown [35]. Periodontal care is moving toward personalised, minimally invasive treatment [69].
- Materials and manufacturing. Printed definitive restorations will need long-term clinical trials before routine use, especially on colour stability, water sorption and biological behaviour [84].
- Living guidelines. The ESE guideline is planned to remain valid until at least 2028 and to be updated as evidence emerges [35], and similar update cycles are expected for other S3-level guidelines [9,78].
- Digital assistance in surgery. Dynamic navigation and robot-assisted implant surgery are emerging as extensions of static guides [79], and their clinical benefit over existing guided techniques needs to be shown in comparative trials.
- Hybrid care models. Teledentistry, supported by better image capture and AI, may extend triage and monitoring, particularly in remote settings [102].
- Medicine-integrated dentistry. As links between periodontitis and systemic disease are better defined [70,71], the dental team will be expected to contribute to chronic-disease prevention, screening and shared care.
- Global governance and harmonisation. Implementation of the WHO global strategy, the integration of oral health into universal health coverage and international principles for AI and digital health will shape what is expected of general dentists in all settings [8,99].
- Environmental sustainability. Dentistry has an environmental footprint from travel, energy, single-use items and materials; prevention, risk-based recall, fewer unnecessary radiographs, waste segregation, amalgam separators [13] and remote follow-up where appropriate can reduce it [325].

- Equity, prevention and sustainability. Because the burden of oral disease is greatest where access is poorest [1,3], prevention, task-sharing and lower-mercury, lower-waste restorative approaches [13] are likely to become more important than any single technology.

3.85 Summary of contemporary positions

Table 50. Summary of contemporary positions for the general dentist, by clinical domain.

Domain	Contemporary position	Basis of evidence
Assessment and imaging	Risk-based assessment; justify every radiograph and CBCT scan	Consensus and guidelines [15,16]
Caries	Prevention first; non-restorative arrest (including 38% SDF); selective removal in deep lesions	Guideline, consensus and meta-analysis [21,22,28]
Pulp and apical disease	Preserve restorable teeth; vital pulp treatment or root canal treatment over extraction; dental dam; single visit without routine calcium hydroxide	S3 guideline, many recommendations low certainty [10,35]
Periodontitis	Stage I–IV and grade A–C; stepwise therapy with supportive care	S3 guideline and consensus [9,67,68]
Implants	Survival about 93–96% at 10 years; peri-implant disease is the main biological risk	Systematic reviews [74,75,77]
Digital workflow	Scanning and CAD/CAM are mainstream; printing suited to models, guides, splints and provisionals	Systematic and narrative reviews [82–84]
Artificial intelligence	Second-reader role; heterogeneous accuracy; needs validation	Systematic review [96–98]
Teledentistry	Triage, screening and follow-up; not for emergencies	Systematic reviews [102,103]
Antibiotics	Restricted to defined high-risk indications; not for routine endodontic emergencies	Position statement and scientific statement [37,89]
Oral surgery	Individualise third molar decisions; identify anticoagulant and antiresorptive patients before surgery	Cochrane review, meta-analysis and position paper [105–107]
Anaesthesia, sedation and analgesia	Articaine benefit mainly for infiltration; nitrous oxide appears safe but evidence is low certainty; ibuprofen plus paracetamol for acute pain	Systematic reviews and HTA [108,118–120]
Medical emergencies	Written protocol, equipment and regular team training	Scoping review [123]
Paediatrics and trauma	Fluoride varnish, micro-invasive care, Hall technique; follow IADT algorithms	Cochrane reviews and IADT guidelines [125–130]
Removable prosthodontics	Two-implant overdenture as first-choice for the edentulous mandible	Consensus statement [135]
Tooth wear, bleaching and TMD	Prevent and monitor wear; bleaching effective with sensitivity risk; use DC/TMD	Consensus and systematic reviews [139–141]
Dental anxiety and behaviour	Identify anxiety; psychological strategies first; sedation as an adjunct with proper training	Review, guidance and standards [148–150]
Sleep-disordered breathing	Screen and refer; custom titratable oral appliances for selected patients after physician diagnosis	Clinical practice guideline [151]
Radiography	Justify every exposure; risk-based bitewing intervals; CBCT for defined indications	Professional recommendations and guideline [16,152]
Antimicrobial stewardship	Source control first; narrow, short courses only when indicated	Cochrane review and cohort data [109,153]
Older adults and pregnancy	Prevent root caries and xerostomia; do not defer necessary care in pregnancy	Reviews [159–161]
Access and ART	Low-technology, biologically sound care where resources are limited	Workforce data and ART review [164,183]
Consent and records	Material-risk consent, contemporaneous records, data protection	Case law, regulator guidance and statute [184–189]
Practitioner wellbeing	Ergonomics and burnout prevention protect clinical capacity	Systematic review and survey [202,203]
Global policy and context	Oral health sits within universal health coverage and noncommunicable disease policy; prevention and upstream action are central	WHO resolution and strategy, FDI vision, global burden analyses [6–8,14]
Resource adaptation	Same principles, adapted technology: toothpaste, SDF, atraumatic restorative treatment, hand instrumentation, urgent care	Basic Package of Oral Care and ART review [163,164]
Law and regulation	Consent standards, data protection and device regulation differ by jurisdiction; local law prevails	Case law, statutes and regulations [184,185,192,195]
Language and culture	Professional interpreters; ask about religious, dietary and traditional practices	Systematic review and framework [199,200]
Complications	Prevent through history, imaging, technique and consent; recognise early; manage within competence and refer promptly	Systematic reviews, guidelines and clinical reviews [240,250,255,268,271]

Domain	Contemporary position	Basis of evidence
Referral	Refer when complexity exceeds competence, equipment or urgency allows; give a complete referral	Authored synthesis of guidance [275,277]
Licensing and standards	Practise only within registration, scope, indemnity and law; use recognised standards for devices, reprocessing and quality	Statutes, regulator rules and ISO standards [274,283,291]
Ethics and consent	Four principles; material-risk disclosure; capacity and children; transparent response to adverse events	Ethics texts, case law and codes [266,292,295]
Practice management and billing	Set fees independently; obtain informed financial consent; bill only for work done at the correct code; avoid upcoding, kickbacks and waiver of co-payments; keep compliant records and registers	Statutes, codes and regulator guidance [277,298,300–302]
Lifelong learning	Meet regulator CPD requirements; favour interactive, practice-based learning with audit and feedback; use postgraduate and specialist pathways within regulatory rules; keep a personal development plan	Education research and regulator guidance [311,312,314,316,317]
Tobacco and lifestyle	Deliver cessation advice in the dental setting	Systematic review [144]

3.86 Limitations of this review

This is a narrative review. Searches were targeted, not exhaustive, and there was no formal risk-of-bias assessment, so selection bias is possible. The complication, referral, licensing and standards tables are authored syntheses of widely taught practice and the cited sources, and they are not clinical guidelines; the business, billing, compliance, education, vital pulp therapy, combined endodontic, coronectomy, procedural-sequence, materials and endodontic-complication material is likewise a general synthesis; thresholds, doses, legal requirements, tax and billing rules and standard editions vary and must be checked locally. The figures are original schematic illustrations that simplify anatomy and technique, are not drawn to scale and do not replace clinical photographs, radiographs or hands-on training. The review leans on guidelines and systematic reviews from European and North American bodies and on English-language sources, which may need adaptation to local regulation, disease patterns and resources, and the international legal and regulatory examples are illustrative only and may have changed. Several areas of general practice, including removable prosthodontics, sedation, paediatric behaviour guidance, oral medicine and special care dentistry, are covered briefly and merit dedicated reviews, and a number of topics (for example orthognathic surgery, advanced periodontal surgery and regenerative bone augmentation) are outside the scope of general practice and were not covered. Legal and regulatory material is summarised only at a general level, reflects the South African context, and should be checked against the current versions of the statutes and professional guidance, because these change over time. Many cited guidelines also note that the underlying evidence is of low certainty, so the positions summarised here should be read as current best practice that is open to revision.

4. Conclusion

Contemporary general practice rests on three connected shifts: from restoring teeth to managing disease biologically, from expert opinion to graded guidelines, and from analogue to digital workflows. For the general dentist this means that prevention, selective and minimally invasive treatment, tooth and pulp preservation, stepwise periodontal care and justified imaging should anchor daily practice, with implants, aligners and digital prosthodontics added within the limits of training and with early specialist referral when complexity exceeds scope.

Practical take-home points. (1) Base every decision on individual risk, and justify every radiograph. (2) Prevent first, and when treatment is needed choose the least invasive option that works. (3) Preserve teeth and pulps wherever restorable, and treat periodontitis in stages with lifelong maintenance. (4) Prescribe antibiotics only for defined indications and control the source of infection. (5) Know the medical history, especially anticoagulants, antiresorptives and cardiac risk, before surgery. (6) Prepare for medical emergencies in writing and with team practice. (7) Obtain and document informed consent, keep complete records and protect patient data. (8) Treat new technology as a tool to be validated, not as proof of quality. (9) Refer early when complexity exceeds competence. (10) Look after your own ergonomics and wellbeing.

Vital pulp preservation, careful management of combined endodontic-periodontal problems and risk-adapted choices for high-risk third molars illustrate how the minimally invasive principle extends into advanced procedures. Step-by-step procedural sequences, an integrated materials guide and a structured approach to endodontic complications make the evidence usable at the chairside. Lifelong learning, through continuing professional development and, where appropriate, postgraduate or specialist education, is what keeps all of this practice current and safe. A dental practice is also a business, and honest fees, informed financial consent, accurate billing and legal compliance are part of professional ethics. Complications are inevitable in clinical practice, and their outcome depends on prevention, early recognition, honest communication, appropriate referral and good documentation, all within the limits of registration, competence and law. The standard of care described here is universal, but its delivery must be adapted to the resources, regulation, culture and patient needs of each setting; prevention, the atraumatic and minimally invasive approaches, informed consent, interpreter use and respect for patient beliefs are portable to any country, whereas technology and regulation must be matched to local conditions.

Two technologies, AI-assisted diagnosis and 3D-printed definitive restorations, are promising but not yet supported by robust clinical evidence, and implant success must be weighed against the substantial prevalence of peri-implant disease. The most important next steps are prospective validation of AI tools, long-term trials of digital materials, living guideline updates and models of care that extend prevention and access to the populations with the greatest need.

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