Principles of Operative Dentistry

A.J.E. Qualtrough
J.D. Satterthwaite
L.A. Morrow
P.A. Brunton

Blackwell
Munksgaard

Blackwell Munksgaard, a Blackwell Publishing company
Editorial Offices:
Blackwell Publishing Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK
Tel: +44 (0)1865 776868
Blackwell Publishing Professional, 2121 State Avenue, Ames, Iowa 50014-8300, USA
Tel: +1 515 292 0140
Blackwell Publishing Asia Pty Ltd, 550 Swanston Street, Carlton, Victoria 3053, Australia
Tel: +61 (0)3 8359 1011

First published 2005 by Blackwell Munksgaard

Library of Congress Cataloging-in-Publication Data
Principles of operative dentistry / A.J.E. Qualtrough . . . [et al.].
p. ; cm.
Includes bibliographical references and index.
ISBN-13: 978-1-4051-1821-7 (pbk. : alk. paper)
ISBN-10: 1-4051-1821-0 (pbk. : alk. paper)
1. Dentistry, Operative. 2. Endodontics. 3. Evidence-based dentistry.
I. Qualtrough, A. J. E.
[DNLM: 1. Dentistry, Operative–methods. 2. Endodontics–methods.
3. Evidence-Based Medicine. WU 300 P9575 2005]
RK501.P854 2005
617.6'05–dc22

2004026345

ISBN-13: 978-1-4051-1821-7
ISBN-10: 1-4051-1821-0

A catalogue record for this title is available from the British Library

Set in 10/13 pt Palatino
by Graphicraft Limited, Hong Kong
Printed and bound in Great Britain
by TJ International, Padstow, Cornwall

The publisher's policy is to use permanent paper from mills that operate a sustainable forestry policy, and which has been manufactured from pulp processed using acid-free and elementary chlorine-free practices. Furthermore, the publisher ensures that the text paper and cover board used have met acceptable environmental accreditation standards.

For further information on Blackwell Munksgaard, visit our website:
www.dentistry.blackwellmunksgaard.com

Contents

Foreword

Operative dentistry forms the central part of dentistry as practised in primary care. It occupies the majority of a dentist's working life and is a key component of restorative dentistry. It is unfortunate that the academic discipline of operative dentistry has become less clearly identifiable within many dental schools. The Operative Dentistry or Conservative Dentistry Department is now often part of a larger department of Restorative Dentistry and can less easily be seen as a discipline in its own right. Indeed, operative dentistry is not recognised as a specialty either in the United Kingdom or the United States which, given its central position in the delivery of oral healthcare to patients, is unfortunate.

The subject of operative dentistry continues to evolve rapidly as the improved understanding of the aetiology and prevention of the common dental diseases is linked with advances in restorative techniques and materials. The effective practice of operative dentistry requires not only excellent manual skills but an understanding of both the disease processes affecting teeth and the properties of the materials available for their restoration.

In view of the seemingly diminished status of operative dentistry, it is all the more pleasing that four well-known, younger academic and hospital-based colleagues have collaborated to create this new book, *Principles of Operative Dentistry*. It is directed primarily towards the dental undergraduate but will benefit the primary care dentist as well as those engaged in more formal postgraduate study. Many operative textbooks place an emphasis on technique but sometimes do not describe adequately the thinking that underpins both the operative procedures and the overall management of the patient. The authors are to be commended for having taken the logical approach of examining the reasons for the procedures and techniques available in operative dentistry. There is wide coverage of the subject, including the restoration of cavities in teeth, management of the dental pulp, the various types of indirect restorations and the management of failed restorations.

The clear presentation and easy style of the book encourages the reader, whilst the arguments for and against particular techniques are supported by reference to the dental literature. The latter is of increasing importance as the demand for evidence-based dentistry gains momentum. The inclusion of a chapter explaining evidence-based practice and how information can be found is particularly welcome. This book provides a wealth of information which is a distillation of the knowledge and experience of the authors. It is also a book for the reader to enjoy and it is to be hoped that it will stimulate a life-long interest in the principles and practice of operative dentistry.

Richard Ibbetson
Director, Edinburgh Postgraduate Dental Institute
and Professor of Primary Dental Care, University of Edinburgh

Preface

Operative dentistry is a significant part of clinical dentistry, with practitioners in the UK spending more than 60% of their time placing and replacing direct restorations. In tandem with this many root canal treatments are carried out and increasingly more indirect restorations are placed. All practitioners whatever their discipline will remember developing their manual skills while engaged in these procedures during their student days.

This book is about the theoretical concepts that underpin clinical practice in the areas of operative dentistry and endodontology and it is primarily directed at clinical dental students and professionals complementary to dentistry. The aim of the text is to provide students with the knowledge required while they are developing the necessary clinical skills and attitudes in their undergraduate training in operative dentistry and endodontology. It is specifically designed to be read in conjunction with pre-clinical and clinical training.

Each chapter addresses various aspects of the subject and there is directed additional reading in the form of selected relevant references. Specific tips will be highlighted throughout the text and there is information about the application of dental materials, although readers are referred to specific texts on dental materials for further information.

After reading this book the reader should be able to:

- Sit properly while operating and be able to organise their operating environment effectively
- Chart teeth
- Understand the basics of cariology, specifically diagnose caries more effectively especially in its early stages
- Prepare teeth to include supplementary retention if indicated clinically
- Understand modern pulp protection regimes
- Select and place the correct restorative material
- Understand when endodontic treatment is indicated
- Access the pulp chamber and root canal systems of teeth

- Effectively clean, shape and obturate the root canal system
- Restore endodontically treated teeth
- Determine when indirect restorations are indicated
- Prepare teeth appropriately for indirect restorations
- Manage soft tissues and use impression materials
- Place a variety of temporary restorations
- Select restorations suitable for repair and refurbishment procedures

Increasingly the evidence base for dentistry is being challenged and it is often said that only 15% of the whole of dentistry is evidence based. The book therefore concludes with a chapter on evidence based dentistry, as the practitioners of the future must have a working knowledge of the principles of evidence based care.

Contributors

Julian D. Satterthwaite BDS MSc MFDS FDSRCS(Eng)
Lecturer in Restorative Dentistry, School of Dentistry, University of Manchester, UK

Leean A. Morrow BDS(Hons) MPhil FDS FDS(Rest Dent) RCS(Eng)
Consultant in Restorative Dentistry, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

Alison J.E. Qualtrough BChD MSc PhD FDS MRDRCS(Edin)
Senior Lecturer/Honorary Consultant in Restorative Dentistry, School of Dentistry, University of Manchester, UK

Paul A. Brunton BChD MSc PhD FDS FDS(Rest Dent) RCS(Eng)
Professor/Honorary Consultant in Restorative Dentistry, Leeds Dental Institute, University of Leeds, UK

Evidence based care
Helen Worthington MSc PhD
Professor of Evidence Based Care/Coordinating Editor of Cochrane Oral Health Group, School of Dentistry, University of Manchester, UK

Anne-Marie Glenny MMedSci
Lecturer in Evidence Based Oral Health Care, School of Dentistry, University of Manchester, UK

Ergonomics
W. Alan Hopwood BDS MDS
Clinical Teacher in Restorative Dentistry, School of Dentistry, University of Manchester, UK

Radiology
Keith Horner BChD MSc PhD FDSRCPS(Glasg) FRCR DDR
Professor of Oral and Maxillofacial Imaging/Honorary Consultant in Dental and Maxillofacial Radiology, School of Dentistry, University of Manchester, UK

Illustrations
Raymond Evans MAA RMIP, Medical Illustrator

Acknowledgements

We would like to express our gratitude to all those individuals who have been formative to the ethos of teaching at the School of Dentistry, University of Manchester. This philosophy was the stimulus for the production of this text. Although many individuals have been involved, we are particularly grateful to Professor Nairn Wilson and Drs John Lilley and Shaun Whitehead.

In addition, we would like to express our thanks to Mr Clive Atack, Chief Photographer, Unit of Medical Illustration, School of Dentistry, University of Manchester, for Figs 1.2 to 1.5.

1 Basic principles

ERGONOMICS IN DENTISTRY

Ergonomics is defined as 'the study of man in relation to his working environment: the adaptation of machines and general conditions to fit the individual so that he may work at maximum efficiency'.

The application of these principles concerns every aspect of design within the building and streamlining of procedure. Within the surgery, the contemporary dental unit is a masterpiece of design incorporating as many ergonomic features as possible to enable the operator, dental nurse and patient to experience the minimum of stress and fatigue. It is evident, furthermore, that this environment must facilitate a high standard of dental treatment as clinical techniques become ever more complex and exacting.

This transformation began with the general adoption of a comfortable, supported and seated position for the operator and the consequent supine positioning of the patient. However, the necessary changes in posture and working procedures were largely overlooked and, despite the convincing work and publication of Paul[1], it would seem that many dentists persist in working in inefficient, distorted postures that must frequently lead to excessive fatigue if not skeletal damage.

The operator's chair

This should be fully adjustable and mobile, provide a broad, preferably anatomically contoured seat and give support in the lumbar region. It should be adjusted in height to suit each individual operator in order to distribute the weight equally between the thighs and feet. The dental nurse chair differs only, but importantly, in that it must adjust to at least a 10 cm increase in height and provide a corresponding 'bar stool' type rim rest for the feet.

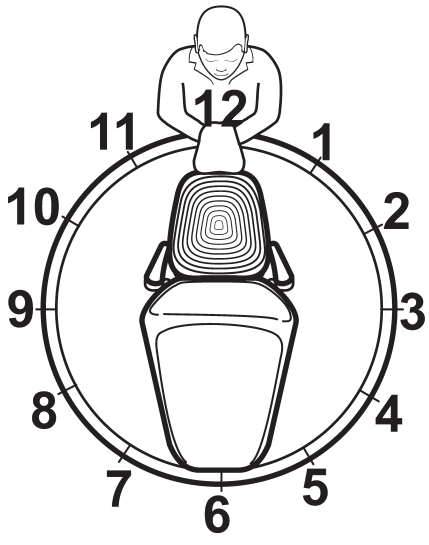

Fig. 1.1 Position of operator relative to chair.

Operator and nurse positions

The dentist will normally work within a range from the 12 o'clock to the 9 o'clock position relative to the patient's head. However, most operative procedures are completed from, at, or near, the 12 o'clock position. The dental nurse will normally remain in a fixed position at 4 o'clock (Fig. 1.1) but at a considerably higher position in order to look down or forward to the mouth. This height not only facilitates the different tasks, but enables the nurse to visualise the back of the mouth and remove any accumulation of debris or water.

Operator's vision

There can be no doubt that any tooth is best visualised by direct vision (Fig. 1.2). However, the nature of operative dentistry demands that, whenever possible, the line of vision is perpendicular to the tooth surface. Clearly, those surfaces inaccessible by direct vision must be visualised indirectly through a mirror (Fig. 1.3). Nevertheless, it remains important, however difficult, to position the mirror and attempt a near perpendicular view. Magnification of the working area provides a major advantage in both the reduction of eye strain and the promotion of high standards.

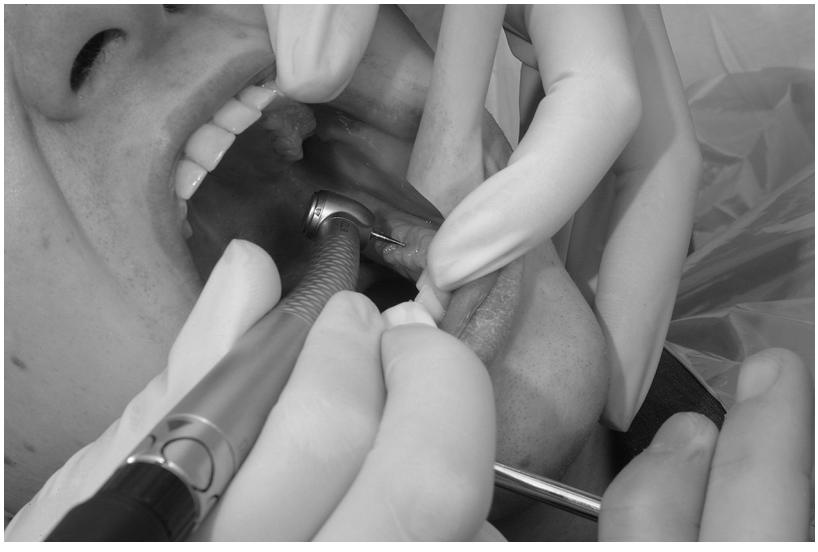

Fig. 1.2 Direct vision.

Fig. 1.3 Visualisation in mirror.

Patient position

Adoption of the supine patient position by most dental practitioners has focused attention on the optimal position of the patient's head in relation to the seated operator. Paul[1] compares this relationship in

Fig. 1.4 The home position.

dentistry to any other precision activity by a seated operator and describes the 'home position' in which the objective is raised to the mid-sternal position and the head tilted forward to observe the fingers. Most dentists will gradually adopt this position by trial and error and indeed many will programme the dental chair to return and permit this situation for every patient (Fig. 1.4).

Observation of a large number of operators over many years reveals, however, that for some procedures, with a supine patient, a large proportion will adopt distinctly uncomfortable, distorted and fatiguing positions. Furthermore, it would appear that the reasons for this distortion are principally related to:

- An attempt to adopt a direct visual approach, despite severe postural distortion, when an indirect approach is more appropriate.
- The natural, almost in-built attempt to visualise the tooth surface via the perpendicular approach, without appropriate positioning and rotation of the patient's head.

The former situation should be corrected by training, practice and a disciplined procedure but the latter can only be corrected by a different patient posture provided by a modified chair position. Specifically, the difficulty lies in viewing the lower posterior teeth in the fully supine patient. In this situation, it can undoubtedly be an

Fig. 1.5 The home position for lower teeth.

advantage to position the chair base considerably lower but tilted forward to approximately 40° from the waist to return the patient's head to the 'home' position (Fig. 1.5). The correctly seated operator will have a visual approach near perpendicular to the posterior surfaces.

Illumination

There can be no better illustration of the recent transformation in working procedures than in the area of illumination. Indeed, it is a tribute to the dentists of the past that they accomplished such complex tasks with little other than an anglepoise lamp.

The enormous advantage of halogen unit lamps is self-evident. No doubt the future will prove even brighter with light emitting diodes (LEDs). In addition, the increasing use of fibre-optic handpieces ensures constantly focused illumination of the working area and eliminates the need to use the mirror as an additional aid to reflect unit-sourced light. Despite these advances, when using light-sensitive materials such as resin composites, it remains necessary to work with low light levels as high intensity light will lead to premature polymerisation of the material, thus preventing manipulation.

Magnification is a further major step forward in enhancing the vision of the work surface and the use of telescopic loupes, sometimes fitted with their own light source, is understandably commonplace.

Four-handed dentistry

The term four-handed dentistry is now rooted in professional terminology but implies no more than the importance of team effort. The dental team normally comprises the operator and nurse (four hands), but it is not uncommon for an additional nurse to make six.

Principles of four-handed dentistry

There are many ways in which the dental team can work efficiently, along ergonomic principles. Nevertheless, the underlying principles are:

- *Rationalisation and standardisation*. The repetitive nature of so much in dentistry offers the ideal opportunity to ration the immediate supply of instruments to those most commonly used and, also, to standardise technique so that, with practice, considerably greater efficiency will be achieved.
- *Delegation*. Delegation is the transfer of any task to a person who is both qualified and capable. This remains an area in which many dentists fail to take full advantage of the skills of the dental nurse.
- *Anticipation*. The experienced dental nurse will quickly learn the individual methods of the operator and begin to anticipate almost every situation. As a member of a regular dental team, rather than one based on rotational duty, the advantages can be significant.
- *Safety*. The focus and control achieved in all the various approaches to four-handed dentistry is undoubtedly matched by improved safety for both patient and operator. However, while there has been understandable concern that a supine patient may be at greater risk of ingestion or inhalation of foreign matter, it has been shown that, in this position, the tongue rests against the soft palate to provide a seal[2]. Nevertheless, some posterior pooling of fluid will inevitably occur and the responsibility of both nurse and operator in the control and removal of this accumulation cannot be overstated.

  In procedures carrying higher risk, such as endodontics, the total protection of the airway utilising rubber dam is self-evident.

Fig. 1.6 Exchange of instruments in the transfer zone.

However, it is essential that no dental procedure should take place without appropriate airway protection, irrespective of patient position.

All patients, and indeed members of the dental team, should be provided with protective eyewear and for the supine patient, no transfer of materials or instruments should occur over the face.

- *Methods*. The concept of four-handed, ergonomic dentistry is open to varied individual approach and has been described in detail by Paul[1]. However, the underlying principle demands that all delivery, discard and transfer takes place in the area of safety and convenience around and below the chin – the so-called 'transfer zone' (Fig. 1.6). This practice demands maximal delegation to the dental nurse and requires concerted effort and understanding. However, the advantage to the operator, and hence the patient, of an undistracted focus on the tooth is considerable.

  A comparison is with that of the general surgeon awaiting the appropriate instrument, correctly positioned for immediate grasp and use. The dentist's hands should therefore remain whenever possible in the transfer zone, instruments and materials should be asked for, not looked for, and be received to enable correct grasp with no risk of injury.

If both hands are free, instrument transfer is simple but more commonly the task must be completed in one hand. This method of instrument retrieval by the fourth finger, rotation of the wrist, and supply from thumb to first fingers is easily mastered and is undoubtedly efficient.

Therefore, it is clear that when due attention is paid to basic procedural aspects and organisation, the clinical scenario is efficient, effective, enjoyable and professional. On the other hand, without such discipline, there is the potential for inefficiency, lower standards and a lost opportunity to maximise the potential for a fulfilled professional career.

EXAMINATION OF THE DENTITION – OCCLUSION

Before examining any individual teeth that may require restoration, it is important to look at all the teeth, how they meet and how they move against each other. These relationships are collectively termed the *occlusion*. The occlusion will affect not only the functional load to which a tooth or restoration is subjected, but can also influence the shape and form of a restoration. For example, if a molar tooth is separated by a considerable amount from its antagonist tooth during movement of the mandible, than there is plenty of height for cusps to be carved into a restoration. Conversely, if restoring a tooth that rubs against its antagonist during movement of the mandible, then cusps are likely to be more shallow, and care must be taken that excess load is not placed onto the restoration during function.

Preoperative examination of the occlusion is essential. Note must be taken of existing relationships, both static and dynamic/excursive. The use of thin articulating paper to mark the teeth and identify contacts is required. Differing colours may be used for static and dynamic contacts. Study models, mounted with a face bow record on an articulator, may also prove to be useful, especially if multiple units or units involving guiding surfaces are to be restored. An explanation of occlusal terminology and relationships follows.

Intercuspal position (ICP)

The intercuspal position is the static position of maximum interdigitation of the cusps of the teeth, where the mandible is in its most closed position: it is also an habitual position. This position may be easily reproducible and identified on study models as 'best fit' (e.g. in

a fully dentate patient) or may be difficult to identify and perhaps variable (e.g. in a patient with tooth wear). It is a *changeable and unstable position* as it will change as the teeth change throughout the lifetime of the patient. It is also called *maximum interdigitation position (MIP)* and *centric occlusion (CO).*

Retruded axis position (RAP)

The retruded axis position is not a fixed point, but an 'arc' defined by the movement of the mandible when retruded, at which only hinge movements are possible. It is also called *terminal hinge axis* or *centric relation (CR)*. RAP is also defined anatomically as the position where the condyles are most superiorly placed within the glenoid fossae, with the articular discs in a close-packed position. It is a relaxed relationship and is the only true reproducible position.

Retruded contact position (RCP)

The retruded contact position is the point of first contact (between a maxillary and mandibular tooth) when closing on the retruded arc of closure (see RAP above). The movement from the RCP to ICP is termed a *slide*, and note should be taken of the magnitude of this slide as well as direction (i.e. vertical, horizontal – anterior to posterior and lateral components).

Excursion/excursive movements

Excursion relates to the dynamic movements of the mandible, as in:

- *Lateral excursion* – to the side (left or right)
- *Protrusion* – forward/anterior movement of the mandible
- *Retrusion* – backward/posterior movement of the mandible

Working side

The working side is the side to which the mandible moves when making a lateral excursive movement.

Non-working side

The non-working side is the opposite side from that to which the mandible moves when making a lateral excursive movement. Sometimes called the *balancing* or *orbiting* side.

Anterior/posterior determinants and guidance

Determinants of mandibular movements are the influences determining the envelope of possible movements of the mandible. These influences may be:

- *Posterior determinants* (i.e. the temporomandibular joints and anatomical structures associated with them, also termed *condylar guidance/posterior guidance*).
- *Anterior determinants* (i.e. the teeth).

The tooth surfaces that are in contact during an excursive movement are said to 'guide' movement of the mandible. The type of guidance may be divided as below, the divisions broadly describing the teeth that provide the guiding surface:

- *Anterior guidance* – the tooth surfaces that are in contact during a protrusive excursion. This is normally the incisor teeth, and hence is then termed *incisal guidance*: in some cases (for example an occlusion with an anterior open bite) it may actually be the posterior occlusal tooth surfaces that provide the anterior guidance.
- *Canine guidance* – when a lateral excursion is made, the canines on the working side are the only teeth to make contact.
- *Group function* – when a lateral excursion is made, multiple pairs of teeth on the working side make contact.

Tooth contacts during dynamic excursive movements that do not provide a smooth guidance, or separate guiding surfaces, may be termed an *interference*.

Non-working contact

A non-working contact is a contact between a pair of tooth surfaces on the non-working side during an excursive movement that does *not* otherwise interfere with the smooth movement of the mandible nor cause the guiding surfaces on the working side to be separated.

Non-working interference (NWI)

A non-working interference is a contact between a pair of tooth surfaces on the non-working side, during an excursive movement, that *interferes* with the smooth movement of the mandible and/or