Chapter 7

Restorative dentistry 3: replacing teeth

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Relevant pages in other chapters Occlusion ➔ p. 226; acrylic and other denture materials ➔ Denture materials—acrylic resins, p. 660; casting alloys ➔ p. 650; impression materials ➔ p. 646.

Further reading D. W. Bartlett 2004 *Clinical Problem Solving in Prosthodontics*, Churchill Livingstone. D. Ricketts & D. W. Bartlett 2011 *Advanced Operative Dentistry: A Practical Approach*, Churchill Livingstone. G. A. Zarb *et al.* 2013 *Prosthodontic Treatment for Edentulous Patients: Complete Dentures and Implant-supported Prostheses*, Elsevier.

Treatment planning for patients with missing teeth

Solutions for missing teeth will vary depending on the number, their location and function, and the patient's wishes. A minimally invasive approach is preferable where possible. 21 or more is considered the minimum number of teeth consistent with a functioning dentition. Replacement of missing teeth, therefore, isn't always necessary. The Adult Dental Health Survey in 2009 showed that 86% of dentate adults had 21 or more natural teeth but this proportion ↓ significantly as age ↑.[1] In 2009, 6% of adults aged 16 or over were edentulous compared with 37% in 1968. These edentulous patients are also in the older age groups.

For those with insufficient teeth for satisfactory function and aesthetics, fixed or removable prosthodontic solutions will be needed. The use of bonding techniques and implants can help minimize unnecessary destruction of valuable tooth tissue.

Indications for the replacement of missing teeth

- ↑ masticatory efficiency.
- Improve speech.
- Preserve or improve health of the oral cavity by preventing unwanted tooth movements (vertical/rotational/tipping/drifting).[2]
- Improve distribution of occlusal loads.
- Space maintenance.
- Restore aesthetics.
- Prepare patient for complete dentures.

Treatment planning for the replacement of missing teeth

History Active listening in order to clarify the patient's aims and expected outcomes is essential.

It is important to enquire about previous denture history (just because a patient is not wearing a denture does not mean that they have not had one) and assess the reasons for failure or success.

PMH Medical factors can impact upon availability for treatment and ability to cope with dentures. Some drugs may ↓ salivary flow.

Social history Other considerations may affect treatment, e.g. transport arrangements.

Clinical examination EO and IO exam, including a thorough assessment of any pathology, remaining teeth, existing restorations, periodontium, and edentulous areas (ridge form and extent, compressibility of mucosa). Assess tongue size, tonicity of the lips, and the volume and viscosity of saliva. An evaluation of any current dentures: what to copy and what to correct. Some patients present with a collection of unsuccessful dentures!

1 Health and Social Care Information Centre (℞ http://www.hscic.gov.uk).

2 H. L. Craddock *et al.* 2007 *J Prosthodont* **16** 485.

Special investigations Radiographs/sensibility testing (especially of potential bridge abutments). Mounted study models and wax up in partly dentate cases.

Diagnoses are then listed and will allow appropriate treatment planning after considering the treatment options. If pre-existing denture problems are diagnosed, some could be addressed via modifications to the existing dentures prior to embarking on construction of replacement prostheses.

Options for the replacement of missing teeth

No replacement First consider whether benefits of replacing missing teeth (improved mastication, speech, occlusal stability, and aesthetics) outweigh disadvantages (↑ oral stagnation, tooth preparation, cost). If not, then replacement is C/I. An occlusion with first premolar to first premolar present in each jaw (shortened dental arch) is usually functionally adequate.

Bridges (➔ Bridges, p. 268.) Have advantage that they are fixed. Resin bonded cantilever design are minimally invasive. Conventional bridges can have good appearance, but destructive of tooth tissue, moderately expensive and require lengthy clinical time.

Implant supported prostheses Can be fixed or removable and have the advantage of avoiding preparation of natural teeth but involve surgical procedures and are expensive. They help maintain supporting bone and have a high level of predictability if carefully planned and carried out.

Removable partial dentures (➔ Removable partial dentures—principles, p. 282.) Can be minimally invasive as only minor (or no) tooth preparation required but ↑ plaque accumulation/changes in composition. Damage to soft tissues and remaining teeth is exacerbated by poor denture design and/or lack of patient care. Can be a good option when there are multiple edentulous areas or as a training/interim appliance prior to F/F. Can be used to replace missing soft tissue and aesthetics can be very good but patients dislike removable prostheses.

Complete immediate dentures Indicated for patients who have already mastered wearing a partial denture and whose remaining teeth have a poor prognosis.

Complete dentures Require patient compliance as well as good clinical and technical management for success. They can replace hard and soft tissue but patients tend to dislike them and successful denture control can be difficult for patients to master.

In the older, partially dentate patient it is important to assess whether the patient is likely to retain some functional teeth for the remainder of their lifespan. If this is improbable, some advocate providing F/F dentures while the patient is still young enough to adapt.

Treatment planning

If replacement is indicated: ? fixed or removable prosthesis. A number of factors affect this decision (see Table 7.1).

Table 7.1 Fixed or removable prosthesis?

General	Local
Patient's motivation/condition	OH and periodontal health
Age	Number of missing teeth
Health	Position of missing teeth
Occupation	Occlusion
Cost	Condition of potential abutments
	Length of span
	Degree of resorption

These factors need to be favourable if expensive and complex bridge-work is required. Removable prostheses are indicated if general or local factors are less than ideal. Always consider implants or shortened dental arch therapy.

Treatment options must be clearly explained to the patient with the advantages and disadvantages of each. This is essential in the management of expectations and to allow informed consent.

Initial treatment

- Relief of pain and any emergency treatment including temporary modification of existing dentures, if indicated.
- Unless immediate dentures planned, extract any teeth with poor prognosis.
- OHI and periodontal treatment.
- Preliminary design of partial denture.
- Carry out restorations required.
- Modify design if necessary and commence prosthetic treatment (➔ Removable partial dentures—clinical stages, p. 290).
- Removal of pathological abnormalities (e.g. retained roots), and pre-prosthetic surgery, if required.
- Carry out definitive prosthetic treatment.

Notebox:
Summary points for treatment planning
(you write here)

Bridges

Definitions

Bridge (fixed partial denture) A prosthetic appliance that is definitively attached to remaining teeth and replaces a missing tooth or teeth.

Abutment A tooth which provides attachment and support for a bridge.

Retainer The component that is cemented to the abutments to provide retention for the prosthesis.

Pontic The artificial tooth that is suspended from the abutments.

Connector The component that joins the pontic to the retainer. May be rigid or non-rigid.

Saddle The area of edentulous ridge over which the pontic will lie.

Units Number of units = number of pontics + number of retainers.

Retention Prevents removal of the restoration along the path of insertion or long axis of the preparation.

Support The ability of the abutment teeth to bear the occlusal load on the restoration.

Resistance Prevents dislodgement of the restoration by forces directed in an apical or oblique direction and prevents movement of the restoration under occlusal forces.

Types of bridge

Fixed–fixed The pontic is anchored to the retainers with rigid connectors at either end of the edentulous span. Both abutments provide retention and support. Both preparations must have a single line of draw.

Fixed–movable The pontic is anchored rigidly to the major retainer at one end of the span and via a movable joint to the minor retainer at the other end (Fig. 7.1). The major abutment provides retention and support whilst the minor abutment provides support only. This design allows some independent movement of the minor abutment and has the advantage that the preparations need not be parallel.

Direct–cantilever Pontic is anchored at one end of the edentulous span only.

Spring cantilever A tooth-retained, mucosal-supported bridge. The retainer and pontic are remote from each other and connected by a metal bar which runs along the palate. Usually an upper incisor is replaced from the premolars or a molar. It is useful where there is an anterior diastema or if the posterior teeth are heavily restored; however, they are often poorly tolerated. These are rarely used now.

Minimal preparation/resin-bonded Retained by resin composite (➔ Resin-bonded bridges, p. 278).

Compound/hybrid Combination of >1 of types listed.

Removable Can be removed by dentist for maintenance.

Fig. 7.1 Fixed movable bridge replacing the lower left first permanent molar.

Types of retainers

- Full coverage crown.
- Three-quarter crown.
- Post-retained crown.
- Onlay.
- Inlay.

All of these restorations have been used as retainers in conventional bridgework. They are listed in order from most retentive to least retentive. Wherever possible one of the first two should be used, as the failure rate of the last three is much higher. Post crowns should be avoided if possible, and onlays or inlays should only ever be used as minor retainers in fixed–movable bridges.

Selection of abutment teeth

General factors must be taken into account, e.g. caries status and existing restorations. Also two other considerations specifically relate to bridgework—*retention* and *support*.

Assessment of retention

Retention offered by a potential abutment tooth depends on clinical crown height and the available surface area. Obviously, larger teeth offer more retention and should be chosen in preference to smaller ones. The teeth of both arches are listed in Table 7.2 in order of the amount of retention offered (if a full coverage restoration is used).

Table 7.2 Assessment of retention

	Greatest	→	→	→	→	→	Poorest
Maxilla	6	7	4	5	3	1	2
Mandible	6	7	5	4	3	2	1

Assessment of support

Three factors are important:

1) *Crown–root ratio.* Ideally should be 2:3 but 1:1 is acceptable. As bone is lost so the lever effect on the supporting tissues is ↑.
2) *Root configuration*. Widely splayed roots provide more support than fused ones.
3) *Periodontal surface area*. Ante's law 'the combined periodontal area of the abutment teeth must be at least as great as that of the teeth being replaced', has no scientific basis and no longer has a place in contemporary bridgework design. It does not take into account that we are dealing with a biological system—as the load is ↑ on the abutment teeth a biofeedback mechanism operates to cause a reduction in this load.

The teeth of both arches are listed in Table 7.3 in order of the support offered, assuming that the periodontal tissues are intact.

Table 7.3 Assessment of support

	Greatest	→	→	→	→	→	Poorest
Maxilla	6	7	3	4	5	1	2
Mandible	6	7	3	5	4	2	1

Taper and parallelism

- Opposing walls of abutments should have 5° taper.
- For most designs abutments should be prepared with a common line of draw.
- Checking parallelism: direct vision, with one eye; survey mirror with parallel lines inscribed.
- Management of tilted abutments ➔ Tilted abutments, p. 272.

Types of pontic

Modified ridge lap This type of pontic should make (minimal) contact with buccal aspect of ridge. Gives good aesthetics and is the most popular type.

Bullet Makes point contact with tip of ridge. Can be used for posterior bridgework.

Ovate Aims to address the issue of emergence profile in the maxillary anterior region. Has greater mucosal contact and applies light pressure to the underlying mucosa. Needs a smooth, convex surface to allow flossing. The patient must have excellent OH.

Hygienic Does not contact saddle, therefore supposedly easy to clean but can still be challenging. Unaesthetic, therefore limited to molar replacement.

Saddle (ridge lap) Extends over ridge buccally and lingually, therefore difficult to clean. Should not be used.

Bridges—design

Designing bridges

- Assess prognosis of all teeth in vicinity to ↓ risk of another tooth requiring extraction in near future.
- Assess possible abutment teeth (check restorations, endodontic status, periodontal condition, mobility, and take periapical X-rays).
- Select design of retainers, e.g. full or partial crown. Full coverage is preferred.
- Consider pontics and connectors.
- With this information compile a list of possible designs for bridge.
- Consideration of the advantages and disadvantages of each design combined with a diagnostic wax-up should help to narrow down the choice. Where possible try the least destructive alternative first.

Specific design problems

Periodontally involved abutments First control periodontal disease. Then ? bridge indicated. Fixed–fixed type of design preferable to splint teeth together. Consider fibre-reinforced resin composite fixed partial dentures for this specific indication.

Pier abutments This is the central abutment in a complex bridge that supports pontics on either side, which are in turn anchored to the terminal abutments. In this situation the pier abutment can act as a fulcrum and when one part of the bridge is loaded the retainer at the other end experiences an unseating force which can lead to cementation failure. To overcome this a stress-breaking element must be introduced, e.g. fixed–movable joint, or avoid pier abutments by simplifying the design.

Tilted abutments Occurs most commonly following loss of a molar. There are several approaches if bridgework is planned:

- Orthodontic treatment to upright abutments.
- Two-part bridge, e.g. fixed–movable.
- Telescopic crowns—placement of individual gold shell crowns on abutments, over which telescopic sleeves of bridge fit.
- Precision attachments—a precision screw and screw tube can be incorporated into a two-part bridge. After cementation the screw is inserted, which effectively converts the bridge to a fixed–fixed design.

Canines The canine is often the keystone of the arch, and a very difficult tooth to replace. The adjacent teeth are poor in terms of the amount of retention and support that they offer and the canine is often subject to enormous stresses in lateral excursion (in a canine-guided occlusion). If a canine is to be replaced with a bridge the occlusal scheme should be designed to provide group function in lateral excursion—never canine guidance.

Notebox:
Summary points for bridges
(you write here)

Bridges—practical stages

As always, thorough history and examination are required (Treatment planning for patients with missing teeth, p. 264). It is essential to clarify the patient's attitude to and expectation of treatment. They must be assessed for active disease due to poor OH or diet and for pre-existing TMPDS. The response to initial treatment to stabilize active disease should be monitored before embarking on definitive treatment. If bridgework is planned, the following stages are carried out:

- *Diagnostic mounting*—take accurate impressions of both arches, a facebow record, and have the models mounted on a semi-adjustable articulator. The mounting can be carried out either in ICP (best fit) or in RCP, for which a precentric record will be necessary. If a reorganized approach to reconstruction is being considered, or if the clinical examination has revealed significant occlusal interferences, an RCP mounting should be performed. Carefully examine the occlusion and consider what occlusal consequences the proposed restoration will have.
- *Diagnostic waxing*—in effect, this is a mock-up of the final restoration on the mounted models. Wax can be added to the teeth to simulate the effect that the restoration will have on the final occlusion and aesthetic result. In the anterior part of the mouth a denture tooth can be used. In addition to assessing aesthetics and occlusion the diagnostic wax-up can serve as a template from which the temporary bridge can be constructed. An impression is taken of the wax-up in a silicone putty and saved for later. At this stage the design of the prosthesis must be finalized.
- *Preparations*—before the preparations are carried out any suspect restorations in the abutment teeth are replaced. Preparations are carried out in accordance with basic principles (Chapter 6) and care is taken to ensure that a single path of insertion is established. When checking for parallelism one eye should be kept closed and the use of a large mouth mirror is very helpful. Custom-made paralleling devices can be used but they are very cumbersome.
- *Temporary bridge*—this is normally constructed using the matrix which has been formed from the diagnostic wax-up; in this way the temporary bridge should reproduce the aesthetics and occlusion of the final bridge (if the wax-up was done properly!). The matrix is filled with one of the proprietary temporary crown and bridge resins (e.g. Protemp®) and seated over the preparations. After it has set it is removed, trimmed, polished, and cemented with a temporary cement (e.g. TempBond®). Or a lab-made temporary bridge may be used.
- *Impressions*—an impression is taken using an elastomeric material. Ideally all of the preparations should be captured on one impression, but this can be very difficult if multiple preparations are involved. If difficulties are encountered in this respect they can often be overcome by using the transfer coping technique. In this technique, acrylic (DuraLay®) copings are made on dies of the preparations for which a successful impression has been achieved. These are then taken to the mouth and seated on the appropriate tooth, and the impression repeated to capture the other preparations. On removal, the coping will be removed in the impression and the dies can be reseated in the copings and a new model poured around them. CAD/CAM digital techniques can also be used.

- *Occlusal registration*—under most circumstances the models will be mounted in ICP in the position of best fit, and therefore an occlusal registration will not be necessary. Where numerous preparations have been carried out and it is difficult to locate this position, some form of inter-occlusal record will be necessary. A popular technique involves the use of transfer copings, and is described in the section on occlusion (Occlusal records, p. 229).
- *Metal work try-in*—if a porcelain fused to metal bridge is being constructed it is advisable to try-in the metal work before the porcelain is added. At this stage the fit of the framework can be evaluated and the occlusion adjusted. On occasions it will be found that one retainer seats fully whilst the other does not. This can occur if there has been some minor movement of the abutments since the impression was taken. If this is the case the bridge should be sectioned, and hopefully both retainers will then seat. The two parts are then secured in their new position with acrylic resin (DuraLay®) and sent back to the lab for soldering.
- *Trial cementation*—the finished bridge is tried in and any necessary adjustments made. The bridge should then be temporarily cemented (with modified TempBond®) for a period of a week or so. The advantage of a trial cementation period is that if any further adjustments are necessary they can be carried out outside the mouth and the restoration repolished and reglazed. The patient is instructed in how to clean the bridge (use of Super Floss®).
- *Permanent cementation*—after the period of trial cementation the bridge is re-evaluated and the patient asked if they are happy with it. If all is well the bridge is removed and cemented with a permanent cement (usually traditional or RMGIC).
- *Follow-up*—arrangements are made to recall the patient to check that the bridge is still functioning satisfactorily.

Bridge failures

Patients should be warned about these prior to treatment. Crown and bridgework is responsible for the greatest proportion of negligence claims against dentists.

Most common reasons for failure

- Loss of retention.
- Mechanical failure, e.g. # of casting.
- Problems with abutment teeth, e.g. 2° caries, periodontal disease, loss of vitality.

Management of failures

Depending upon type and extent of problem:

- Keep under review.
- Adjust or repair *in situ*.
- Replace.

Replacement

Before replacement of a bridge is embarked upon, a careful analysis of the reasons for failure is necessary. Minor problems in an otherwise satisfactory bridge should be repaired if at all possible. Fractured porcelain can be repaired with one of the specialized repair kits available (e.g. CoJet™). Secondary caries or marginal deficiencies, if small, can be restored with traditional GI cement.

A survey of bridges placed by GDPs in Sweden found that 93.3% were still in service after 10yrs.[3] The most common reason for failure was loss of vitality. This is not necessarily an indication for removal of the bridge because RCT can often be carried out through the retainer of the abutment.

Removing old bridges

To remove intact, try a sharp tap at cervical margin with a chisel or preferably a slide hammer. Orthodontic band-removing pliers can also be used but these require a small hole to be cut in the occlusal surface. If only one retainer is loose, support bridge in position while trying to remove it so that it does not bind.

Retainers can be cut through, but this will destroy the bridge.

3 S. Karlsson 1986 *J Oral Rehab* **13** 423.

Notebox:
Summary points for bridge failures (you write here)

Resin-bonded bridges

This technique involves bonding a cast metal framework, carrying the pontic tooth, to abutment teeth using an adhesive resin. This type of bridge is almost exclusively used for cantilever adhesive bridgework, i.e. one abutment and one pontic (Fig. 7.2). Fixed–fixed designs have been problematic, with one retainer debonding being a common clinical finding. The resin bonds to the abutment tooth using the acid-etch technique and to the metal framework by either mechanical or chemical means. Fibre reinforced bridges are also available.

Classification

Position

- Anterior.
- posterior

Retention

- Macromechanical:
  - Perforated (Rochette).
  - Mesh (Klett-O-Bond®).
  - Particular (Crystalbond).
- Micromechanical:
  - Electrolytically etched (Maryland).
  - Chemically etched.
- Chemical:
  - Sandblasted.
  - Tin-plated.

Chemical retention to a sandblasted metal surface is now used virtually exclusively. A dual-affinity cement (e.g. Panavia™ 21) is used, which chemically bonds to both enamel and non-precious alloys.

Advantages

- Less expensive than conventional bridge or cobalt chromium partial denture or implant in the shorter term.
- Minimal, or no tooth preparation required.
- No LA required as preparation is in enamel.
- Potential for rebond if debond occurs

Disadvantages

- Tendency to debond especially if planning and preparation and placement technique is poor.
- Metal may show through abutments.
- Creation of a natural emergence profile can be challenging especially in very resorbed ridges. Use of an ovate pontic can be helpful.

Indications

- Short span-single tooth edentulous space.
- Sound abutment teeth (or only minimal restoration) and sufficient crown height to ensure sufficient surface area for acid etch bonding.
- Favourable occlusion.

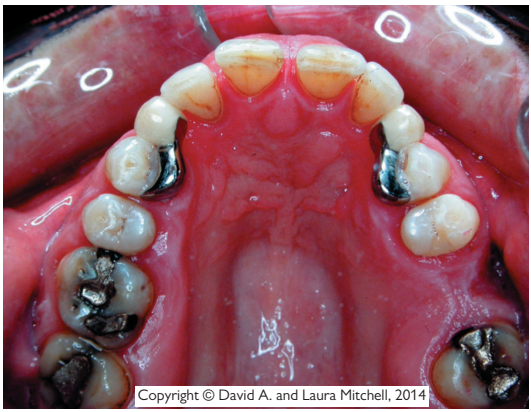

Fig. 7.2 Adhesive cantilever bridgework replacing missing upper canines.

Treatment planning

As for conventional bridgework. If orthodontic treatment is needed to localize space or upright adjacent teeth, it is advisable to retain with a removable retainer for at least 3 months prior to bridge placement.

Design

Is usually cantilever. If a fixed/fixed design is used and there is a debond of one retainer, caries can develop quickly and undetected under this retainer. Fixed/fixed design may be used if periodontal splinting is required or retention required following orthodontics.

Tooth preparation

There is debate as to what is the 'ideal' preparation and some advocate no preparation. The need for preparation will be defined by the individual clinical situation.

Guidelines for preparation

- Give a single path of insertion. Provide near parallel guiding planes eliminating undercuts, which allows coverage of maximal surface area for bonding.
- Provide space in occlusion to accommodate bridge. Need at least 0.7mm for wings.
- ↑ retention, e.g. using a wrap-around design (covering >180° of tooth circumference) to resist lateral displacement and reduce stress on the cement bond.
- Mesial and distal grooves enhance resistance form.
- To prevent gingival displacement. A minimal chamfer is recommended.
- Provide axial loading of the abutments—prepare cingulum or occlusal rests.

NB Tooth preparation should usually be confined to enamel, and the framework should be designed with maximal coverage (to ↑ surface area available for bonding).

Technique

Chemical method using Panavia™ 21 Following tooth preparation an elastomeric impression of the abutment teeth is taken plus an alginate impression of the opposing arch. At the try-in stage the bridge should be assessed for fit, aesthetics, etc., and then the fitting surface thoroughly cleaned with alcohol (assessment of occlusion may not be possible until after cementation). Contamination of the fitting surface with saliva must be avoided and cementation is best done under rubber dam. Following etching and washing of the abutment(s), and placement of a dentine adhesive system, the wings of the bridge are coated with Panavia™ 21 and the bridge seated into place and held firmly until set. Use of acetate strips and Super Floss® at this stage will clear most of the excess cement and prevent it adhering to the adjacent teeth. The cement must then be covered with a substance known as OxyGuard®, which prevents O_2 inhibition of the surface layer. After 5min or so the rubber dam is removed and any excess cement removed.

Problems

- *Dentine exposed during preparation.* Use a dentine adhesive system.
- *Metal shining through abutments.* Cut wings away incisally before cementation or use a more opaque cement. May have to consider conventional bridge or placing veneer on labial surface.
- *Debonds*. If one flange only, can usually detach other by a sharp tap with a chisel or by using ultrasonic scaler tips. If persistent problem, consider conventional bridge. The trend is for these bridges to be used for cantilevered bridgework and it is not usual for fixed–fixed adhesive bridgework to be prescribed due to problems with unilateral debonding.
- *Caries occurring under debonded wings.* Remove bridge and repair.

Further reading

M. W. Barber & A. J. Preston 2008 An update on resin bonded bridges *Eur J Prosthodont Rest Dent* **16** 2.

Notebox:
Summary points for resin-bonded bridges (you write here)

Removable partial dentures—principles

Definitions

Saddle That part of a denture which rests on and covers the edentulous areas and carries the artificial teeth and gumwork.

Connector (major and minor) Joins together component parts of a denture.

Support Resistance to vertical forces directed towards mucosa.

Retainers Components which resist displacement of denture.

Indirect retention Resistance to rotation about clasp axis by acting on the opposite side to the displacing force.

Fulcrum axis Axis around which a tooth- and mucosa-borne denture tends to rock when saddles are loaded.

Bracing Resistance to lateral movement.

Guide planes Two or more parallel surfaces on abutment teeth used to limit path of insertion, and improve retention and stability.

Survey line Indicates the maximum bulbosity of a tooth in the plane of the path of withdrawal.

Free-end saddle Edentulous area posterior to the natural teeth.

Stress-breaker A device allowing movement between saddle and the retaining unit of partial denture.

Gum-stripper A tissue-borne partial denture which can 'sink'.

Dysjunct denture Has complete separation between tooth- and mucosa-borne parts.

Swinglock denture[4] Has a labial retaining bar or flange which is hinged at one side of the mouth and locks at the other.

Sectional denture Made in two or more sections which are then fixed together with screws or other devices.

Classification

Kennedy Describes the pattern of tooth loss (Fig. 7.3):
I Bilateral free-end saddles.
II Unilateral free-end saddle.
III Unilateral bounded saddle.
IV Anterior bounded saddle, only.

Any additional saddles are referred to as modifications (except Class IV), e.g. Class I modification 1 has bilateral free-end saddles and an anterior saddle.

Craddock Describes the denture type:
- Tooth-borne.
- Mucosa-borne.
- Mucosa- and tooth-borne.

4 M. Chan *et al.* 1998 *Dental Update* **25** 80.

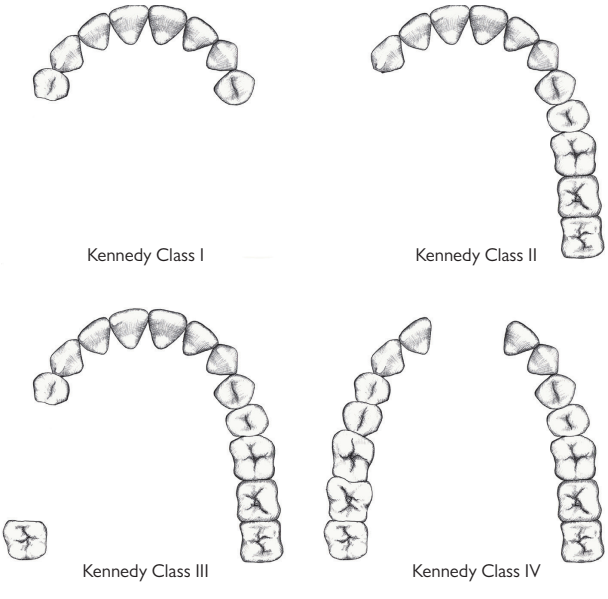

Fig. 7.3 Kennedy classification.

Acrylic versus metal dentures

Approximately 75% of the dentures provided in the UK have an acrylic connector and base. Although metal bases are generally preferred because the greater strength of metal permits a more hygienic design, an acrylic base is indicated for:

- Temporary replacement, e.g. following trauma or in children.
- Where there is inadequate support from the remaining teeth for a tooth-borne denture.
- When additions to the denture are likely in the near future.

However, where financial constraints C/I a metal base, attention to the following may avoid the production of a gum-stripper:

- Wide mucosal coverage to provide maximum support.
- Keep base clear of the gingival margins wherever possible.
- No interdental extensions of acrylic.
- Point contact and wide embrasures between natural and artificial teeth.
- Labial flanges for extra retention and bracing.
- Additional support from wrought SS rests.

Removable partial dentures—components

Saddles can be made entirely of acrylic or have a sub-framework of metal overlaid by acrylic.

Rests are an extension of the denture onto a tooth to provide support &/or prevent over-eruption. Occlusal rests are used on posterior teeth (usually over either the mesial or distal marginal ridge and fossa) and cingulum rests on anterior teeth. Rests may be wrought or cast; the latter is preferred for strength and fit.

Clasps provide direct retention by engaging the undercut portion of a tooth (Fig. 7.4 and Fig. 7.5). The action of a clasp must be resisted either by a non-retentive clasp arm above the maximum bulbosity of the tooth or by a reciprocal connector. Clasps can be classified by their position (occlusally approaching or gingivally approaching) or by their construction and material.

Cast (cobalt chrome) clasps are stiff, easily distorted and liable to #. However, provided they are limited to undercuts of 0.25mm, the advantage of being able to cast them as an integral part of a denture framework offsets these drawbacks.

Wrought clasps are usually attached by insertion into the acrylic of a saddle. SS is the most commonly used alloy, but gold clasps are more flexible and easily adjusted (and distorted).

The stiffer the wire the smaller the undercut that can be engaged. This can be offset by reducing the diameter of the wire to ↑ flexibility (but ↑ the likelihood of #) or by increasing the length of the clasp arm (e.g. gingivally approaching clasp). Cast cobalt chrome can be too stiff for occlusally approaching clasps on premolar teeth. The actual design used depends upon:

- Depth of undercut: 0.25mm—cast cobalt chrome; 0.5mm—SS wire; <0.75mm—wrought gold.
- Position of undercut on tooth and relative to saddle, e.g.:
  - High survey line: gingivally approaching clasp or modify tooth shape by grinding.
  - Diagonal survey line, (i) sloping down from saddle: gingivally or occlusally approaching (ring or recurved) clasp; (ii) sloping up from saddle: gingivally or occlusally (circumferential) approaching clasp.
  - Medium survey line: as above.
  - Low survey line: modify tooth shape, e.g. with resin composite.
- Position of tooth. Gingivally approaching clasps are less conspicuous and are therefore preferred for anterior teeth.
- Occlusion: adequate inter-occlusal space should be present or created for a clasp arm to cross a contact point between two natural teeth, to prevent occlusal disruption.
- Shape of sulcus: fraenal attachments and alveolar undercuts may prevent use of gingivally approaching clasps.
- Periodontal health: reduced periodontal support requires more flexible clasps to avoid overload.
- Material of denture base. Cast clasp arms are easily cast as part of the framework but for acrylic dentures wrought clasps are more usual.

Connectors

In addition to joining parts of the denture together, the connector can also contribute to support and retention (Table 7.4).

Table 7.4 P/– connectors

	Patient tolerance	Indirect retention	Support	Comments
Ant. Bar	–	+	–	Useful for Kennedy IV
Mid. Bar	+	–	++	C/I torus
Post. Bar	++	+	–	Need mucocompression
Ring	–	++	+	
Plate	+	++	++	Less hygienic
Horseshoe	+	+	++	Useful for multiple saddles

–/P connectors

- Lingual bar should only be used if there is >7mm between floor of mouth and gingival margin to give 3mm clearance from gingivae. Does not contribute to indirect retention. Usually cast. C/I if incisors are retroclined. If insufficient space can use sublingual bar.
- Sublingual bar lies horizontally in anterior lingual sulcus, but opinions differ as to patient tolerance. More rigid than lingual bar.
- Lingual plate is well tolerated and provides good support, bracing, and indirect retention if used in conjunction with rests but covers gingival margins. Can be made of cast metal or acrylic.
- Continuous clasp is really a bar which runs along the cingulae of the lower anterior teeth and is usually used in conjunction with a lingual bar. Poorly tolerated.
- Dental bar is similar to continuous clasp, but of ↑ cross-sectional area and without lingual bar. Useful for teeth with long clinical crowns. Provides support and indirect retention. May not be well tolerated.
- Buccal/labial bar is indicated when the lower incisors are retroclined.

Fig. 7.4 and Fig. 7.5 show the two most commonly used types of clasp.

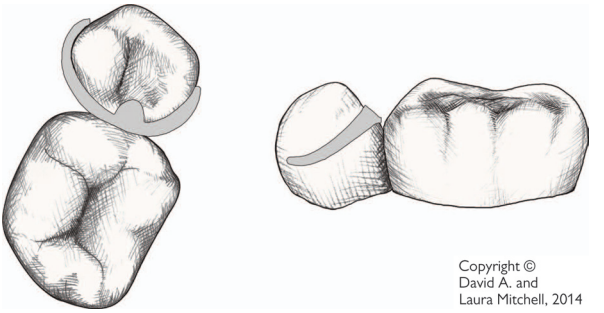

Fig. 7.4 Occlusally approaching three-arm clasp.
One arm is the bracing reciprocal arm.
One arm is the retentive component.
One arm is the occlusal rest.

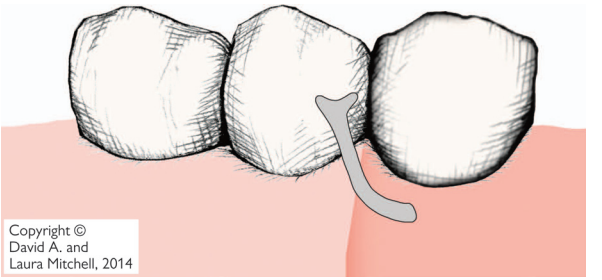

Fig. 7.5 Gingivally approaching T clasp.

Notebox:
Summary points for removable partial dentures (you write here)

Removable partial dentures—design

P/P design is carried out after assessment of the patient and with reference to any previous dentures. A set of accurately articulated study models is essential.

Surveying

Objectives:

- Establish path of insertion.
- Define those undercuts which may be used to retain denture.
- Define those undercuts which require blocking out prior to finish.

If the path of insertion is at 90° to the occlusal plane insertion of the denture will be straightforward; however, where the teeth are tilted or few undercuts exist, an angled path of insertion may be advantageous. Which provides more resistance to displacement during function is controversial.

A survey line can then be marked on the teeth to indicate their maximum bulbosity in the plane of the path of withdrawal. This is done using a dental surveyor.

Design

- *Outline saddles.* Usually straightforward. If <1/2 tooth width or if in doubt of the need to replace a missing tooth, omit.
- *Plan support.* Support can be tooth only, mucosa only, or both. Tooth-borne support (occlusal and cingulum rests) should be used wherever possible, as teeth are better able to withstand occlusal loading and support will not be compromised following resorption. Tooth and mucosa support are inevitable with large or free-end saddles and where plate designs are used. Tissue-only support should be utilized when no suitable teeth are available, and is less damaging in the upper than the lower arch, because of the palatal vault.
- Need to assess the role of the denture, length of the saddles, the amount of support required (? denture opposed by natural or artificial teeth), and the potential of remaining teeth to provide support (root area in bone), before a final decision is made.
- *Obtain retention.* Retention can be:
  - *Direct.* E.g. clasps, guide planes, soft tissue undercuts, or precision attachments. Of these, clasps are the most commonly used. The best arrangement is to use three clasps as far away from each other as possible. Guide planes help to establish a precise path of insertion and withdrawal. Need be only 2–3mm in length, reducing reliance on clasps. Composite resin can be added to abutment teeth to maximize undercuts.
  - *Indirect.* This is derived by placing components so as to resist 'rocking' of the denture around direct retainers, e.g. by the position of clasps and rests and the type of connector. Particularly important with free-end and large anterior saddles.
- *Assess bracing required.* Bracing is provided by the connector, maximum saddle extension, and the reciprocal arms of clasps. Elimination of occlusal interferences ↓ need for bracing.
- *Choose connector.* After consideration of earlier listed points. Is there space in the occlusion to accommodate the chosen connector? Where possible the connector should be cut away from the gingival margins.

- *Reassess* ? As simple as possible. ? Aesthetic.
- *Instructions to technician.* Should include written details and diagram. Where some confusion may arise over the precise position of a component it may be helpful to mark this directly on the cast. CAD programs are now available.

Some design problems

The lower bilateral free-end saddle (Class I) This presents a particular problem because of a lack of tooth support and retention distally, small saddle area compared to force applied, and distal leverage on abutment tooth in function (which ↑ with resorption). Possible solutions include:

- Maximize indirect retention by placing rests and clasps on mesial aspect of the abutment tooth and using lingual plate design.
- Using a muco-compressive impression of saddle area to ↓ displacement in function. The altered cast technique.
- Use fewer, smaller teeth and maximize base extension.
- RPI system for distal abutment teeth. Mesial *R*est, distal guiding *P*late and mid-buccal *I* bar. During function the saddle moves tissue-ward and rotates around the mesial rest. The plate and I bar are constructed in such a way as to disengage from the tooth and avoid potentially harmful loading.
- Stress-breaker design (advantages more theoretical than practical).
- Use precision attachments (beware of overloading abutments).

Class IV Can sometimes avoid unsightly clasps anteriorly by the use of:

- A flange engaging a labial alveolar undercut.
- A rotational path of insertion[5] utilizing rigid minor connectors that are rotated into proximal undercuts anteriorly.
- Inter-proximal undercuts, which may allow minimal display of clasps—'hidden clasps' (Fig. 7.6).
- An acrylic spoon denture held in place by the tongue.

Multiple bounded saddles A horseshoe design, which utilizes guide planes for retention, may be indicated.

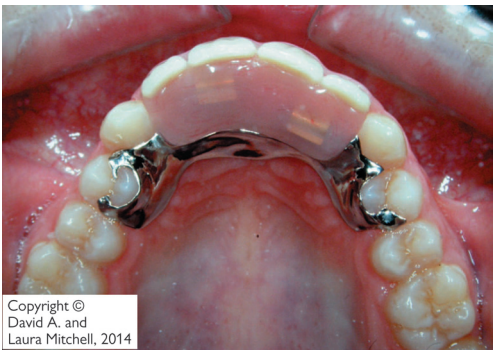

Fig. 7.6 Sectional partial denture.

5 T. W. Chow *et al*. 1988 *BDJ* **164** 180.

Removable partial dentures—clinical stages

- *Assessment and treatment plan* ➔ Treatment planning for patients with missing teeth, p. 264.
- *Take first impressions.* These are usually taken using alginate in a stock tray. For free-end saddles modify the tray first with compound or silicone putty.
- *Record occlusion.* If ICP is obvious the occlusion can be recorded conventionally (➔ Occlusal examination, p. 228) at the same visit as first impressions. If ICP is not obvious, wax record blocks will be required and a separate visit. Where there are no teeth in occlusal contact, the steps involved are the same as for recording the occlusion for F/F (➔ Complete dentures—recording the occlusion, p. 298). If there is an occlusal stop, but insufficient standing teeth to produce a stable relationship of the casts, the procedure is as follows:
  - Determine the OVD and mark the position of two index teeth with pencil.
  - Define the occlusal plane using the record block on which this is easiest, e.g. tooth to tooth, tooth to retromolar pad.
  - Check the record blocks in the mouth, using the mark on the index teeth as a guide, and adjust blocks if necessary.
  - Record occlusion with bite-recording paste.
  - Check the relationship of the index teeth on the articulated casts corresponds to that in the mouth.
- *Mounted casts are surveyed and denture designed* ➔ Occlusal considerations for restorative procedures, p. 228.
- *Tooth preparation* may be required to:
  - Accommodate rest seats. Rests need to be >1mm for strength, therefore if insufficient room in occlusion to accommodate this bulk, tooth reduction is required.
  - Establish guide planes.
  - Modify unfavourable survey line, e.g. ↓ bulbosity.
  - Increase retention, e.g. by the addition of resin composite to create undercuts.
- *Record second impressions* using a special tray. Alginate is the most commonly used material, but elastomers are preferable. It is helpful to have a wax try-in before the framework is made. This enables you to confirm tooth position so that the retentive elements for the acrylic are placed appropriately.
- *Try-in of framework*:
  - Check extension, adaptation, and position of clasp, and rests. If casting does not fit, use of correcting fluid may reveal which areas to relieve.
  - Check upper and lower separately for OVD and occlusion, and then together.
  - Major faults: repeat second impressions.
  - Minor faults: adjust at finish.
  - Re-record occlusion, if required.
  - Select tooth mould and shade.
  - Altered cast technique, if required.

- *Try-in of waxed denture on framework*:
  - Check position of denture teeth.
  - Check flange extensions/thickness.
  - Check OVD and occlusion.
  - Check aesthetics with patient and only proceed when patient is satisfied.
  - Prescribe post-dam relief areas and management of undercuts.
- *Finish*. Once any fitting surface roughness is eliminated, the dentures are tried in separately, adjusting undercuts and contacts as required. The extension, occlusion, and articulation are then adjusted if necessary. Give the patient written and verbal instructions, and a further appointment.

Rebasing P/P

Acrylic mucosa-borne dentures can be rebased at the chair-side with self-cure materials, but difficulty may be experienced in removing the denture in the presence of undercuts, and the materials are generally inferior to the original denture base. Alternatively, P/P can be rebased in the laboratory by means of a technique similar to that used for F/F (➔ Rebasing, p. 304). Alternatively, make a new denture. For cast metal dentures an impression can be recorded of saddle area using an elastomer or ZOE, whilst holding denture by the framework. In all cases care must be taken to avoid the introduction of occlusal errors, e.g. ↑ OVD.

Immediate complete dentures

When the remaining teeth have a poor prognosis the transition from the partly dentate to edentulous state must be managed carefully. Patients must be warned about the effects of resorption and the need for early rebasing/replacement. Treatment planning must be thorough.

Rx alternatives for partial denture wearer

- Gradual transition towards being edentulous via additions to a transitional P/P can ↑ the chances of successful adaptation to F/F especially for the older patient.
- Immediate complete denture. This has the advantage that the form and position of the natural teeth can be copied and is said to promote better healing and reduce resorption, but frequent adjustments and early replacement are necessary.
- Overdenture (➔ Overdentures, p. 314); may retain alveolar bone.

Rx alternatives for patients with no previous denture experience

- Provide partial denture and allow patient to adapt before progressing to an immediate complete denture. The best solution.
- Extract majority of posterior teeth leaving sufficient only to maintain OVD and occlusal relationship, and then make immediate complete dentures when resorption has slowed.
- Extraction of the remaining teeth and provision of a denture after healing has occurred (post-immediate denture). Avoid if possible as considerable guesswork is involved in the subsequent denture and the chances of the patient coping successfully are ↓.

Types of immediate complete denture

- *Flanged*. Either full or part (extended 1mm beyond maximum bulbosity of ridge).
- *Open face*. No flange, artificial teeth sit over (or just into) the socket of natural predecessor.

Flanged dentures are preferable as they afford better retention and make subsequent rebasing easier. However, where a deep labial undercut exists into which it would be impossible to extend a flange, the choice is either surgical reduction or an open-face denture. Most patients choose the latter.

Clinical procedures

- *Primary impressions* (as for P/P ➔ Removable partial dentures—clinical stages, p. 290).
- *Secondary impressions* in alginate or silicone.
- *Recording occlusion*. Where there are sufficient posterior teeth remaining a hand articulation should suffice, and this can be taken at the same visit as impressions are recorded. Otherwise, record blocks will be required.
- *Try-in* This will be limited to those teeth that are already missing. Check fit, extension, and stability, etc. In addition, need to prescribe:
  - Type of flange required.
  - Any proposed changes in position of anterior artificial teeth compared to natural teeth.

- *Extraction* of remaining teeth as atraumatically as possible.
- *Finish.* Repeated removal and insertion of the denture should be avoided, therefore adjustments should be limited to making the patient comfortable. They should be instructed not to remove the denture before the review appointment in 24h.
- *Review.* The fitting and occlusal surfaces are adjusted as required. If dentures are unretentive they will require temporary reline (see ➔ Denture problems and complaints, p. 308).
- *Recall.* Regular inspection of immediate dentures is important as rapid bone resorption means that they will require rebasing early. However, this should be deferred, if feasible, for at least 3 months after the extractions. A possible regimen is 1 week, 1 month, 3 months, 6 months, and then yearly.

Laboratory procedures These are similar to F/F except that the plaster teeth are removed and the cast trimmed to mimic the changes that will occur in the hard and soft tissues following extraction, before final processing.

Surgical procedures See ➔ The extraction of teeth, p. 357 and ➔ Minor preprosthetic surgery, p. 400.

Problems

- *Denture unretentive.* Use a temporary reline material (replaced regularly) to tide patient over initial 3 months and then reline with heat-cure acrylic.
- *Gross occlusal error.* Adjust occlusal surface of one denture until even contact attained. This denture can then be replaced after initial resorption has occurred.

Complete dentures—principles

Retention

The resistance of a denture to displacement. Dependent upon: (i) peripheral seal; (ii) contact area between denture and tissues; (iii) close fit; (iv) viscosity/volume of saliva. Neuromuscular control has more to do with stability than retention.

Stability

The ability of denture to resist displacing forces during function. Influenced by forces acting on polished and occlusal surfaces, as well as the form of the supporting tissues.

Neutral zone

The area where the muscular displacing forces are in balance.

Ways to optimize retention and stability

- Maximum extension of denture base (as far as the surrounding musculature will allow). The upper denture should extend distally over the tuberosities and onto the compressible tissue just anterior to the vibrating line on the palate. The lower denture should extend the full depth and width of the lingual pouch, and halfway across the retromolar pad. *NB* Over-extension will result in a denture that is easily displaced in function.
- As close an adaptation of denture base to mucosa as possible, to maximize the surface tension effects of saliva.
- Placement of the teeth in the neutral zone. More important in -/F. The better retention of F/- often allows some latitude in this respect.
- Correct shape of the polished surfaces so that muscle action tends to re-seat the denture.
- A good border seal. This is achieved by ensuring that the flanges fill the entire sulcus width and by placing a post-dam on compressible tissue.
- Balanced occlusion free from interfering contacts.

Common denture faults

These are, in order of ↓ prevalence:[6]

- Lack of freeway space.
- Failure to reproduce closely enough the features of previous successful dentures.
- Occlusal errors.
- Incorrect adaptation and extension.

6 R. Yemm 1985 *BDJ* **159** 304.

Notebox:
Summary points for complete dentures (you write here)

Complete dentures—impressions

▶ Tissues must be healthy before final impressions are recorded. If necessary use tissue conditioner in present F/F (➔ Tissue conditioners, p. 304).

Classically, two sets of impressions are recorded of the edentulous mouth. The purpose of the first is to record sufficient information for a special tray to be made in which to record the second or master impression.

Preliminary impressions

These are recorded using an (edentulous) stock tray and alginate, elastomer (both preferable for undercut or flabby ridges) or impression compound. A line should be marked on the impression to indicate to the technician the desired extension of the special tray. In the upper, the posterior limit should be the hamular notches and the vibrating line, and in the lower the retromolar pads.

Special trays can be made in self-cure or light-cure acrylic. The space left for the impression depends upon the material to be used: ZOE = 0.5mm; elastomer = 0.5–1.5mm (depending on viscosity); alginate = 3mm. For trays with >1mm space use greenstick stops clinically to aid positioning.

Master impressions

These aim to record the maximum denture-bearing area, and to develop an effective border seal, the functional width and depth of the sulcus. The special tray should be modified by reducing any over-extension and the peripheries adapted by the addition of greenstick tracing compound. It is important that the trays are not perforated so that a peripheral seal with the upper tray can be demonstrated before taking the impression. Gently manipulate the patient's soft tissues and ask them to slightly protrude their tongue to imitate functional movements.

Muco-compressive versus muco-static A muco-compressive impression technique is sometimes advocated to give a wider distribution of loading during function and to compensate for the differing compressibility of the denture-bearing area, thus preventing # due to flexion. ZOE or composition is used. However, dentures made by this method are less well retained at rest, which is the greater proportion of time. Alginate is said to be more muco-static. Tissue adaptation following a period of use probably reduces the clinical difference between the two techniques.

Special techniques

Neutral zone impression technique This is used for recording the neutral zone in patients with limited natural retention for -/F.

- Record second impressions and occlusion.
- A fully extended acrylic baseplate is made on the lower cast, with wire loops added which do not extend above occlusal plane.
- The upper trial denture or record block is inserted.
- Tissue conditioner is placed on the baseplate and around loops, and inserted.
- Ask patient to swallow, purse lips and say 'Ooh' and 'Eee'.

- The impression is removed and trimmed down until it can be fitted onto the articulator to replace the lower occlusal rim.
- A mould of the impression is made into which wax is poured.
- The wax is cut away so that each denture tooth can be positioned within the zone recorded to make the trial denture. The polished surfaces should replicate the impression.

Flabby (displaceable) ridge Classically occurs under a F/- opposed by natural lower teeth. If mild, then an impression recorded with alginate or elastomer in a tray perforated over the flabby area may suffice. For more severe cases a two-stage technique is required, using a special tray with a window cut out over the flabby tissue. First, an impression is recorded in the tray with ZOE and the paste trimmed away from the flabby area. This is then re-seated and low-viscosity elastomer or impression plaster placed into the window to complete the impression. *NB* Combination type cases should have the dentures constructed on a semi-adjustable articulator to minimize occlusal displacing forces.

Functional impression Tissue conditioner is placed inside the patient's existing denture. After several days of wear a functional impression is produced.

Common impression problems and faults

- A feather edge indicates under-extension. This can be corrected by the addition of greenstick to the tray and repeating.
- Tray border shows through impression material. Reduce tray in the area of over-extension and repeat the impression.
- Air blows. If small, can be filled in with a little soft wax. If large, retake the impression.
- Tray not centred. Often partially due to using too much material so that it is difficult to see what is where. Remember to line up the tray handle with the patient's nose (except for ex-boxers).
- Retching. A calm and confident manner is necessary for successful impressions. Gain the patient's confidence by attempting the lower first and use a fast-setting, viscous material. Distraction techniques may help, e.g. wriggling the toes on the left foot and the fingers of the right hand at the same time (the patient, not the operator!).
- Patient with dry mouth: ZOE is C/I; use elastomer instead.
- Areas where tray shows through in otherwise good impression. Can be overcome by prescribing a tin-foil relief when dentures being processed.

Complete dentures—recording the occlusion

When recording the occlusion with wax rims mounted on rigid acrylic or shellac bases the aim is to provide the technician with information for constructing trial dentures.

As head posture can affect FWS, position the patient so that the Frankfort plane is horizontal. A wax trimmer and a heat source are required to adjust the rims.

- Check fit of bases. If poor, can either repeat second impressions, or take a ZOE or low viscosity elastomer impression with the base and proceed.
- Adjust upper rim to give adequate lip support.
- Trim occlusal plane of upper rim.
  - *Position of the occlusal plane*. This should be placed so that ~1–2mm (↓ with age) of tooth are visible below the patient's upper lip at rest. The occlusal plane should lie midway between the ridges parallel to the inter-pupillary and the ala-tragal lines. At rest the tongue should rise just above the lower occlusal plane posteriorly. Centre lines, canine lines and smile line should be marked
- Trim lower record block to obtain correct lip support and bucco-lingual position of posterior teeth.
- Adjust lower rim so that it meets upper evenly in RCP, with 2–4mm of FWS:
  - *Vertical dimension*. The FWS is the space between the occlusal surfaces of the teeth when the mandible is in the rest position. In the majority of patients it is 2–4mm. The OVD for an edentulous patient can therefore be determined by measuring their resting face height and subtracting a FWS. Resting face height is assessed using:
    - A Willis gauge, to measure the distance between the base of nose and the underside of the chin. Is only accurate to ±1mm.
    - Spring dividers, to measure the distance between a dot placed on both the chin and the tip of the patient's nose. This method is less popular with patients and is C/I for bearded gentlemen (or ladies!).
    - The patient's appearance and speech.
    - Mark the centre lines.
- Locate rims in RCP e.g. with bite-recording paste:
  - *Horizontal jaw relationship*. Record the more reproducible RCP. In the natural dentition, ICP is ~1mm forward of RCP, some prosthetists advise adjusting the finished dentures to allow the patient to slide comfortably between the two positions.
- Prescribe mould and shade of artificial teeth for try-in
- Consider using a facebow registration to mount the maxillary cast on the articulator.

Position of the anterior and posterior teeth

Ideally, the artificial teeth should lie in the space occupied by the natural dentition. The extent to which it is possible to compensate for a Class II or III malocclusion depends upon the retention afforded by the ridges. In the natural dentition the upper incisors lie ~10mm anterior to the posterior border of the incisive papilla. With resorption this comes to lie on the ridge crest, therefore the artificial teeth should be placed labial and buccal to the ridge, to give adequate lip support and a nasolabial angle of ~90°.

Posterior teeth should be narrow to ↑ masticatory efficiency. Low cusped teeth are preferred, but cuspless teeth are useful for patients with poor natural retention or a 'wandering' ICP. When considering the colour, mould, and arrangement of the anterior teeth, the patient's age, facial appearance, and most importantly their opinion, must be taken into account. If you disagree about the suitability of their choice, document it.

Type of articulator to be used for setting-up the teeth

Most textbooks advocate semi-adjustable or average value articulators for F/F dentures. However, most dentures are made on simple hinge articulators to the satisfaction of the majority of patients, probably because they are able to adapt to the occlusion that results. An average value type will give some degree of balanced articulation which can then be refined in the mouth and will help avoid the introduction of occlusal interferences, and is the preferred method.

Common pitfalls

- Inaccuracies caused by poorly fitting bases.
- Rims contacting prematurely posteriorly and flipping-up anteriorly, or vice versa.
- Failure to provide adequate FWS. This is less likely to occur if the rest position is recorded with only one denture or rim in position.
- Attempting to correct too much when replacing old worn dentures and exceeding the adaptive capacity of the patient.

Complete dentures—trial insertion

Trial dentures are constructed by setting-up the prescribed teeth in wax on acrylic or shellac bases. Both the dentist and patient must be satisfied before the dentures are processed in acrylic.

Clinical procedures

Check the trial dentures

- On and off the articulator. Comparison with the patient's existing dentures is helpful to see if the features to be copied or modified have been successfully incorporated.
- Singly in the mouth. To check extension, stability, and the position of the teeth relative to the soft tissues.
- Together in mouth. Examine vertical dimension, occlusion, aesthetics, and phonetics ('S' sound will be affected by ↑ or ↓ FWS).

Seek the patient's opinion Some advocate getting patients to sign an acceptance slip before going to finish.

Prepare post-dam This should be placed just anterior to the vibrating line on the palate, which can be assessed by asking patient to say 'Aah'. The degree of compressibility of the tissues is assessed and the depth of the post-dam cut accordingly (usually ~1mm). The post-dam is recorded by marking the master impression with indelible pen and prepared on the upper cast with a wax knife in the shape of a Cupid's bow.

Complete prescription to the technician This should include:

- Any changes in posterior tooth position or anterior tooth arrangement.
- For fibrous undercuts >4mm and bony undercuts >2mm, decide whether they are to be plastered out or the flange thickened for adjustment at finish.
- Tin-foiling for relief of hard or nodular areas, if required.
- Gingival colour and contour.
- Denture base material. This is usually heat-cure acrylic; however, metal bases are indicated for patients with a history of fractured dentures.
- Identification marker, which is preferably legible.

Common problems and possible solutions

- Over-extension of flanges. Reduce.
- Under-extension of flanges. Try a temporary wax addition to flange first, to check effect of extending it. If this is satisfactory a new impression is required.
- Teeth outside neutral zone. Remove offending teeth and replace with wax which can be trimmed until correct.
- Incorrect OVD. If too small, can ↑ by adding wax to the occlusal surfaces of teeth, but if too large, will need to replace lower teeth with wax and re-record OVD.

- Occlusal discrepancy or anterior open bite or posterior open bite. Replace lower posterior teeth with wax and re-record OVD.
- Too little of upper anterior teeth visible. Reset anterior teeth to correct position and ask lab to adjust occlusal plane accordingly.
- Too much of upper anterior teeth showing. The effect of reducing the length of the incisors can be judged by colouring incisal region with a black wax pencil and then indicating desired change in position to lab.
- Inadequate lip support. An increase in support can be assessed by adding wax to the labial aspect of the upper try-in.

A new try-in will be required if large errors are being corrected or if any doubt still exists about the occlusion.

Complete dentures—fitting

Some adjustment of completed dentures is inevitable following processing. On average, a 0.5-mm increase in height occurs and a slight shift in tooth contact posteriorly. The main steps are:

Adjustment of fitting surface First, smooth any roughness and if necessary gradually reduce the bulk of the flanges in areas of undercut until the denture can be easily inserted without compromising retention.

Check occlusion The vertical dimension of the dentures is maintained by contact between the upper palatal and lower buccal cusps, therefore adjustment of these should be avoided if possible.

- Get patient to occlude and check contact with articulating paper. If contact uneven, or heavy contacts seen, adjust the fossae.
- For cusped teeth only, place articulating paper between occlusal surfaces and ask patient to make small lateral movements and adjust Buccal Upper and Lower Lingual (BULL rule) cusps only to remove any interferences.
- Remove any interferences to protrusive movements.
- Balancing contacts are desirable, but not essential unless they can be established easily by minor adjustments to working side contacts. Some authorities suggest providing even occlusal contact only at the time of fitting, allowing the patient to adapt to their new dentures before trying to achieve balanced articulation.

Advice to the patient Verbal and written instructions should be given.

- Most patients take some time to adapt to their new dentures. During this time a softer diet is advisable.
- If pain is experienced the patient should try to continue wearing their dentures and return for adjustment as soon as possible so that affected areas can easily be seen. If this is not possible they should stop wearing the dentures until 24h prior to the next visit.
- Although patients should be encouraged not to wear their dentures at night, adaptation may be speeded up if they are worn full-time for the first 1–2 weeks.
- When the dentures are not being worn they should be stored in water to prevent them drying out and warping. Plastic denture boxes are cheap, and safer than a glass of water at the bedside.
- Cleaning Cleaning dentures, p. 306.

Review The patient should be seen 1–2 weeks after fitting to ease the dentures and adjust the occlusion. Localization of the cause of any irritation due to a flaw on the fitting surface can be helped by:

- Pressure relief cream which is painted onto the fitting surface of the denture.
- Indelible pencil, or denture fixative powder mixed with zinc oxide, which is applied carefully to area thought to be responsible and the denture inserted. On removal the mark will have been transferred to the adjacent mucosa and should correspond with the damaged area.

- If there is no obvious cause relating to the fitting surface remember that occlusal faults can cause displacement and mucosal trauma, and an excessive OVD is a common cause of generalized soreness under –/F (➔ Denture problems and complaints, p. 308).

Stress the importance of regular review of all patients with dentures.

Notebox:
Summary points for complete dentures (you write here)

Denture maintenance

▶ Review patients with F/F annually. Regular maintenance will help prevent damage due to ill-fitting dentures and will ↑ the likelihood of early detection of oral pathology.

Problems caused by lack of aftercare of F/F As a result of resorption all dentures become progressively ill-fitting, leading to loss of retention and stability. Movement of dentures in function may result in:

- Resorption.
- Predisposition to candidal infection.
- Denture irritation hyperplasia (➔ Problems in denture wearers, p. 400).
- Inflammatory papillary hyperplasia of the palate.

All of these are exacerbated by wear of the occlusal surfaces.

Rebasing

The terms 'rebasing' and 'relining' are commonly used interchangeably. Strictly speaking relining is replacement of the fitting surface (e.g. with a temporary material) and rebasing is replacement of most or all of the denture base.

Rebasing is indicated where the only feature of F/F that requires improvement is the fitting surface; otherwise consider replacement F/F using copy method. For rebasing the material of choice is heat-cure acrylic (➔ Denture materials—rebasing, p. 662), but this necessitates the patient being without their dentures while the addition is being made. Self-cure acrylic applied at the chair-side appears attractive, but its properties are inferior. For a heat-cure rebase, a wash impression (ZOE or low viscosity elastomer) must be recorded inside the denture.

Technique To avoid an ↑ in OVD, record the impression for one denture at a time.

- Check occlusion and adjust if required. Note OVD.
- Remove undercuts from fitting surface.
- Correct extension and place post-dam in greenstick.
- Apply impression material and insert in mouth. Get patient to close into contact with opposing denture. Check OVD and occlusion.
- Remove and examine impression; if unsatisfactory (or if in doubt) repeat.

An alternative method for inflamed tissues is to record a functional impression (➔ Functional impression, p. 297) over several days with a tissue conditioner (e.g. Visco-gel®), in which case the resulting impression needs to be cast immediately.

Tissue conditioners (e.g. Coe-comfort, Visco-gel®)

These are resilient materials which give a more even distribution of loading and thus promote tissue recovery. They are particularly useful where ill-fitting dentures have caused trauma, as it is important to allow the tissues to recover before impressions for replacement dentures or a rebase are taken.

Technique Relieve any areas of pressure on the fitting surface and reduce any over-extension. A minimum thickness of 2mm is required and the material should not be left for >1 week. Repeated applications may be necessary.

Tissue conditioners can also be used after pre-prosthetic surgery. They become less soft with time therefore they should be replaced at least weekly.

For patients who have very atrophic ridges and who struggle with denture wearing, a definitive soft lining aimed at distributing stresses more evenly to the denture bearing area may be helpful, e.g. GC reline™, Permasoft®. GC reline™ may also be used to engage bony undercuts.

Soft linings are indicated for:

- Older patients with a thin atrophic mucosa. Usually for –/F.
- Following prosthetic surgery.
- To utilize soft tissue undercuts for ↑ retention, e.g. following hemimaxillectomy, clefts.

It is wise to make a new denture first in acrylic and adjust the occlusion, before placing soft lining. A minimum thickness of 2mm is required, which may significantly weaken a lower denture necessitating placement of a metal strengthener on the lingual aspect. No material is ideal and soft linings are best avoided (➔ Soft liners, p. 662).

Cleaning dentures

When new dentures are fitted the importance of regular, thorough cleaning, especially of fitting surfaces with soap, water, and a brush to prevent the build-up of plaque, stain, and calculus should be emphasized. Unfortunately, few patients are sufficiently diligent, due in part to being conditioned by advertising, to expect to use a denture cleaner.

Advise patients to clean their dentures over a basin of water to act as a safety net (see Table 7.5).

Table 7.5 Cleaning dentures—formulations

Formulation	Active ingredients	Problems
Powder	Abrasives, e.g. calcium carbonate	Abrasion
Paste	Abrasives + eugenol	Abrasion + crazing
(Dentu-creme®)	Abrasive + phenol oil	Abrasion + sensitivity
Hypochlorite (Dentural®)	Sodium hypochlorite	Can corrode metal
Effervescent (Steradent®)	Dissolves to give alkaline peroxide solution	Doubts about effectiveness
Dilute acids (Denclen®)	3–5% hydrochloric acid or 5–10% phosphoric acid	Can corrode metal
Enzymatic	Proteolytic enzymes	Not widely available

Practical tips

Hypochlorite solutions are effective for acrylic dentures when used overnight, but if used with hot water are liable to cause bleaching, therefore warn patient.[7] The peroxide cleaners are popular but are ineffective if used for only 15–30min as the manufacturers advise. See Table 7.6.

Table 7.6 Cleaning dentures—peroxide cleaners

	Avoid	Use
Visco-gel®	Acids, alkaline peroxide	Hypochlorite
Molloplast®	Acids, alkaline peroxide	Hypochlorite
Coe-Comfort™	Hypochlorite, alkaline peroxide	Soap + water
Metal denture	Hypochlorite	Alkaline peroxide
Any denture	Household bleach	

7 C. A. Crawford *et al.* 1986 *J Dent* **14** 258.

Notebox:
Summary points for cleaning dentures
(you write here)

Denture problems and complaints

The most common complaints are of pain &/or looseness, which can be due to denture errors or patient factors. The latter should be foreseen and the patient warned in advance of the limitations of dentures. Unless the cause is immediately obvious, e.g. a flaw on the fitting surface, a systematic examination of the fitting, and polished and occlusal surfaces (including the jaw relationship) should be carried out.

Pain

This can be due to a variety of causes, including roughness of the fitting surface, errors in the occlusion, lack of FWS, a bruxing habit, a retained root, or other pathology. Forward or lateral displacement of a denture due to a premature contact can lead to inflammation of the ridge on the lingual or lateral aspect, respectively. With continued resorption bony ridges become prominent and the mental foramina exposed, which can lead to localized areas of specific pain.

Pain from an individual tooth on P/P

- Excessive load &/or traumatic occlusion.
- Leverage due to unstable denture.
- Clasp arm too tight.
- Inadequate lining under amalgam restoration failing to insulate against a galvanic couple with metal denture.

Looseness This more commonly affects the lower than the upper denture (Table 7.7).

Table 7.7 Denture faults—looseness

Denture faults	Patient factors
Incorrect peripheral extension	Inadequate volume of saliva
Teeth not in neutral zone	Poor ridge form
Unbalanced articulation	↓ adaptive skills, e.g. elderly patient
Polished surfaces unsatisfactory	

Burning mouth This can be due to: (i) local causes: e.g. ↑ OVD or sensitivity to acrylic monomer, or be unrelated to the denture (e.g. irritant mouth washes, candidiasis); (ii) systemic causes: e.g. the menopause, deficiency states, cancerophobia, xerostomia.

Speech See Table 7.8.

Cheek biting Check first that teeth are in neutral zone. If satisfactory, ↓ buccal 'overjet', i.e. reduce buccal surface of lower molars (provided normal bucco-lingual relationship).

Table 7.8 Denture faults—speech

Patient's complaint	Possible cause
Difficulty with f, v.	Incisors too far palatally
Difficulty with d, s, t	Alteration of palatal contour
	Incorrect overjet and overbite
s becomes th	Incisors too far palatally
	Palate too thick
Whistling	Palate vault too high behind incisors
Clicking teeth	OVD
	Lack of retention

Retching

- Map out extent of sensitive area on palate using a ball-ended instrument and firm pressure, and check extension of denture.
- Palateless dentures may be a solution, but their retention is poor.
- Training dentures. These can take the form of a simple palate to which teeth are added incrementally, starting with the incisors.
- Hypnosis.
- Implants (➔ Implantology, p. 316) and a fixed prosthesis.

The grossly resorbed lower ridge

Resorption is progressive with time, which is a good argument for avoiding rendering young patients edentulous. The mandible resorbs more quickly than the maxilla, which exacerbates the problem of retention for -/F. Management is dependent upon the severity of the problem and the patient's biological age.

- Minimizing destabilizing forces upon the lower denture, e.g.
- (i) maximum extension of denture base; (ii) ↓ number and width of teeth; (iii) ↑ FWS; (iv) lowering occlusal plane.
- Neutral zone impression technique (➔ Special techniques, p. 296).
- Surgery (➔ Problems in denture wearers, p. 400).
- Implants (➔ Implantology, p. 316).

Recurrent fracture

Apart from carelessness, this is usually caused by occlusal faults or fatigue of the acrylic due to continual stressing by small forces. Flexing of the denture can occur with flabby ridges, palatal tori, and following resorption. Notching of a denture, e.g. relief for a prominent fraenum, can also predispose to #. Treatment depends upon the aetiology, but in some cases provision of a metal plate or a cast-metal strengthener may be necessary.

Candida and dentures

Candida is a common oral commensal. It becomes pathogenic if the environment favours its proliferation (e.g. dentures, ↑ carbohydrate intake, antibiotic alteration of the bacterial flora) or the host's defences are compromised ➔ Oral candidosis (candidiasis), p. 414.

Denture stomatitis

Also known as denture sore mouth, a misnomer because the condition is usually symptomless. Classically, seen as redness of the palate under a F/- denture, with petechial and whitish areas. 90% of cases due to *Candida albicans*, 9% to other *Candida*, and <1% to other organisms, e.g. *Klebsiella* spp.

Incidence A common condition, having been reported in 30–60% of patients wearing F/F. It affects F more commonly than M, in a ratio of 4:1, and usually affects the upper denture-bearing area only.

Aetiology is still not completely understood.

- Infection with *Candida* spp.
- Poor denture hygiene.
- Night-time wear of dentures.
- Trauma is often cited as a contributing factor to denture stomatitis, *but:*
  - It occurs more commonly under F/– than –/F.
  - It can affect patients wearing F/– only.
  - It is also found under well-fitting orthodontic appliances.
- Systemic factors can predispose to *Candida* infection, e.g. iron and vitamin deficiency, steroids, drugs which cause xerostomia, and endocrine abnormalities.
- A high sugar intake provides substrate for *Candida* to multiply.

Management

- Patients should be encouraged to remove their dentures at night.
- They should cleanse denture thoroughly, e.g. brushing fitting surface and soaking in hypochlorite cleanser.
- New dentures may be required if these measures fail despite good compliance. The denture can act as a reservoir for *Candida*.
- Reduce sugar intake.
- Miconazole gel can be added to the fitting surface of the denture before insertion.
- If suspect systemic factors exacerbating condition, refer to GMP.
- Coexisting papillary hyperplasia of palate may need surgical reduction.
- Systemic fluconazole may be used in some cases

Angular cheilitis See ➔ Chronic candidosis, p. 414.

Notebox:
Summary points for candida and dentures (you write here)

Denture copying

Successful function with complete dentures depends to a marked degree upon the patient's ability to control them. This ability is learnt during a period of denture use. When replacement dentures become necessary, it is helpful if the new appliances require as little adaptation as possible to the existing skills. This is generally considered to be particularly important for the older patient. Not only may skills have been developed over a long period, but also the ability to relearn may be diminished. So-called denture copying techniques provide a more reliable method for provision of replacements.

Treatment planning

Before undertaking treatment it is essential to decide which features of the previous dentures are satisfactory, and which require modification, and by how much. Consider:

- Fitting surface—if this is the only feature that requires improvement, then rebasing is a possibility.
- Polished surface shapes.
- Occlusal surface; jaw relationship; OVD. The effect of an ↑ in OVD can be assessed by self-cure addition to the existing dentures (occlusal pivots), but remember that this irreversibly alters them.
- Anterior tooth size, arrangement, relation to lips.
- Posterior tooth mould and arch width (relation to tongue and cheeks).

Copying complete dentures

A number of techniques have been described. They vary in the materials used, and these in turn affect the acceptability of laboratory work, and the clinical freedom to incorporate 'corrections'. In general, copies of the old appliances are used as substitutes for record blocks, and as special trays. Typical method:[8]

Step 1. Clinic

- Correct under-extension with greenstick tracing compound.
- Record impressions with silicone putty of polished surface and teeth, using large disposable tray. Complete mould with second mix of putty to record fit surface (use a separating medium—white soft paraffin or, better, emulsion hand cream).
- Open mould, clean dentures, and return to patient.
- Send putty moulds to laboratory.

Step 2. Laboratory

- Fabricate self-cure acrylic baseplates on the silicone model of the fit surface.
- Pour wax into remaining space.
- After cooling remove completed copy, cut off sprues, and polish.

8 R. Yemm 1991 *Int Dent J* **41** 233.

Step 3. Clinic

- Employ the copies ('replica record blocks') to record required changes in denture shapes (➔ Treatment planning, p. 312), by adding or removing wax. Record working impressions in low viscosity silicone *with adhesive* to aid retention on base.
- Record jaw relationship with 'bite recording paste'.
- Select shade/moulds for new teeth.

Step 4. Laboratory

- Cast impressions and articulate.
- Set-up, cutting away modified replica rims to substitute new teeth (rather like setting up an immediate denture).
- Wax-up, including borders defined by working impressions.

Step 5. Clinic

- Try-in stage.

Step 6. Laboratory

- Finishing stages as normal.

Step 7. Clinic

- Normal insertion stage (and subsequent review).

Other methods use alternative materials (e.g. alginate for impressions of existing dentures, wax, and shellac to form the copy dentures). Choice will depend on acceptability to both clinic and laboratory. In no instance, however, is an all-wax copy regarded as being acceptable, since rigidity is inadequate for use as an impression tray.

Copying partial dentures for immediate dentures[9]

In patients with successful P/P, for whom extraction of the remaining teeth is planned, the transition to complete dentures can be facilitated by using a copy technique.

Clinic 1 Correct under-extended flanges with greenstick and then take impressions of the dentures with putty in stock trays (see F/F technique ➔ Copying complete dentures, p. 312). Record an alginate impression of the opposing arch, if no denture is planned for that arch.

Lab 1 Wax/shellac or acrylic replica of partial denture is constructed.

Clinic 2 Use the replica denture to develop the prescription and then record a wash impression inside the base with a light-bodied silicone. Record the occlusion using bite registration paste. Finally, take an overall impression in a stock tray with the modified replica denture *in situ*.

Lab 2 The impression is cast and used as a base for articulating the wax replica with the cast of the opposing arch. The teeth prescribed are then set up, and the wash impression retained in the replica, for the try-in.

Try-in and finish as for complete immediate dentures ➔ Immediate complete dentures, p. 292.

9 J. R. Drummond *et al.* 1983 *BDJ* **155** 297.

Overdentures

An overdenture (OD) derives support from one or more abutment teeth or implants by completely enclosing them beneath its fitting surface. It can be a partial or complete denture.

Advantages

- Alveolar bone preservation around the retained tooth.
- Improved retention, stability, and support.
- Preservation of proprioception via PDL.
- Better crown to root ratio, which ↓ damaging lateral forces.
- ↑ masticatory force.
- Additional retention possible using attachments.
- Aids transition from P/P to F/F.
- Psychological benefits of maintaining natural teeth

Disadvantages

- RCT probably required.
- To avoid excessive bulk in region of retained tooth (which may compromise aesthetics) denture base may need to be thinned, which ↑ likelihood of #.
- ↑ maintenance for both patient and dentist.
- Roots may be prone to caries.

Indications

- Motivated patient with good oral hygiene.
- Because of ↓ retention and stability of -/F and ↑ rate of mandibular resorption, ODs are particularly useful for -/F or free-end saddle.
- Cleft lip and palate.
- Hypodontia.
- Severe toothwear.

Choosing abutment teeth

- Ideally: bilateral, symmetrical with a minimum of one tooth space between them.
- Order of preference: canines, molars, premolars, incisors.
- Healthy attached gingiva, adequate periodontal support (>1/2 root in bone), and no or limited mobility.
- Is RCT required and if so is it feasible?

Preparation of abutment teeth

Alternatives include:

- If pulps have laid down lots of secondary dentine (e.g. severe tooth wear), can just cut down crowns and place dentine bonding agent.
- Preparation of crown for thimble/telescopic gold coping.
- RCT, tooth cut to dome shape, and access cavity restored with amalgam or an adhesive restoration.
- RCT and gold coping over root face.
- RCT and precision attachment.

Precision attachments[10,11] are useful for ↑ retention of dentures or bridges, especially in cases with tissue loss (e.g. trauma or CLP), but they ↑ loading on abutment teeth, and are expensive and difficult to rebase and repair. Usually of two parts, which are matched to fit together. One part is attached to the abutment tooth and the other to the denture. A variety of attachments are available, including stud/anchor (e.g. Rotherman eccentric clip), bar (e.g. Dolder), and magnets.

Since precision attachments require the highest technical skill and are highly dependent on patient and professional maintenance, it is wise to first use a basic OD and then reassess the need for additional retention. Hybrid dentures are partial dentures that utilize precision attachments (either intra- or extracoronal) on the abutment teeth for retention. Implants which are inserted in edentulous areas can be used with precision attachments to ↑ retention.

Clinical procedures

- Assessment (clinical examination, study models, X-rays, etc.).
- RCT if required.

If abutment preparation is limited to crown reduction:

- The steps involved are as for immediate dentures, with the abutment teeth reduced less on cast than is planned clinically. At the visit during which the final dentures are to be fitted, the abutment teeth are prepared and the dentures relined with self-cure acrylic to improve their adaptation.

If precision attachments or copings to be used:

- The teeth are prepared and an impression of the abutments, including post holes, taken. In the lab, dies are prepared and transfer copings (usually metal) made. The transfer copings are tried on the abutments, and if satisfactory an overall impression is recorded to accurately locate the copings to the remainder of the denture-bearing area. Alternatively, a two-stage technique using a special tray with windows cut out over abutments can be used.
- Regular review (6-monthly) and maintenance is necessary for success.

Problems

The most important are:

- Caries of abutment teeth, therefore need good oral and denture hygiene and topical fluoride, e.g. toothpaste, applied to the fitting surface of the denture. Patients should be encouraged to remove their denture at night.
- Periodontal breakdown.

Implant retained overdentures

- There is good evidence that patient's satisfaction and quality of life is significantly ↑ with implant supported mandibular dentures than with conventional dentures. The York Consensus Statement on implant supported overdentures states that 'a large body of evidence supports the proposal that a 2- implant supported mandibular overdenture should be the minimum offered to edentulous patients as a first choice of treatment'.[12]

10 H. W. Preiskel 1984 *Precision Attachments in Prosthodontics*, Quintessence.

11 H. W. Preiskel & A. Preiskel 2009 *Dental Update* **36** 221.

12 British Society for the Study of Prosthetic Dentistry 2009 *Eur J Prosthodont Rest Dent* **17** 164.

Implantology

Implantology in restorative dentistry is based on the principle of osseointegration, i.e. a direct functional and structural connection between a load-carrying titanium implant with bone with no intervening connective tissue. See also ➔ Implantology, p. 402.

This concept has revolutionized tooth replacement in recent years (Fig. 7.7). Successful osseointegration depends on meticulous planning. There is little point in a successfully integrated implant in the wrong place!

Preparation for implants

There are two aspects to treatment planning:

Assessment of suitability for implant placement

Achieved by thorough history, clinical examination of hard and soft tissue availability, periodontal health, dentition, occlusion, available interdental and interocclusal space, and mouth opening ability. Smoking and untreated periodontal disease are risk factors for implant placement. Poorly controlled diabetes, immunosuppression, scleroderma, use of bisphosphonates are possible C/I to implant placement. Radiographic examination looks at the quality and quantity of bone and adjacent anatomical structures (e.g. ID canal/maxillary sinus), and any bony pathology. All prosthetic options (i.e. no treatment, removable partial denture, fixed bridge, or implant) are considered.

Planning of implant position if implant indicated

This uses the 'top-down' approach. This means deciding on tooth position first using wax-ups on mounted study models. If there is insufficient bone available in the right place then either bone augmentation is required or other prosthetic options need to be considered.

Bone augmentation may be achieved by onlay grafting, ridge expansion, sinus elevation, or distraction osteogenesis. The material used may be autogenous bone or allografts, xenografts (e.g. Bio-Oss®) or alloplastic materials. Barrier membranes (e.g. Bio-Gide®) may be used to support the graft material. Bone morphogenetic proteins may be used as bioactive mediators.[13]

The wax-up is used to produce a radiographic stent which is used to help plan the appropriate size and position of implant. A surgical stent is also made to help guide implant placement. Digital implant planning systems (e.g. SimPlant®) are now available. These allow for 3-D planning and the production of surgical guides.

Placement

Careful technique is required to avoid overheating bone resulting in bone necrosis. There are many implant systems available. Some use a two-stage technique where the implant is buried while it integrates and has to be exposed at a later date. Others are transmucosal while they integrate.

13 M. Esposito *et al.* 2008 *Cochrane Database Syst Rev* **3** CD004152.

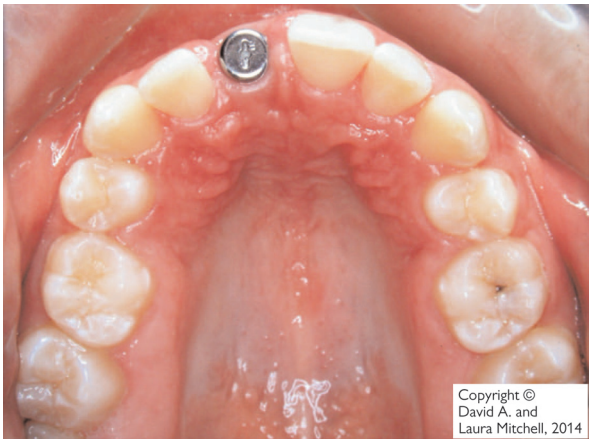

Fig. 7.7 Implant placed to replace the upper right central incisor.

Integration times

Traditionally the time from placement to integration and loading has been accepted as 3 months in the mandible and 4–6 months in the maxilla. There is now some evidence that, in certain circumstances, implants may be loaded earlier than this.[14]

Abutment connection

Once integrated (and, if necessary, exposed) an abutment is connected to the implant. This allows the prosthetic superstructure to be manufactured and connected via the abutment to the implant.

Implant superstructures may be single tooth crown, implant retained bridge, or implant retained overdentures.

Follow-up and maintenance

Implant retained restorations need to be carefully maintained by the patient. The implant needs to be followed up long term clinically and radiographically by the clinician. Implant failure may be early or late. Early failure may be due to inadequate site preparation, overheating of bone, infection, premature loading, or lack of primary stability. Late failure may be due to overloading or infection (peri-implantitis). Literature shows maintenance of restorations will be an ongoing problem for the implant patient, e.g. # screws, clips, porcelain, acrylic.

14 M. Esposito *et al.* 2007 *Cochrane Database Syst Rev* 2 CD003878.

Dentistry and the older patient

From a chronological and social and healthcare planning perspective, being elderly means being >65yrs old. This is entirely different from biological age. Two factors are mainly responsible for the ↑ relevance of dentistry for the elderly: an ↑ in the proportion of the elderly in the population and the improvements in dental health that have resulted in more people keeping their natural teeth for longer. The proportion of edentulous adults in the UK fell from 37% in 1968 to 6% in 2009.[15]

Challenges

- Age changes, both physiological and pathological.
- Disease and drug therapy (Chapter 12).
- Delivery of care.

Restorative problems

- Reduced adaptive capacity; therefore if teeth are unlikely to last a lifetime, the transition to at least partial dentures should be made whilst the patient is able to learn the new skills necessary.
- Age changes in the denture-bearing areas, including bone resorption and mucosal atrophy.
- Root caries, which can occur following exposure of root surfaces by gingival recession, in association with changes in diet, ↓ self-care, and ↓ salivary flow. Details of management are given in ➔ Root caries, p. 25. Prevention of root caries in susceptible patients is possible using either a topical fluoride mouthrinse, high fluoride toothpaste, or fluoride-containing artificial saliva, e.g. Luborant® or Saliva Orthana®.
- Toothwear (➔ Tooth wear/tooth surface loss, p. 244) is especially prevalent when partial tooth loss has occurred.
- Pulpal changes, including sclerosis (➔ Sclerosed canals, p. 344) and ↓ repair capacity.
- Reduced manual dexterity, making OH procedures difficult. Epidemiological studies of the periodontal needs of the elderly population are still sparse and some trends may be masked by a high rate of edentulousness. The available evidence suggests that, although older patients develop plaque more quickly, the need for periodontal treatment ↑ up to middle age, and thereafter the majority can be maintained by regular non-surgical management.
- Bleaching and bonding and minimally invasive dentistry should be considered.

15 Health and Social Care Information Centre 2009 *Adult Dental Health Survey: Oral Health in the United Kingdom* (℞ http://www.hscic.gov.uk).

Notebox:
Summary points for dentistry and the older patient (you write here)

Age changes

Age changes are defined as an alteration in the form or function of a tissue or organ as a result of biological activity associated with a minor disturbance of normal cellular turnover.

In general

↓ microcirculation, ↓ cellular reproduction, ↓ tissue repair, ↓ metabolic rate, ↑ fibrosis. Degeneration of elastic and nervous tissue. These result in reduced function of most body systems.

Oral

Oral soft tissues A ↓ in the thickness of the epithelium, mucosa, and sub-mucosa is seen. Taste bud function ↓. With age, an ↑ occurs in the number and size of Fordyce's spots (sebaceous glands), lingual varices, and foliate papillae. Recent evidence suggests that stimulated salivary flow rate does not fall purely as a result of age. However, medications, head and neck radiotherapy or systemic disease can affect salivary output.

Dental hard tissues Enamel becomes less permeable with age. Clinically, older teeth appear more brittle, but there is no significant difference between the elastic modulus of dentine in old or young teeth. The rate of 2° dentine formation reduces with age, but still continues. Occlusion of the dentine tubules with calcified material spreads crownwards with age.

Toothwear is an age-related phenomenon and can be regarded as physiological in many cases. However, excessive and pathological wear can be caused by parafunction, abrasion, erosion (dietary, gastric, or environmental), or a combination of these factors (➔ Tooth wear/tooth surface loss, p. 244).

Dental pulp ↑ fibrosis and ↓ vascularity mean that the defensive capacities of the pulp ↓ with ↑ age, therefore pulp capping is less likely to succeed. Also ↑ 2° dentine and ↑ pulp calcification.

Periodontium ↑ fibrosis, ↓ cellularity, ↓ vascularity, and ↓ cell turnover are found with ↑ age. Gingival recession has been previously thought to be an age change but is now known to be a part of periodontitis.

Systemic

Immune system A ↓ in cell-mediated response and ↓ in number of circulating lymphocytes leads to an ↑ incidence of autoimmune disease as well as a ↓ in the older patient's defence against infection. Also an ↑ in neoplasia is seen. Steroid treatment for autoimmune disease may complicate dental treatment.

Nervous system Ageing involves both a physiological decline in function and dysfunction associated with age-related disease (e.g. strokes, parkinsonism, trigeminal neuralgia). A ↓ in acuity compounds the problem.

Cardiovascular Hypertension and ischaemic heart disease worsen with age. Anaemia is more common in the elderly. In general, the greatest problems arise when a GA is required, or the practice is on the second floor.

Pulmonary system Lung capacity ↓ with age and chronic obstructive airways disease ↑ in prevalence.

Endocrine system Diabetes is more common.

Muscles ↓ bulk, slower contractions, and less precision of control occur.

Nutrition Poverty, impaired mobility, ↓ taste acuity, and ↓ masticatory function can result in nutritional deficiencies in the elderly. These can manifest as changes in the oral mucosa.

Mucosal disease, which is more common with increasing age

- Oral cancer ➔ Oral cancer, p. 428.
- Lichen planus ➔ Lichen planus, p. 442.
- Herpes zoster is more common with ↑ age due to a ↓ in T-cell function. Neuralgia occurs more frequently after an attack in the elderly.
- Benign mucous membrane pemphigoid ➔ Mucous membrane pemphigoid, p. 420.
- Pemphigus ➔ Pemphigus, p. 418.
- Candida is seen more frequently in the older age groups due to an ↑ proportion of denture wearers and ↑ immune deficiencies.

This list is obviously not exhaustive.

Dental care for the elderly

General management problems

Medical and drug history (Chapter 12) It is wise to check any complicated medical problems with the patient's GMP or physician. Unfortunately, many doctors are only familiar with the dental treatment they have personally received, therefore give details of what is proposed.

Communication with the elderly may sometimes require patience and understanding. Older patients may try to cover up deafness, poor eyesight, and lack of comprehension, so it is better to err on the side of over-stressing an important point or instruction, but avoid sounding patronizing. Active listening and questioning to check understanding is helpful. It is often helpful to enlist the assistance of a relative or friend of the older patient (with the patient's consent).

Oral hygiene may be compromised by arthritis &/or a stroke. Advise an electric toothbrush or modifying the handle of an ordinary toothbrush to make it easier to grip, e.g. with elastoplast or bicycle handlebar grips. Alternatively, self-cure acrylic can be used to make a custom grip for a toothbrush.

Delivery of care

Dental practice Consideration should be given to:

- Access for a wheelchair or Zimmer frame. Dental practices are required to provide reasonable adjustments to ensure treatment is accessible.
- Timing of appointments; e.g. for a diabetic patient these need to be arranged around meals and drug regimens, and early morning visits are probably C/I for arthritic patients as it may take them a couple of hours to 'get going'.
- Positioning of the patient. Some elderly patients are unhappy to be recumbent in the dental chair. In addition, this position is C/I for those with cardiovascular or pulmonary disease. Adjust dental chair gradually as rapid movement from a flat to upright position can result in postural hypotension.

Domiciliary care An estimated 12–14% of the elderly population is bedridden or housebound to such a degree that they cannot visit their GMP or GDP. Domiciliary care aims to provide care for those patients.[16] There is an increasing demand for domiciliary oral healthcare and guidelines for delivering these services have been published.[17]

Key points

- Can treatment be carried out successfully?
- Consider maintenance required by any proposed treatment. Elaborate procedures which fail may leave the patient worse off.
- The objective is to maintain optimum oral function. Sometimes retention of a few teeth can be disadvantageous.

16 D Lewis & J. Fiske 2011 *Dent Update* **38** 231.

17 British Society for Disability and Oral Health 2009 *Guidelines for the Delivery of a Domiciliary Oral Healthcare Service* (℞ http://www.bsdh.org.uk).

- Medical crises (e.g. a period in hospital) can result in a very rapid change in a previously stable oral state, e.g. rapid caries attack, loss of denture-wearing skill through lack of use.
- Avoid sudden changes in occlusion. The shape/form of dentures should not be changed anteriorly. During restorative work refrain from introducing significant occlusal change. If necessary to extract teeth, do so a few at a time, with additions to existing dentures.

Some clinical techniques of particular value in elderly

- Adhesive restorations, e.g. GI for root caries.
- Acid-etch bridgework is less destructive to abutments and is therefore more fail-safe.
- Gradual tooth loss, with additions to existing P/P, is less demanding of a ↓ adaptive capacity.
- Replacement dentures should be made with careful regard to existing appliances. Use of copying techniques again ↓ amount of adaptation required.
- If recording the occlusion proves difficult, use cuspless teeth.
- Mark dentures with the patient's name.

Notebox:
Summary points for dentistry and the older patient (you write here)

Notebox:
Summary points for replacing teeth
(you write here)