# 10 Operative dentistry

**This chapter discusses operative dentistry, fixed prosthodontics and endodontics**

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# DIAGNOSIS OF PULPAL PAIN

## TYPES AND FEATURES OF PULPAL AND RELATED PAIN

*Reversible pulpitis* Pain of short duration on response to hot, cold or sweet things. Relieved by analgesics. Poor pain localisation.

*Irreversible pulpitis* Pain of long duration, often worse with hot stimuli, may be throbbing and dull in nature, better pain localisation than reversible pulpitis, not always relieved by analgesics.

*Periapical periodontitis* Dull, throbbing, often constant pain; frequently kept awake, patient can usually localise pain to a particular tooth, tender to chew on tooth, poor relief by analgesics.

## HISTORY

Pain history is important in the diagnosis of pulpal pain.
Important features are:

## PAIN QUALITY

*Sharpness* Sharp pain can indicate, e.g. exposed dentinal tubules, fractured cusp.

*Dullness* May indicate pulpal hyperaemia.

*Throbbing* Throbbing pain, particularly if constant, may indicate an irreversible pulpitis.

## DURATION

*Short* (i.e. a few seconds) can indicate a reversible pulpitis but may indicate pain of non-dental origin, e.g. trigeminal neuralgia (p. 427).

*Constant* Often indicates irreversible pulpitis or one of its sequelae.

## STIMULI

*Reaction to heat* Often irreversible pulpitis if reacts to heat but not cold.

*Reaction to cold* Often reversible pulpitis, exposed dentine or cracked cusp. These conditions also often react to heat.

*Reaction to pressure* May indicate periapical or periodontal abscess. Reaction to *release* of pressure may indicate a cracked cusp.

*Reaction to sweet stimuli* Frequent occurrence in reversible pulpitis.

### SITE AND RADIATION

History should indicate the primary site of pain and where it radiates. Pain in teeth adjacent to the tooth the patient suspects as the cause of pain or opposing arch is common. Referred pain from non-dental causes (e.g. sinusitis) should be borne in mind.

Pain localisation is particularly difficult in low-grade reversible pulpitis and in children.

### TIMING

Pain pattern day and night is important. Pulpal pain is often worse at night.

A pain history gives the dentist a guide as to the source of pulpal pain. It does *not* produce a diagnosis on its own.

## CLINICAL EXAMINATION

In dealing with pulpal pain, the examination should be conducted as follows:

### VISUAL

Look for: • obvious cavities • cracked cusps • fractured restorations • swelling • sinus tracts.

### PROBING

To aid visual examination.

### PERCUSSION

When coupled with pain history, tenderness on percussion is an important feature of irreversible pulpitis, periapical periodontitis and periapical abscess. Percussion should be in an apical and lateral direction and several 'control' teeth should be percussed to check responses.

## SPECIAL TESTS

Special tests are extremely useful in confirming suspicions from a pain history and examination.

### SENSIBILITY (VITALITY) TESTING

Use heat, cold, electric stimuli. Important to use 'control' teeth. May indicate normal, exaggerated or no response to stimulus.

### LASER DOPPLER

Measures pulpal blood flow and gives an indication of pulpal vitality.

## RADIOGRAPHS

*Periapical radiographs* Indicate bony change apically, although they also show proximity of restorations/caries to the pulp and may give an indication of previous indirect or direct pulp capping.

*Bitewing radiographs* Also indicate proximity of restorations/caries to the pulp.

Multirooted teeth may need two or more radiographs at different angles to show problems.

## TRANSILLUMINATION

May indicate caries mesially or distally on anterior teeth.

## TOOTH 'SLOOTH'

Aid to localising cracked cusps.

## PROBLEMS IN DIAGNOSING PULPAL PAIN

To the inexperienced dentist, pain history and examination may be extremely confusing and resultant diagnosis difficult. This is particularly true when:

*The mouth is heavily restored* Multiple crowns, endodontically treated teeth, etc. may 'hide' the diagnosis. Less radio-opaque restorative materials make radiographic diagnosis of caries difficult.

*Multiple pathology* In a neglected mouth multiple problems may be apparent, making it difficult to localise the source of an individual's pain at a particular time.

*Non-organic pain* Symptoms of atypical facial pain may be confused with pulpal pain.

*Dual pathology* Where symptoms are arising from more than one tooth simultaneously.

*Anxious patient* May be withdrawn. Can be difficult to obtain a satisfactory history. Additionally there may be exaggerated responses to examination.

In the diagnosis of pulpal pain, intervene only on the evidence of more than one symptom or sign. If unsure of the diagnosis in a particular case, more evidence should be gathered by further special tests or repeating history or examination. *Irreversible* dental treatment should not be embarked upon until the diagnosis is established.

# TREATMENT PLANNING

## HISTORY TAKING

The general features of history taking and treatment planning are discussed in Chapter 2. This section discusses features specific to treatment planning in fixed prosthodontics and endodontics.

## FACTORS REQUIRED IN HISTORY

*Patient complaints* • Pain history of critical importance (p. 202) • swelling • failed or fractured restorations • aesthetic or speech problems • tooth wear.

*History of treatment to teeth* • When were restorations placed? • How many times have they failed? • Has tooth caused symptoms before? • How long has tooth been wearing away?

*General dental history* • How heavily restored is the dentition? • Have dentures been worn? • Has there been orthodontic therapy? • What treatments have been tried for present complaint? • Is the patient dentally motivated?

*Medical history* In fixed prosthodontics and endodontics, relevant medical problems may alter proposed treatment (p. 13).

*Social history* When contemplating prolonged or complex treatment, the patient's ability to attend and withstand long appointments is important, as is mobility. Financial considerations may also impact on treatment options. Sometimes specific family history of dental disease is important, e.g. aggressive periodontitis.

## EXAMINATION

### EXTRAORAL EXAMINATION

In fixed prosthodontics and endodontics, extraoral examination may reveal important points: • presence of swelling • signs of craniomandibular disorders, e.g. joint clicking, masseteric hypertrophy, tenderness in joints or muscles of mastication • smile lines, general aesthetics of current teeth and anterior restorations • trismus. In severe trismus, access to undertake restorative procedures may be impossible.

### INTRAORAL EXAMINATION

*Mucosa* Mucosal health is important. Features of particular relevance in fixed prosthodontics include lichenoid eruptions adjacent to restorations and desquamative gingivitis.

*Periodontal health* Oral hygiene, gingival condition, periodontal status, mobility and drifting of teeth, recession and sensitivity should be assessed and charted (p. 177).

*Caries* Caries should be carefully charted. Note tooth surface affected. Differentiation should be made between active, recurrent, root surface and arrested caries. Individuals with rampant uncontrolled caries should be identified.

*Restorations* Existing restorations should be carefully probed and charted to determine marginal leakage, recurrent caries, contour, occlusal relationship with other teeth, fracture, debonding and cleansability.

*Tooth wear* Both physiological and pathological tooth wear should be noted.

*Occlusion* Particular attention should be paid to the functional occlusion, tilted and overerupted teeth.

*Symptomatic teeth* Examination and diagnosis of pulpal pain has been discussed previously (p. 202).

*Endodontic status* Suspicious or key teeth should be confirmed as apically healthy or unhealthy, vital or non-vital. Evidence of previous root canal treatment and its quality should be noted.

*Saddles* Edentulous saddles should be noted and particular interest paid to abutment teeth.

*Removable prostheses* If present, these should be examined in detail (p. 263).

It is extremely important to chart restorations and essential treatment needed in the patient's case record in order that a treatment plan can be formulated.

## RADIOGRAPHIC EXAMINATION

Comprehensive radiographic examination is an essential feature in fixed prosthodontics and endodontics to determine: • caries • apical pathology • endodontic success or failure • problems with posts e.g. perforation, short post • overhanging restoration margins • failing restorations • periodontal bone support • root fractures.

Radiographs should be taken using doses of radiation according to the As Low As Reasonably Practicable (ALARP) principle. (Chapter 3)

*Useful radiographs in fixed prosthodontics:* periapicals, bitewings, occlusals.

*Useful radiographs in endodontics:* periapicals.

## ADDITIONAL FEATURES OF EXAMINATION

Special tests are frequently required: • percussion testing of teeth • sensibility (vitality) testing • study casts • full occlusal analysis • diagnostic wax-up of potential prostheses or rehabilitation.

## DIAGNOSIS IN THE DENTATE PATIENT

Good history taking and sound clinical examination techniques ease diagnosis and allow for appropriate patient management. The possible diagnoses in dentate patients are numerous. Most patients will fall into one or more of the categories listed in Table 10.1.

Great care should be taken in 'categorising' patients since an individual's dental needs may vary throughout life.

## MANAGEMENT

Prioritisation of treatment is the key to effective treatment planning in fixed prosthodontics and endodontics. *Control of pain is the first priority*.

**Table 10.1**
**Potential categories of dentate patient**

- Dental pain
- Non-dental pain
- Caries
- Tooth wear
- Periodontal disease
- Previous misdiagnosis, e.g. treated for periodontal problem when problem may be endodontic
- Iatrogenic problems, e.g. previous failed crowns or endodontics
- Routine, e.g. symptom-free patient attending for check-up
- Aesthetic problem, e.g. tooth discoloration
- Occlusal problem
- Functional problem, e.g. insufficient teeth to chew adequately
- Traumatic problem, e.g. broken teeth following acute trauma
- Management problem, e.g. dental phobic

Thereafter a suggested sequence of treatment is:

## INITIAL TREATMENT

*Control aetiology of problem* e.g. for caries give advice on diet, oral hygiene, use of topical fluoride.

*Basic remedial therapy* • Extract unrestorable teeth • restore by simple means (usually intracoronal restorations) all restorable teeth • simple endodontic treatment to key teeth.

*Reassess response to treatment* • Assess patient's motivation, oral hygiene, diet • reassess problem teeth • reassess treatment plan – in some poorly motivated patients, complex treatment will inevitably fail due to poor oral hygiene • in some patients no further treatment is required.

## DEFINITIVE TREATMENT

This includes: • premolar and molar endodontics • endodontic retreatment • provision of post cores • crown and bridgework • removable prosthesis construction • implants.

In the formulation and carrying out of treatment attempt to: • keep treatment as simple as possible • construct treatment plans where there is scope to reassess and change plan • know your own professional limitations • know your patient's limitations.

## MANAGEMENT OPTIONS IN OPERATIVE DENTISTRY

*Who?* The dentist must decide who is the most appropriate person to devise and carry out treatment on the dentate patient. Specialist help should be sought for difficult cases.

*What?* Taking history, examination and diagnosis into account, decide what to do given varying possible treatment options, e.g. for a discoloured tooth crown or veneer or bleach or do nothing.

*When?* Timing of treatment is important. Clearly pain management is carried out as soon as possible. On the other hand, complex crown and bridgework often has time and financial implications for the patient and may have to be delayed.

*Where?* Patients with medical problems may require treatment in a hospital setting. In elderly patients mobility can be a problem.

*How?* Complex crown and bridgework, molar endodontics, retreatment endodontics, etc. are difficult and demanding. The dentist should be capable of carrying out these procedures if attempting a treatment plan involving them. Referral to specialists should be sought if treatment is beyond an individual's limitations.

When planning treatment in operative dentistry the dentist should take into account not just the teeth but the individual patient's total oral health and general health needs.

## OCCLUSION

Occlusion is the relationship of cusps or masticating surfaces of maxillary and mandibular teeth.

Retruded contact position Position of the mandible when the condyles are in their most retruded position in the glenoid fossa and there is occlusal contact of the teeth.
Intercuspal position The position of maximum intercuspation of the teeth.
Stable occlusion An occlusion in which overeruption, tilting and drifting of teeth cannot cause new occlusal interferences. (Sometimes a degree of occlusal instability is acceptable.)
Occlusal harmony The absence of occlusal interferences, which allows mandibular movement in all excursions (with the teeth together), and does not result in discomfort, strain or harm to the teeth or masticatory apparatus.

How key teeth move across each other is important. In fixed prosthodontics a *functional* rather than a *morphological* (Angles class) approach to occlusion is required.

### BORDER MOVEMENTS OF THE MANDIBLE

Bennett movement Condyle on working side moves laterally.
Bennett angle Condyle on non-working side moves forwards and mesially.
Working side describes the side *towards* which the mandible deviates in lateral excursive movements.
Non-working side describes the side *away from* which the mandible deviates in lateral excursive movements.

*Occlusal interferences* may encroach on or expand border movements. Can occur, e.g. by tooth extraction or overcontouring of a restoration.

Mandibular border movements are shown in Figures 10.1 (lateral view) and 10.2 (view from above):

### RETRUDED CONTACT POSITION (RCP)

- In 10–20% of population RCP = intercuspal position (ICP).
- In 80–90% of population RCP ≤ 2 mm posterior to ICP.
- Restorations are usually built in RCP as this is the most reproducible position.

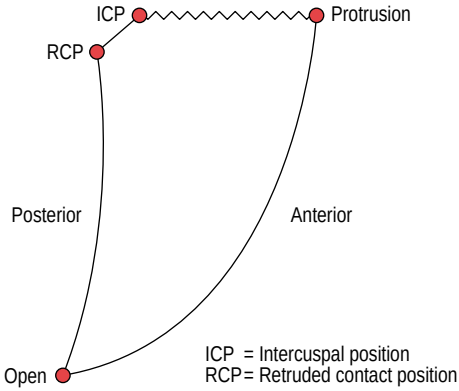


Figure 10.1 Mandibular border movements (lateral view).

## MANDIBULAR MOVEMENTS

Mandibular movements are defined as protrusive, retrusive and lateral (left and right).

### PROTRUSIVE MOVEMENT

Usually incisor teeth guide protrusion except in anterior open bite or Class III incisor relationships. Incisor relationship

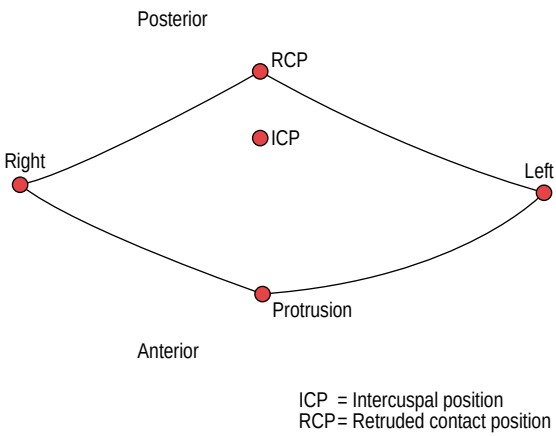


Figure 10.2 Mandibular border movements (view from above).

determines length and angle of protrusion, e.g. Class II division 2 occlusion with deep overbite results in nearly vertical protrusion. When building restorations, usually want to reproduce incisor relationship. In other circumstances, e.g. very worn teeth, restorations change incisor relationship and therefore protrusion.

### RETRUSIVE MOVEMENT

Retrusion is the slide from ICP to RCP. Any disturbances of an even slide may require adjustment.

### LATERAL MOVEMENT

Ideally *canine guided* occlusion with no contact on non-working side. In some cases '*group function*' (pairs of bicuspid teeth) may guide the working side.

## OCCLUSAL INTERFERENCES

An occlusal interference results from contact between teeth in one of the excursions so that the smooth movement of the mandible is interrupted or unfavourable guidance (e.g. non-working contact) occurs.

Interferences are difficult to detect as periodontal proprioceptors condition the mandible to move so that interference is avoided.

## EXAMINATION OF THE OCCLUSION

Examination of the occlusion should be a routine procedure in fixed prosthodontics. However, certain aids help in full occlusal assessment (which is often reserved for complex occlusions, tooth wear cases or when contemplating occlusal rehabilitation).

*Aids to occlusal examination* • Articulating paper • occlusal indicator wax (0.5 mm thick) • plastic strips (Mylar 40 μm thick; shimstock 8 μm thick) • study casts • diagnostic wax-up • facebow mounting.

*Features to be noted in occlusal examination* • Degree of occlusal stability • type of lateral guidance • patient complaints (especially myofascial pain dysfunction syndrome [MPDS], chronic dental pain, mobile teeth) • degree of difficulty in making mandibular movements • presence of occlusal interferences • overerupted and tilted teeth • does RCP = ICP? • smoothness and slide from RCP to ICP • presence of non-working contacts • tooth wear/faceting • tooth mobility in excursive movements.

## OCCLUSAL AIMS IN FIXED PROSTHODONTICS

To leave a stable occlusion with no additional occlusal interferences.

Use of an articulator that is *semi-adjustable* and allows the maxillary cast to be related to an approximation of the *terminal hinge* axis is essential in advanced crown and bridgework. This type of articulator has variable condylar guidance in at least a straight line and permits adjustment to incisal guidance.

Terminal hinge axis describes an axis passing through the lower part of the condyles, about which the condyles rotate when they are in their uppermost, centred position in the glenoid fossae.

## MANAGEMENT OF THE DEEP CARIOUS LESION

A deep carious lesion occurs when the caries lies in close proximity to the dental pulp.

When a cavity is considered deep but the pulp is not exposed, hard stained dentine may be left over the pulpal area. Removal of this frequently results in pulpal exposure.

## TECHNIQUES FOR MANAGEMENT OF THE DEEP CARIOUS LESION

### INDIRECT PULP CAPPING

The object of this technique is to protect the pulp from bacterial contamination via a pulpal exposure. A pulpal exposure is recognised by pulpal haemorrhage. It must be noted that a microexposure may be present. Therefore the classical bleeding exposure is a relatively severe pulpal wound. Deep cavities should be managed under *rubber dam* to decrease bacterial contamination of microexposures, pulpal exposures or carious exposures (p. 150).

#### Technique

Indirect pulp capping should be used for all cavities where it is considered there may be a micro-exposure or where removing further remnants of caries is likely to cause classic pulpal exposure. A layer of calcium hydroxide (setting) is placed over the dentine closest to the microexposure. This is reinforced by a structural lining.

## DIRECT PULP CAPPING

An exposed vital pulp may be pulp capped. Less successful than indirect pulp capping.

Direct pulp capping is most likely to succeed when: • pulpal exposure is small, i.e. small pinpoint • pulp is free of salivary contamination • carious exposure is not present (pulp already likely to be chronically inflamed) • tooth was symptom free prior to cavity preparation (less initial pulpal inflammation) • patient is young (better pulpal blood supply).

### Technique

Haemorrhage is arrested with a sterile paper point or cotton-wool ball. Cavity cleaned with sterile saline. Calcium hydroxide flowed over exposure and allowed to set. Structural lining placed.

*Mode of action of calcium hydroxide in pulp capping* Calcium hydroxide has several actions in pulp capping:

*Antibacterial action* Demineralisation and staining precedes bacterial invasion of dentine. Calcium hydroxide can render this demineralised dentine sterile via its inherent antibacterial activity due to its high pH, although quickly neutralised.

*Remineralisation* Calcium hydroxide may be involved in the remineralisation of carious dentine. This is not fully understood.

*Reparative dentine formation* In the pulpal tissue adjacent to calcium hydroxide there is a zone of necrosis followed by repair, by formation of intertubular or intratubular mineralisation of dentine, or by the formation of atubular dentine.

## CARIOUS EXPOSURES

A carious exposure means that the exposed pulp is contaminated with bacteria and essentially undergoing a chronic inflammatory process. The treatment of choice for a carious exposure is removal of the pulp and conventional root canal treatment.

*Use of corticosteroid–antibiotic preparations in management of the deep carious lesion* Corticosteroid–antibiotic pastes have been used for many years to relieve acute pain associated with deep carious lesions.

*Mode of action* *Anti-inflammatory* (from the steroid) and *antibacterial* (from the antibiotic). Useful when there is a hyperaemic pulp and failure of local anaesthesia; most commonly when there is an irreversible pulpitis and/or carious exposure. Use of these pastes may cause relief of symptoms, decreased inflammation with ability to successfully anaesthetise the tooth on the next occasion.

It is imperative to realise that once these pastes have been used, conventional root canal treatment should be performed on the tooth. Use of these materials as a long-term indirect or direct pulp cap is ill advised.

## PRINCIPLES OF CAVITY PREPARATION

### OBJECTIVE OF CAVITY PREPARATION

• Removal of carious or fractured tooth tissue. • Secondary prevention of caries. • Minimise pulpal or periodontal damage. • Cavity should be prepared such that the filling material to be used can restore function and appearance of the tooth and is retained in the tooth.

### BASIC PRINCIPLES OF CAVITY PREPARATION

Although cavities vary widely, the following basic steps are common to the preparation of most cavities (Table 10.2):

#### 1. OUTLINE FORM

This is the cavity outline. Generally outline form encompasses the carious lesion, grossly unsupported enamel, and is made up of smooth angles rather than sharp edges. In the past outline form included adjacent areas which may become carious (i.e. '*extension for prevention*'); thus the complete fissure system was included in a cavity outline. Whilst the outline form of some types of cavity may well require some extension to satisfy resistance and retention form, it is hard to justify 'extension for prevention' in modern cavity design. Ideally cavity outline should be self cleansing, supragingival and not exposed to occlusal trauma. This ideal is frequently compromised by the extent of the caries and pre-existing restorations.

**Table 10.2**
**Stages in cavity preparation**

1. Outline form
2. Resistance form
3. Retention form
4. Management of remaining caries
5. Enamel margin finishing
6. Cavity toilet

## 2 & 3 RESISTANCE AND RETENTION FORMS

These are considered together as they are achieved simultaneously.

Resistance form refers to the features of the cavity design which resist occlusal forces.
Retention form refers to the features of the cavity design which resist displacement of the final restoration.

Retention form may vary depending on the material that will fill the cavity, e.g. a cavity to be filled by resin composite gains additional retention via micromechanical retention from acid etching of enamel. Therefore such a cavity requires less retention than a cavity that will be restored by a material such as amalgam.

*General requirements of cavities*

*Undercut* If the internal cavity diameter is greater than the marginal diameter the cavity is undercut. Additional undercut can be achieved by preparation of grooves or notches in dentinal walls.

*Main walls should be near parallel* If there is near-parallelism then, due to the close contact of restorative material to the walls, the material will be difficult to displace.

*Dovetail lock* Mesial or distal displacement can be resisted by preparation of such a lock in the occlusal surface of a tooth. Lock diameter should not weaken cusps, and form is dependent on tooth anatomy.

*Flat floors* Resist occlusal forces favourably.

## 4. MANAGEMENT OF REMAINING CARIES

Caries will be removed by preparation of outline, resistance and retention form. Usually there will be some caries left after this has been performed. Removal of existing caries should be undertaken with the following principles in mind: • The cavity margin must be caries free. • Great care should be taken to remove all caries and stained dentine from the amelodentinal junction. • Stained but hard dentine may be left in the deepest parts of the cavity. • Soft dentine should be removed.

## 5. ENAMEL MARGIN FINISHING

In most cavities the cavosurface angle (solid-line angle between cavity wall and tooth surface) should be 90°. Cavity margins should be closely inspected and gross unsupported enamel removed. However, the marginal strength of the restorative material for a particular cavity is a factor in determining the best cavosurface angle and the amount of unsupported enamel to be removed.

### 6. CAVITY TOILET

After mechanical cavity preparation is complete, residual debris should be dislodged with a hand instrument, the cavity cleaned with atomised heated water spray, isolated and dried.

## CLASSIFICATION OF CAVITIES

Black's cavity classification is a simple way of classifying cavities based on tooth surface affected (Table 10.3).

## CAVITY PREPARATION FOR CLASS I AND V CAVITIES

Classical cavity preparations for Class I cavities are usually described when the restorative material will be amalgam.

### CLASS I

• Initial preparation with air turbine. • Do *not* overextend outline form. • Small burs preferable. • Caries removal with rose head bur (large or small depending on extent of caries). • Floor usually as flat as possible. • Cavosurface angle usually 110º. • Cavity margins in non-stagnation areas to minimise risk of recurrent caries.

### CLASS V

• Gingival margin of outline form often *subgingival* due to caries. • May need retraction cord to arrest gingival haemorrhage. • Floor parallel to crown/root surface. • If amalgam to be used, may need undercuts in occlusal and gingival walls (use inverted cone or small rose head bur).

**Table 10.3**
**Black's classification of cavities**

| | |
|---|---|
| I | Cavity originating in anatomical pit or fissure |
| II | Cavity originating on mesial or distal aspect of molar/premolar teeth |
| III | Cavity originating on mesial or distal aspect of incisors/canines not involving incisal edge |
| IV | Cavity originating on mesial or distal aspect of incisors/canines involving incisal edge |
| V | Cavity originating in cervical third of buccal/lingual/palatal aspects of teeth (excluding anatomical pits) |

## CAVITY PREPARATION FOR CLASS II CAVITIES

Classical Class II cavity is described for amalgam restoration.

• Access via occlusal surface with air turbine to define outline. Use small burs to prevent overextension. • Cavity through enamel to dentine. • Proceed axially removing caries; do not open cavity too much laterally. • Remove marginal ridge to 0.5 mm thickness, then use low-speed handpiece to complete marginal ridge removal – decreases risk of damage to adjacent tooth. • Hand instruments useful in defining enamel margins. • Cavity should be extended so that box margins are self-cleansing. • Where possible, the box margins should be supragingival (often compromised due to caries). • Retention achieved by parallel walls and dovetail lock. • If additional retention is required, grooves/notches may be cut in axial walls of box. • Floor of occlusal part and box as flat as possible.

Diagrammatic representations of the classical Class II cavity preparation for amalgam are shown in Figures 10.3 and 10.4.

Frequently the Class II cavity must be extended and the classical cavity design compromised due to extensive caries.

## CAVITY PREPARATION FOR CLASS III AND IV CAVITIES

Classical Class III and IV cavities are described for resin composite restorations.

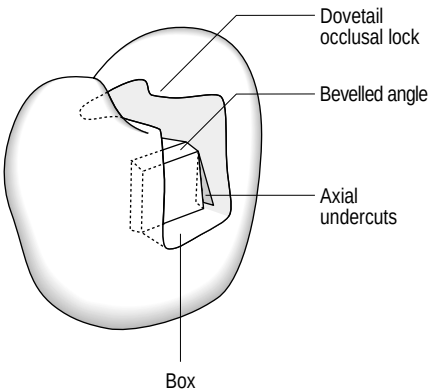


Figure 10.3 Class II cavity.

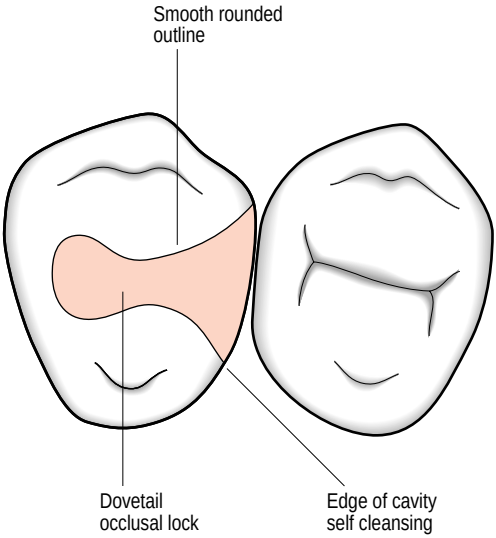


Figure 10.4 Class II restoration.

## CLASS III

• Initial outline approach from lingual or palatal side (to conserve labial enamel) using small round bur in air turbine through enamel to prevent overextension. • Cavity is normally undercut. • 90° cavosurface angle. • Margins should be self-cleansing. • Bevel of marginal enamel increases surface area for acid-etch bond and possibly enhances aesthetics. Some unsupported enamel may be left due to bonding of composite.

## CLASS IV

• Essentially same principles as Class III. • As incisal edge involved, may want longer bevel of enamel edges to increase surface area for acid etching.

### Tunnel preparations

Useful for early carious cavities on mesial and distal surfaces which just penetrate to dentine. Penetrate occlusally and 'tunnel' under marginal ridge to contact area *preserving* marginal ridge. Remove caries from occlusal surface through tunnel. Restore by packing into cavity from occlusal surface using matrix band. If extent of caries is misjudged, residual caries may be left around margins.

## CAVITY PREPARATION IN DECIDUOUS TEETH

Principles of cavity preparation are similar to permanent teeth but influenced by anatomy of deciduous teeth (p. 153).

## CAVITY PREPARATION FOR THE EARLY CARIOUS LESION

The early carious lesion in the fissure system of molars is often managed by small cavities which merely remove the offending caries, the cavity being restored by either glass ionomer or resin modified glass ionomer or resin composite and the fissure system sealed – a so-called *sealant restoration*. Cavity preparation should therefore be minimal and the use of very small burs in the air turbine is indicated.

In cavity preparation the 'first bite of the cherry' is very important. Achieving a good cavity preparation in the unrestored carious tooth often leads to a successful restoration; replacing failed restorations in previously inadequate cavities is always more difficult.

# PLASTIC RESTORATIONS

Plastic restorations are used intracoronally. Materials include amalgam, resin composite, glass ionomer – less commonly resin modified glass ionomers and cermets, although their frequency of use is increasing.

Placement of a satisfactory restoration requires sound cavity preparation (p. 214).

## LININGS

*Uses*

*Pulpal protection* Against thermal irritation in metallic restorations or leaching of toxic materials in non-metallic restorations.

*Structural function* Used to improve cavity design, e.g. to create a flat floor.

*Therapeutic function* In the deep carious lesion as an indirect or direct pulp cap.

*Clinical tips* The deeper the cavity, the greater the need to insert lining for pulp protection. Lining over dentine should not extend to amelodentinal junction or cavity margin. Lining must not occlude undercuts (e.g. grooves) compromising retention form of cavity.

## MATRICES

*Functions of matrices* • Retain restorative material in cavity during placement. • Allow close adaptation of restorative material to cervical and axial margins. • Ensure contact area and provides external contour of restoration.

*Types of matrices*

*Metal* Firm, used for amalgam restorations.

*Mylar* Easily mouldable and can light-cure through; used for resin composite.

*Plastic* Rigid, can light-cure through; used in Class V cavities.

*Difficult cases* In deep subgingival cavities use of special matrices such as tofflemire or automatrix or copper bands often achieve better contact points and marginal adaptation. Occasionally electrosurgery required to permit matrix adaptation.

## WEDGES

Allow firm adaptation of matrix to tooth. Available in a variety of sizes. Made of wood or plastic. Some permit light-curing via wedge.

## AMALGAM RESTORATIONS

Described for classical Class II cavity:

**Matrix placement**

- Matrix band should be inserted between gingivae and cervical margin of box, taking care not to catch gingivae or other oral soft tissues as band is tightened.
- Burnish band to achieve desired contact shape after tightening.
- Wedge should be placed.

**Condensation**

- Place amalgam initially into deepest part of box.
- Thorough condensation (hand instruments usually but can use mechanical condenser) into axiocervical margin.
- Progressive incremental build-up and condensation until box filled.
- Incrementally fill and condense occlusal lock.

**Carving**

- Before matrix band removal remove fillet of amalgam to adjust height of marginal ridge.
- Matrix band loosened and removed.
- Trim axial and cervical margins.

➔

- Carve occlusal morphology with particular emphasis on marginal ridge and pit.
- Check and adjust occlusion.
- Advise patient to avoid eating for 1 hour.

**Finishing and polishing**

- Amalgam may be smoothed with cotton wool and alcohol.
- After 24 hours may be polished using a selection of amalgam polishing burs and rubber wheels/cups.

## RESIN COMPOSITE RESTORATIONS

Described for classical Class III cavity:

**Pretreatment**

- The cavity may be pretreated by one or more of:
  – acid etching of enamel
  – dentine bonding
  – application of unfilled resin.

**Matrix placement and insertion of restoration**

- Matrix strip placed below contact area.
- Adapt matrix to cervical margin as this is the area where excess composite is difficult to remove, matrix supported palatally by finger and material placed into cavity, when filling complete, strip is moved over labial surface and the restoration light cured.
- Sometimes require transparent wedge for closer cervical adaptation.

**Finishing and polishing**

- Excess can be removed by hand instruments or composite finishing burs.
- Series of polishing discs are useful in gaining an aesthetic polish.
- Contact areas may be finished by using finishing strips.

## GLASS IONOMER RESTORATIONS

Described for classical Class V cavity:

- Restorative material may be autocured or light-cured.
- Material is placed in cavity, plastic or metal matrix pushed over cavity and material until set.
- Matrix is carefully removed, excess cement trimmed with sharp scalpel or excavator.
- Surface protected from desiccation by light-cured unfilled resin.

## MOISTURE CONTROL

Good moisture control is essential for placement of plastic restorations. Rubber dam should be used routinely (p. 150). In the absence of rubber dam, moisture control may be assisted by use of saliva ejectors, cotton-wool rolls and sponges.

## PINNED RESTORATIONS

Dentine pins provide additional retention for a restoration.

*Use* Additional retention for: • fractured cusps • crown cores • fractured incisal edges of anterior teeth • gold inlay, i.e. a pinlay.

*Types of pins*

*Threaded* Cuts a thread in a slightly smaller hole in dentine.

*Friction* Roughened pin placed in an undersized hole and retained due to dentine elasticity.

*Roughened* Cemented into a slightly oversized hole.

*Clinical aspects of pins* • Only use pins if retention is insufficient. • Use minimum number of pins. • Use water coolant during pin hole preparation. • Pin must not be placed in pulp or periodontium (knowledge of dental anatomy is essential). • If using more than one pin in a restoration they should be as far apart as possible. • Pin should be placed in largest bulk of sound dentine available, not at amelodentinal junction – usually 1 mm inward from the amelodentinal junction. • Pins may be bent after placement. • Correct packing of filling material around pins is essential for retention.

# CROWNS

A crown is a restoration which encompasses coronal tooth tissue, covering remaining tooth substance and restorations. When insufficient tooth tissue remains, the root canal can be used to aid retention – a post crown.

## TYPES OF CROWNS

*Full coverage* • Full veneer crowns (usually made of gold for posterior teeth) • porcelain jacket crowns (anterior teeth) • metal ceramic crowns.

*Post crowns* • Cast gold core • prefabricated core.

*Partial coverage* • Three-quarter crowns and reverse three-quarter crowns.

## ASSESSMENT OF TEETH FOR CROWNS

Case selection is important. In order to plan treatment appropriately, when considering crowns, assess: • tooth vitality • periodontal support and gingival condition • oral hygiene • caries control • occlusion • radiographic appearance • aesthetics (including patient's expectations) • adjacent teeth.

In some cases study casts, clinical photographs and a diagnostic wax-up of anticipated appearance may be useful.

## CLINICAL STAGES IN MAKING CROWNS

### 1. PREPARATION

Crown preparation involves removal of enough tooth substance allowing sufficient thickness of material (from which the crown is to be made) to provide strength and aesthetics. Preparation must not damage the pulp. Preparation must provide sufficient retention for the crown. This can be achieved by taper of 5–20° (especially in cervical third of preparation), and inclusion of retention grooves or slots is useful in teeth of reduced occlusogingival height. Preparation should involve minimal gingival trauma. Preparation should have smooth curves, not right angles or sharp edges. Finishing lines depend on the material from which the crown is to be made. Options for finishing lines:

*Butt joint* e.g. porcelain jacket crown.

*Chamfer* e.g. palatal margin metal ceramic crown.

*Taper* e.g. full veneer gold crown.

Preparation is usually achieved by a selection of high-speed diamond burs.

### 2. TEMPORISATION

Prepared teeth require temporisation for aesthetics, pulpal protection and prevention of overeruption or drifting of opposing or neighbouring teeth.

#### Types of temporary crowns

*Anterior teeth:* • polycarbonate preformed crowns • polyethylmethacrylate crowns fabricated using an initial irreversible hydrocolloid impression.

*Posterior teeth:* • stainless steel • polycarbonate or polyethylmethacrylate.

Usually temporary crowns are cemented with temporary cement. Occasionally a more permanent luting cement may be used when the temporary crowns are to be worn for a prolonged period or preparations are of reduced occlusogingival height. Heat-cured acrylic temporary crowns may be used if temporisation is for a prolonged period.

## 3. IMPRESSIONS

An accurate impression of the preparation is *essential* if the crown is to fit. Materials used in crown impressions include polyvinylsiloxane, polyether, polysulphide (usually with an individual tray) and reversible hydrocolloid (needs special apparatus) (p. 110).

To ensure an accurate impression:

- Follow the manufacturer's instructions for the particular material selected.
- Obtain gingival retraction where a preparation is subgingival via use of appropriate thickness of retraction cord or occasionally using electrosurgery.
- Examine the set impression critically, paying particular attention to air blows, voids, tears and shiny surfaces (lack of flow of impression), and if necessary repeat.
- In difficult cases use of impression copings or proceeding to a trial of a casting may ensure a satisfactory end result.
- An impression of the opposing arch in irreversible hydrocolloid is required.
- Jaw registration is essential and is usually achieved by using wax, reinforced wax or silicone rubber.
- Use of a facebow for mounting models on a semi-adjustable articulator is often desirable.

## 4. PRESCRIPTION TO TECHNICIANS

The dentist should communicate information about crown shape, shade, irregularities and design (e.g. type of margin, type of material, rest seats/undercuts/guide planes) clearly to the technician.

## 5. CEMENTING A CROWN

On receipt of a crown from the laboratory check that: • the cast has been trimmed correctly; compare impression margin and cast margin • the neighbouring teeth on the cast have not been abraded • the crown fits the cast • the correct design features are present • the occlusion is correct • the shade looks broadly correct.

The temporary crown should be removed from the mouth and any adherent temporary cement removed (often this requires local anaesthetic).

The permanent crown is tried in. The following should be carefully checked:

*Marginal fit*

*Contact point with neighbouring teeth* This should be such that interdental cleaning is possible.

*Gingival emergence angle*

*Occlusion* In all mandibular movements.

When the dentist is satisfied, the patient should be shown the crown aesthetics and modifications made if required. When both dentist and patient are satisfied, the preparation is degreased (with alcohol), dried and the crown cemented with a permanent luting cement. If there is any doubt, it is prudent to use a temporary luting cement and review the situation. Excess cement must be removed from around the crown margin. The patient should be given oral hygiene instruction regarding the crown.

## COMMON FAULTS WITH CROWNS

Despite careful attention to detail the following faults with crowns occur commonly:

*Overhanging margin* • Usually due to poor impression or poor technical work. • Can in some cases be corrected by trimming with a bur, but often requires a remake. • If uncorrected leads to plaque accumulation, gingival inflammation or recurrent caries.

*Negative margin* • Usually due to poor finishing line delineation, over-trimming of die or over-vigorous polishing of crown margins. • Often patient feels sensitivity. • Risks recurrent caries or poor aesthetics.

*Poor gingival emergence angle* • Usually due to lack of communication between dentist and technician. • Overbulking of material at the gingival margin leads to plaque accumulation.

*Poor contact point* • Usually due to under-preparation of mesial and distal walls or overbulking of interdental area by technician. • Hinders interdental cleaning.

*Poor aesthetics* • Can be due to incorrect shade, shape or under-preparation leading to insufficient space for material. • Occasionally patients have unrealistic expectations.

*Persistent debonding* • Often due to inadequate retention on preparation • May be due to occlusal interference. • In post crowns may be due to poor post design or longitudinal root fracture.

## ANTERIOR CROWNS

*Indications* • Protection of heavily restored teeth • aesthetics • bridge retainer • tooth wear.

## TYPES OF ANTERIOR CROWNS

*Metal–ceramic crown* • Used when limited occlusal space and high functional loads. • Relies on ability of porcelain to bond to metal oxide. • Modern metal–ceramic crowns have excellent

aesthetics. • Can have metal (when very limited occlusal space) or porcelain palatal surface. • Often have butt joint labially (1.5 mm shoulder to allow adequate metal and porcelain for aesthetics) and chamfer margin palatally.

A typical metal–ceramic crown preparation for an anterior tooth is shown in Figure 10.5.

*Porcelain jacket crown* • Used when aesthetics of prime concern.• Problem in high-load situation as porcelain in thin section and liable to fracture. Not usually suitable for posterior teeth.• Usually butt joint around whole preparation (minimum 1 mm shoulder to allow adequate porcelain for aesthetics).• Need 1.5 mm thickness of porcelain incisally.• A typical porcelain jacket crown preparation for an anterior tooth is shown in Figure 10.6.

*Other anterior crowns* Porcelain crowns with superior aesthetics and with higher tensile strength than conventional porcelain jacket crowns are finding increasing use – employ sintered alumina cores or injection moulding of ceramic. Require even reduction; preparation similar to a conventional aluminous

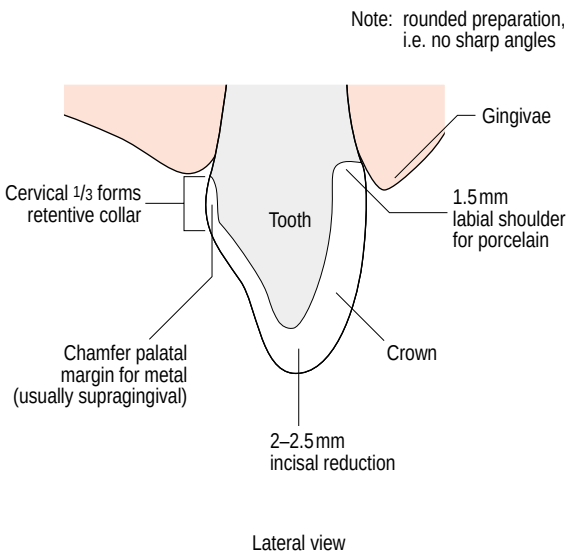


Figure 10.5 Metal–ceramic crown preparation of upper anterior tooth.

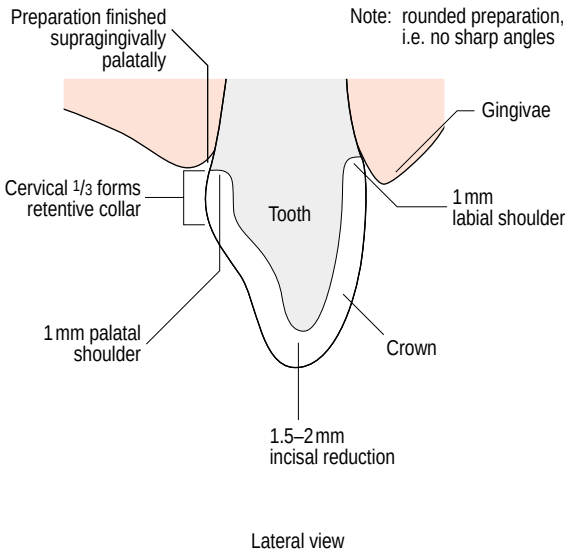


Figure 10.6 Porcelain jacket crown preparation of upper anterior tooth.

porcelain jacket crown. Use of dentine-bonded crowns and reverse three-quarter crowns involve significantly less tooth preparation.

## POST RETAINED CROWNS

*Indications* When there is insufficient coronal dentine to withstand occlusal forces or retain a crown. Root dentine is used and loads transmitted via a post to the root dentine. The post retains the crown. Usually root filled teeth (but not every root filled tooth requires a post crown).

*Assessment of teeth for post crowns* Careful assessment of individual teeth is required before considering a post crown.

*Root length* A long post is favourable for crown retention and a post extending to within 5–6 mm of the root apex is ideal. Root length may vary due to apicectomy, resorption, fracture.

*Root width* A wide post is often desirable, however, teeth such as first premolars or lower incisors are often extremely narrow and a wide post would leave such a tooth very weak.

*Root alignment* Curves and dilacerations complicate post design.

*Root canal filling* In general a sound root canal filling must be present with no apical pathology evident before post placement.

*Problems with post crowns*
Failed post crowns are a common occurrence. Problems include:

*Root perforation* Occurs after failing to judge root alignment. More common with engine-driven instruments.

*Root fracture* Occurs particularly with wide posts (in high occlusal load situations) where root dentine is excessively weakened.

*Post debonding* Occurs especially with short, tapered posts. Likely with high occlusal load or root fracture.

*Fractured post* Thin cast posts are susceptible to fracture due to occlusal loads or trauma. Removed with a trephine system.

*Corrosion* Can be a problem if core and post are made of dissimilar metals.

## TYPES OF POST CROWNS

A multitude of post crown systems exist. There is no single post core system that is suitable for all situations.

*Basic types* • Cast post core systems • prefabricated post core systems. Within these systems, posts may be parallel sided, tapered, threaded, serrated or parallel pins.

*Cast post core systems* Usually made of cast gold, sometimes wrought gold post and cast gold core. Problems involve casting porosity. Used successfully for many years. Tooth preparation should preserve as much coronal dentine as possible. Resist rotational forces by means of anti-rotational grooves or parallel pins. Post hole preparation should ideally be achieved with hand instruments to avoid risk of perforation.

Impression techniques may be indirect or direct indirect:

*Indirect* Involves use of wire or preformed plastic in the canal and an impression in an elastomeric impression material. An opposing arch impression and jaw registration is taken and the post core waxed up in the laboratory, invested and cast. Can sometimes make post core and final crown using single impression.

*Direct indirect* Involves use of a plastic post and either inlay wax or self-cured acrylic, modelled at chairside to gain an impression of the post hole and core shape. This is then invested and cast in the laboratory. Advantage – clinician has control over core shape.

*Prefabricated post core systems* These may be subdivided into: • post and integral core • post (core built in plastic restorative

material). Wide range of materials are in use – stainless steel, brass, titanium and nickel–chromium.

*Advantages* • Can be placed directly, so avoiding laboratory stage • material properties often superior to cast gold • easy to use • cheap.

*Disadvantages* • Increased clinical time • preparation often involves mechanical instruments so increased risk of root perforation or fracture • often designed for 'average' teeth so do not meet needs of teeth with wide or narrow root canals • failure of core (if made in plastic restorative material).

When using prefabricated post systems, the dentist should bear in mind the individual manufacturer's recommendations, the limitations of the particular system and the core material to be employed.

*Core materials* Amalgam, resin composite, glass ionomer, glass cermet or resin modified glass ionomer. Use of autocured or dual-cured materials is important so that restorative material is properly set.

## CLINICAL TIPS

*The 'first bite of the cherry' principle* Post crowns are most successful the first time they are constructed on a particular tooth. Treating failures is difficult as the preparation is already compromised. If fortunate to have the 'first bite of the cherry' in post crown treatment ensure: • as much coronal dentine as possible is maintained • post of adequate length and width to enhance retention but not compromise root strength or apical seal of root canal filling • there is adequate resistance to rotational forces in the preparation • post crown system most appropriate to clinical situation is chosen • final crown design is known at the outset in order that core can be designed properly • if using an indirect cast post system, instructions on design are clearly communicated to technician.

*Cementation* Luting failures are common. The tooth should be dried. A spiral paste filler should be used to transport luting cement into the canal and to coat the walls; further luting cement is placed on the post and the post core firmly seated.

*Variations*

*Posterior teeth* In molars and some premolars, roots are often narrow and at differing angulations leading to an increased risk of perforation or fracture by use of posts. Therefore use only posts essential for core retention. Consideration should be given to the use of dentine pins or packing of plastic restorative materials into root canal orifices to enhance core retention (so-called amalgam 'post').

*Diaphragm* Where there is subgingival root fracture, use of a cast post core and diaphragm may be appropriate.

*Angulated teeth* Minor tooth angulation problems, e.g. retroclined individual tooth, may be corrected by altering core angulation within the confines of occlusal harmony.

*Apicected teeth* Often have fairly short roots; thus post retention may be particularly difficult. Consideration should be given to making the final restoration non-functional.

## POSTERIOR CROWNS

*Indications* • Aesthetics (some posterior teeth only) • bridge retainer • tooth wear • protection of heavily restored teeth • partial denture abutments.

## TYPES OF POSTERIOR CROWNS

*Metal–ceramic crown* Used when insufficient occlusal space, high functional loads, or aesthetics important. Metal (when limited occlusal space) or porcelain occlusal surface. Junction of metal and porcelain should not be in area of high occlusal stress. Can have metal or porcelain (superior aesthetics) labial margin. Often have *butt joint* labially (1.5 mm shoulder to allow adequate metal and porcelain for aesthetics) and chamfer margin palatally or lingually. Functional cusps (in Class I occlusion upper palatal cusps and lower buccal cusps) need further tooth reduction by means of a functional cusp bevel. A typical metal–ceramic crown preparation for a posterior tooth is shown in Figure10.7.

*Full-veneer crown* Used when aesthetics of minimal concern (usually second or third molars). Usually made of cast gold. Tooth preparation should be as conservative as possible with the following features: • buccolingually and approximally, a 5º taper is ideal; chamfer margin removing all undercut areas. • Should finish supragingivally – not always possible as preparation should extend more gingivally than existing restorations so that preparation finishes on sound dentine. • Require minimum of 1 mm reduction occlusally to allow for gold to cover preparation. • Functional cusp bevel is needed to allow more occlusal clearance (1.5 mm) over functional cusps. • A typical full-veneer crown preparation for a posterior tooth is shown in Figure 10.8.

*Other posterior crowns* Cast gold partial-veneer crowns such as three-quarter crowns are occasionally useful to preserve a single intact cusp (usually mesiobuccal cusp of upper first molar). Porcelain crowns using sintered alumina cores or injection moulding of ceramic are finding increasing use in posterior crown situations.

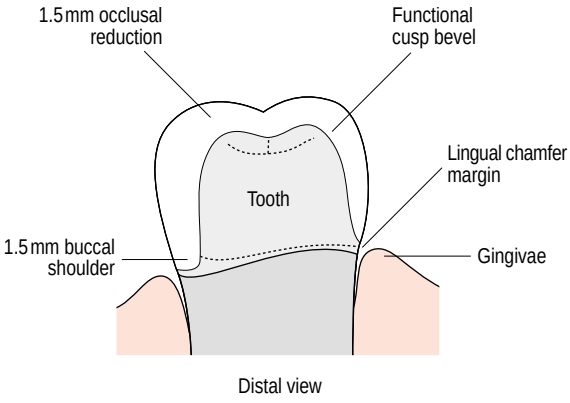


Figure 10.7 Metal–ceramic crown preparation on lower molar with porcelain labial shoulder and metal lingual shoulder.

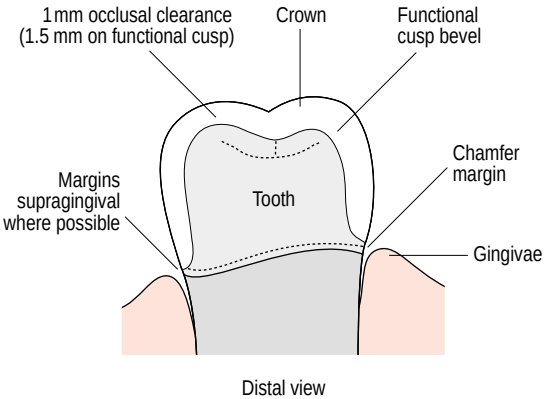


Figure 10.8 Full-veneer crown preparation on lower molar.

## VENEERS

A veneer is essentially a facing placed on a tooth.

### TYPES OF VENEERS

• Labial veneers • palatal veneers • reverse three-quarter • dentine-bonded crowns.

## LABIAL VENEERS

*Uses* • Aesthetic improvement of discoloured teeth • closure of diastemas • reshaping of hypoplastic teeth (e.g. peg laterals) • aesthetic masking of minor tooth position problems (e.g. slightly in-standing tooth) • trauma to anterior teeth • very rarely, as a bridge retainer in low occlusal stress situations.

*Materials* • Porcelain laminate veneers. • direct composite veneers • indirect composite veneers • mastique veneers.

In modern fixed prosthodontics, the porcelain laminate veneer is most commonly used as a labial veneer. Occasionally composite veneers may be used following trauma (usually in children). Consequently only porcelain laminate veneers will be discussed.

*Case selection* Existing caries, periodontal disease, occlusion and endodontic status should be assessed. Often porcelain laminate veneers are provided for aesthetic reasons so patient expectations should be determined. Teeth with large mesial or distal plastic restorations are usually not suitable for veneers due to increased risk of recurrent caries. Tooth wear and parafunctional habits should be assessed; veneers are often ill advised in such situations. Smile lines should be determined to identify which teeth require veneers.

## TYPES OF PORCELAIN LAMINATE VENEER PREPARATION

*Intra-enamel* A localised area within the labial surface of a tooth. Often requires minimal preparation.

*Feathered incisal* This preparation involves 0.5–1 mm reduction on labial surface with chamfer margins approximally, incisally and at gingival margin. There is no incisal overlap.

*Overlapping incisal* As for feathered incisal, except that there is 1 mm of incisal reduction and the incisal, edge is overlapped.

*No preparation* Sometimes (often interim measure in children) there is no preparation. This, however, leaves an over-bulked tooth.

## CLINICAL STAGES

### 1. PREPARATION

- The appropriate type of preparation is chosen and undertaken with an air turbine and a selection of fine grit diamond burs.
- Usually in enamel only and so local anaesthesia is not required.
- With the increased bond strength of dentine bonding agents, veneers are being used on teeth with exposed dentine so increasingly veneer preparations extend into dentine.

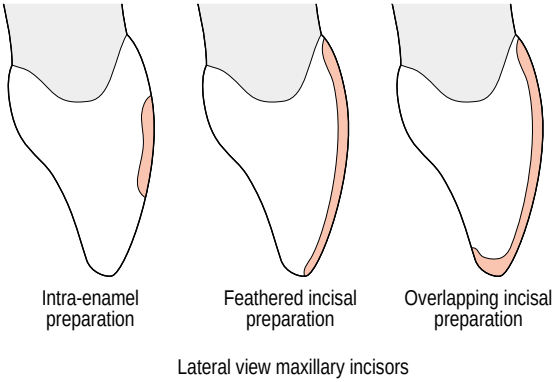


Figure 10.9 Porcelain laminate veneer preparations.

## 2. IMPRESSIONS

Usually performed in an elastomeric material with irreversible hydrocolloid impression of the opposing arch.

## 3. TEMPORISATION

Temporary veneers are usually not required. Patients should be warned of some post operative sensitivity and poor aesthetics.

## 4. CEMENTATION

The finished veneer should be tried in and checked for occlusion, fit and aesthetics. Once satisfactory, it is cemented as follows:

a. Enamel is etched with 37% phosphoric acid.
b. Unfilled resin is placed on enamel, excess blown off with air and light-cured.
c. Fitting surface of veneer is *silane coupled*.
d. Unfilled resin is placed on veneer, excess blown off with air and light-cured.
e. Filled *dual-cured* resin is placed on veneer and veneer seated.
f. Remove excess flash and light-cure.
g. Remove any remaining cement flash and check interdental contacts.

Note: Where there is dentine present labially, a suitable *dentine bonding agent* should be used.

## PALATAL VENEERS

Facings on the palatal surfaces of upper anterior teeth only.

*Uses* • Tooth wear (in particular acid erosion) • decrease dentine sensitivity • restore aesthetics • protect pulp.

*Types*

*Porcelain palatal veneers* Use in acid erosion. Should be about 1 mm thick. If the aetiology of tooth wear is diagnosed incorrectly and there is a large attrition component, may fracture. Usually feathered incisal or overlapping incisal (poor aesthetics). Preparation minimal as erosion often 'creates' preparation. Often eroded into dentine – thus require dentine bonding agent.

*Indirect composite veneers* Can be thinner than porcelain palatal veneers. Easier to adjust occlusion.

*Gold backings* Tin-plated to bond effectively. Can be very thin. Poor if translucent incisal edge present as metal shines through (but better aesthetically than nickel–chromium).

*Nickel–chromium backings* Can be very thin. Poor if translucent incisal edge is present as metal shines through. Better mechanical properties than gold. Useful if attrition is the main cause of tooth wear.

## REVERSE THREE-QUARTER (OR ADHESIVE) CROWNS

Has features of both a porcelain laminate veneer and a porcelain jacket crown. This restoration involves enamel reduction labially, approximally and incisally and from the incisal quarter of palatal or lingual surfaces. All finishing lines are a heavy chamfer to enable a butt joint with porcelain (Figure 10.10).

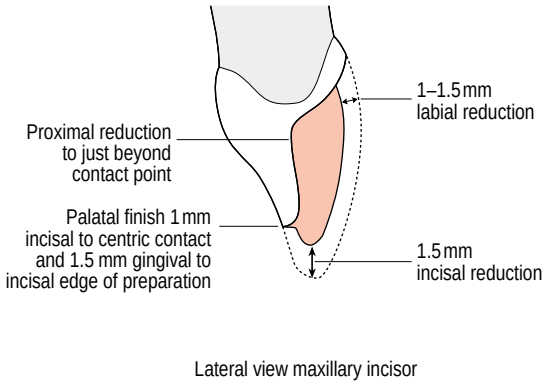


Figure 10.10 Reverse three-quarter crown preparation.

*Uses* • Fractured incisal edges • closure of diastemas • discoloured teeth • labial caries • alternative to conventional crowns in lower anterior teeth.

*Advantages*

*Advantages over porcelain laminate veneer:* • Greater strength • larger area for retention • less over-bulking gingivally • potentially improved aesthetics • more accessible approximal margins.

*Advantages over porcelain jacket crown* • More conservative of tooth tissue • decreased gingival problems • less abrasion of opposing tooth.

*Disadvantages* Adhesive crowns may fracture in high occlusal stress situations, e.g. parafunctional habits or canine teeth.

*Common problems with veneers include* • Poor gingival emergence angle • fracture in function • fracture on cementation • poor interdental contact • aesthetics not ideal (especially if need translucent incisal tip) • lack of positive seating on cementation so cemented incorrectly.

## INLAYS AND ONLAYS

### INLAYS

Inlays are intracoronal restorations which are manufactured in the laboratory and cemented into place.

*Types* • Gold inlays • composite inlays • porcelain inlays.

*Uses* Main use is in Class II cavities. Historically gold inlays have had limited use in Class III and Class IV cavities. Occasional use as a minor bridge retainer.

*Advantages* • Offer an alternative to amalgam as an intracoronal restoration • may protect weakened cusps • more aesthetic than amalgam (composite and porcelain have superior aesthetics).

*Disadvantages* • Require two clinical stages and one laboratory stage • increased tooth tissue destruction • microleakage and recurrent caries can be a problem • luting cement flash causing gingival irritation (worst with porcelain inlays) • gold inlays may result in galvanic reaction if amalgam in opposing or adjacent teeth • radiographic marginal diagnosis not easy with composite or porcelain inlays as they are less radio-opaque than metal.

*Clinical techniques* In all inlays the usual features of cavity design should be followed; that is, caries removal, retention and resistance form. Linings and structural linings should be placed as they would be for a plastic restoration (p. 219).

## GOLD INLAYS

### 1. PREPARATION

Cavity must ensure a path of insertion and removal of inlay (5º taper). Margins usually a fine taper or chamfer. Often need to cusp protect, i.e. cover functional cusps. If retention is poor, additional retention by means of parallel pins (pinlays) may be incorporated.

### 2. IMPRESSIONS

*Indirect* Involves an impression in an elastomeric impression material. An opposing arch impression and jaw registration is taken and the inlay waxed up in the laboratory, invested and cast.

*Direct indirect* Involves use of either inlay wax or self-cured acrylic. The dentist models self-cure acrylic or inlay wax to gain an impression of the inlay cavity and models the inlay shape. This is then invested and cast in the laboratory.

### 3. TEMPORISATION

Inlay temporisation is difficult, particularly if fine chamfer margins exist. The usual temporary crown materials (p. 124) are used but are not ideal. In some cases a temporary restorative material such as zinc oxide–eugenol may be used.

### 4. INLAY INSERTION

Once fit, occlusion and contact points have been checked, the inlay is adjusted and polished; it may be cemented with a conventional luting cement, e.g. glass ionomer. With the advent of improved bonding systems, sandblasting and tin plating the inlay, and cementing with dual or autocured resin composite, is becoming popular.

## COMPOSITE INLAYS

### 1. PREPARATION

Cuspal coverage not usually required. Chamfer margins not required. Where possible, margins should be supragingival to reduce microleakage.

### 2. IMPRESSIONS

An indirect technique as for gold inlays is used. In the laboratory, inlays are heat-, pressure- or light-cured (or a combination of these methods) depending on individual manufacturer's recommendations.

### 3. TEMPORISATION

Similar to gold inlays.

### 4. CEMENTATION

a. Enamel and dentine is usually etched with maleic or nitric acid.
b. On dentine, a suitable *dentine bonding agent* should be used and light-cured (depending on manufacturer's recommendations).
c. Unfilled resin is placed on enamel, excess blown off with air and light-cured.
d. Unfilled resin is placed on inlay, excess blown off with air and light cured.
e. Filled *dual-cured* resin is placed on inlay and inlay seated.
f. Excess flash removed before light curing.
g. Any remaining flash is removed and interdental contacts checked.

## PORCELAIN INLAYS

### 1. PREPARATION

Similar to composite inlays except that a *butt* joint is required; therefore greater destruction of tooth tissue.

### 2. IMPRESSIONS

An indirect technique as for gold inlays is used. In the laboratory, inlays are waxed up and injection moulded ceramic can be used. There is increasing manufacture of inlays by both CAD–CAM technology and using sintered alumina cores.

### 3. TEMPORISATION

Similar to gold inlays.

### 4. CEMENTATION

Similar to composite inlays except that the fitting surface of the inlay is often *silane coupled* prior to application of unfilled resin.

## ONLAYS

Onlays are extracoronal restorations on the occlusal surface of a tooth.

*Types* • Gold onlays • composite onlays • porcelain onlays.

*Uses* In tooth wear cases they are a less destructive alternative to increasing vertical dimension of occlusion than crowns. (*Note*: In severe attrition cases may not withstand parafunctional forces.) Also used for arrested caries, fractured cusps.

Onlays often require minimal tooth preparation and are supragingival. The porcelain onlay, however, requires a butt

joint so often a shoulder of 0.5 mm or more is needed. Clinical techniques are similar to inlays.

## FIXED BRIDGES

A bridge is a dental prosthesis which replaces a missing tooth or teeth and is attached permanently to one or more natural teeth (or implants). It is not removable by the patient.

### Definitions

Abutment tooth A tooth which supports a bridge.
Retainer Part of a bridge which is cemented to an abutment tooth.
Pontic Each replacement tooth in a bridge.
Unit Each part of a bridge, i.e. abutment or pontic, is referred to as a unit. Thus two abutments and one pontic constitutes a three-unit bridge.
Pier Non-terminal abutment.

The components of a bridge are illustrated in Figure 10.11.

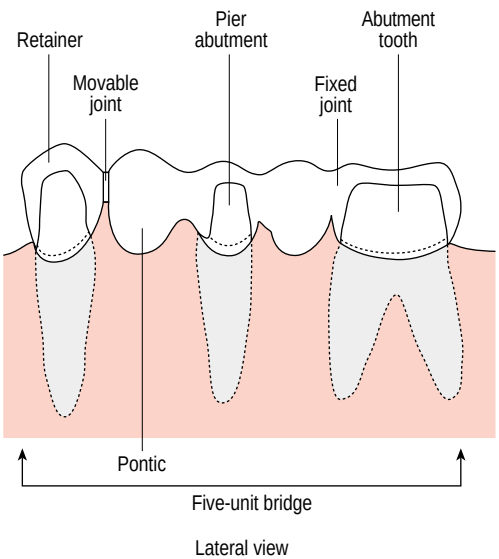


Figure 10.11 Bridge components.

*Indications for bridgework* • Aesthetics • occlusal stability – prevention of drifting, tilting, overeruption • function – usually in posterior regions • periodontal – a bridge is tooth supported (and covers less tissue) so is often considered more favourable to the periodontium than a removable prosthesis • small bounded saddles – ideal for fixed bridgework.

*Disadvantages of bridgework* • Tooth tissue destruction • expensive • difficult to repair.

*General considerations in bridgework*

*Patients* Patients often consider a fixed prosthesis more favourable than a removable prosthesis. However, bridges are costly in terms of tooth tissue, time and money.

*Saddle* Small saddles are more favourable than large saddles; however, marked resorption is a problem as cannot replace alveolar tissue (so bridge may cause aesthetic or speech problems).

*Abutment teeth* Teeth of small occlusogingival height unfavourable – as are tilted teeth, teeth with caries, endodontic problems, perforations, periodontal disease. Require careful assessment as to suitability as an abutment.

*Occlusion* Deep overbites, evidence of severe bruxism and overeruption of opposing tooth into saddle are all unfavourable.

*Support* Bony support of abutment teeth and root morphology important.

*Complications of bridgework*

*Short term:* • Traumatic periodontitis (occlusal imbalance) • pulpitis (following tooth preparation) • debonding (unretentive preparation) • 'sprung' retainer (bridge debonds from one abutment predisposing to caries under debonded retainer) • pain (irritant cement, pulpitis) .

*Long term:* • Loss of vitality of abutments • caries • periodontal disease • fracture of bridge component (e.g. porcelain facing) • 'sprung' retainer • persistent debonding • abutment mobility (excessive loading).

Care with case selection and attention to detail in clinical stages can reduce incidence of complications and failures.

*Ante's Law* This law states 'The combined peri-cemental area of the abutment teeth should be equal or greater in peri-cemental area than the tooth or teeth to be replaced'.

In bridgework this is a useful 'rule of thumb' as to suitability of teeth as abutments. There is evidence, however, that it is the quality and not quantity of bone support that is important. Teeth with large pericemental areas are first and second molars,

canines, premolars. These teeth are often good quality bridge abutments. Teeth with small pericemental areas include upper lateral incisors, lower incisors; may not be optimal as abutment teeth for bridgework.

## PONTIC DESIGN

Pontic design is extremely important for good aesthetics and hygiene.

### Broad principles of pontic design

*Occlusal surfaces* As narrow as possible to prevent excessive force on abutments (posterior teeth).

*Buccal and palatal/lingual surfaces* Should be in same plane as surfaces of adjacent teeth to be in harmony with cleansing action of lips/cheeks/tongue.

*Contact angle* Angle of pontic to gingivae – contact should be as wide as possible to prevent food stagnation.

*Contact area* Where pontic joins mucosa should be as small as possible.

*Mucosal contact* Avoid concave contacts as patient cannot clean under them.

*Interdental spaces (embrasures)* Narrow spaces should be avoided. Space should be available for cleaning by an interdental brush or superfloss.

*Material in contact with mucosa* In a metal–ceramic bridge, mucosal contact should be with glazed porcelain.

A commonly used anterior pontic (*modified ridge lap*) is shown in Figure 10.12. An all-gold posterior pontic (sanitary pontic) is shown in Figure 10.13.

## RETAINERS

Many types of retainers are used in bridgework. Factors influencing choice of retainer include: • retention required • occlusogingival height of abutment teeth • quality and quantity of dentine remaining after preparation • existing restorations in the tooth • the amount of metal that can be seen without compromising aesthetics • requirement for cusp or incisal protection.

*Usual retainers are:* • full-veneer gold crowns (posterior teeth) • metal–ceramic crowns (anterior teeth).

*Other retainers used include:* • three-quarter crowns • adhesive crowns/porcelain veneers/porcelain jacket crowns (for all-porcelain bridges) • inlays/pinlays (in declining use) • telescopic or milled crowns (for tilted teeth).

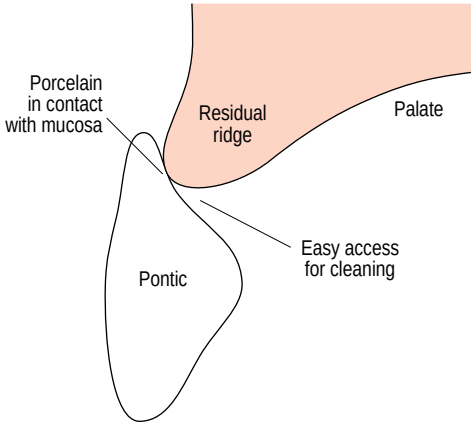


Figure 10.12 Anterior pontic design (modified ridge lap).

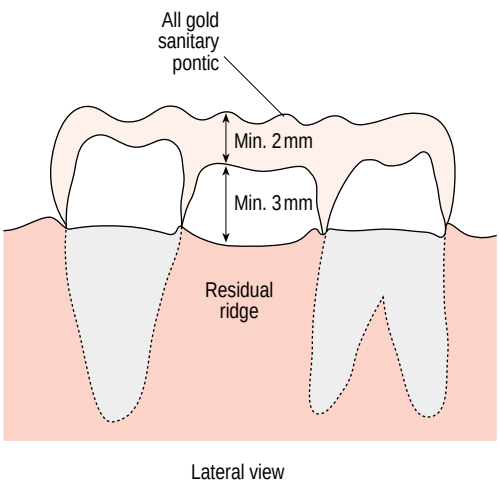


Figure 10.13 Posterior pontic design (sanitary pontic).

## CONVENTIONAL FIXED–FIXED BRIDGE

All joints are cast (or soldered) in one piece to connect abutment teeth rigidly.

Crown preparation has been discussed previously (p. 223). Only difference in fixed–fixed bridge is the need to parallel the abutments to achieve a common path of insertion of the bridge. This may necessitate over tapering of a tooth surface in teeth which are slightly tilted in relation to each other.

## CLINICAL PROCEDURES

### 1. Abutment preparation

Tooth preparation should be undertaken after planning the prosthesis as the amount of preparation will vary according to design: • metal occlusal surface (less tooth reduction occlusally) • porcelain occlusal surface (more tooth reduction occlusally) • metal collar (chamfer margin buccally) • porcelain shoulder (wider buccal shoulder).

### 2. Impressions

Elastomeric impression of abutments, often with the use of gingival retraction cord. In extensive bridgework, individual tray or reversible hydrocolloid may be needed. Subgingival preparations may need tissue management with electrosurgery before impression. Irreversible hydrocolloid impression of opposing arch is required.

### 3. Occlusal registration

Recorded in either wax or polyvinylsiloxane; in extensive bridgework, mount casts on a semi-adjustable articulator using facebow registration.

### 4. Shade taking

Individual teeth in a bridge may have different shades.

### 5. Temporary bridge

Can be made at the chairside or in the laboratory. Laboratory-fabricated are more satisfactory as made in heat-cured acrylic.

### 6. Try-in of casting

In extensive bridgework it is sometimes useful to try in the metal casting as it may need to be sectioned and relocated.

### 7. Checks prior to bridge cementation

The following should be carefully checked: • marginal fit • occlusion • aesthetics • contact points • access for oral hygiene measures • speech.

**8. Trial cementation**
In most cases it is advisable to cement the bridge temporarily for a short time (1–2 weeks). Thus if problems arise bridge can be removed and modified.

**9. Final cementation**
Undertaken usually with conventional luting cement, e.g. glass ionomer, zinc polycarboxylate. Can sandblast, tin plate and use composite or chemically active resins with metal bonding components. A post-cementation radiograph is useful as baseline data for further review.

**10. Review**
At usual check-up times bridges should be carefully assessed for oral hygiene, carious margins, debonding from retainers, periodontal support. Periodic radiographs are useful for early detection of caries, endodontic or periodontal problems involving abutment teeth.

## CANTILEVER BRIDGE

This type of bridge has a pontic connected to a retainer at one end only.

*Indications* • Low occlusal loads • replacement of lateral incisors with canine as abutment • replacement of one premolar (often pontic is merely an aesthetic facing) • can use twin abutments, e.g. first molar and second premolar as abutments to first premolar.

*Advantages* • One abutment does not require parallelism • more conservative of tooth tissue.

*Disadvantage* • Excess force on abutment.

## FIXED–MOVABLE BRIDGES

A fixed–movable bridge has a joint allowing limited movement between pontic and retainer.

*Uses*

*Malaligned abutment teeth* Use of a joint allows for differing paths of insertion e.g. mesially tilted lower molar.

*Pier abutment* In long-span bridgework where there are three abutments, the centre abutment acts as a fulcrum and is subjected to large occlusal forces. Addition of a joint reduces load on the pier abutment tooth.

*Retrievability* In long-span bridgework incorporation of a joint enables part of the bridge to be removed should one retainer fail, avoiding the need to replace the complete bridge.

*Combination of materials* e.g. mesial part of bridge metal–ceramic; distal gold. Allows combination of materials without solder joint.

*Mobile teeth* If one abutment is mobile, may help dissipate unfavourable forces.

*Joints*

*Laboratory made* Simplest is tube lock.

*Precision attachments* Can be intracoronal or extracoronal. A wide variety exist.

Fixed–movable bridges offer an alternative to fixed bridgework. The joint, however, builds in complexity and if a precision attachment is used, sufficient occlusogingival height is required.

These bridges are very successful but case selection is critical.

## SPRING CANTILEVER BRIDGES

Support a pontic at some distance from the retainer. A gold bar which is in contact with palatal mucosa connects pontic to retainer.

*Indications* Replacing spaced anterior teeth.

*Design* Retainer usually one or two premolars or a single molar. Connector should be oval in shape for cleansing. Bridge should be rigid near retainer and flexible near pontic.

Careful case selection is important. This is not an ideal prosthesis as it results in an area of mucosa permanently covered by the bar.

## ADHESIVE BRIDGES

Modern adhesive bridgework relies on the micromechanical bonding of composite resin or chemically active resin to etched enamel and etched or sandblasted metal.

### CASE SELECTION

• Small occlusal forces – adhesive bridges in bruxist patients or when replacing maxillary canine have poor results. • Intermediate restoration. • Missing lateral incisors. • 'Virgin' abutment teeth.

• Favourable occlusal scheme – deep overbite unfavourable, Class III occlusion favourable. • Splinting teeth.

## MODERN TYPES OF ADHESIVE BRIDGES

*Perforated framework* Relies on macromechanical retention, e.g. Rochette bridge.

*Unperforated framework* Relies on micromechanical bonding, e.g. Maryland bridge.

*Temporary* Uses either natural tooth or acrylic or composite as a pontic.

## DESIGN OF BRIDGE

Most commonly, unperforated frameworks are used. Using two abutments increases torquing forces on least mobile tooth so bridge may 'spring'. Therefore design often is cantilevered off single abutment tooth. There is currently great debate as to whether one or two abutments is the design of choice.

*Anterior design* Incorporate largest area of enamel without compromising aesthetics. Need 0.5 mm occlusal clearance, supragingival chamfer margin, guide planes mesially and distally, parallel grooves mesially and distally along path of insertion, cingulum rest.

*Posterior design* Similar to anterior design, except uses mesial and distal occlusal rests rather than cingulum rests. Maximise axial wall enamel incorporated in design. Narrow aesthetic type pontic design.

## CLINICAL TIPS

The bridge should be tried in and assessed for fit, aesthetics and occlusion prior to cementation. Do not extend preparation too far incisally as incisal edges will look grey. After cementation *do not* polish without water coolant as this reduces bond strength.

*Preparation of metal surface* For bonding to resin, the metal substructure of the adhesive bridge must be treated by one of the following methods:

*Electrolytic or chemical etching* Uses hydrofluoric acid in the laboratory. Bond may be severely compromised by salivary contamination so very technique sensitive.

*Sandblasting* Sandblasting with 50–150 μm aluminium oxide gives some degree of micromechanical retention; sandblasted surface is more robust than etched surface.

*Cementation* To ensure good moisture control this is best performed under rubber dam.

Types of cements available:

*Composite resins* Low-viscosity microfilled composite resins (autopolymerising or dual-cured with thin film thickness) can be used for cementation. Enamel should be etched with phosphoric acid and an unfilled resin used for bonding.

*Chemically active resins* Metal pretreatment with 4-META (4-methacryloxyethyl trimellilite anhydride) improves bonding. Chemically active resins typically have a monomer with a phosphate group and bond well to a sandblasted surface.

*Recementing debonded adhesive bridges* An assessment should be made as to why the bridge has debonded, check occlusion, look critically at the preparation, consider other treatment options – a conventional bridge may be more appropriate.

The tooth should be cleaned, the bridge ultrasonically cleaned and re-sandblasted before recementation.

*Success of adhesive bridges* Over 10 years a debond rate of about 30% may be expected for adhesive bridges. Unperforated framework more successful than perforated framework.

## TOOTH WEAR

Tooth wear is also known as tooth surface loss, non-carious tooth surface loss and non-bacterial tooth surface loss.

### AETIOLOGY OF TOOTH WEAR

Tooth wear comprises *attrition*, *abrasion* and *erosion*. These are often interrelated. Wear is much worse where more than one aspect is present simultaneously.

Tooth wear is increasing in prevalence and affects both adults and children. In the future, the effects of tooth wear will present many restorative challenges as individuals retain their teeth for longer.

Attrition is the loss of tooth substance by wear due to mastication or contact between occluding surfaces.

### AETIOLOGY OF ATTRITION

- Bruxism (grinding, clenching)
- lack of posterior support and occlusal collapse
- salivary flow and composition
- tooth structure.

It is unknown why people brux. Several factors are involved, although the relative importance has not been established.

*Factors involved in bruxism* • psychogenic • genetic • local • systemic • occupational • instinctive (thegosis).

Abrasion is the loss of tooth substance by wear due to factors other than tooth contact.

## AETIOLOGY OF ABRASION

• Aggressive oral hygiene techniques (toothbrush, toothpaste, interdental cleaning) • habitual chewing (pens/pencils, fingernails, nut shells) • occupational chewing (electrical wire, fishing line, ironmongery, etc).

Erosion is the progressive loss of hard dental tissues by a chemical process not involving bacterial action.

## AETIOLOGY OF EROSION

• Acidic diet (carbonated drinks, fruit juices, citrus fruits, pickled foods, mouthwashes) • acid regurgitation (bulimia nervosa, gastrointestinal problems, chronic alcoholism, morning sickness) • industrial processes (armament production, battery workers) • medical problems (compulsive achievers, 'chewing the cud') • leisure activities (swimming) • tooth structure • salivary flow and salivary composition.

In over 30% of cases it will not be possible to elicit any significant aetiological factor in individuals displaying tooth wear.

## DIAGNOSIS AND ASSESSMENT OF TOOTH WEAR

*Case history* A detailed case history should be taken to determine the nature of the problem, including: • patient's view of the nature of the problem • duration of the problem and whether or not in the patient's view the problem is ongoing • history and longevity of current restorations • assessment of aetiological factors • patient concerns over appearance, function or pain.

*Clinical examination* Clinical examination in cases of tooth wear should pay particular attention to the following: • occlusogingival height of worn teeth • lack of posterior support • overeruption of teeth • occlusal assessment • assessment of freeway space • craniomandibular disorders • state of existing restorations.

Additional information, particularly in assessment of the occlusion, is often required in complex tooth wear cases. Occlusal assessment involves: • study casts • use of mounted casts on a semi-adjustable articulator • diagnostic wax-ups of possible occlusal schemes • trial occlusal adjustments on mounted casts.

*Assessment* Once a detailed history and examination have taken place the following questions should be considered:

• What are the immediate problems or concerns of the patient? • Can these be addressed? • Does the patient have unrealistic expectations? • What is the major aetiological factor? • Can the aetiological factors be modified to give a long-term satisfactory outcome? • Is intervention desirable? • Is the patient capable of undergoing a complex restorative treatment plan or would a simple approach be better? • Is the scope of the problem within the clinician's capabilities?

Answering these questions will enable the clinician to decide upon a management strategy that may include appropriate monitoring, initial treatment, definitive treatment or referral.

*Measurement of tooth wear* Tooth wear is often measured subjectively. Various indices exist which are used primarily for research, e.g. Smith and Knight tooth wear index.

## PREVENTION OF TOOTH WEAR

A detailed wear history and establishment of a diagnosis is important in the prevention of tooth wear.

### *Practical aspects of tooth wear prevention*

*Dietary advice* Patients should be advised to reduce carbonated drink intake (including 'diet/light' drinks); avoid excessive intake of citrus fruits, pure fruit juices and acidic dilutable drinks. Avoid chewing very abrasive foods. Remember not only is the frequency of consumption important, the pattern of consumption may result in prolonged exposure to acid, e.g. drinking a can of beverage very quickly or sipping it over a period of hours.

*Fluoride* Daily use of a fluoride mouthwash encourages fluorapatite formation (p. 136).

*Splint therapy* Useful where attrition is the main aetiological factor. Splints may be *hard* or *soft* and can be made for *upper* or *lower arches*. It is unclear if the splint acts as a habit breaker for bruxism or is merely a damage limitation exercise as the splint wears in preference to tooth substance. Splints may be worn night-time, daytime, full time or during periods of the day when bruxism is known to occur (often stress/anxiety related).

*Hypnotherapy* Occasionally used to eliminate bruxism.

*Tricyclic anti-depressants* Often useful, using their side-effect of muscle relaxation, in the prevention of further bruxism; may also help with underlying psychological problems.

## MONITORING TOOTH WEAR

Monitoring of patients experiencing tooth wear is important to determine if the wear is progressive and in deciding the timing of treatment. Merely observing a patient's dentition periodically is insufficient to detect small changes in wear. Progression can be evaluated using serial study casts and clinical photography.

## MANAGEMENT OF TOOTH WEAR

Definitive management options are extremely varied. In general the following basic principles apply:

1. Control of aetiological factors.
2. Pain and caries control.
3. Period of observation to determine if wear is progressing.
4. Provisional intervention:
   - provision of posterior support, e.g. partial dentures
   - increase in vertical dimension, e.g. overdentures, splints.
   - provision of anterior space, e.g. anterior bite plane, Dahl appliance.
5. Definitive rehabilitation:
   - crown restorations.
   - definitive dentures/overdentures.
6. Review.

Frequently an increase in the vertical dimension of occlusion is required. This should be provided in a reversible manner in the first instance.

## TOOTH WEAR FAILURES

A small proportion of patients (particularly bruxists) fail to control aetiology despite rehabilitation. Over a period of years these patients present with a number of failures, including porcelain debonding from metal, root fracture, bent/fractured posts and cracked cusps.

Failure can be reduced by attention to detail when treatment planning. Where possible avoid multiple anterior post retained crowns in bruxists and use metal occlusal surfaces in crown restorations.

# BLEACHING AND MICROABRASION

Bleaching techniques aim to whiten discoloured teeth.

Bleaching works by oxidation of organic matter without dissolving the enamel matrix and changing coloured parts to a colourless state. It is not particularly effective for tetracycline-stained teeth.

## TECHNIQUES

### VITAL BLEACHING

*Professionally applied* Teeth are etched with phosphoric acid then heated; 35% hydrogen peroxide applied; repeated two or three times. As an alternative activated gels are applied, which change colour when bleaching complete (usually 3–4 minutes).

*Nightguard vital bleaching* Dentist-prescribed home bleaching involves an impression, and a nightguard is made with spacers over teeth to be bleached. Patient applies gel of 10% carbamide peroxide to nightguard and wears this overnight for 2–5 weeks.

*Home bleaching kits retailed directly to patients* Not controlled by dentist. Often three-step process: 15 seconds acid rinse; then apply 6% hydrogen peroxide gel; then tooth whitening pigment.

*Whitening toothpastes* Compositions vary, some with weak solution of carbamide peroxide. Some are very abrasive. Clinical efficacy varies.

### NON-VITAL BLEACHING

Used for discoloured non-vital teeth. Requires sufficient coronal dentine for restoration of crown. If not, consider crowns or veneers. Technique involves: • replacement of defective restorations • removal of gutta-percha to below the amelocemental junction • bleaching using heated 35% hydrogen peroxide applied internally to the pulp chamber • 'walking bleach' between appointments with sodium perborate sealed inside the pulp chamber • usually requires 2–3 visits.

### SAFETY OF BLEACHING

Bleaching is generally considered safe. Home bleaching requires careful monitoring, especially if acids are used for pretreatment as erosion may result. In some countries nightguard vital bleaching is banned as carbamide peroxide is classified as a cosmetic and does not have a drug product licence.

### MICROABRASION

Used for improving appearance of mottled enamel (usually due to fluorosis). Works best when mottled enamel is superficial and when white or light brown rather than dark brown mottling present. Simplest technique involves: • acid etch enamel • polish with a rubber cup or prophy brush using a slurry of pumice and glycerine • apply topical fluoride • repeat several times • may require 2–3 visits • occasional postoperative sensitivity • other more complex proprietary methods exist.

## ENDODONTICS

Endodontics involves treatment of the dental pulp.

### CAUSES OF PULPAL DAMAGE

• Dental caries • trauma • periodontal disease • damage during operative procedures.

### DIAGNOSIS

Diagnosis of pulpal damage involves a comprehensive pain history (p. 202). In addition special tests are often required to

ascertain a correct diagnosis: • percussion testing of teeth • sensibility testing of teeth (heat/cold/electric) • radiographs (periapical).

## CONVENTIONAL ROOT CANAL THERAPY

Conventional root canal therapy is undertaken for non-vital teeth, dying teeth, teeth where the pulps are so badly damaged that the pulp must be removed if the tooth is to remain in function and elective treatment where the root canal must be treated for the crown to be restored.

## AIMS OF ROOT CANAL TREATMENT

• To cleanse the pulp cavity of infected debris, toxic materials and pulpal remnants. • To seal the pulp cavity apically, periodontally and coronally. • To maintain the tooth in function.

## INSTRUMENTATION

There are many instruments in use in root canal treatment. Commonly used instruments include:

*Files* Used to widen the root canal, e.g. K flex files, K files and Hedström files (Figure 10.14). Files may be hand held or operated in a handpiece or ultrasonic handpiece.

*Rotary files* Used to widen the root canal, especially the coronal part, e.g. Rotary files of greater taper, safety Hedström files. Files should be used correctly in speed-reducing handpieces and not autoclaved too many times (leads to instrument fracture within canals).

*Broaches* These instruments, e.g. barbed broach, are used for vital tissue removal.

*Side cutting burs* Used for preparation of the coronal two-thirds of the root canal.

*Spiral paste fillers* Used for placing sealer or intracanal dressings into the pulp cavity.

*Spreaders and compactors* Used in root canal obturation.

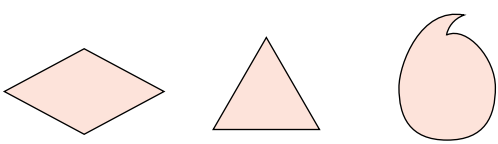


Figure 10.14 Cross-section of common file types.

**Table 10.4**
**Dimensions and colour coding in endodontic instruments**

| Colour | Tip diameter (mm) | Size |
|---|---|---|
| White | 0.15 | 015 |
| Yellow | 0.20 | 020 |
| Red | 0.25 | 025 |
| Blue | 0.30 | 030 |
| Green | 0.35 | 035 |
| Black | 0.40 | 040 |

Standardised files have a taper of 0.02 mm/mm and range in size from 008 to 140

Instruments are usually standardised and colour coded (Table 10.4).

## RUBBER DAM

Rubber dam isolation is ESSENTIAL in modern root canal treatment.

See page 150.

## ACCESS CAVITY PREPARATION

Knowledge of dental anatomy is essential for appropriate access cavity preparation.

*Maxillary and mandibular canines and incisors* Access cavity should permit straight-line access to within 1 mm of the apex. Ideally access cavity is close to incisal edge on the palatal or lingual surface of tooth. Triangular shape with broadest portion incisally. Mandibular incisors may need access through incisal edge. Access through Class III cavities results in sharp instrument bends.

*Maxillary and mandibular premolars* Access cavities should be ovoid bucco-lingually and through the occlusal surface.

*Maxillary molars* Access cavities should be through the occlusal surface, triangular in nature, with the base of the triangle buccally and the apex palatally.

*Mandibular molars* Access cavities should be through the occlusal surface, triangular in shape, with the base of the triangle mesially and the apex distally. Occasionally need to remove mesiobuccal cusp to access mesiobuccal canal.

## WORKING LENGTH DETERMINATION

Working length is usually determined by estimating a length from the preoperative radiograph. Length of a canal may be finalised by:

*Working length radiograph* Using files of known length to a stable reference point. Multiple radiographs of multirooted teeth may be required to show all roots.

*Electronic apex locators* Some are not particularly accurate if canal is wet with pus/exudate.

During instrumentation of curved canals, working length must be reassessed as it may change as a canal straightens.

## TECHNIQUES FOR CANAL SHAPING

There are many techniques for root canal shaping. Three common techniques are described:

*Step-back technique* In this technique the working length to the apical constriction is determined and the canal filed to the apex using a master apical file (MAF). Further larger files are inserted in an incremental step back, 1 mm coronally in the canal each time, recapitulating to the working length with the MAF. Good technique for straight, simple canals. For example, if MAF is size 030 at 21 mm, file sequence will be 030 to 21 mm; 035 to 20 mm; 030 to 21 mm; 040 to 19 mm; 030 to 21 mm; 045 to 18 mm and so on.

*Step-down technique* Principles are: • coronal access • then radicular access • then apical instrumentation.

*Technique* Gain coronal access. Radicular access with 015–025 Hedström files with an up-and-down action (away from furca in mulitrooted teeth), together with side-cutting burs. Step-back technique at apex.

*Advantages:* • Straighter access to apex • removal of dentinal interferences • bulk of debris and bacteria removed before apical instrumentation • working length less likely to change during apical instrumentation as canal curvature has already been reduced • allows deeper penetration of irrigating solutions • good for molars.

*Balanced force technique* Canal curvature introduces complexity into canal preparation.

*Technique* Uses force magnitudes to control undesirable cutting associated with canal curvature, e.g. ledging, transportation, perforation. A lighter restoring force is applied against the walls of curved canals using modified tipped (blunt) K files (flex R files). Straight-line access with side cutting burs; then flex R files using large radius, low arc, low restoring force with 120º anticlockwise rotation to cut and 120º clockwise rotation to clean; good technique for curved molars.

Techniques vary where thermoplasticised gutta percha is used for obturation.

## ROOT CANAL CLEANSING

Cleansing of a root canal is essential for successful root canal treatment. Cleansing disinfects the canal contents, flushes out debris, in some cases dissolves organic debris and softens dentine.

Cleansing is achieved by irrigating solutions into the root canal either endosonically or using a syringe with a 27 gauge needle and an endodontic tip (which has a side perforation to reduce risk of cleansing fluid being forced through the apex). Solutions which may be used are as follows:

*Sodium hypochlorite solution* Most commonly used cleanser, effective antibacterial action.

*Ethylene diamine tetra acetic acid (EDTA)* Removes smear layer.

*EDTA and urea peroxide* Releases nascent oxygen.

*EDTA and sodium hypochlorite*

*Saline*

*Chlorhexidine*

Copious amounts of cleanser should be used for root canal cleansing.

## INTRACANAL DRESSINGS

Inter-visit dressings are frequently required. After instrumentation, canals should be dried with paper points. Non-setting calcium hydroxide is the material of choice as an inter-visit intracanal dressing. Other materials in use include 35% solution of camphorated monochlorophenol and betamethasone (anti-inflammatory, antiseptic), 1% triamcinolone and 3% dimethylchlortetracycline paste (used for hyperaemic pulps). Coronally 3 mm of temporary dressing is required to obtain an adequate seal.

## ROOT CANAL OBTURATION

Obturation of the root canal implies occlusion of the canal and accessory and lateral canals in order to prevent the movement

into or out of the canal of tissue fluids, micro-organisms and toxins.

*Criteria for root canal obturation* Canal must be dry and must usually be symptom free.

*Materials used for root canal obturation* Although many materials have been used for root canal obturation (e.g. silver points, absorbable pastes), root canals are most commonly obturated with gutta-percha and sealer.

*Gutta-percha* Available as cones (standardised or non-standardised), thermoplasticised.

*Sealers* Gutta-percha alone does not provide an adequate seal, therefore sealers are required. Sealers may be based on calcium hydroxide, zinc oxide–eugenol, resin, glass ionomer or PVC.

### Common obturation techniques

*Single gutta-percha cone* Uses standardised files and a standard gutta-percha cone corresponding to the file size. Cemented with sealer. Simple technique. Disadvantage is that complex root canal anatomy frequently results in voids. Can be used with glass ionomer cement as sealer.

*Laterally condensed cold gutta-percha* Extension of single cone technique. Single cone fits only in apical 2 mm. Unfilled spaces are obturated around the master gutta-percha cone with accessory cones. Create space by using a spreader. Useful for ovoid canals. Time consuming.

*Vertically condensed hot gutta-percha (Schilder's technique)* Uses heat to plasticise gutta-perch, which is then vertically condensed to create a homogenous root canal filling of greater density, especially apically. A heat carrier (pointed root canal spreader) is heated until cherry red then plunged 3–4 mm into the gutta-percha and the softened material is condensed apically with a series of pluggers. Requires a wide preparation in the coronal third of the tooth, which may complicate subsequent tooth restoration.

*Hybrid technique* Combination of lateral and vertical condensation.

*Laterally condensed warm gutta-percha* Same as cold lateral condensation, except that a warmed spreader is used.

*Thermomechanical compaction of gutta-percha* Uses an Archimedean screw at 8000 rpm to provide frictional heat. Technically difficult procedure. Can be used only in straight portion of a canal. Generates lots of heat.

*Thermoplasticised gutta-percha* Uses alpha gutta-percha, which is tacky and flows better than normal (beta) gutta-percha. Uses

inserts made of plastic, titanium or stainless steel. Requires slow-setting sealer.

*Injection techniques with thermoplasticised gutta-percha* Can be either high heat (>160°C) or low heat (<75°C). Marked shrinkage as cools. Problem with extruding gutta-percha through apex.

There is no ideal obturation technique for all situations. An appropriate technique should be chosen, depending on individual clinical situation.

## SUCCESSFUL ROOT CANAL TREATMENT

For a root canal treatment to be deemed successful the tooth must be: • functional • symptom-free • of normal radiographic appearance with complete bony infill of radiolucencies • periodontium of normal radiographic appearance.

## RESTORATION OF THE ROOT CANAL TREATED TOOTH

Previous restoration and access cavity often leaves a root filled tooth compromised. Coronal leakage is a major factor in failed root canal treatment so a sound coronal restoration is important.

The amount of tooth substance remaining and its ability to withstand occlusal loads should be assessed. In the absence of sufficient sound dentine, a post crown restoration should be considered.

## SINGLE-VISIT ROOT CANAL TREATMENT

Conventionally, root canal treatment is carried out over 2–3 visits. This is time consuming for the patient and often clinically unnecessary.

## INDICATIONS FOR SINGLE-VISIT ROOT CANAL TREATMENT

• Elective root canal treatment • apical radiolucency but draining sinus present • patient requiring antibiotic cover for medical reasons • irreversible pulpitis.

*Disadvantages* Emergency treatment for drainage is complicated by presence of a root canal filling, appointment may be too protracted for patient (especially curved canals in molars).

*Contraindications* • Excessive exudates • symptom-free teeth with periapical radiolucencies and no sinus (these often cause acute symptoms after first visit).

## PROBLEMS IN CONVENTIONAL ROOT CANAL THERAPY

*Fractured instruments* More likely with small-sized instruments, incorrect filing techniques (e.g. 'watchwinding'), old work-hardened instruments, instruments autoclaved too many times, incorrect handpiece used for rotary instruments. Removal

can be attempted with endosonics or further filing. Removal not always possible!

*Perforation* May occur due to over-instrumentation of apex, furcal perforation during access cavity preparation and perforation of concave surface of curved molar roots during filing. May need to be repaired by surgical endodontics. Perforation may be a cause of post-appointment pain.

*Zipping (or transportation)* Occurs by using straight large files in curved canals. Minimised by instrument precurving and use of files with blunt tips.

*Failures* 95% of root canal treatments can be successful if appropriate techniques are chosen and followed. Common causes of root canal treatment failure include breakdown of coronal restoration, inadequate cleansing, shaping or obturation and root fracture.

Pulp therapy in deciduous teeth and permanent teeth with open apices is discussed on pages 155–159.

## SURGICAL ENDODONTICS

### PERIRADICULAR SURGERY (INCLUDING APICECTOMY)

Apicectomy is the surgical removal of the root apex and surrounding tissue and is often combined with retrograde filling.

Surgical aspects of apicectomy are discussed on page 352.

*Indications for apicectomy* • Extreme canal curvature • sclerosed canal • inaccessible lateral canals • heavily restored tooth where root canal is occluded by a post which cannot be removed without risk to the tooth • fractured instrument in canal which cannot be removed by conventional means • root fracture of apical part of root • bay cyst • extruded root filling causing symptoms • open apex that cannot be sealed conventionally.

Apicectomy should be considered only for well motivated patients with good oral hygiene and controlled caries. In addition the tooth to be apicected should be restorable after the procedure.

*Retrograde root filling* A good coronal seal is required so, before apicectomy, a sound orthograde root filling should be placed where possible. Sometimes a retrograde root filling is required. This involves preparation of a Class I cavity apically and restoration with reinforced zinc oxide–eugenol or glass ionomer cements. Historically amalgam was used but this has fallen from favour.

## OTHER TYPES OF PROCEDURES IN SURGICAL ENDODONTICS

*Root amputation* Used when one root is untreatable by conventional means. Root is sectioned and crown reshaped to be self-cleansing. Usually upper molars.

*Hemisection* 'Premolarisation', usually lower molars. Used when one root is untreatable conventionally. It is sectioned and extracted.

*Periapical curettage* Similar to apicectomy, except leaves root apex intact.

*'Through and through' root filling* Combined orthograde root filling with periapical curettage; useful in lower incisors.

*Reimplantation of teeth* Replacement of tooth in socket after trauma. Light splinting is required for 1 week and conventional root treatment required. Complicated by root resorption.

*Transplantation of teeth* One tooth (immature) transplanted into a socket of another; fairly unsuccessful; often results in root resorption.

*Incision and drainage of endodontically associated swellings* Sound treatment for dental abscesses. Immediate relief of patient's symptoms.

*Perforation repair* This can be attempted surgically or by a combined approach; orthograde root filling through perforation then immediately trimming surgically.

# RELATIONSHIPS WITHIN RESTORATIVE DENTISTRY

Total patient care often requires a combined approach between the disciplines of fixed prosthodontics, removable prosthodontics, periodontology and endodontics. Of particular importance in integrated treatment planning are:

## ENDO-PERIO LESIONS

Endo-perio problems involve pulpal inflammation or necrosis associated with periodontal bone loss around the same tooth.

Endo-perio lesions arise as: • primary endodontic lesions • primary endodontic lesions with secondary periodontal involvement • primary periodontal lesions with secondary endodontic involvement • true mixed lesions – aetiology a combination of both primary causes.

In general, root canal treatment should be attempted first. Prognosis is best for primary endodontic lesions (p. 251).

## CROWNS AND PARTIAL DENTURES

It is frequently the case that crowns are made before partial denture construction. It is imperative that the partial denture design is decided before crown construction. This enables the crowns to be constructed with appropriate rest seats, undercuts and guide planes or crowns to be milled so that the partial denture has improved retention, support, function and aesthetics.

## SURGICAL CROWN LENGTHENING

Used to increase the height of the clinical crown prior to restoration where occlusogingival height is small.

Indications for this treatment include: • tooth wear cases • subgingival horizontal root fracture • subgingival caries or restoration margins.

Surgical technique involves bone removal and bone contouring of the alveolar crest.