

Planning and Making **Crowns and Bridges**

Fourth Edition

Bernard GN Smith
Leslie C Howe



informa
healthcare

Planning and making crowns and bridges

Planning and making crowns and bridges

Fourth Edition

Bernard G N Smith

BDS, PhD, MSc, MRD, FDSRCSEng, FDSRCSEdin

*Professor Emeritus of Conservative Dentistry
Guy's, Kings and St Thomas' Dental Institute, London*

Leslie C Howe

BDS FDSRCSEng

*Consultant in Restorative Dentistry
Guy's and St Thomas' NHS Hospitals Trust
and Private Practitioner*

informa
healthcare

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2013 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works
Version Date: 20150121

International Standard Book Number-13: 978-0-203-09063-3 (eBook - PDF)

This book contains information obtained from authentic and highly regarded sources. While all reasonable efforts have been made to publish reliable data and information, neither the author[s] nor the publisher can accept any legal responsibility or liability for any errors or omissions that may be made. The publishers wish to make clear that any views or opinions expressed in this book by individual editors, authors or contributors are personal to them and do not necessarily reflect the views/opinions of the publishers. The information or guidance contained in this book is intended for use by medical, scientific or health-care professionals and is provided strictly as a supplement to the medical or other professional's own judgement, their knowledge of the patient's medical history, relevant manufacturer's instructions and the appropriate best practice guidelines. Because of the rapid advances in medical science, any information or advice on dosages, procedures or diagnoses should be independently verified. The reader is strongly urged to consult the relevant national drug formulary and the drug companies' printed instructions, and their websites, before administering any of the drugs recommended in this book. This book does not indicate whether a particular treatment is appropriate or suitable for a particular individual. Ultimately it is the sole responsibility of the medical professional to make his or her own professional judgements, so as to advise and treat patients appropriately. The authors and publishers have also attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, micro-filming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Visit the Taylor & Francis Web site at
<http://www.taylorandfrancis.com>

and the CRC Press Web site at
<http://www.crcpress.com>

Contents

Preface	vii
Acknowledgements	ix
Part 1 Crowns	
1 Indications and contraindications for crowns	3
2 Types of crown	29
3 Designing crown preparations	53
4 Occlusal considerations	77
5 Planning and making crowns	105
6 Clinical techniques for making crowns	123
Part 2 Bridges	
7 Indications for bridges compared with partial dentures and implant-retained prostheses	177
8 Types of bridge	197
9 Components of bridges: retainers, pontics and connectors	211
10 Designing and planning bridges	225
11 Clinical techniques for bridge construction	241
Part 3 Implants, splints and maintenance	
12 Dental implants	261
13 Fixed splints	287
14 Crown and bridge failures and repairs	297

Preface

The aim of this book is to answer at least as many of the questions beginning with 'why' as those that begin with 'how'. A textbook is not the ideal medium for teaching practical, clinical or technical procedures. These are best learnt at the chair-side and in the laboratory. However, the mass of material which must be learnt, usually in a restricted timetable, in the clinic and laboratory means that there is often insufficient time to answer the questions, 'Why am I doing this?' or, 'When should I not do this?' or even, 'What on earth can I do here?'.

The book is meant for clinicians, both undergraduate and postgraduate, and so although the emphasis is on treatment planning, crown and bridge design and the related theory, clinical techniques are also described in some detail. Laboratory technique is, though, almost completely omitted, both to keep the book to manageable proportions and because most clinicians no longer undertake this themselves. It is nevertheless abundantly clear that a good standard of laboratory work is as important as the other phases in the construction of crowns, bridges and implants.

The process may be divided into three stages:

- Initial decision making and mouth preparation
- Clinical procedures
- Technical procedures.

The purpose of this book is to help quite a lot with the first stage, rather less with the second (a book cannot replace clinical experience) and hardly at all with the third.

The intention is to help solve real clinical problems. The student sitting in a technique laboratory faced with an arch of intact perfectly formed natural or artificial teeth planning to undertake 'ideal' crown preparations will find little help here. It may be good initial teaching to cut 'classic' preparations, but this is only part of the training towards solving the real problems of real patients in the real world. The opinions expressed in a textbook can only go a little way further towards solving these problems.

Undergraduate and postgraduate students need also to take advantage of their own and others' clinical experience and learn by thinking about their clinical problems and talking about them with others. Making the right decision is as important as executing the treatment well.

There is no reference to 'case selection' or 'patient selection' for the techniques described. That is not the way things are in practice. There it is necessary to select the appropriate technique for the patient in front of you rather than select the patient for the technique. Things are different in dental schools. It often happens that in order to provide a balanced range of experience for undergraduate students in a limited period of time, patients are selected to go on to particular waiting lists to provide a flow of 'clinical material' for the students' needs. This may be necessary but the attitudes it sometimes develops are unfortunate. The essential feature of any profession is that it attempts to solve the problems of its clients before concerning itself with its own welfare.

Because this is the approach, clinical photographs or at least photographs of extracted teeth or casts, are used to illustrate the text in preference to line drawings, except where a photograph is impractical. Photographs are used even when the work shown is not 'perfect'. No apology is made for this. In reality, although we should strive for perfection (if we know what perfection is in a given case, and we often do not), we will frequently not achieve it. It is more realistic to talk about levels of acceptability. This is not to advocate unnecessary compromise, but to recognise that in many situations a compromise (from knowledge, not ignorance) is necessary. After all, the ideal would be to prevent caries, trauma and congenital deformity so that crowns and bridges were not necessary in the first place. Once they are needed there is already a situation that is less than perfect.

Some of the work photographed is the authors', some is undergraduate and postgraduate student work with a greater or lesser amount of help by teachers, some of the technical work is carried out

by the clinicians themselves but most by technicians or student technicians, and some illustrations have been kindly lent by colleagues. In view of the likelihood, and indeed the intention that readers will find fault with some of the illustrations and because some illustrate the work of a team rather than an individual, no acknowledgement is given for individual illustrations. We are, however, extremely grateful to all those who have allowed us to photograph their work and in particular to those who have lent their own illustrations. Their names appear in the Acknowledgements.

There are no text references. In a book of this size, which is not intended to be a reference book, it is not possible to be comprehensive, while it is impolite to use phrases such as 'there is evidence that . . .' without making proper reference to the source of the evidence. Isolated references in these cases could well lead the enthusiastic student into an unbalanced reading programme. The further reading suggestions which were in previous editions have been omitted as they so quickly became out-of-date in this fast-developing field and because computer access to the literature is now very easy.

Leslie Howe has joined Bernard Smith as a joint author for the fourth edition. His influence can be seen throughout the book and particularly in

the new Chapter 12 on implants. Much more attention is given to implants than in previous editions. Modern implants had only recently been introduced into the UK when the first edition was published. The purpose is to help dentists to advise patients in their choice of what to do when teeth are missing. It is also to inform dentists about details of implant treatment so that they can explain to patients what to expect and help them to make informed choices.

Chapter 12 is not sufficient to guide dentists in starting to place implant-retained restorations themselves. Much more training is needed before that can be done. A comparison can be made with referral for orthodontic treatment which, like implants, most dentists do not offer but they do need to know who and when to refer and to be able to answer patients' questions.

Much of the material in earlier editions has been omitted as being out-of-date; however, some restorations which are no longer made but which a significant number of patients continue to wear satisfactorily are still included so that dentists can recognise them and know something about their maintenance and repair.

Because of these deletions, many illustrations have been left out but even more have been added.

BGNS
LCH

Acknowledgements

The following have lent photographs but for reasons explained in the preface, specific credit is not given to each one. We are, however, extremely grateful to them for their generosity: Chris Allen; David Bartlett; Nicholas Capp; John Cardwell; Russell Greenwood; George Kantorowicz; Bernard Keiser; Frances Manochi; Orthomax Limited, Bradford; Richard Palmer; David Parr; Ian Potter; John Richards; David Ricketts; Paul Robinson; Saridatum Abdul Samal;

Evelyn Sheehy; Michael Thomas; Sachim Varma; John Walter; Katherine Warren; Tim Watson.

Other help with illustrations has been given by: Ruth Allen; Osama Atta; Dennis Bailey; Trevor Brooker; Peter Chittenden; Cottrell and Co., London; Usha Desai; Andrew Dyer; Terence Freeman; Richard Hamill; June Hodgkin; Orodent Limited, Windsor; Peter Pilecki; Peter Rhind; Bill Sharpling; Nicholas Taylor; Leslie Wilcox; Geraldine Williams.

Part I Crowns

Indications and contraindications for crowns

Before the introduction of techniques to bond restorative materials to teeth, crowns were the only way of restoring teeth that can now be restored by these other techniques. At the same time, more patients are keeping more of their teeth for longer and are expecting faulty teeth to be repaired rather than extracted. Therefore, although there are fewer indications for crowning teeth than there were, more teeth are actually being crowned than ever before. About two million crowns per year are made in the UK National Health Service, representing two to three crowns per week per dentist. In the latest (1998) Adult Dental Health Survey in the UK, a third of all dentate adults had at least one crown and nearly half the 45–54 age group had one or more crowns. Similar numbers of crowns are being made in many other countries.

So, a lot of crowns are still being made.

When the only choice for a tooth was a crown or extraction, the decision was relatively simple. Now, with more options it is more difficult. This chapter discusses the current indications for crowns and their alternatives, and guides the reader towards a decision. However, clinical decision making is the very substance of the dentist's work and cannot be done by textbook instructions: do not expect a set of clear rules to follow. Each set of clinical judgements and decisions must be unique, taken in the context of the patient's circumstances.

General indications and contraindications for crowns

Crowns versus fillings in the treatment of caries

Most dental restorations are provided as treatment for dental caries. Once the initial lesion has penetrated the enamel, the caries spreads along

the enamel–dentine junction and balloons out in dentine towards the pulp. The growth of the carious lesion is much faster in dentine than it is in enamel, so the enamel becomes undermined and then suddenly collapses into the cavity. (Because of this, our forefathers thought that caries started inside the tooth and worked its way to the surface.) Today, many carious lesions are detected and treated at an early stage while the enamel is still largely intact. Indeed, even more lesions are prevented from occurring at all.

Since caries produces most of its damage inside the tooth rather than on the surface, the commonest types of restoration are fillings (intracoronal restorations). Often, sound enamel has to be cut away to give access to the caries. Only very rarely is the surface of a tooth extensively destroyed by caries leaving a base of sound dentine, and it is therefore most unusual in the treatment of primary caries for a crown (an extracoronal restoration) to be made on a preparation consisting of intact dentine. When secondary caries develops around existing fillings, intracoronal restorations are still more conservative and more closely relate to the pattern of development of caries than crowns, and are therefore preferred whenever possible. Indeed, a high caries rate is a contraindication to crowns. In these cases the caries should be removed, the tooth stabilized and a preventive regime instituted before crowns are made.

With larger lesions and particularly when cusps are lost, the decision between filling and crowning a tooth becomes more difficult (see pages 20–25).

General indications for crowns for other reasons

Having established that primary caries is not a common reason for making crowns, more common reasons are:



Figure 1.1

General indications for crowns.

a This mouth has been well treated in the past but the restorations are now failing. In particular the lateral incisor has lost two fillings, the pulp has died and the tooth is discoloured. It now needs a crown (Figure 2.1k).



b Trauma: the result of a blow from a hockey stick. Two incisors have been lost and the upper right central incisor is fractured, exposing the pulp, the fracture line extending subgingivally on the palatal side. The lateral incisor is fractured involving enamel and dentine only. The pulp retained its vitality. Although it could be restored in other ways, a crown would be the most satisfactory solution since it would then match the other anterior restorations. If the central incisor is to be retained, it will need to be root-filled and crowned, probably as a bridge abutment (see later).



c Gross tooth wear arising from a combination of erosion and attrition. This has passed the point where the patient can accept the appearance, and crowns are necessary.



d Peg-shaped upper lateral incisors.



e A moderate degree of amelogenesis imperfecta (defects in the formation of enamel) in a 16 year old. The posterior teeth are affected more than the anterior teeth but the upper incisors are slightly discoloured and are chipping away at the incisal edge. Crowns were made for all the teeth except the lower incisors and these will be kept under review.



f Dentinogenesis imperfecta (a defect in the formation of dentine) in a teenage patient. The incisor teeth have been protected with acid-etch-retained composite from shortly after their eruption and the first molar teeth have been protected with stainless-steel crowns. It is now time to make permanent crowns for all the remaining teeth.



g Typical distribution of enamel hypoplasia, in this case due to typhoid in the patient's early childhood. Crowns were made rather than composite restorations or veneers because the stain was too dark to be disguised by these means.

- Badly broken-down teeth
- Primary trauma
- Tooth wear
- Hypoplastic conditions
- To alter the shape, size or inclination of teeth
- To alter the occlusion
- As part of another restoration
- Combined indications
- Multiple crowns
- Appearance.

Badly broken-down teeth

Extensive composite or amalgam fillings bonded to the remaining tooth structure or retained by other means have the advantage of being directly placed, are conservative of tooth structure and do not involve laboratory procedures. However, when very large, involving most of the occlusal surface, such restorations are rarely able to produce an acceptable occlusal and proximal contour and have an unpredictable long-term durability and so a crown may be the treatment of choice.

Usually these teeth will have been restored previously, and may have suffered secondary caries or parts of the tooth or restoration may have broken off. Before crowns can be made the

lost dentine will often need to be replaced by a suitable core of restorative material sometimes following endodontic treatment (Figure 1.1a).

Primary trauma

An otherwise intact tooth may have a large fragment broken off without damaging the pulp and leaving sufficient dentine to support a crown: see the upper right lateral incisor in Figure 1.1b. If this was the only tooth damaged then a directly placed composite restoration bonded to the remaining tooth structure would usually be the initial treatment, progressing to a crown if the direct restoration was inadequate or failed.

Tooth wear

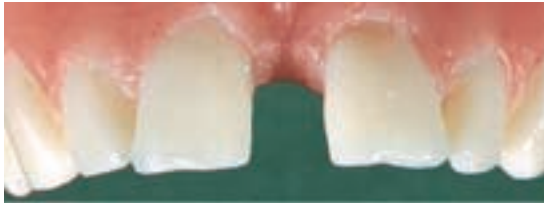
The processes of erosion (damage from acid other than that produced by bacteria), attrition (mechanical wear of one tooth against another) and abrasion (mechanical wear by extraneous agents) occur in all patients. What is remarkable is that teeth, which have little capacity for regeneration and which are in constant use, do not wear out long before the patient dies. Although tooth wear is normal, if it is excessive or occurs



Figure 1.2

Changing the shape and size of teeth.

a and *b* Increasing the size of incisors with composite:
a before, *b* after.



c A large midline diastema that the patient found aesthetically unacceptable.



d The same patient after the central incisors have been moved closer together orthodontically and all four incisors crowned. The patient must be warned of any compromise in the appearance that is anticipated – in this case the triangular space that remains at the midline. It is possible to increase the width of the incisal edges to fill the space, but the width of the crowns at the neck is determined by the width of the roots, so that only minimal enlargement is possible without creating uncleanable overhanging crown margins. It is unlikely that a long-term acceptable result could have been achieved with composite in view of the size of the gap.

early in life, crowns or other restorations may be needed (Figure 1.1c).

The lifelong management of excessive tooth wear is a topic of increasing interest as patients keep their teeth longer. In general the approach should be:

- Early diagnosis and prevention.
- Monitoring any further progression until the

patient complains of the appearance, sensitivity (which does not respond to other treatment), function is affected, or the wear reaches a point where restorations will become technically difficult.

- At this point provide minimal restorations, normally directly bonded composite restorations.
- If the problem continues, provide crowns.



Figure 1.3

An attractive appearance spoiled by unsightly teeth.

Hypoplastic conditions

These are divided into congenital and acquired defects. Examples of congenital defects are hypodontia (small teeth – see the peg-shaped lateral incisors in Figure 1.1d), amelogenesis imperfecta (Figure 1.1e) and dentinogenesis imperfecta (Figure 1.1f). Examples of acquired defects are fluorosis, tetracycline stain and enamel hypoplasia resulting from a major metabolic disturbance (usually a childhood illness) at the age when the enamel was developing (Figure 1.1g).

To alter the shape, size or inclination of teeth

Major changes in the position of teeth can be made only by orthodontic treatment, although minor changes in appearance can be achieved by building up the tooth with composite or by composite or porcelain veneers (see pages 13–20). For example, a diastema between teeth which the patient finds unattractive can be closed or reduced by means of additions of composite or veneers following orthodontic treatment (Figure 1.2a and b). However, when the space is large, oversized crowns will produce a durable and attractive result (Figure 1.2c and d). This approach

is very destructive of tooth tissue and composite or veneers should always be attempted first before irreversibly preparing the teeth for crowns.

To alter the occlusion

Crowns may be used to alter the angulation or occlusal relationships of anterior and posterior teeth as part of an occlusal reconstruction either to solve an occlusal problem or to improve function (see Chapter 4).

As part of another restoration

Crowns are made to support bridges and as components of fixed splints. They are also made to alter the alignment of teeth to produce guide planes for partial dentures or to carry precision attachments for precision attachment retained partial dentures (see Parts 2 and 3).

Combined indications

More than one of these indications may be present, so that, for example, a broken-down



Figure 1.4

The appearance of composite restorations.

a Following trauma the right central incisor tooth requires root canal treatment.



b The appearance of the tooth has been restored by internal bleaching and a composite repair to the mesial corner.



c The central incisors were fractured in a riding accident 8 years earlier. Composite restorations were placed by the patient's mother and then replaced by another dentist and again at a dental school. These restorations have been in place for 3 years and are discolouring again. The patient was 21 and refused further composites and crowns were made.



d Composite restorations at the necks of all the incisor teeth. They have been present for 18 months and are maintaining their appearance.

posterior tooth that is over-erupted and tilted may be crowned as a repair and at the same time to alter its occlusal relationships and its inclination, providing a guide plane and rest seat for a partial denture.

Multiple crowns

With some of these indications, notably tooth wear and hypoplastic conditions, many or all of the teeth may need to be crowned.



Figure 1.5

The central incisor has a necrotic pulp and is grossly discoloured. This degree of discoloration could not be resolved by bleaching or veneering the tooth. The periodontal condition must be improved before a crown can be made successfully.

Appearance

One of the principal reasons for patients seeking dental treatment is to maintain or improve their appearance. Relative prosperity, changing social attitudes and the success of modern dental materials mean that expectations of good dental appearance are rising. Fewer teeth are being extracted, and when they are it is at a later age. It is much less common now to see a mouth such as that shown in Figure 1.3) than it was in the mid-1960s, when this photograph was taken. As standards of appearance and expectations rise, some dental defects or types of restoration, which at one time would have been tolerated, are no longer acceptable to patients.

Much more can now be done to improve appearance with the current range of composite materials than was the case a few years ago. Composite has the advantage of being more adaptable than porcelain. It is applied, shaped and polished at the chair-side and later it can be repaired and resurfaced (Figure 1.4). This means that crowns are now less often indicated to improve appearance.

Many patients simply wish to lighten the colour of their teeth, which may have darkened with age or from smoking. If the teeth are substantially sound and their position and shape are acceptable to the patient, a significant improvement can be made by thorough cleaning and external bleaching (see Figure 1.7). However, sometimes the discolouration is so intense that bleaching alone will not provide a satisfactory result (Figure 1.5). Initial bleaching to lighten the tooth as much as possible helps because the crown then does not have to disguise too dark a preparation.

Appearance is important to the patient and is therefore important to the dentist. After the

relief and prevention of pain and infection it is probably the next most important reason for providing dental treatment.

Function

It is possible to eat and speak without any teeth, or with complete dentures, but most patients (and probably all dentists) do not want to. As with appearance, this is a question of the quality of life. An occluding set of natural, or second best, restored teeth is better at coping with a full varied range of diet than dentures.

Mechanical problems

Sometimes, although it would be possible to restore a tooth by means of a filling, the pattern of damage to the tooth gives rise to anxieties about the retention of the restoration, the strength of the remaining tooth tissue, or the strength of the restorative material. The degree to which a crown strengthens the remaining tooth structure compared to a bonded intra-coronal restoration is not clear. Usually, however much damage there is, some sound tooth tissue needs to be removed to prepare the tooth for a crown (see Figure 1.12).

Fillings fail because they fall out, because of secondary caries, or because part of the tooth or part of the restoration fractures. These failures are upsetting to the patient and embarrassing to the dentist, and it is therefore tempting to prescribe crowns when there is even a small possibility that one of these problems will arise.

However, crowns can also fail. If a filling fails, it is often possible to make a more extensive



Figure 1.6

Tetracycline stain.

a Mild, uniform staining. It is unlikely that treatment will be necessary other than to replace the missing lateral incisors.



b Tetracycline staining with severe banding. The extent of treatment depends on the lip line. In this case the lower lip covered the gingival half of the lower incisors, and therefore treatment for the lower teeth was not necessary.



c Darker but more uniform tetracycline staining. In this case a vital bleaching technique was used.



d Extreme tetracycline staining with banding.



e Darkly stained teeth with four teeth, the upper and lower left premolars, prepared for crowns.

restoration or a crown. If a crown fails, a further crown may not be possible and extraction may be all that is left.

In deciding between a crown and a filling there are two considerations to be weighed up. First, how real is the risk of mechanical failure of the filling or surrounding tooth and what can be done to minimize this risk? Second, how much more destruction of sound tooth tissue is necessary to make a crown?

In general, it is better to take the more conservative approach first, even if this involves some risk of the restoration failing. The alternative is to provide far more crowns than are strictly necessary and perhaps give rise to even greater problems for the patient later on.

Indications for anterior crowns

Caries and trauma

All the general indications listed above may apply to anterior crowns. Before the days of acid-etch retained composite restorations and composite and porcelain veneers, anterior crowns were indicated much more frequently for the restoration of carious or fractured incisors. Today many of these teeth can be restored without crowns, which are often not needed until the pulp is involved (Figure 1.1a and b).

Non-vital teeth

When a pulp becomes necrotic the tooth often discolours due to the haemoglobin breakdown products. Internal bleaching (see Figure 1.7a and b) is the initial treatment of choice and will often produce a good initial result, although sometimes some of the discolouration returns. However, the discoloration may be such that it can only satisfactorily be obscured by a crown following initial bleaching to produce a lighter core for the crown (Figure 1.5).

Tooth wear

The ideal approach to problems of tooth wear is to prevent the condition getting worse by identi-

fying the cause and eliminating it as early as possible. Crowns should be made only when the cause of the tooth wear cannot be identified or cannot be eliminated, and the damage is serious. Sometimes the rate of tooth wear slows down or stops with no obvious explanation and the teeth remain stable for some years. Crowns are not a good preventive measure except as a last resort.

Hypoplastic conditions

In many of the hypoplastic conditions the patient (or parents) will seek treatment at an early age, often as soon as the permanent teeth erupt, and treatment may be carried out in conjunction with orthodontic treatment. In some of these cases large numbers of teeth are affected, and so the decision whether to crown them, offer some alternative form of treatment, or simply leave the condition alone, is a fairly momentous one. Figure 1.6 shows several cases of tetracycline staining affecting many teeth. Differences in the lip morphology, the depth of uniformity of the colour, and the patient's age and general attitude will all influence the decision.

Unfortunately tetracycline stain often does not respond well to bleaching, particularly when the staining is in bands. The success of veneers depends on the quality of the remaining enamel for bonding, but in suitable cases veneers are the ideal treatment. The option of multiple crowns is a considerable undertaking and should not be embarked upon lightly by either patient or dentist. In particular with young patients, the lifelong maintenance implications must be fully understood. It should be explained that crowns are very unlikely to last the whole of a natural lifetime and replacements will be costly if they are possible at all. If veneers are made first the teeth can still be crowned later but the opposite is not true.

However, if after proper consideration crowns are made, they can dramatically improve the patient's appearance in a way that is difficult or impossible by any other form of treatment.

The decision often has to be made while the patient is a teenager, when social development can be seriously affected by appearance including dental appearance. This is often an important factor in making decisions on whether, how and when to treat.



Figure 1.7

Alternatives to crowns – bleaching.

a A discoloured, non-vital lower central incisor.



b The tooth shown in *a* has been root-filled and internally bleached to produce a satisfactory appearance.



c This young patient was unhappy with the appearance of their crowded discoloured teeth. The discoloration is due to tetracycline given when the patient was a child. Extensive and complex restorations could be considered but the simplest approach would be to undertake orthodontic treatment and then improve the colour of the teeth with external home bleaching.



d The resulting appearance following external vital bleaching – although not perfect the patient is happy with the result and extensive restorations have been avoided.

As part of other restorations

Sometimes crowns are needed to support partial dentures. Crowns as part of bridges and splints are dealt with in Parts 2 and 3.

What are the alternatives to anterior crowns?

Internal and external bleaching

Bleaching agents can be used to lighten the colour of teeth by internal or external application. Controversy over the legality of some bleaching materials and techniques in the UK has been resolved after much debate. Dentists should be aware of the regulations in their own countries before using some of the bleaching materials and techniques.

The advantage of tooth bleaching is that it offers simple and conservative improvements for patients who simply want whiter teeth or to reverse some of the effects of aging without damaging tooth structure. Tooth bleaching techniques cannot do anything other than improve colour and remove staining.

Internal bleaching

Discoloured non-vital teeth can be treated by removing the contents of the pulp chamber and sealing the root canal with a glass ionomer cement at or just below the gingival level to prevent leakage of the bleaching agent into the canal. Hydrogen peroxide gel or a slurry of hydrogen peroxide and sodium perborate is left sealed in the tooth for 24 hours and repeated until the desired shade is obtained (Figure 1.7a and b). The access cavity needs to be completely sealed to prevent future relapse. Internal bleaching will not improve the colour of teeth made grey by the corrosion of dental amalgam fillings in access cavities.

External bleaching

Vital teeth can be lightened by various techniques with the external application of carbamide peroxide or other bleaching agents (Figure 1.7c and d).

The home bleaching technique employs a 2% carbamide peroxide gel applied to the teeth within a customized tray that the patient wears overnight. Chair-side bleaching utilizes a more concentrated carbamide peroxide gel applied by the dentist and activated by heat or light to act in a short period of time. The colour changes achieved by both techniques are not permanent but can be repeated. Vital bleaching techniques applied over lengthy periods of time can treat even very severe discolouration such as some types of tetracycline staining.

Composite restorations

The appearance of modern composite restorations is excellent (Figure 1.4). With the rapid development of anterior restorative materials, it is better in many cases to replace and repair restorations until such time as even more durable materials are available, rather than make crowns.

It is clear that no absolute rules can be given on whether crowns or fillings are indicated other than to say that in general the more conservative procedures are to be preferred.

Composite and porcelain veneers

There has been a debate in the dental profession about the advantages and disadvantages of these two materials for veneers. Considerations in this debate are discussed below.

Appearance

Both can have a very good appearance initially (Figure 1.8). Earlier composites tended to wear and discolour, losing the quality of their appearance. However, this is less of a problem with the improving current materials. When veneers are being made to mask intense discoloration porcelain veneers may be preferred because they can have an initial layer of opaque porcelain which helps to mask discoloration.

Reversibility

Composite veneers can be made very thin and so often do not need any tooth preparation. They



Figure 1.8

Alternatives to crowns – veneers.

a Broken and eroded incisor teeth.



b The same patient as shown in *a* with composite veneers 3 years after being placed.



c Eroded upper central incisors.



d The same patient as shown in *c* with two porcelain veneers in place.



e Polyacrylic veneers which have been in the mouth for several years. The margins are staining and chipping.



f The same patient as e. The polyacrylic veneers have been removed and the six anterior teeth prepared for porcelain veneers.



g An incisal view of the prepared teeth.



h Porcelain veneers on the model for the patient shown in e and f.



i The etched fit surface of the porcelain veneers.



j The teeth have been isolated with acetate strip and are about to be etched with phosphoric acid gel.



k An incisal view of the porcelain veneers in place. In this case the porcelain was carried over the incisal edges



l The completed porcelain veneers.

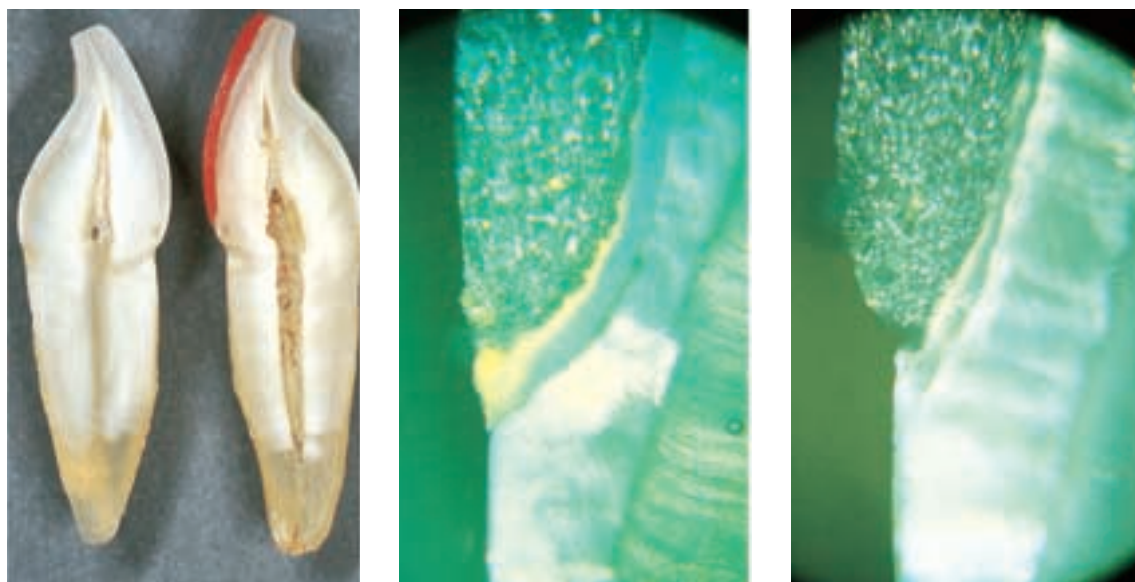
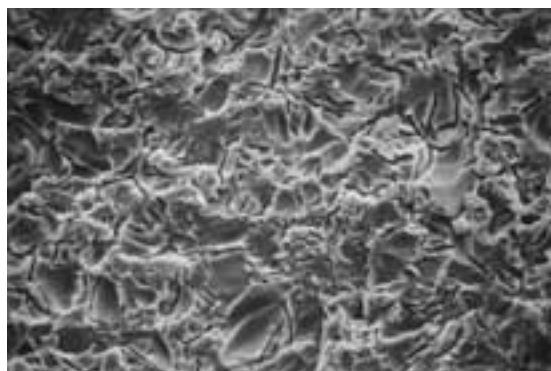


Figure 1.9

a A sectioned upper central incisor tooth. *Left* the intact tooth, *right* the tooth has been prepared for a porcelain veneer and the profile of the veneer is illustrated in wax. The features of this preparation are that the gingival margin is chamfered and is in enamel and the incisal edge preserves the bulk of the natural tooth. Had the incisal edge been more worn the veneer preparation could have been taken over it as in Figure 1.8k.

b A view through the confocal microscope of the margin of a porcelain veneer. From the *left* the veneer, the luting cement, enamel and dentine. This is a good fit.

c A porcelain veneer which has been grit-blasted too much in its construction, leaving the margin deficient.



d Porcelain surface etched with hydrofluoric acid. A grit-blasted surface looks similar.



e A high magnification confocal microscope image with a different contrast medium showing penetration of composite luting cement into dentine tubules on the left and etched porcelain on the right.



Figure 1.10

Failing veneers.

These porcelain veneers were made less than a year ago and are now leaking.

can therefore be removed if the result is not ideal. Porcelain veneers almost always need some tooth preparation because the margins cannot be made as thin as composite, which can be tapered down to nothing at the margin (Figure 1.9). This means that porcelain veneers are usually not reversible. Because the indications for veneers usually apply to young people the decision to prepare teeth for porcelain veneers must be considered very carefully. Tooth preparation is irreversible and it is often better to make, and when necessary refurbish, composite veneers, thus allowing the patient to keep their options open for the long term.

Cost

Porcelain veneers are more costly because two appointments are necessary and considerable chair-side time is necessary for the delicate preparations and the bonding process. Laboratory charges add considerably to the cost. Composite veneers are placed at the chair side in one visit, the total clinical time is usually less than porcelain veneers and there is no laboratory cost.

Surveys of success and failures of veneers

There have been a number of medium-term surveys that show that the life expectancy of porcelain veneers is commonly less than had been hoped. Fractures and debonding are not uncommon and a frequent type of failure is staining around the margins or even frank leakage (Figure 1.10).

Failures like this cannot be repaired and as the tooth has usually been prepared a new veneer or crown is necessary. In an attempt to reduce the effect of marginal staining some clinicians carry the preparations for veneers right through the mesial and distal contact points so that the margin is on the other lingual/palatal side. This is an even more destructive preparation. There have been no good long-term studies of the success and failure of composite veneers, partly because clinicians know that the materials are changing all the time and starting a medium- or long-term survey of a particular material will become redundant in a short time with the introduction of new, better materials. However, clinical experience suggests that composite veneers do have a good medium-term prognosis and also have the advantages that they can be repaired and polished.

See Chapter 14 for a more detailed discussion of the success and failure of restorations.

Physical properties

The modulus of elasticity of porcelain is quite different to that of enamel. There is a view among some dental material scientists that this difference will inevitably lead to a breakdown of the bond at the margins of veneers in due course. Initially the estimate was about 10 years and some of the surveys confirm this approximate time. The coefficient of thermal expansion is also different between porcelain and enamel and this adds to the likelihood that marginal breakdown will occur.

Composite is nearer to enamel in terms of these physical properties and because the composite is bonded directly via a bonding resin



Figure 1.11

Resin bonded ceramic crowns.

a Peg-shaped lateral incisors.



b The upper right lateral incisor prepared for a resin bonded ceramic crown. The preparation is entirely within enamel. The neck of the tooth has been prepared all round with a chamfer finishing line, similar to the preparation for a veneer, and a small amount has been removed from the incisal edge. Nothing has been removed from the labial or proximal surfaces other than blending them into the gingival finishing line.



c Palatal view of the finished crowns.



d The labial appearance.



Figure 1.12

Badly broken-down teeth, all of which were vital when they were extracted. *Left*: the tooth on presentation. *Right*: after removing old restorations, caries and grossly overhanging enamel. Only at this stage can a final decision be made on the most suitable restoration. These teeth could be treated with:



a a bonded or pin-retained amalgam restoration;



b a gold inlay with cuspal protection or a glass ionomer/composite layered restoration to strengthen the cusps;



c a composite core or a bonded or pin-retained amalgam core and partial crown;



d a composite core or a bonded or pin-retained amalgam core and complete crown.

**Figure 1.13**

Amalgam and gold restorations.

The amalgam in the first molar, which has just been repolished, has been in place for 15 years. Less than half the natural crown is present and so a crown could have been considered when the treatment was first planned. The decision to place an amalgam was justified. The amalgam restorations in the premolar teeth are more recent, and less satisfactory. The inlay in the second molar has been present for 20 years.

to the etched enamel, marginal breakdown is less common. Porcelain veneers require two bonds, one to enamel and the other to the porcelain.

Taking all these considerations together the emphasis is now swinging towards composite veneers rather than porcelain. However, porcelain veneers still have an important role to play in some cases.

An alternative to porcelain veneers – resin bonded ceramic crowns

These are, in effect, a porcelain veneer that goes right round the tooth and therefore does not have the same problems with the differences in physical properties between porcelain and enamel as do porcelain veneers. They require the same amount of labial, incisal and approximal preparation as a porcelain veneer, usually entirely in enamel, together with equivalent preparation of the palatal or lingual surface (Figure 1.11).

Restoration of badly broken-down teeth

The most common indication for a posterior crown is a badly broken-down tooth usually resulting from repeated restorations, each of which fails in turn until finally a cusp or larger part of the tooth fractures off. In most cases it is necessary to build up a core of amalgam or composite before the crown is made. Two such teeth are shown in Figure 1.12c and d.

Restoration of root-filled teeth

There is a strong clinical impression and some scientific evidence that root-filled teeth are more likely to fracture than teeth with vital pulps. It follows that some thin and undermined cusps of root-filled teeth need to be protected or removed where similar cusps in vital teeth would be left. Together with the original damage that necessitated the root filling and the access cavity, this means that many, but by no means all, root-filled posterior teeth are crowned. The fact that a posterior tooth is root-filled is not in itself sufficient justification for a crown. When a crown is indicated it is almost always necessary to make a core.

As part of another restoration

In Parts 2 and 3 partial and complete crowns are discussed as retainers for bridges and fixed splints. In addition, they may be indicated in conjunction with conventional or precision-attachment retained partial dentures.

What are the alternatives to posterior crowns?

Bonded or pin-retained amalgam restorations

The success of bonding amalgam to large unretentive cavities is improving. Some dentists now use bonded amalgam routinely while others are less

confident of the bond (and find the technique difficult) and use pins or a combination.

Figure 1.13 shows an amalgam restoration which has been present for 15 years. A crack is visible on the mesial palatal aspect of this tooth; this has also been present for some years. The tooth is symptomless and remains vital. It could be argued that all teeth with large lesions, such as this one, should be crowned in order to prevent such cracks occurring. However, it is impossible to predict which teeth will crack and what the effects will be. It is therefore not justified to crown all teeth with large cavities or restorations just as a preventive measure. To do so is overtreatment and is not cost-effective. It is better to apply a general policy of minimum intervention, with prophylactic restorations only when there is a clear risk of failure. When occasional failures, such as broken cusps, do occur, these problems can usually be solved without the need for extraction.

Tooth-coloured posterior restorations

Composite materials suitable for posterior restorations have been developed intensively in recent times. One reason for this is increasing anxiety in some parts of the world and in some patients about the wisdom of continuing to use amalgam restorations in view of the possible risk of mercury toxicity or allergy. The subject has received much attention in the popular press and in the rest of the media. The scientific evidence is that mercury allergy does exist in a very small proportion of the population, although in some parts of the world, for example Japan, it appears to be greater, probably due to patients being sensitized by eating fish contaminated with mercury that has got into the marine food chain.

Mercury toxicity is a proper concern of dentists, and over the last 30 years or so considerable improvements have been made in mercury hygiene. Most amalgam used now is capsulated, avoiding the need for liquid mercury to be available in bulk in the dental surgery, and other precautions are also used to protect the staff in the dental surgery. It is the staff, who are likely to be exposed over a long period to mercury vapour should mercury hygiene not be adequate, who are at risk rather than individual patients. There is no reliable scientific evidence that the mercury from amalgam restorations is a serious

toxic hazard to patients, despite occasional flurries of media hype. It is also possible that the alternatives to amalgam may have equally low levels of toxic effect.

Nevertheless there are some patients who refuse to have amalgam restorations, and hence there has been a drive to develop satisfactory, cost-effective alternatives for the restoration of posterior teeth. Some patients also have concerns about the appearance of amalgam restorations, even in areas of the mouth that show little, and request tooth-coloured restorations. The materials are improving year by year, but some dentists still feel that they are not yet comparable to amalgam for the larger posterior restoration. These dentists will therefore more commonly prescribe crowns than composite restorations in teeth that would otherwise be treated with an amalgam restoration, for example the tooth shown in Figure 1.12a. The tooth shown in Figure 1.12b still has substantial buccal and palatal cusps and a good ridge of dentine between them. However, if the tooth is subject to occlusal stress (and wear facets can be seen on the cusps) then a restoration either protecting or reinforcing the cusps is indicated with this amount of tooth loss.

There is good evidence that the layered restoration (a core of glass ionomer cement replacing the dentine, with an occlusal surface of composite replacing the enamel) is successful in binding weakened cusps together and producing a stronger tooth than one restored with amalgam alone. It is used when there is a large MOD cavity where a crown preparation would simply remove all or most of the remaining tooth tissue.

In order to increase wear resistance and to minimize the effects of polymerization contractions, which are complications of large directly placed composite restorations, systems have been developed to process composite inlays outside the mouth by a combination of heat, pressure and light. A non-undercut inlay cavity is prepared, an impression taken and the composite inlay (or onlay) made in the laboratory (Figure 1.14).

Gold inlays and onlays protecting weak cusps

The gold inlay shown in Figure 1.13 is an intra-coronal restoration and is not an alternative to a crown. Figure 1.15a shows a tooth similar to