

IN BRIEF

- The principles of crown preparation and crown selection
- Guidelines for tooth reduction and margin design
- Preparation of the taper
- Strategies for enhancing resistance and retention
- Tooth preparation

Crowns and other extra-coronal restorations: Preparations for full veneer crowns

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Preparations for full veneer crowns is the eighth in the series on crowns and other extra-coronal restorations. Whilst handpiece skills are important, many other factors combine to ensure provision of a satisfactory full veneer crown (also termed 'full coverage crown'). Our aim in writing this article is to consider the principles which influence crown preparation, seasoned with clinical advice our undergraduate and postgraduate students have found useful.

CROWNS AND EXTRA-CORONAL RESTORATIONS:

1. Changing patterns and the need for quality
2. Materials considerations
3. Pre-operative assessment
4. Endodontic considerations
5. Jaw registration and articulator selection
6. Aesthetic control
7. Cores for teeth with vital pulps
8. Preparations for full veneer crowns
9. Provisional restorations
10. Impression materials and technique
11. Try-in and cementation of crowns
12. Porcelain veneers
13. Resin bonded metal restorations

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In the second article of this series we considered the broad range of materials from which crowns are made. The four main categories of crown were metal, ceramic, metal-ceramic and composite. Tooth preparations need to reflect the different requirements of these materials in terms of amount of space needed to accommodate the crown and its marginal configuration. Tooth preparations also need to be free from undercuts whilst reliably retaining the crown.

The principles of crown preparation described by Shillingburg¹ (Table 1) determine the shape and form of our preparations, but they cannot be considered in isolation as there has to be a balance between them. For example, minimal preparation can result in the production of a bulky, unaesthetic crown which can in turn cause periodontal or occlusal problems (Fig. 1). Conversely over preparation can be compensat-

ed by making a thicker and perhaps very aesthetic crown, but the strength and pulpal vitality of the underlying tooth may be compromised. In reality, preparations should be planned according to each individual case and in each case the balance will be different. Clearly, patients need to be involved in deciding what is best for them. This approach differs fundamentally from simply cutting 'off the shelf' preparations based entirely on text-book diagrams.

CROWN SELECTION

The usual indications for full veneer crowns are:

- To protect weakened tooth structure
- To restore the tooth to function
- To improve or restore aesthetics
- For use as a retainer for fixed bridgework

However, recent developments in dental

Table 1 Seven key principles of preparation (derived from Shillingburg¹)

Seven key principles	Function
Conservation of tooth tissue	To avoid weakening the tooth unnecessarily To avoid compromising the pulp
Resistance form	To prevent dislodgement of a cemented restoration by apical or obliquely-directed forces
Retention form	To prevent displacement of a cemented restoration along any of its paths of insertion, including the long axis of the preparation
Structural durability	To provide enough space for a crown which is sufficiently thick to prevent fracture, distortion or perforation
Marginal integrity	To prepare a finish line to accommodate a robust margin with close adaptation to minimise microleakage
Preservation of the periodontium	To shape the preparation such that the crown is not over contoured and its margin is accessible for optimal oral hygiene
Aesthetic considerations	To create sufficient space for aesthetic veneers where indicated

materials mean that the use of less destructive alternatives such as veneers, onlays, and suitably designed plastic restorations are often an option. Where crowning is in the patient's best interests the type of crown provided will usually depend on the functional requirements, the strength and vitality of the remaining tooth and the patient's aesthetic demands. Occasionally, the choice may be limited by a patient's con-

cerns, real or imagined, over biocompatibility of proposed materials.

Full veneer metal crowns (VMC) have the advantage of requiring relatively little tooth preparation. They are generally limited by aesthetics to the back of the mouth, but bear in mind that some people may favour an anterior display of gold.

Porcelain jacket crowns (PJC) are indicated in areas of critical aesthetics, but problems of fracture under occlusal load limit their use to anterior teeth.

High strength porcelain crowns (HSPC), using modern ceramics without the need for a metal substructure, may be used on posterior teeth and in certain selected cases for anterior bridgework especially where the use of metal is an issue. However, not all systems are suitable for these purposes. The preparation design for a posterior HSPC is important^{2,3} and relatively destructive. Enough tooth tissue needs to be removed to permit an adequate thickness of porcelain while the degree of taper should be greater than for a conventionally cemented crown, and all corners and line angles need to be rounded to allow unhindered, passive seating of the crown. At least one system (Procera AllCeram, Nobel Biocare, Göteborg, Sweden) provides burs designed to cut a deep chamfer at the finish line to allow the profile of the die to be scanned with a digital profilometer for the production of a high strength ceramic core.

Resin bonded porcelain crowns (RBPC) are similar to porcelain veneers but provide coverage on all surfaces and are very conservative of tooth tissue. The strength of these restorations is largely reliant on the resin bond as there is no reinforcing ceramic core. Excellent aesthetics are possible and a much less destructive preparation can be used than for either PJCs or porcelain fused to metal crowns (look at Fig. 2). RBPCs may be particularly useful in younger patients who have large, vulnerable pulps. Long term follow-up is lacking but a similar success rate to veneers might be expected. In our experience this type of restoration is not suited to areas of heavy occlusal load (eg where tooth wear has been caused principally by parafunction) as the porcelain may fracture.

Porcelain fused to metal crowns (PFM), also called metal-ceramic crowns, are undoubtedly most versatile combining strength with aesthetics. Tooth preparation to accommodate both metal and porcelain can be very destructive (Fig. 3) so the design, particularly the distribution of porcelain, needs to be carefully thought through. Metal surfaces require less tooth destruction, are easier to construct and adjust, and do not chip like porcelain. Porcelain coverage should only be used where it is required for aesthetics, or possibly when opposing other porcelain surfaces (as metal does not wear well against porcelain, especially the metal backs of anterior crowns).

If full porcelain coverage is required for a

Fig. 1 Under preparation results in poor aesthetics or an over built crown (dotted line) with periodontal and occlusal consequences. Over preparation results in pulp and tooth strength being compromised

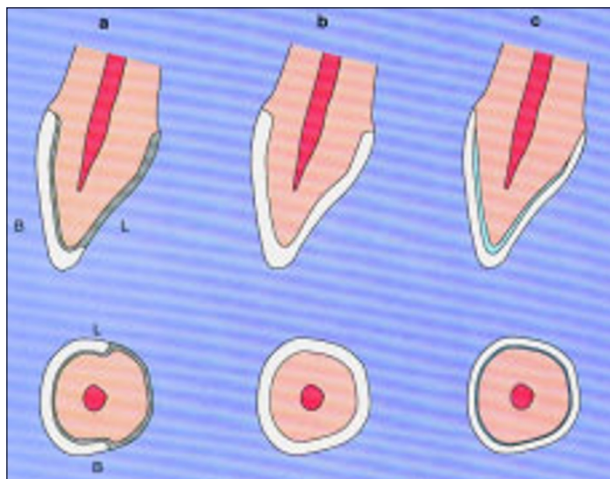
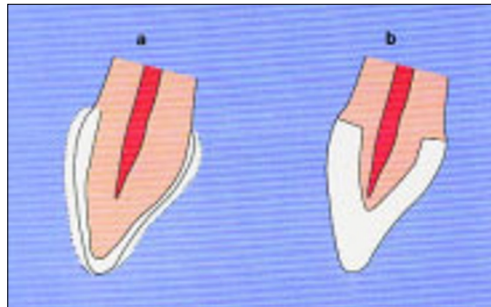


Fig. 2 Preparation features for three different types of crown for an upper central incisor: a) Porcelain fused to metal; b) Porcelain jacket; and c) Resin bonded porcelain crown (remaining enamel shown light blue). Questions – which crown or crowns: Provide the best aesthetics? Has the least destructive preparation? Is least destructive to opposing teeth? Allows anterior guidance to be developed easily? Is best suited to bruxists? (see text for answers)

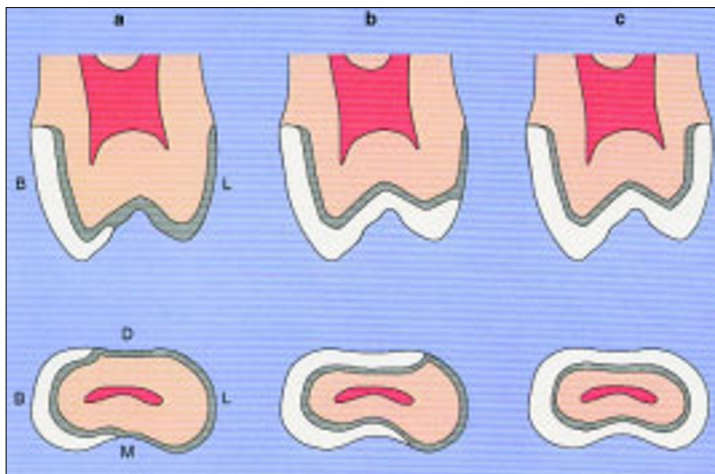


Fig. 3 Sections (axial and transverse) through an upper first premolar showing how a logical use of metal lessens the amount of tooth reduction: a) Porcelain restricted to buccal cusp; b) Porcelain covering proximal and occlusal surface; and c) Full porcelain coverage

PFM the amount of tooth preparation may be reduced slightly by using a special metal composite coping (Captek, Schottlander, Letchworth, UK). This type of coping is 0.1–0.2 mm thinner than a cast coping made from a noble metal alloy.

Composite crowns which use newly developed laboratory materials have not been fully evaluated. Specific indications and limitations have yet to be defined. Manufacturers are currently recommending that the tooth be prepared in the same way as for a HSPC.

The major factor to be considered before selecting the most suitable type of crown is the amount of tooth destruction you are willing to allow in order to give the aesthetics you want. You may also want to consider the need for the crown to incorporate special features, for example:

- A metal anterior guidance surface
- Rest seats and other features to retain a partial denture
- Metal occlusal surfaces for a bruxist

GUIDELINES FOR AMOUNT OF TOOTH REDUCTION AND MARGIN DESIGN

Tooth preparation represents a balance between, conserving tooth structure and pulp health on the one hand, whilst on the other, achieving an aesthetic and strong crown. Guidelines for the amount of tooth reduction for different types of crown have evolved largely as a result of experience rather than scientific evidence. Tables 2 and 3 give an indication of the amount of occlusal and cervical reduction for different types of crowns for posterior and anterior teeth. It is worth emphasising that there will be times when less tooth should be removed in the interests of conserving tooth structure and pulp health. There are also occasions when little or no tooth reduction is needed, eg from the occlusal surface when the vertical dimension is to be increased, or, from the buccal surface where the tooth is already worn and is to be re-contoured by the crown.

The amount of reduction can be gauged using depth cuts coupled with a knowledge of the appropriate bur end diameter (look at Fig. 4 for examples of typical bur end diameters). A preparation reduction matrix, formed on a diagnostic wax-up (described in the sixth article in the series), can be invaluable when the shape of the intended crown differs from that of the original tooth.

The metal margins of VMCs and PFMs can be configured in a variety of ways (Fig. 5). It is best to avoid the knife edge as the finish line can be difficult for the technician to detect. Chamfer margins and shoulder with bevel margins allow a fine edge of metal to be cast which, if a suitable alloy is chosen, can be burnished by the technician to improve marginal fit. However, there is always the danger that the die may be damaged by burnishing. Furthermore, the margin should

Table 2 Suggested preparation features for posterior crowns

Crown type	Posterior crowns – preparation features	
	Occlusal reduction*	Finish line depth and configuration
VMC	1 mm non-functional cusps	0–1.0 mm
	1.5 mm functional cusp	Chamfer, knife-edge, shoulder or shoulder with bevel
HSPC	2 mm non-functional cusps	0.8–1.0 mm
	2.5 mm functional cusps	Shoulder or heavy chamfer
PFM	As for VMC if metal surface	1.2 mm labial shoulder [†] or chamfer
	2 mm non-functional cusps	0.5 mm lingual chamfer
	2.5 mm functional cusps	

*Where tooth is tilted or where vertical dimension is to be increased, the amount of occlusal reduction required will vary

[†]Too deep a reduction for diminutive teeth or for long clinical crowns where a metal collar is preferable

Table 3 Suggested preparation features for anterior crowns

Crown type	Anterior crowns – preparation features	
	Occlusal reduction*	Finish line depth and configuration
PJC	2 mm incisally	0.8–1.0 mm shoulder
	1 mm lingual aspect	
RBPC	2 mm incisally	> 0.4 mm chamfer
	0.5–1.0 mm lingual aspect	
PFM	2 mm incisally	1.2 mm labial shoulder [†] or heavy chamfer
	0.5–1.0 mm lingual aspect	
	(porcelain guidance requires greater clearance)	0.5 mm lingual chamfer

*Where the vertical dimension is to be increased, the amount of occlusal reduction required will be less or non-existent

[†]Too deep a reduction for diminutive teeth eg lower incisors or for long clinical crowns where a metal collar is preferable

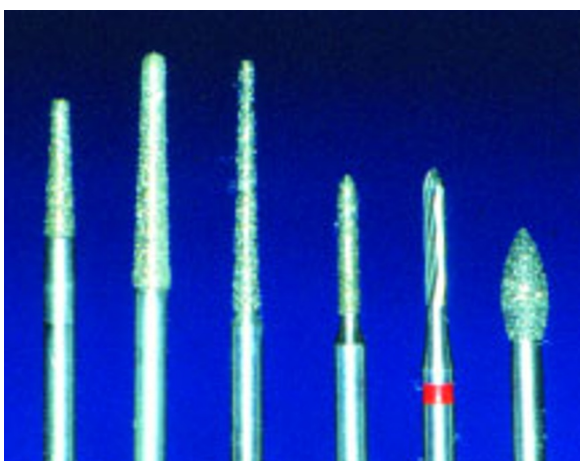


Fig. 4. Burs used for preparation of full veneer crowns at Newcastle Dental Hospital (from left to right): a) Flat-end tapered diamond (occlusal and axial reduction) end $\varnothing = 0.8$ mm; b) Long, round-end tapered diamond (as for a. and also shoulder production) end $\varnothing = 1.1$ mm; c) Long needle diamond (initial proximal reduction); d) Chamfer diamond (chamfer production) end $\varnothing = 1.0$ mm; e) Chamfer tungsten carbide (chamfer and preparation finishing); and f) Large flame or 'rugby ball' diamond (lingual concavity production)

not be too acute. Theoretical arguments have been made in favour of acute margins compensating for seating discrepancy⁴ but only before cementation. Once cemented, an acutely bevelled margin may prevent the crown from seating fully,^{5,6} presumably by restricting cement extrusion.

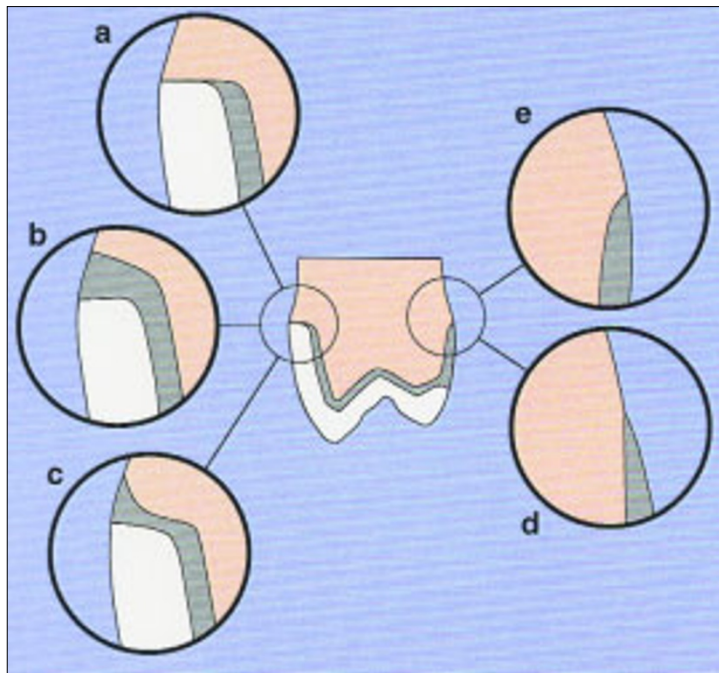


Fig. 5. Finish lines with marginal configurations for PFMs: a) Shoulder with porcelain butt fit; b) Deep chamfer with metal collar; c) Shoulder plus chamfer (bevel) with metal collar; d) Knife edge with metal margin; and e) Chamfer with metal margin

As a general rule when using porcelain or PFMs, adequate clearance is required to achieve good aesthetics. Traditionally, this is achieved with a shoulder or heavy chamfer of 0.8–1 mm width for PJC's and 1.2 mm width for PFMs. However, shoulders of these depths may compromise tooth strength and pulp health especially for diminutive teeth such as mandibular incisors. A similar problem occurs on teeth with long clinical crowns because of the narrowing of their diameter in the cervical region. In a long preparation extending onto or beyond the cemento-enamel junction, considerable tooth tissue must be removed to eliminate undercuts. Solutions include using a minimal shoulder, a metal collar on a chamfer (as illustrated in Fig. 6) or placing the margin at the cemento-enamel junction. Under normal circumstances these options do not compromise aesthetics, being hidden by the lip. Clearly, patients need to understand the benefits of a less destructive preparation and, as stated previously, must be involved in the decision making process pre-operatively.

Some operators use what they describe as a mini-shoulder, 0.5–0.7 mm wide, for both

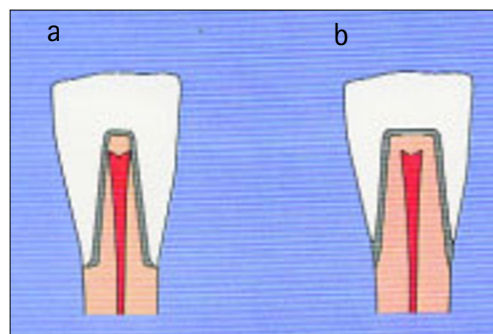


Fig. 6. Teeth with long preparations are prone to pulpal exposure especially if a deep finish line is cut. (a) Teeth with narrow roots are most vulnerable (b) A metal collar reduces the need for a deep finish line

ceramic and metal margins. This approach can produce acceptable results for metal margins, although it is easier for the technician to adapt the wax and finish to a chamfer. A much greater problem occurs when ceramics are used as the inevitable consequence is for the crown to be over-bulked resulting in compromised aesthetics and a poor gingival emergence profile.

PREPARATION TAPER

The subject of taper is contentious. In the first place it means different things to different people. For our purpose it has the same meaning as 'convergence angle' ie the angle between opposing preparation walls. To avoid confusion when reading different publications, it is important to appreciate that 'taper' may also be defined as 'the angle between a single preparation wall and the long axis of the preparation'. Taper defined by the first definition will be twice the angle defined in the second.

As regards the question of ideal convergence angle, text books have traditionally based their recommendations (variously between 3 and 14°)^{7–9} on the results of experimental studies^{10,11} which show a decrease in retention of conventionally cemented crowns as taper is increased. Experimental studies have also shown that preparations with tapers greater than 20° display a significant fall in resistance to oblique displacing forces¹² and show increased stress concentration within the cement¹³ which may rupture the cement lute.

On the other hand, clinical measurements of taper have been made indirectly on stone casts.^{14–18} These studies showed mean values of about 20° with a considerable variability around the mean. Furthermore, greater tapers were achieved on mandibular molars than on maxillary incisors¹⁹ possibly because of differences in tooth shape and problems with access. These findings suggest that clinicians, even those who are technically gifted, frequently cut a greater taper than text books recommend.

The issue of taper may not be quite as critical for single crowns as was once thought, but as a working rule operators should strive to produce the least taper compatible with the elimination of undercut. It is helpful to know that many tapered burs have a 5–6° convergence angle which can be used to survey preparation taper by holding the handpiece in the same plane for all axial surfaces.

Resin bonded crowns are the important exception to the rule of minimizing taper, especially RBPCs which may benefit from having tapers of about 20° to avoid generating high seating hydrostatic pressures during luting resulting in crown fracture.

STRATEGIES FOR ENHANCING RESISTANCE AND RETENTION

While many factors influence resistance and retention, one of the most important is the nature of the cement lute. Conventional cements are strong in compression and weak in

tension, so, wherever possible, preparations should be designed to limit tensile and shear stresses in the lute, especially when oblique forces are applied to the crown (Fig. 7). Cement selection will be considered in detail in Part 11 of the series.

Preparations which are either short or over-tapered or both are vulnerable to crown decementation. Often one is confronted with having to replace a crown where the preparation is over tapered and simply re-preparing the tooth may be excessively destructive. This section considers aspects of preparation design and other methods which can be used to prevent decementation.

Any dentist who has seen a number of decemented crowns will have an idea of what an unretentive preparation looks like. However, there are no absolute guidelines for preparation dimensions which risk decementation. An *in-vitro* study²⁰ has shown a significant increase in resistance and retention as axial walls extend from 2–3 mm in height and recommended 3 mm as the minimum preparation height. As a working rule this seems reasonable but there will be a multitude of exceptions and caveats depending on factors such as taper, cement selection and occlusal loading.

Where the preparation is over-tapered it is possible to up-right the axial walls at the base of the preparation, but this can result in a deep shoulder, excessive destruction of tooth tissue and possible compromise of pulpal health. If the bulk of remaining core or tooth tissue permits, a series of near parallel steps can be made in the over-tapered axial walls which results in a much less destructive preparation.

Other less destructive approaches of dealing with an unretentive preparation are:

- Retentive preparation features ie grooves and boxes
- Resin cements
- Surgical crown lengthening
- Pins and cross-pinning

Grooves and boxes provide increased retention by presenting additional near-parallel sided walls to the preparation and limiting the path of insertion. Resistance is improved by preventing rotation of the restoration (Fig. 8). They are used mainly for metal and metal-ceramic restorations but are generally impractical for all ceramic crowns.

Grooves

Grooves can be placed in one or more of the axial walls using a minimally tapered bur. The bur chosen should be of sufficient diameter to provide a groove that will not be blocked out on the die with die-spacer (see flat-end tapered diamond in Fig. 4). The groove should be placed within a sound bulk of tooth tissue or core not leaving any weak surrounding areas which are liable to fracture. The tooth may also be less vulnerable to the effects of micro-leakage if the base of the groove is kept 0.5 mm clear of the

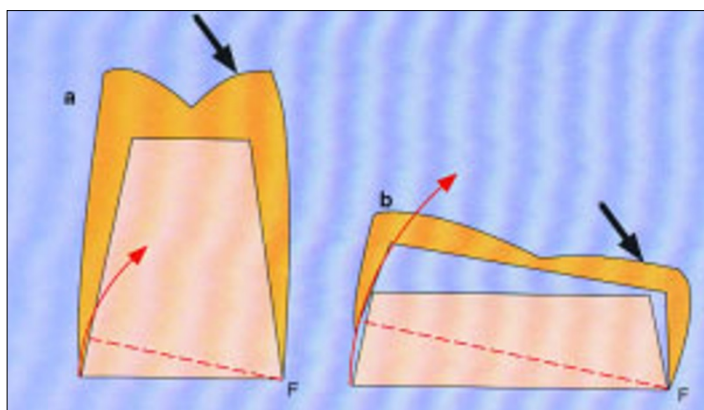


Fig. 7 Preparations (a) and (b) have similar retention (similar axial surface area and convergence angle) but (a) has much greater resistance. Application of oblique force to occlusal surface results in potential rotation of crown (a) around a fulcrum (f). Rotation is resisted by the cement above the arc of rotation of the base of the crown being thrown into compression — represented by arrow. Rotation of the shorter crown (b) results in tensile forces fracturing the cement lute. It is therefore important that the radius of rotation intersects the opposing axial wall.²⁸

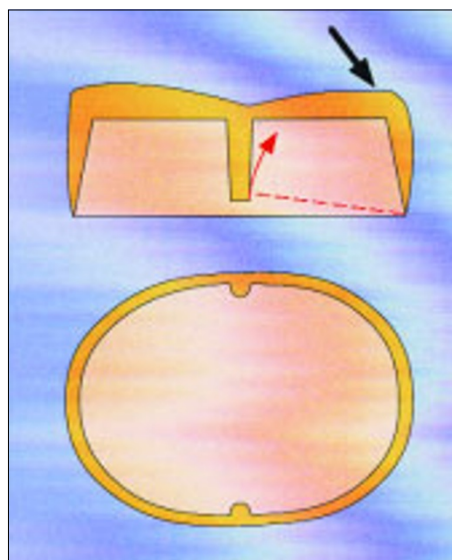


Fig. 8 Placement of axial grooves increases resistance by effectively reducing the radius of rotation

finish line. To be effective the groove should be sunk to at least half the bur's diameter. When placing grooves in tapered axial walls be very careful to ensure that the walls of the groove do not conflict with the path of insertion. This requires the bur to be held parallel to the path of insertion and not parallel with the tapered axial wall. Providing these precautions are taken, grooves provide a simple, effective means of improving resistance.

Boxes

Boxes function similarly to grooves in providing increased resistance and retention, but are less conservative so it is difficult to justify them being cut into sound tooth structure unless there are other reasons for their presence (eg provision of a crown with an intra-coronal attachment). Nevertheless, a tooth may have previously contained a restoration with a box form. Instead of using the box to retain a core the box can be incorporated into a crown preparation. This is a useful approach where the core would otherwise be thin and weak. You may

need to take care to ensure the resulting crown is not so bulky that casting porosity or thermal sensitivity becomes a problem.

Boxes need not necessarily be sited solely on axial walls. For example, it is sometimes very useful to cut an intra-coronal box, resembling an occlusal inlay, into the occlusal aspect of a substantial core. Clearly, this approach would be inappropriate if it weakened the core appreciably.

Resin cements

Resin cements (to be described in Part 13 of the series) provide a relatively simple option to overcome the low tensile strength and poor adhesion of conventional cements. Resin cements have much higher tensile strength²¹ and when used in combination with dentine bonding agents are less sensitive to repetitive dislodging forces.^{22,23} They are, however, technique sensitive and are not supported by long term clinical data. Current clinical wisdom is, where possible, to combine sound retentive design with resin cementation.

Crown lengthening

Exposure of a greater height of clinical crown may involve either gingivectomy (with a scalpel or electrosurgery) or flap surgery with osseous recontouring. It is an invaluable means of enhancing retention, but can be a substantial undertaking and has to be balanced against the disadvantage of patient discomfort. Details of technique are described elsewhere.²⁴ Crown lengthening needs to be planned in advance of tooth preparation (Fig. 9). If the ultimate position of the gingival margin is critical then good provisional restorations should be provided and worn for 2–3 months before the final impression

to allow the gingival tissues to recover fully to their final form.

Pins and cross-pins

Pins and cross pins are rarely used as they are technically demanding and have become even less popular since the introduction of resin cements. Pins may be considered where there is a good bulk of tooth tissue. They are incorporated during the construction of the restoration and are sunk through the occlusal surface.

Cross-pins are placed following cementation and are screwed transversely through the axial surface of the crown into the underlying preparation.

TOOTH PREPARATION

To avoid any unwanted surprises, the structural, endodontic, periodontal, aesthetic and occlusal factors outlined in the previous parts of the series should be checked before bur is put to tooth.

There are a variety of burs which can be used for crown preparations and operators will have their own preferences. Some operators may prefer a flat ended bur for shoulder production. However, the round ended bur has the benefit of producing a rounded junction between the finish line and axial walls which will help reduce stress concentration in this vulnerable part of the preparation and is less likely to cut steps.

Most practitioners in the UK use air rotor handpieces, although in continental Europe and elsewhere speed increasing handpieces are favoured. Whatever option is chosen a water spray is absolutely essential to avoid

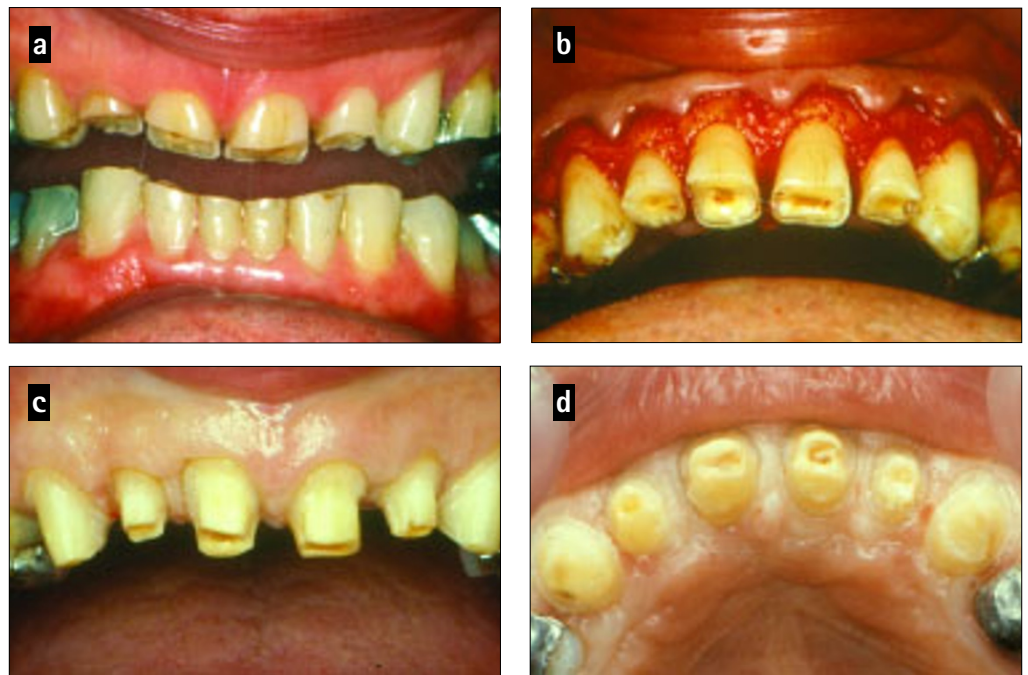


Fig. 9 When clinical crown height is short, plan ahead. a) Upper anterior teeth needing crowning with PFMs b) Crown lengthening using apically repositioned flap and osseous recontouring c) Preparations made 3 months after surgery. Note no incisal reduction needed as vertical dimension to be increased d) Preparations viewed occlusally (mirror view) showing retention grooves in gingulum of UL2 (22)

pulpal damage and endodontic complications. Following air rotor preparation, a speed increasing handpiece can be useful for finishing the preparation, defining finish lines and placing retention devices such as grooves or boxes.

Preparation sequence

There are definite advantages in following a set order of tooth reduction and ensuring that each element of reduction is complete before starting the next. For instance, if the occlusal surface is prepared first there will be better access for the more difficult proximal preparation. Depth cuts placed before embarking on larger areas of tooth reduction help ensure controlled removal of tooth tissue but where the proposed crown is to be shaped differently from the original tooth a preparation matrix, as described in Part 6 of the series, is more helpful. During axial preparation it is best to complete the most difficult wall first so if any alignment modifications are required they can be made in more accessible areas.

Each stage of reduction has its own special considerations and these will now be discussed in the sequence of preparation that we would recommend.

Posterior preparations

Occlusal reduction

Before any reduction is carried out it is important to assess the occlusion and note any space already available between opposing teeth. For example, a mesially tilted molar may require little or no reduction of its mesial occlusal surface so depth cuts can be confined to the distal occlusal area. If the reduction follows the cuspal contours you will get maximum axial wall height available for resistance and retention, but clearly this is not so critical where long axial walls are to be prepared. The functional cusp bevel, shown in Fig. 10, is a useful feature of the occlusal reduction and ensures space for adequate bulk of crown material in a site of heavy occlusal contact. The functional cusp (or holding cusp) must be identified and, after beveling, adequate clearance should be confirmed in all excursive movements. This small simple step helps avoid the creation of an occlusal interference or perforation of a crown's occlusal surface.

Lingual reduction

Lingual access may be difficult. However if the lingual surface is the first axial surface to be prepared, it reduces the likelihood of producing an over tapered preparation especially if the bur is held parallel to the long axis of the tooth. Subsequent alignments to the prepared lingual wall are then carried out on more accessible surfaces.

Buccal reduction

Good retention relies on near parallelism cervically of the buccal and lingual axial walls. However, it is also important to ensure that the preparation is in harmony with the buccal contours of the adjacent teeth so that sufficient

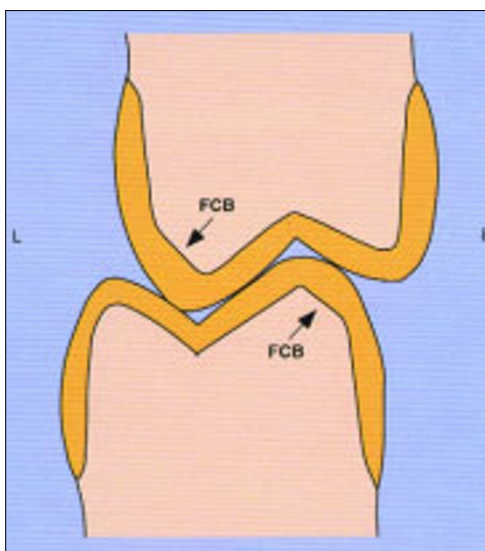


Fig. 10 Functional cusp bevel (FCB) of the holding cusps required for occlusal clearance

space is available for good aesthetics. It is worth viewing the tooth from both occlusal and buccal aspects to ensure the correct planes of adjustment have been made.

On molars the preparation may extend towards the furcation region where a concavity of the buccal surface can be found. To avoid creating a crown with an over-bulky buccal surface, the finish line should be cut to its full depth in this area and the concavity should be extended up the buccal axial wall to the occlusal surface. This approach, which may also need to be used on other axial walls with cervical concavities, eg the mesial aspect of upper first premolars, results in a preparation having a kidney shaped appearance when viewed occlusally.

Proximal reduction

During proximal reduction many adjacent teeth are damaged.²⁵ If a fine tapered bur is used for the preliminary cut it can be kept safe by ensuring a fine sliver of tooth or core material remains between the preparation and the adjacent tooth. This sliver can then be flicked away before refining the reduction with a bur of larger diameter. To ensure clearance of the proximal contact, try to keep the tip of the bur at the level of the proposed finish line. There is no doubt that this is the most difficult stage of the preparation.

Once the basic preparation is complete, check the path of insertion and taper. Again, if you view the preparation from both occlusal and buccal aspects you should ensure that no undercut goes undetected. A surface reflecting mirror is especially useful for such inspection. When viewing occlusally do so with one eye closed because an undercut can be perceived as a near parallel taper when seen with two eyes. Take special care to check the junction between proximal and buccal/lingual reductions which are a common site for undercuts.

On PFM preparations, where the deeper reduction for porcelain and metal meets the shallower reduction for metal (this is shown from the occlusal aspect in Fig. 3a) there is often a distinct step in the axial wall. This feature is termed

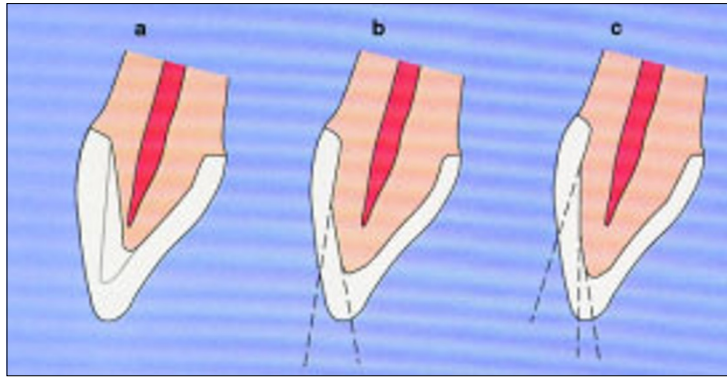


Fig. 11 Single plane reduction (a) can result in either shine through of the porcelain core (feint outline) or pulpal damage. Problem solved by two plane reduction (b). Three plane reduction (c) needed for long clinical crowns giving a slightly more buccal path of insertion

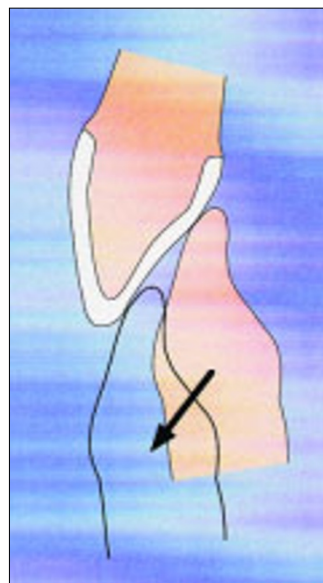


Fig. 12 Ensure occlusal clearance in both ICP and excursions

rather confusingly the 'wing', resulting in generations of students creating a bizarre preparation resembling a small bird in flight, but correctly cut it is a useful feature providing some increase in resistance and helps guide the technician in the position of the porcelain-metal junction. Should a metal proximal contact be required the 'wing' should lie buccal to the contact. Conversely, if a porcelain proximal contact is planned the wing should lie lingual to the contact. To avoid undercut it is important that the wing is made parallel to the buccal axial reduction.

Finish line

Ideally, this should be placed supra-gingivally^{26,27} on sound tooth tissue, but in reality this is often not possible. Sometimes aesthetics dictates a margin is placed subgingivally and in these situations it should extend by 0.5–1 mm, but certainly no more than half the depth of the gingival sulcus, to ensure the epithelial attachment is not compromised. Packing of retraction cord in the gingival sulcus prior to preparing the finish line will allow displacement of the gingival margin for access and help minimise gingival trauma

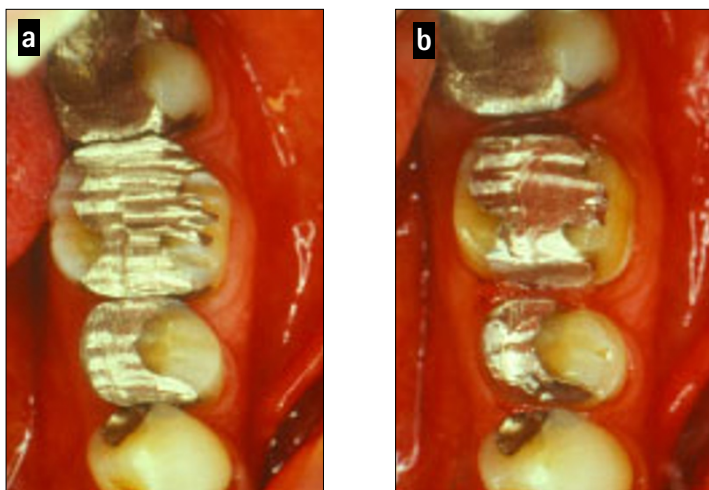


Fig. 13 Full veneer crown preparation LL6 (36) and three quarter preparation at LL5 (35): a) Occlusal reduction carried out on both teeth. In the same way each axial surface was completed sequentially. Note the depth grooves on the occluso-buccal aspect of LL6 (36); b) The completed preparations showing the mesial finish line on a sound amalgam core

ma during preparation. Whether a finish line should ever be placed on core rather than tooth is an area of contention. Some consider the practice acceptable if the core has a perfect margin. However, in practice it is rarely possible to guarantee the condition of the core margin and we would generally recommend the preparation should be extended sub-gingivally to finish onto sound tooth tissue. Where the finish line is likely to be extensively sub-gingival a crown lengthening procedure can often facilitate crown provision and ensure a more accessible crown margin.

Whatever type and location of finish line is chosen it is important that:

- It has no unsupported lips of tooth structure at the edge which can either break away on the die causing problems with crown seating or break away from the tooth resulting in a marginal gap. Use hand instruments to plane these away
- It is in harmony with the outline of the gingival margin which will optimise aesthetics of crowns finished at or above gingival level, and, for sub-gingival margins, will ensure there is no localised over-cutting
- The technician will be able to detect it on the die
- There is sufficient space to provide a crown with an appropriate gingival emergence profile.

Additional retention features

At this stage consider whether, as described earlier, there is a need for grooves or boxes to enhance resistance and retention in a short or tapered preparation.

Final finishing

Complete smoothing of the preparation is not essential, may diminish micro-mechanical retention and may also risk overheating the pulp if it is not done under water spray. However, the final preparation must be free from irregularities, sharp line angles and corners. These cause difficulty in casting models and result in dies which are vulnerable to damage leading to an ill-fitting crown. An area which is often neglected is the axio-occlusal line angle but it is important that all line angles and corners are carefully rounded. This is especially so for preparations for all ceramic restorations to reduce areas of potential stress concentration.

Anterior preparations

With the exception of provision of a functional cusp bevel, anterior preparations need similar consideration to posterior preparations. However, a few additional points need highlighting:

- Incisal reduction is best carried out first. This will improve subsequent preparation access and helps to ensure correct proportioning of axial reduction planes
- The reduction of the labial surface should be in two or more planes to achieve good aesthetics and conserve tooth tissue. Long clinical

cal crowns will often need to undergo three plane reduction; Figure 11 illustrates this

- The palatal reduction needs to reproduce the natural concavity of maxillary teeth if space is to be provided for the development of anterior guidance; Figure 12 illustrates this. Unless clearance during lateral and protrusive movements has been checked, it is very easy to end up with a crown which occludes satisfactorily in the intercuspal position, but which interferes during excursions.

Multiple preparations

Preparation of multiple teeth can be stressful for both patient and dentist. Where possible try to sequence treatment so that no more than four teeth are prepared at one sitting or perhaps six if dealing with the maxillary anteriors.

If you are able to prepare multiple teeth with a mutual path of insertion it will facilitate the construction of provisional restorations and helps with cementation of definitive crowns. However, this must not be done at the expense of excessive tooth reduction. To ensure a mutual path of insertion it is usually best to prepare each surface sequentially for all the teeth rather than fully complete each preparation before moving onto the next (Fig. 13).

CONCLUSION

Crown preparations are destructive to underlying tooth tissue and can affect the pulp. Therefore, the type of crown selected should have the least destructive preparation in keeping with the patient's functional and aesthetic requirements. Where appropriate the use of less destructive, adhesively retained restorations should be considered.

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Details of burs mentioned in article

Bur	No	Supplier
Flat-end tapered diamond	554	Kent - AD Burs Ltd, Gloucester, UK
Long, round-end tapered diamond	503	Kent - AD Burs Ltd, Gloucester, UK
Long needle diamond	557	Kent - AD Burs Ltd, Gloucester, UK
Chamfer diamond	877/010	Komet-Brasseler gmbh, Lemgo, Germany
Chamfer tungsten carbide	282/101	Komet-Brasseler gmbh, Lemgo, Germany
Large flame ('rugby ball') diamond	257/023	Horico-Hopf Ringled & Co GmbH, Berlin, Germany