Stewart's Clinical

REMOVABLE PARTIAL PROSTHODONTICS

Fourth Edition

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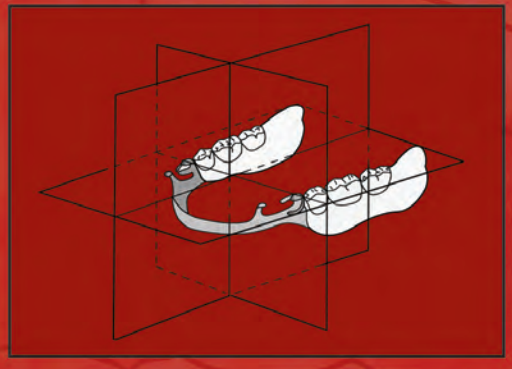

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Fourth Edition

Stewart's Clinical REMOVABLE PARTIAL PROSTHODONTICS

Fourth Edition

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Preface

In 1983 Dr Kenneth Stewart collaborated with Drs Kenneth Rudd and William Kuebker to publish *Clinical Removable Partial Prosthodontics.* This textbook provided a new, more practical approach to removable partial denture therapy. Unlike previous texts in the field, the book was arranged in the sequence of patient treatment. Supported by an impressive collection of expertly crafted photographs and illustrations, the textbook was well received by the dental profession, and a second edition was released in 1992.

We were blessed to have worked under the collective guidance of Drs Stewart, Rudd, and Kuebker. In our estimation, there has been no finer collection of professional minds within the discipline of removable prosthodontics. In addition, there has been no group more deserving of the description "gentle men." Their knowledge, patience, and availability were instrumental in our professional development, and we—like so many dental professionals—owe them an incalculable debt of gratitude.

In 1996 Dr Stewart died following an extended battle with cancer. We were honored when Drs Rudd and Kuebker approached us with the opportunity to author a new edition of the text, and we gratefully accepted. Published in 2003, the third edition of this textbook was the culmination of our efforts. In 2008, we have been afforded the chance to publish the fourth edition of *Stewart's Clinical Removable Partial Prosthodontics.*

Like the preceding editions, this book is intended for dental students, residents, and practitioners and is presented in chronological sequence. Each chapter is intended to build upon the information presented in previous chapters, thereby providing a firm foundation in removable partial denture design, construction, and placement. The text is supported by numerous photographs and illustrations designed to facilitate understanding. This edition also features a section describing the Prosthodontic Diagnostic Index (see chapter 6) as well as a new chapter on implant-assisted removable partial dentures (see chapter 9). As before, our aim is to provide readers with a clear understanding of removable partial denture concepts and procedures. In turn, we hope this book will lead to improved patient treatment and years of enjoyable dental practice.

We would like to thank the family of Dr Kenneth Stewart for their encouragement and support throughout this process. We also would like to thank Dr Kenneth Rudd and Dr William Kuebker for their contributions to dentistry, their mentorship, and the opportunity to author this textbook. They have been superb role models and have provided indispensable counsel throughout our professional and personal lives.

We would like to acknowledge Drs James Brudvik, Raymond Koeppen, Michael Mansueto, Patrick Mattie, Thomas Schneid, and Ronald Verrett for their contributions to the current edition of this textbook. They are among the most talented and dedicated professionals in contemporary dentistry, and their continued support and friendship are greatly appreciated.

We would be remiss if we did not thank our instructors and mentors through the years for their wisdom and counsel. The countless hours they spent with us are very much appreciated. Likewise, we would like to thank our many students who continue to motivate and inspire us on a daily basis.

Finally, our heartfelt thanks go to our families and friends, particularly our wives and children. Without their support, none of this would have been possible.

In Memoriam

Kenneth Lowe Stewart
1925–1996

A talented clinician, inspirational teacher, and trusted colleague, his memory and beliefs will live forever through his students and the many lives he touched.

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1

Introduction and Classification

Terminology

Several efforts have been made to standardize dental terminology, beginning with Dr Louis Ottofy's compilation of accepted dental terms in 1923.[1] This document greatly improved communication within the dental profession. As the dental profession matured, new materials and techniques were introduced. Increasing dental knowledge gave rise to recognized dental specialties, and dental terminology continued to evolve.

The greatest advance in prosthodontic terminology was made in 1956 when the Academy of Denture Prosthetics published the *Glossary of Prosthodontic Terms.* Since that time, the publication has been updated on a regular basis. Currently, the Glossary is published in the *Journal of Prosthetic Dentistry* every 2 years.

To ensure that the terminology used throughout this book will be understood by all readers, definitions of some of the most frequently encountered words are provided in this section. In addition, the terms used in this book are limited to those that are recognized as acceptable.

Branches of prosthodontics

The art or science of replacing absent body parts is termed *prosthetics,* and any artificial part is called a *prosthesis*. As applied to dentistry, the terms *prosthodontics* and *dental prosthesis* are used. Prosthodontics is the branch of dental art and science that deals with the replacement of missing teeth and oral tissues to restore and maintain oral form, function, appearance, and health. There are three major divisions of prosthodontics: fixed prosthodontics, removable prosthodontics, and maxillofacial prosthodontics (Fig 1-1). Despite the importance of dental implants, the authors of this text do not consider implantology a major division of prosthodontics. Instead, implants are considered adjuncts in fixed, removable, and maxillofacial therapy.

According to the *Glossary of Prosthodontic Terms,* fixed prosthodontics is the branch that deals with the replacement and/or restoration of teeth by artificial substitutes that are not readily removed from the mouth.[2] This book addresses fixed prosthodontics only as it relates to removable partial dentures. The glossary defines maxillofacial prosthodontics as the branch of prosthodontics concerned

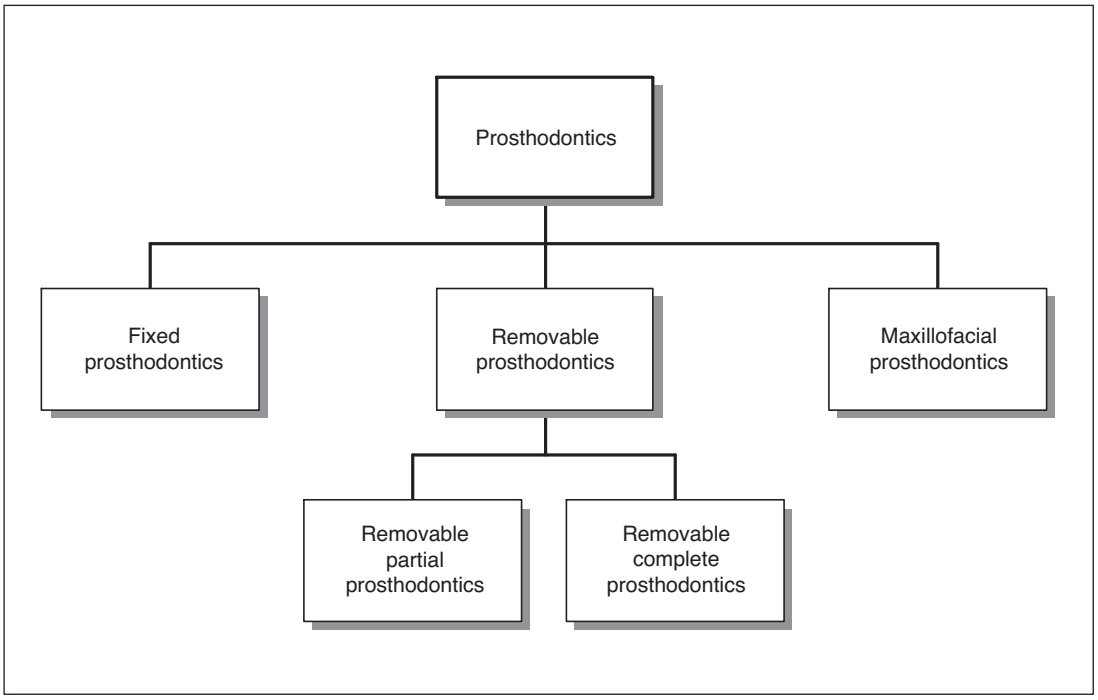

Fig 1-1 Branches of prosthodontics.

with the restoration and/or replacement of stomatognathic and associated facial structures that have been affected by disease, injury, surgery, or congenital defect.[2] Removable prosthodontics is devoted to replacement of missing teeth and contiguous tissues with prostheses designed to be removed by the wearer. It includes two disciplines: removable complete and removable partial prosthodontics. This book deals with the latter.

Terms related to dental prostheses

As previously noted, a prosthesis is an artificial replacement for a missing body part. A dental prosthesis is an artificial replacement of one or more teeth and/or associated structures. In clinical applications, dental prostheses may be supported by teeth, residual ridges, dental implants, or a combination thereof. Consequently, practitioners must be familiar with the associated terminology.

The terms *abutment* and *retainer* are central to a discussion of dental prostheses. An abutment is any tooth or dental implant that supports a dental prosthesis. In contrast, a retainer is the portion of a fixed or removable partial denture that attaches the prosthesis to an abutment (Fig 1-2). Hence, an abutment is part of the patient's oral cavity (eg, a tooth or implant), while a retainer is part of the prosthesis.

Traditionally, fixed partial dentures have been attached to abutments using dental cements, while removable partial dentures have been attached to abutments by other means. In removable partial denture prosthodontics, there are two principle types of retainers. They are termed *extracoronal retainers and intracoronal retainers*. Extracoronal retainers consist of two fingers of metal (ie, clasps) that lie on the surface of a clinical crown (Fig 1-3). One finger of metal is termed a *retentive clasp*, while the other is termed a *reciprocal clasp*. The retentive clasp is located in an undercut area of the clinical crown and resists displacement of the prosthesis away from the underlying hard and soft tissues. The reciprocal clasp is located in a non-undercut area and serves as a bracing or stabilizing element for the prosthesis. The resultant assembly is termed an *extracoronal retainer* because the retentive and reciprocal components lie on the external surfaces of an abutment.

Unlike extracoronal retainers, intracoronal retainers are contained entirely within the contours of a clinical crown (Fig 1-4). Consequently, the use of intracoronal retainers generally requires the fabrication of two or more specially designed, complete-coverage crowns. In most instances,

Fig 1-2 An abutment is any tooth or dental implant that supports a prosthesis. A retainer is the portion of the prosthesis that attaches the prosthesis to an abutment.

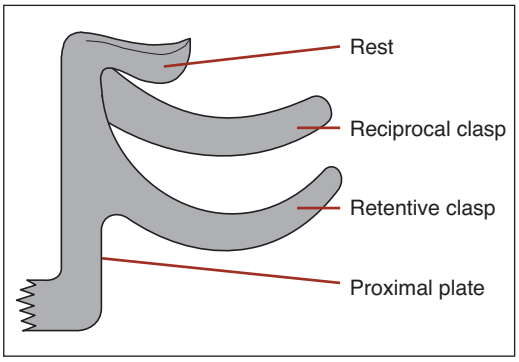

Fig 1-3 Components of an extracoronal retainer usually include a rest, retentive and reciprocal clasps, and a proximal plate.

Fig 1-4 An intracoronal retainer lies within the contours of the clinical crown. An intracoronal retainer consists of a matrix or "female" component *(right)* and a patrix or "male" component *(left)*.

Fig 1-5 When joined, matrix and patrix components form a closely fitting retentive assembly.

retention of intracoronal removable partial dentures is dependent upon exact parallelism of the retentive assemblies. Each assembly consists of two parts, commonly termed *matrix* ("female") and *patrix* ("male"). Figure 1-5 illustrates the joining of a patrix and matrix to form a functional retentive unit. When a dislodging force is applied to the removable partial denture, binding occurs between the external walls of the patrix and the internal walls of the matrix. This binding results in retention of the prosthesis.

Another method for categorizing removable partial dentures relates to the manner of their support. A partial denture that receives support from natural teeth at each end of the edentulous space or spaces is a *tooth-supported removable partial denture* (Fig 1-6). Although the denture base contacts the adjacent soft tissues, the prosthesis does not receive significant vertical support from the residual ridge.

A second category of removable partial dentures includes those that extend anteriorly or posteriorly and are supported by teeth at only one end (Fig 1-7). These are called *extension base removable partial dentures* or *tooth-tissue–supported removable partial dentures*. The majority of these are *distal extension removable partial dentures*. Distal extension removable partial dentures are supported by teeth at the anterior aspect of the edentulous space and by tissues of the edentulous ridge posteriorly.

In certain instances, the terms *interim*, *transitional*, and *treatment* are applied to specific types of removable partial dentures. An interim removable partial denture is a provisional prosthesis intended to improve esthetics and function until a more definitive form of treatment can be rendered. A transitional removable partial denture may be used when loss of additional teeth is inevitable, but immediate extraction is not advisable or desirable. Artificial teeth may be added to a transitional removable partial denture as natural teeth are extracted. A transitional removable partial denture may be worn during the healing process and replaced with a definitive prosthesis when extraction sites have stabilized. A treatment denture may be used as a carrier for treatment material, as a protective covering for a surgical site, or as a matrix for soft tissue

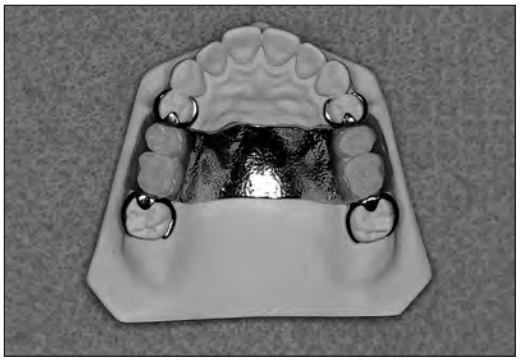

Fig 1-6 A tooth-supported removable partial denture.

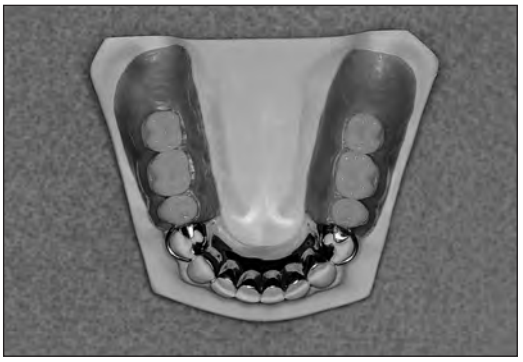

Fig 1-7 A tooth-tissue–supported (extension base) removable partial denture.

healing. In most instances, treatment dentures are used in conjunction with resilient tissue conditioners. The resultant prostheses provide cushioning effects for the underlying soft tissues and promote improved tissue health. Interim, transitional, and treatment prostheses are intended for short-term applications and should never be used for prolonged treatment. The use of such prostheses over extended periods may cause irreparable damage to a patient's remaining teeth, soft tissues, and bone.

Other terms of interest include *model* and *cast.* While *cast* may be used as a verb (to cast an inlay) or as an adjective (a cast framework), it is most often used as a noun to describe an accurate, positive reproduction of a maxillary or mandibular dental arch. Certain adjectives are commonly used to provide more specific meanings for the term (eg, diagnostic cast, master cast, refractory cast). The term *model* is used to describe a reproduction for demonstration or display purposes. The term *model* does not imply dimensional or spatial accuracy. Hence, a model should be a reasonable facsimile of an object, but need not be an accurate reproduction such as that required for construction of a successful prosthesis.

Terms related to clinical applications also must be considered. Undoubtedly the most defined term in prosthodontics is *centric relation*, closely followed by *maximal intercuspal position* and *centric occlusion position*. The basic definition of centric relation is the physiologic relationship of the mandible to the maxilla when both condyles are properly related to their articular discs and the condyle-disc assemblies are stabilized against the posterior slopes of the articular eminences. This relationship may occur at varying degrees of mandibular opening, but must precede the downward and forward movement (ie, translation) of the condyles. This definition may be embellished in many ways, but if the basic premise of a bone-to-bone relationship is maintained, acceptance of this simple concept can eliminate confusion. Maximal intercuspal position may be defined as the most complete interdigitation of the teeth independent of condylar position. Hence, maximum intercuspation is a maxillomandibular relationship determined by tooth-to-tooth relationships. Centric occlusion position represents the first contact of the teeth that occurs when the mandibular condyles are in centric relation. Therefore, centric occlusion position is a maxillomandibular relationship dictated by bone-to-bone relationships (Fig 1-8).

Other key terms relate to the displacement resistance exhibited by a prosthesis. The most important of these are *retention*, *support*, and *stability*. For purposes of this discussion, retention may be defined as resistance to displacement away from the teeth and soft tissues of the dental arch; support may be defined as resistance to displacement toward the teeth and soft tissues of the dental arch; and stability may be defined as resistance to displacement in a mediolateral or anteroposterior direction (Fig 1-9).

Those terms that deal directly with the components of a removable partial denture will not be presented here, but will be covered in subsequent chapters.

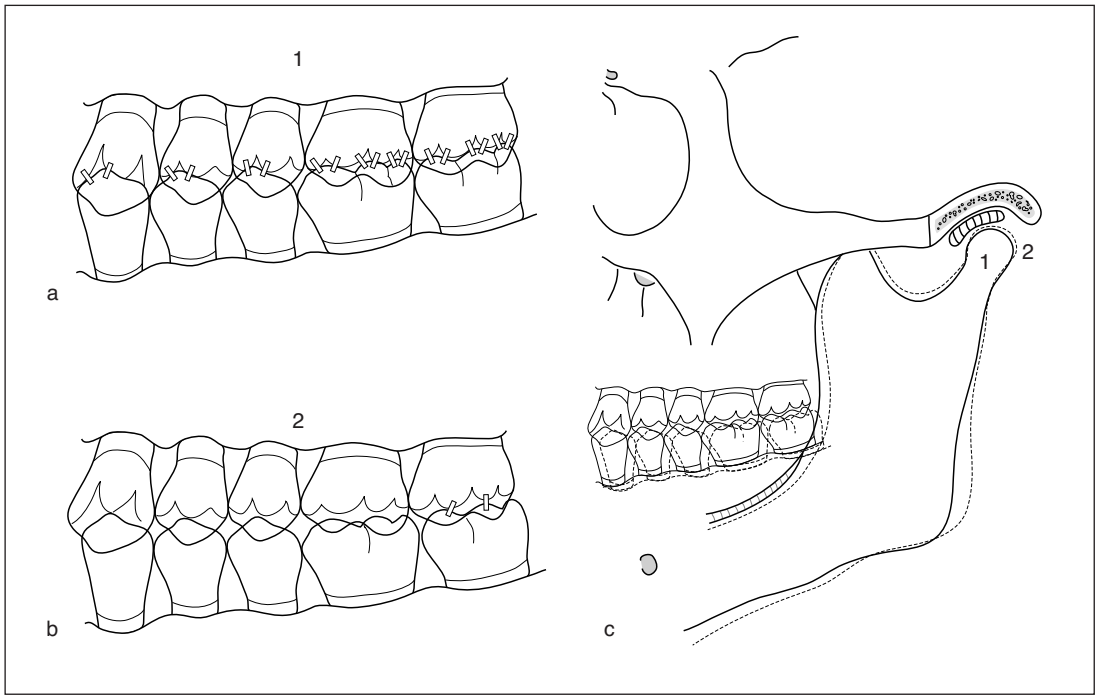

Fig 1-8 *(a)* Maximal intercuspal position is the most complete interdigitation of the teeth and is independent of condylar position. *(b)* Centric occlusion position is the first contact of the teeth that occurs when the mandibular condyles are in their centric relation positions. *(c)* Maximum intercuspation and centric relation can be coincident if the occlusion is appropriately developed or properly adjusted. This would occur with the teeth in position 1 and the temporomandibular joints in position 2.

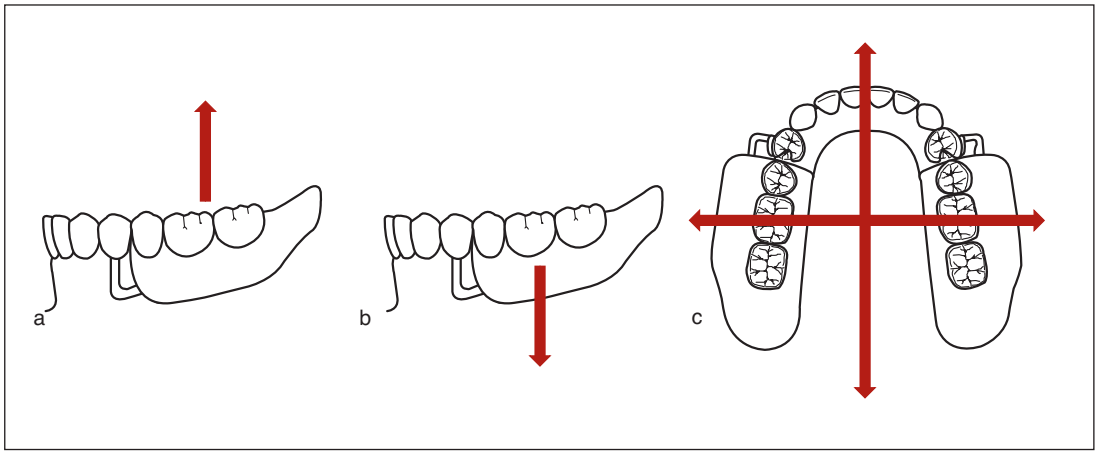

Fig 1-9 *(a)* Retention may be defined as resistance to displacement away from the underlying hard and soft tissues. *(b)* Support may be defined as resistance to displacement toward the associated tissues. *(c)* Stability may be defined as resistance to displacement in a mediolateral or anteroposterior direction.

Treatment of Partially Edentulous Patients

When all factors are favorable, the treatment of choice for a partially edentulous patient is placement of a fixed partial denture, and the advent of dental implants has provided a number of new options for carrying out this treatment modality. However, not all patients are candidates for dental implant therapy. Contraindications for dental implant therapy include unfavorable regional anatomy, uncontrolled systemic disease, high-dose head

and neck radiation, and extreme surgical risk. Moreover, there are contraindications associated with any type of fixed partial denture therapy, as outlined in the following section.

Contraindications for fixed partial denture therapy

Age of patient

Most patients younger than 18 years are poor candidates for fixed partial dentures because of large dental pulps and lack of clinical crown height. Tooth reduction sufficient to reestablish normal coronal anatomy in the cast restoration often compromises the health of the pulpal tissues. Consequently, an interim partial denture should be considered for patients younger than 18 years.

Length of endentulous span

One of the rules of dentistry that has most successfully passed the test of time is that of Dr Irvin Ante. Ante's Law states that the periodontal membrane area of the abutment teeth for a fixed partial denture must be equal to or greater than the periodontal membrane area of the teeth being replaced.[3] Although other conditions may modify this rule to some degree, exceeding the rule by a margin of any significance is almost certain to create problems.

Loss of supporting tissues

When a large amount of the edentulous ridge has been lost, the practitioner must fabricate a prosthesis that restores function and provides support for the lips and cheeks. In addition, the prosthesis must allow access for oral hygiene. Replacement of missing tissues with a fixed partial denture generally makes it difficult for the patient to maintain a healthy oral environment. In contrast, restoration with a removable partial denture allows the patient to remove the prosthesis from the mouth. This facilitates cleaning of the prosthesis and permits increased access to the remaining teeth and soft tissues.

Rationale for removable partial denture therapy

As stated by Dr M. M. DeVan, the primary purpose of removable partial denture therapy must always be "the preservation of that which remains, and not the meticulous replacement of that which has been lost."[4] After it has been determined that this purpose can be satisfied, one should consider the additional purposes of removable partial denture therapy: maintaining or improving phonetics, establishing or increasing masticatory efficiency, stabilizing dental relationships, and developing the required esthetics.

If, on the other hand, it is determined that the health of all or part of the remaining oral structures will be compromised, alternative forms of treatment must be considered. For too many years, removable partial dentures were considered stepping stones on the road to complete dentures. With the materials, equipment, and techniques currently available, this type of thinking must be relegated to the past. Removable partial denture therapy is an acceptable form of treatment that provides an increased spectrum of restorative options.

Indications for removable partial denture therapy

Long-span edentulous area

The teeth adjacent to a long-span edentulous area support a removable partial denture in much the same manner that they would support a fixed partial denture. However, a removable denture receives additional support and stabilization from the tissues of the residual ridge and from the abutment teeth on the opposite side of the arch. Without this distribution of forces, the leverage and torque on the abutment teeth would be excessive.

No abutment tooth posterior to the edentulous space

Where there is no tooth posterior to the edentulous space to act as an abutment, the choice of replacements is limited. Fixed partial dentures that are supported at only one end (ie, cantilevered fixed partial dentures) produce harmful torquing forces (Fig 1-10). These forces often produce bone resorption, tooth mobility, and restoration failure.

In some instances, one or more dental implants may be placed in the edentulous area, and the arch may be restored with a fixed partial denture. When placement of implants is not possible, the only practical treatment involves placement of a removable partial denture.

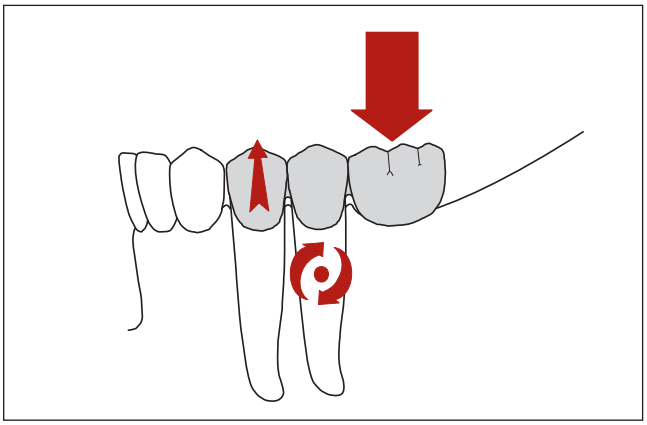

Fig 1-10 When a load *(large arrow)* is applied to a fixed partial denture that is supported only at one end, harmful torquing forces *(small arrows)* can result.

Reduced periodontal support for remaining teeth

In mouths where bony support for the remaining teeth has been severely compromised, prospective abutments may be unable to support fixed prostheses. In these situations, removable partial dentures can derive appreciable support from the remaining teeth and residual ridges. Hence, the total support that must be provided by the abutment teeth is diminished.

Need for cross-arch stabilization

When stabilization of the remaining teeth is needed to offset mediolateral and anteroposterior forces (eg, after treatment of advanced periodontal disease), cross-arch stabilization frequently is required. A fixed partial denture can provide excellent anteroposterior stabilization, but limited mediolateral stabilization. Because removable partial dentures are bilateral prostheses, cross-arch stabilization is enhanced.

Excessive bone loss within the residual ridge

When a missing tooth is replaced by a fixed partial denture, the artificial tooth (pontic) is positioned so its neck lightly contacts the mucosa over the edentulous ridge. When trauma, surgery, or abnormal resorptive patterns have caused excessive bone loss, a clinician also must deal with replacement of ridge contours. With the advent of successful regenerative therapies (eg, bone grafting, guided tissue regeneration), it may be possible to restore optimum dimensions to severely resorbed residual ridges. But for patients in whom regenerative therapy is not a viable option, denture bases can be used to restore missing portions of the dental arches. Therefore, properly contoured denture bases may be used to support the lips and cheeks, and to reestablish desirable facial contours.

Physical or emotional problems exhibited by patients

The lengthy preparation and construction procedures for fixed partial dentures can be trying, especially for patients with physical or emotional problems. In many instances, removable partial denture therapy is indicated to minimize patient-dentist contact time. Treatment should be designed to prevent further oral deterioration and continued until the underlying physical or emotional problems are resolved or appropriately managed. Treatment selection should not compromise the fit and function of the completed reconstruction.

Esthetics of primary concern

In some instances, a practitioner is faced with the option of fixed versus removable partial denture therapy. It is often possible to attain a more pleasing appearance by using one or more denture teeth on a denture base. This is particularly true when the practitioner must simulate the appearance of diastemata, dental crowding, dental rotation,

or extreme changes in the soft tissue architecture (eg, recreation of papillae to avoid the appearance of dark interdental spaces). Denture teeth on a denture base also may permit the practitioner to more effectively satisfy a patient's phonetic and functional requirements.

Immediate need to replace extracted teeth

The replacement of teeth immediately following extraction is most readily accomplished using a removable prosthesis. Unlike fixed restorations, properly designed removable partial dentures may be altered rather easily. Acrylic resin denture bases may be relined as ridge resorption occurs. When the edentulous area has stabilized, definitive treatment can be undertaken with fixed or removable partial dentures.

Patient desires

Patients sometimes insist on removable prostheses in place of fixed prostheses *(1)* to avoid operative procedures on sound, healthy teeth; *(2)* to avoid the placement of one or more implants; and *(3)* for economic reasons. Patients who have had unpleasant experiences with previous dental procedures often object strenuously to the tooth reduction required for fixed prosthesis fabrication. Other patients are hesitant to undergo surgical procedures associated with implant placement. A third category of patients needs and desires replacement, but cannot afford fixed or implant-borne prostheses. Differences in these forms of treatment should be explained to patients. It should never be implied that patients opting for removable partial denture therapy will receive inadequate treatment. Successful removable partial denture therapy should be expected if fundamental principles are observed.

Unfavorable maxillomandibular relationships

Difficulties are often encountered in patients with unfavorable maxillomandibular relationships. These unfavorable relationships include disharmonies in arch size, shape, and position. A common scenario involves a patient with few serviceable teeth and a moderate-to-severe Class 2 skeletal relationship. Because of the difficulties associated with complete denture therapy in such a patient, every attempt should be made to retain the teeth that may support removable partial dentures. Failure to retain such teeth may result in extremely difficult restorative situations.

Classification of Partially Edentulous Arches

During the early 1900s, dental practitioners began devising methods for the classification of partially edentulous arches. While numerous classification systems were proposed, few met the needs of the profession. Some classification systems were overly simplified, while others were immensely complex. It was decided that for a classification system to be acceptable, it should:

1. Allow visualization of the type of partially edentulous arch being considered
2. Permit differentiation between tooth-supported and tooth-tissue–supported partial dentures
3. Serve as a guide to the type of design to be used
4. Be universally accepted

Kennedy Classification System

The most widely used method for classification of partially edentulous dental arches was proposed by Dr Edward Kennedy of New York in 1925.[5] Although relatively simple, the system can easily be applied to nearly all semi-edentulous conditions.

The Kennedy Classification System is composed of four major categories, denoted Class I through Class IV. The numeric sequence of the classification system was based partly on the frequency of occurrence, with Class I arches being most common and Class IV arches least common.

- Kennedy Class I arch: Characterized by bilateral edentulous areas located posterior to the remaining natural teeth (Figs 1-11 and 1-12).
- Kennedy Class II arch: Displays a unilateral edentulous area located posterior to the remaining natural teeth (Figs 1-13 and 1-14).
- Kennedy Class III arch: Presents a unilateral edentulous area with natural teeth both anterior and posterior to it (Figs 1-15 and 1-16).
- Kennedy Class IV arch: Displays a single, bilateral edentulous area located anterior to the remaining natural teeth. It is important to note that the edentulous space must cross the dental midline (Figs 1-17 and 1-18).

Fig 1-11 Maxillary Kennedy Class I arch.

Fig 1-12 Mandibular Kennedy Class I arch.

Fig 1-13 Maxillary Kennedy Class II arch.

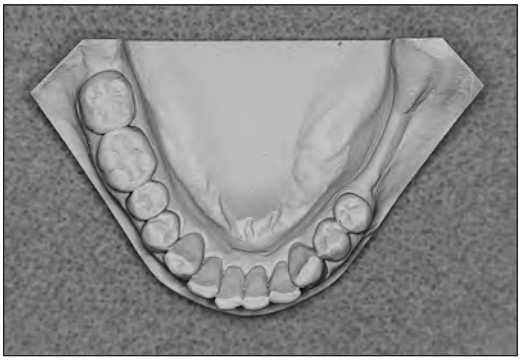

Fig 1-14 Mandibular Kennedy Class II arch.

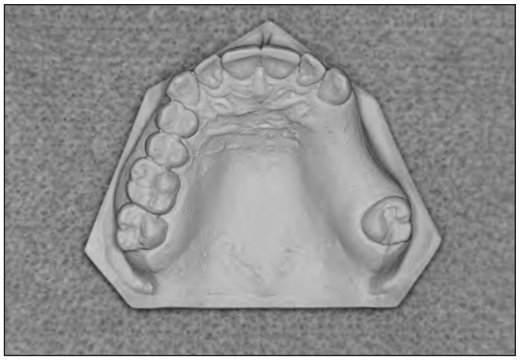

Fig 1-15 Maxillary Kennedy Class III arch.

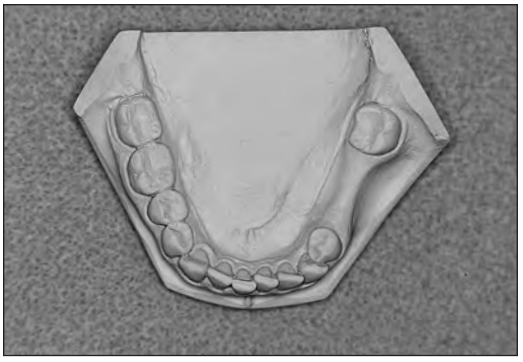

Fig 1-16 Mandibular Kennedy Class III arch.

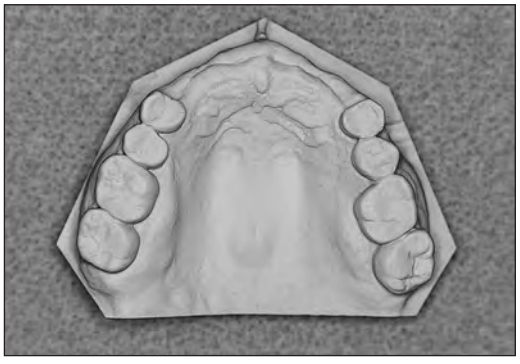

Fig 1-17 Maxillary Kennedy Class IV arch.

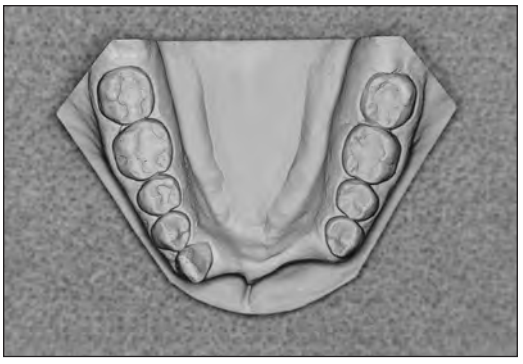

Fig 1-18 Mandibular Kennedy Class IV arch.

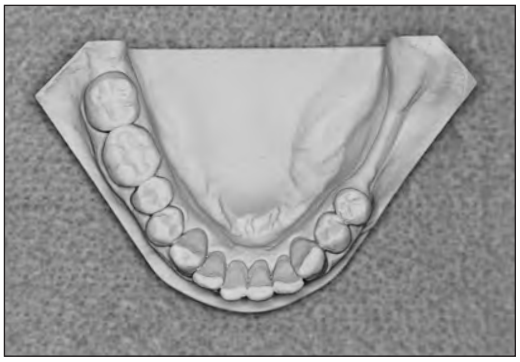

Fig 1-19 A representative mandibular Kennedy Class II arch with no modification spaces.

Fig 1-20 A mandibular Kennedy Class II arch with a one-tooth modification space (Kennedy Class II, Modification 1).

Fig 1-21 A mandibular Kennedy Class II arch with a three-tooth modification space (Kennedy Class II, Modification 1).

Modification spaces

Each Kennedy classification, except Class I, refers to a single edentulous area. In reality, additional areas of edentulism may occur within a dental arch (Figs 1-19 to 1-21). Kennedy referred to each additional edentulous area—not each additional missing tooth—as a modification space (see Figs 1-20 and 1-21). Dr Kennedy included the number of modification areas in the classification (eg, Class I, Modification 1; Class II, Modification 3).

Applegate's rules for classification

While the Kennedy system provided a method for classification of partially edentulous arches, there was some uncertainty regarding its application. In 1954, Dr O. C. Applegate provided the following rules to govern application of the Kennedy system[6]:

1. Classification should follow rather than precede extractions that might alter the original classification (Fig 1-22).
2. If the third molar is missing and not to be replaced, it is not considered in the classification (Fig 1-23).
3. If a third molar is present and is to be used as an abutment, it is considered in the classification (Fig 1-24).
4. If a second molar is missing and is not to be replaced (that is, the opposing second molar is also missing and is not to be replaced), it is not considered in the classification (Fig 1-25).
5. The most posterior edentulous area(s) always determines the classification (Fig 1-26).
6. Edentulous areas other than those determining the classification are referred to as modification spaces and are designated by their number (Fig 1-27).
7. The extent of the modification is not considered, only the number of additional edentulous areas (Fig 1-28).
8. There can be no modification areas in Class IV arches. Any edentulous area lying posterior to the single bilateral area determines the classification (Fig 1-29).

Properly classified maxillary and mandibular arches are presented in Figs 1-30 to 1-35.

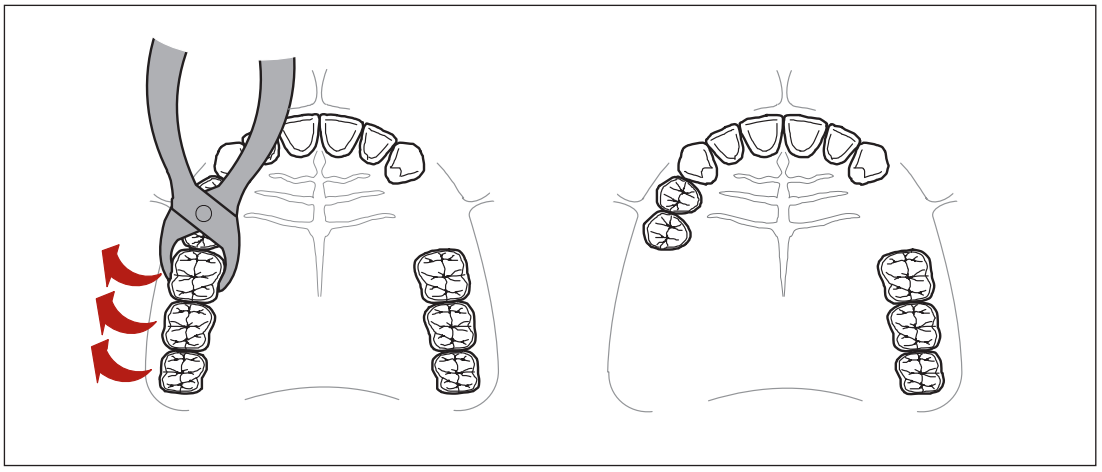

Fig 1-22 If extractions are to be performed, classification should follow rather than precede the extractions. In this instance, the indicated extractions yield a Kennedy Class II, Modification 1 arch.

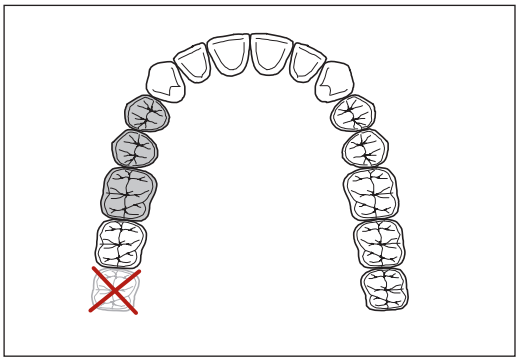

Fig 1-23 If a third molar is missing and is not to be replaced, it is not considered in the classification. For purposes of this discussion, each tooth that is missing and to be replaced is shaded. Each tooth that is missing and not to be replaced is identified with an *X*. Hence, the illustration represents a Kennedy Class III arch.

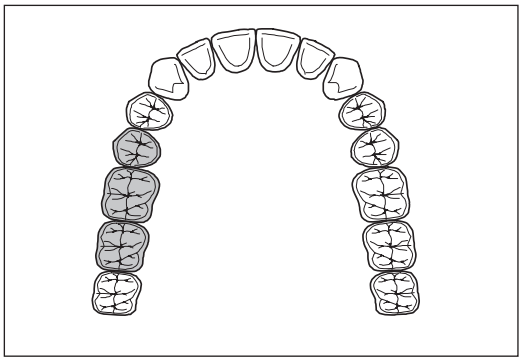

Fig 1-24 If a third molar is present and is to be used as an abutment, it is considered in the classification. Consequently, this illustration represents a Kennedy Class III arch.

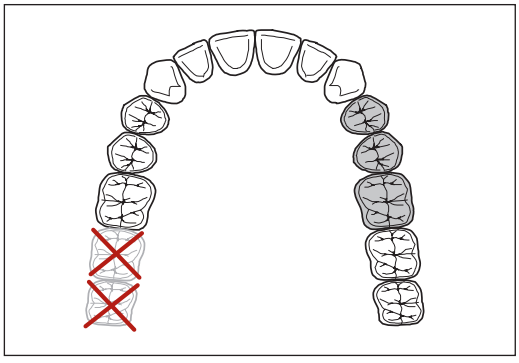

Fig 1-25 If a second molar is missing and is not to be replaced, it is not considered in the classification. This illustration represents a Kennedy Class III arch.

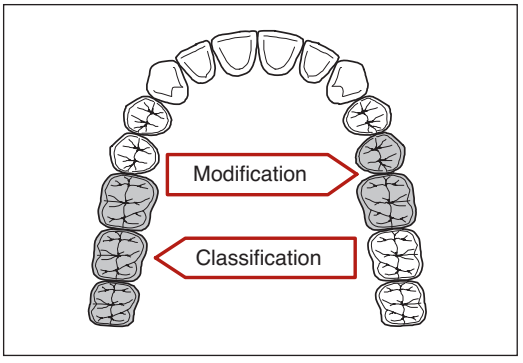

Fig 1-26 The most posterior edentulous area(s) always determines the classification. As a result, this pattern of edentulism represents a Kennedy Class II, Modification 1 arch.

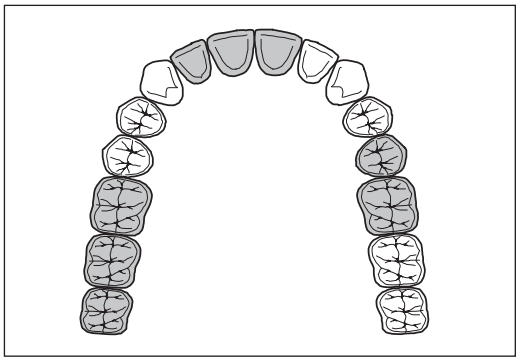

Fig 1-27 Edentulous areas other than those determining the classification are referred to as modification spaces and are designated by their number. This illustration represents a Kennedy Class II, Modification 2 arch.

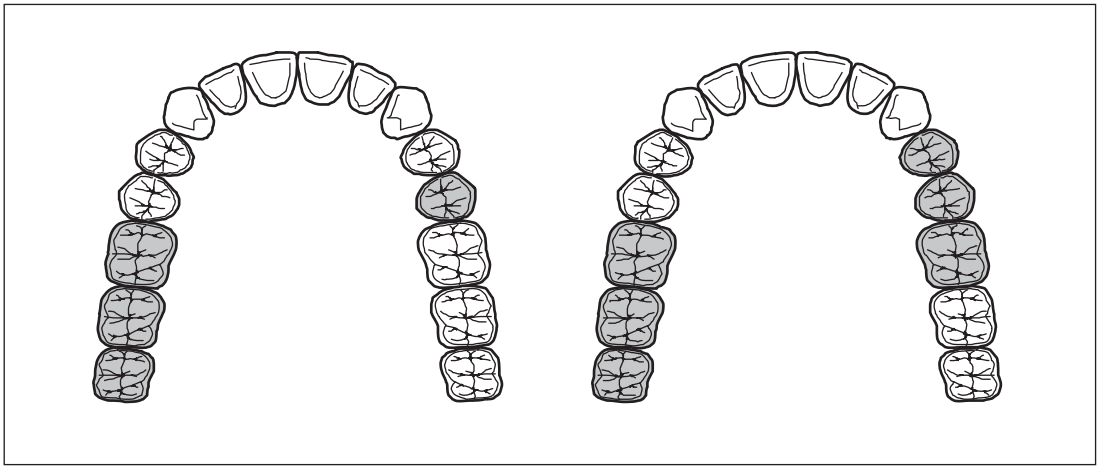

Fig 1-28 The extent of the modification is not considered; only the number of additional edentulous areas is important. Consequently, both illustrations represent Kennedy Class II, Modification 1 arches.

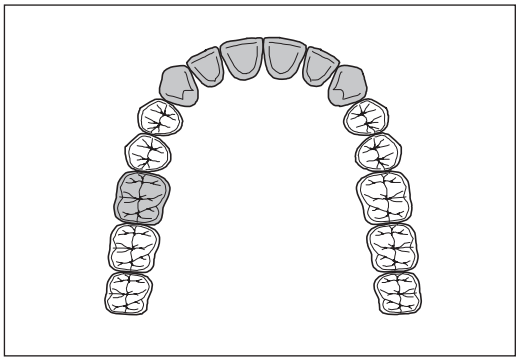

Fig 1-29 There can be no modification areas in Class IV arches. Any edentulous area lying posterior to the single bilateral area determines the classification. This illustration depicts a Kennedy Class III, Modification 1 arch.

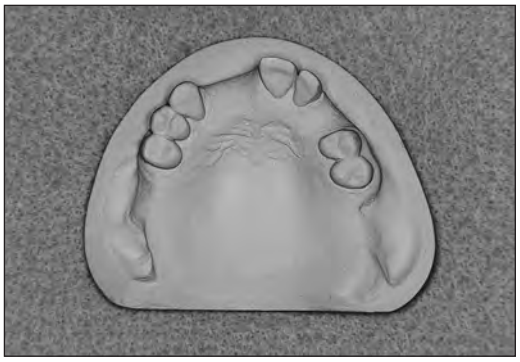

Fig 1-30 Maxillary Kennedy Class I, Modification 2 arch.

Fig 1-31 Mandibular Kennedy Class II, Modification 1 arch.

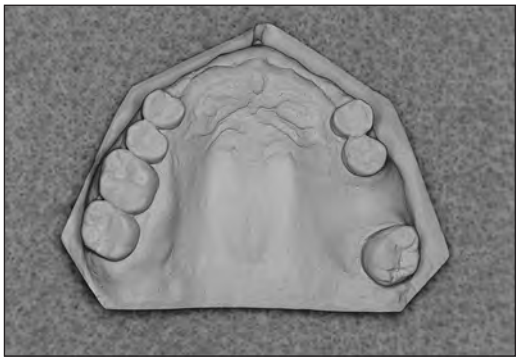

Fig 1-32 Maxillary Kennedy Class III, Modification 1 arch.

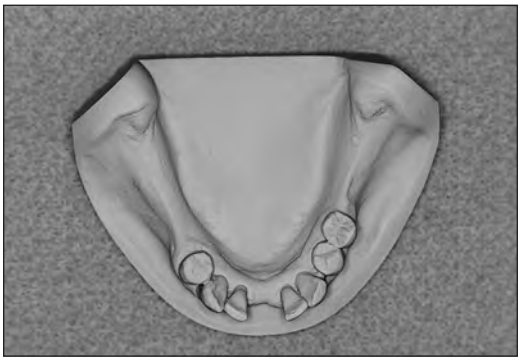

Fig 1-33 Mandibular Kennedy Class I, Modification 1 arch.

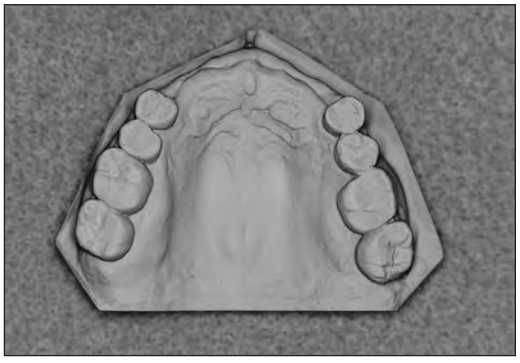

Fig 1-34 Maxillary Kennedy Class IV arch.

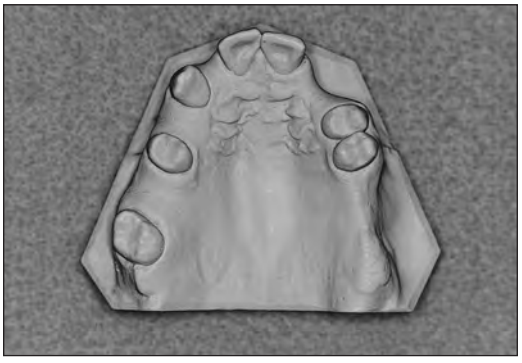

Fig 1-35 Maxillary Kennedy Class II, Modification 4 arch.

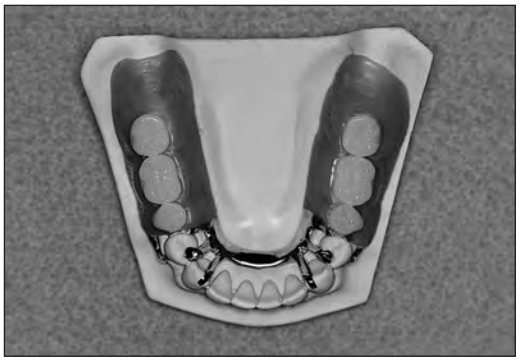

Fig 1-36 A Kennedy Class I removable partial denture must derive support from the teeth and soft tissues.

Fundamental Design Considerations

Any discussion of removable partial denture design should be preceded by a basic understanding of oral biomechanics. Support for removable partial dentures may be derived from the remaining teeth, the hard and soft tissues of the residual ridge, or both. As might be expected, there is a significant difference in the support that can be derived from these structures.

Teeth are connected to the surrounding bone via thin periodontal ligaments. Under function, healthy teeth may be displaced as much as 0.2 mm. In contrast, soft tissues overlying residual bone generally may be displaced 1.0 mm or more. As a result, there may be a significant difference in the support provided by the teeth and the tissues of the residual ridge. It is important to understand this difference when designing removable partial prostheses.

A practitioner also must consider the components that prevent displacement of removable partial dentures away from the underlying oral tissues. In removable partial denture design, the components responsible for retention of the prosthesis are termed *direct retainers* and *indirect retainers*. These components will be discussed more fully in subsequent chapters.

Class I removable partial dentures

Kennedy Class I removable partial dentures present significant challenges for patients and dentists alike. Because Class I removable partial dentures exhibit bilateral extension bases, they must derive support from the remaining teeth and residual ridges (Fig 1-36). To preserve the remaining teeth and residual ridges, removable partial dentures must provide an equitable distribution of forces. Concentration of forces upon the remaining teeth may produce rapid destruction of the periodontal tissues and potential abutment loss. Concentration of forces upon the residual ridges may produce rapid destruction of the associated tissues and an accompanying decrease in ridge height. Consequently, practitioners must carefully consider the effects of removable partial denture design upon the remaining oral structures. The following features must be included in the design of Class I removable partial dentures: provision of optimum support for the distal extension denture bases, incorporation of flexible direct retention, and provision of indirect retention.

Optimum support for distal extension denture bases

All portions of a residual ridge that are capable of providing support should be covered by an accurately fitting denture base. Broad coverage permits a favorable distribution of stresses, often described as a *snowshoe effect* (Fig 1-37). Inadequate soft tissue coverage can lead to stress concentration, breakdown of underlying bone, and a decrease in ridge volume. Adequate support of a distal extension base is often so critical that a second impression of the residual ridge is required. The technique and rationale for this procedure are covered in chapter 13.

Flexible direct retention

The soft tissues are displaceable and allow vertical movement of the denture bases upon loading (Fig 1-38). Vertical displacement of the denture bases may result in the application of stresses to the most posterior abutments. Improperly designed direct retainers may magnify these

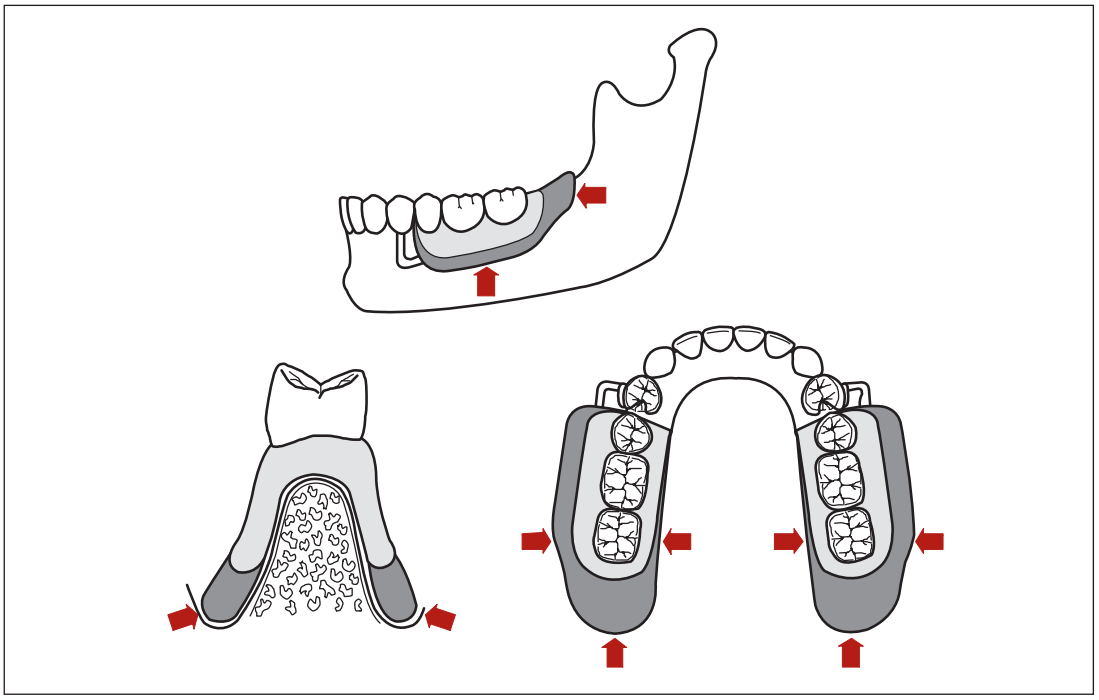

Fig 1-37 Full extension of the denture base permits a more favorable distribution of applied forces. The lightly shaded area depicts an underextended denture base. The darker shading depicts a denture base that has been fully extended.

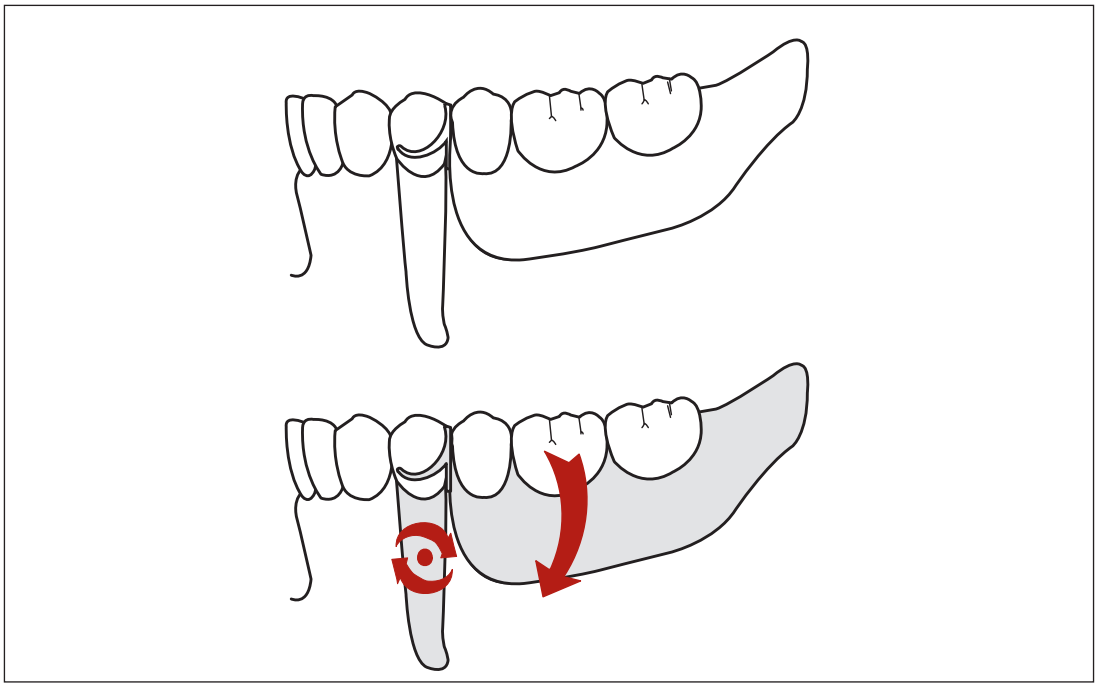

Fig 1-38 Because the soft tissues are displaceable, loading often produces vertical movement of denture bases. Flexible direct retention must be utilized to prevent the application of harmful torquing forces to the abutments.

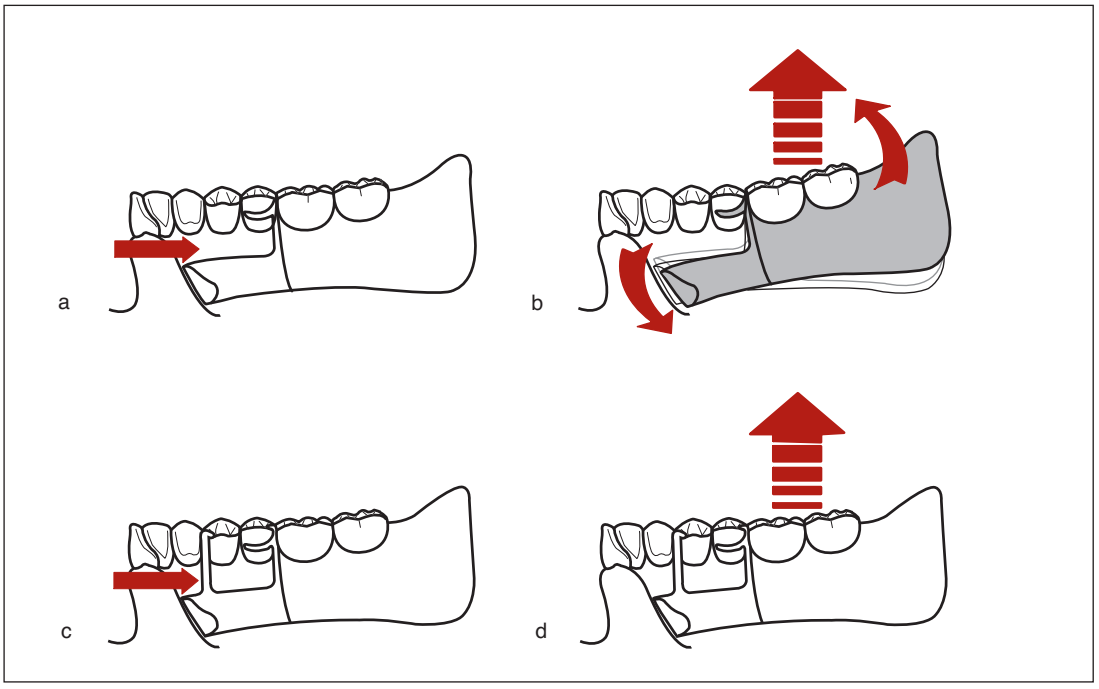

Fig 1-39 Indirect retention must be provided in Class I applications. *(a)* An extension base removable partial denture that lacks appropriate indirect retention *(arrow)*. *(b)* When the denture base moves away from the underlying soft tissues *(large arrow)*, uncontrolled rotation of the removable partial denture occurs *(small arrows)*. *(c)* Indirect retention has been provided *(arrow)*. *(d)* When an unseating force is applied to the denture base *(arrow)*, the indirect retainer resists rotation.

stresses. The resultant "rocking" forces may damage the associated periodontal tissues and produce mobility of the abutment teeth. Therefore, direct retainers must permit dissipation of forces resulting from denture base movement. Each direct retainer should be designed to flex or move into an area of greater undercut as forces are applied to the removable partial denture. Clasp design is a key factor in successful removable partial denture service.

Indirect retention

In some instances, sticky foods may lift denture bases away from the supporting tissues. This displacement produces rotation of the removable partial denture around the most posterior abutment (Fig 1-39). Rotation must be controlled to prevent damage to the remaining teeth and oral tissues. To accomplish this objective, auxiliary rests should be placed as far as practical from the fulcrum line. Because the auxiliary rests minimize rotation and aid in retention of the associated prosthesis, they are termed *indirect retainers*. The concept of indirect retention is discussed in detail in chapter 3.

Class III removable partial dentures

Class III removable partial dentures (Fig 1-40) do not have the same design requirements as Class I removable partial dentures. Because Class III removable partial dentures are supported by teeth or dental implants at both ends of an edentulous space, denture bases generally do not rotate or lift away from the underlying tissues. Therefore, compensation for rotational forces is not needed.

There are a few things that should be kept in mind when designing a Class III removable partial denture. First, support should be provided entirely by the abutment teeth. Due to the favorable distribution of abutments, Class III removable partial dentures often function like fixed prostheses. Residual ridges should be used for support only when edentulous spans are long or abutments display decreased periodontal support.

It is also important to remember that appropriate direct retention must be incorporated into the design. Class III removable partial dentures do not tend to move in function. Consequently, a wide variety of retentive elements may be used in Class III applications. Direct reten-

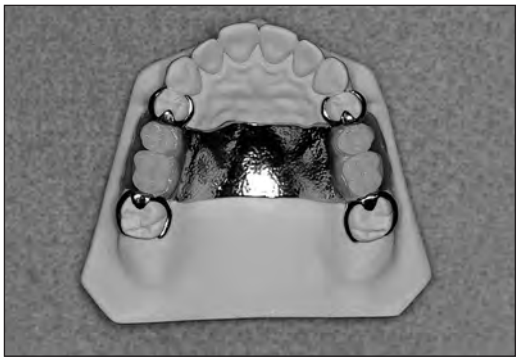

Fig 1-40 Representative Class III removable partial denture (Kennedy Class III, Modification 1).

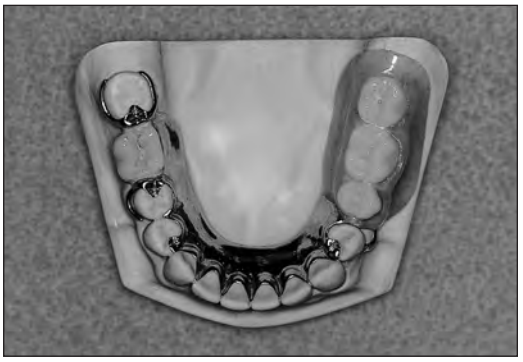

Fig 1-41 Representative Class II removable partial denture (Kennedy Class II, Modification 1).

Fig 1-42 Representative Class IV removable partial denture.

tion is needed only to prevent dislodgement of the prosthesis. The characteristics of commonly used clasping assemblies are presented in chapter 3.

Finally, one must keep in mind that indirect retention generally is not necessary. Since Class III removable partial dentures do not tend to move or rotate in function, there is no need for indirect retention. However, if direct retention cannot be obtained on one or more abutment teeth, indirect retention may be required.

Class II removable partial dentures

A Class II removable partial denture must embody features of both Class I and Class III designs (Fig 1-41). The unilateral distal extension side must be designed as a Class I removable partial denture, whereas the tooth-supported side must be designed as a Class III removable partial denture. The prosthesis must include a well-adapted denture base, properly designed direct retention, and appropriately positioned indirect retention.

Class IV removable partial dentures

A Class IV design should be regarded as a Class I removable partial denture in reverse, particularly if the edentulous span is lengthy (Fig 1-42). As previously noted, the prosthesis must include a well-adapted denture base, properly designed direct retention, and appropriately positioned indirect retention.

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2

Major Connectors, Minor Connectors, Rests, and Rest Seats

Each component of a removable partial denture has a name that is descriptive of its function. For example, a major connector serves as the principal method for connecting the opposing sides of a removable partial denture. A minor connector joins smaller components to the major connector. A rest contacts the surface of the abutment tooth to prevent movement of the removable partial denture toward the underlying tissues. A clasp assembly grasps an abutment tooth and resists removal of the prosthesis. Components of a clasp assembly are further classified as retentive and reciprocal elements based upon their primary functions. Retentive clasps are designed to keep a removable partial denture in position, while reciprocal clasps are intended to brace abutment teeth upon insertion and removal of the prosthesis. Representative components are displayed in Figs 2-1 to 2-13.

Every removable partial denture will have some or all of the following components:

- Major connector
- Minor connectors
- Rests
- Direct retainers/clasps
- Indirect retainers
- One or more denture bases in conjunction with prosthetic teeth

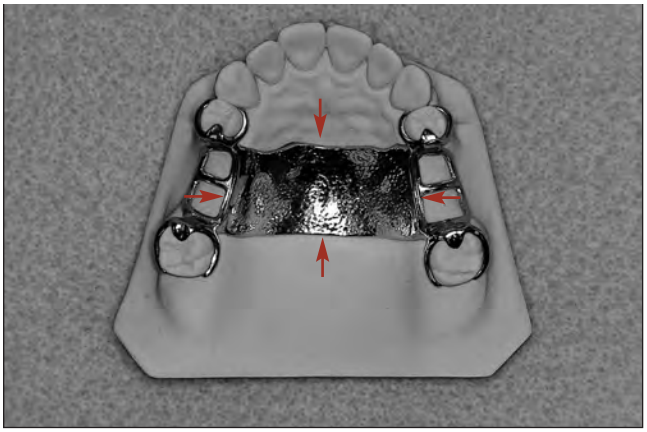

Fig 2-1 A major connector *(arrows)* is a relatively large, rigid band of metal that joins components on the right and left sides of a removable partial denture.

The first three components are considered in this chapter, while the remaining components are presented in chapter 3.