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Aesthetic criteria in removable partial dentures

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Prosthetic
in Partial Fulfillment for the Bachelor of Dental Surgery

By

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Certification of the Supervisor

I certify that this project entitled " **Aesthetic criteria in removable partial dentures** " was prepared by the fifth-year student **Fatima Saad Khalaf** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry

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Dedication

I humbly dedicate this piece of work to my father prof. Dr. Saad khalaf for his outmost support and endless inspiration throughout the journey. Thank you for being a great role model from the very beginning. Thank you for all the knowledge and all the great things that you taught me, I would've never thought of becoming who I am today without your guidance.

To my mother for her presence through all the tough times, guidance, and for always being a safe shoulder that I will never stop coming back to.

To my brother for never letting my hands, and for always being there for me.And to the soul of my grandfather and grandmother, may they rest in peace.

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Introduction

Esthetic Removable Partial Dentures (RPDs) are dental prostheses that are designed to replace missing teeth in a way that is both functional and aesthetically pleasing. They are removable, meaning that they can be taken out of the mouth for cleaning and maintenance.

The design of esthetic RPDs is particularly important because patients often have high expectations for the appearance of their teeth. Poorly designed RPDs can result in functional or esthetic deficiencies, which can lead to patient dissatisfaction and complaints. To ensure that esthetic RPDs are designed properly, dentists use a variety of techniques and tools, including classification systems, surveyors, and attachments.

These tools help dentists to diagnose and design RPDs that meet the functional and esthetic requirements of the patient. In addition to design considerations, dentists must also consider the long-term maintenance of esthetic RPDs. This includes selecting attachments that are easy to maintain and limiting the use of attachments to those that meet the functional and esthetic requirements of the majority of patients.

Overall, esthetic RPDs are an important treatment option for patients who have lost teeth. By designing RPDs that are both functional and aesthetically pleasing, dentists can help patients to maintain their oral health and improve their quality of life. **(Goldstein et al., 2018).**

Managing partially edentulous patients is always a great challenge to dentists. With advancements in technology, treatment modalities for tooth replacement have been expanded.

Removable partial dentures, resin-bonded bridges and implant-supported prostheses are commonly prescribed treatment options for teeth replacement of

partially edentulous patients. The removable partial denture has a wide scope of applications. It can replace multiple missing teeth in a single prosthesis and provide replacement to the loss of hard and soft tissues.

For patients who anticipate further tooth loss, simple modifications can be made to the existing denture that has incorporated components to accommodate the future loss with good planning in advance. It is often regarded as a reversible treatment option and does not preclude the more complex future modalities. **(van der Sanden et al., 2002).**

Hence, it is useful as a definitive prosthesis as well as a temporary prosthesis or a diagnostic tool prior to the next phase of treatment.

A well-designed removable partial denture can replace the loss of hard and soft tissues, restore masticatory function and maintain arch integrity. It is relatively simple, non-invasive and economical compared to other treatment options. Removable partial denture is therefore a common option among various treatment replacing missing teeth.

A removable partial denture replacing anterior missing teeth can improve esthetics and hence the patient's quality of life. However, metal components of a removable partial denture may be visible and affects patient satisfaction. Esthetics of a removable partial denture can often be improved with some modifications to traditional designs. **(Yeung et al., 2020).**

Aims of the study

- The aims of this review are to discuss the aesthetic criteria in removable partial dentures (RPDs) and how they can be designed to replace missing teeth in a functional and aesthetically pleasing way.
- The review covers various aspects of RPD design, the importance of esthetics, different clasping options, and the role of attachments, digital design, and esthetic enhancement.
- Additionally, the review discusses the use of a detachable 3D-printed diagnostic denture and a removable partial denture with a polyetheretherketone framework to restore missing teeth in a patient with high aesthetic expectations.

The ultimate goal of this review is to emphasize the importance of designing RPDs that are both functional and aesthetically pleasing to improve patients' quality of life.

CHAPTER ONE

REVIEW OF LITERATURE

Chapter one

Review of the literature

1.1 Overview

Prosthodontics is an area of dentistry focused on improving oral function and esthetics. Prostheses are used not only to restore partial and total edentulism but also to restore tooth damage. Thus, they must achieve harmony in shape and color with the lips, gingiva, smile, and face. Nowadays, esthetic considerations are the most common motivation for patients seeking prosthodontic treatment **(Larsson *et al.*, 2010).**

The esthetic concept in prosthodontic refers to the definition of esthetic in dentistry, which is the theory and philosophy that deal with beauty and the beautiful, especially with respect to the appearance of dental restoration, as achieved through its form and or color; those subjective and objective elements and principles underlying the beauty and attractiveness of an object, design, or principle**(Dannemand and Øzhayat, 2014).**

An essential consideration in the pursuit of orofacial esthetics is the concept of body image, defined as each individual's mental picture of his or her appearance. The role of esthetics in prosthodontic treatment is strongly related to the individual's self-esteem, psychosocial perspective, and, ultimately, his/her quality of life**(Parashar *et al.*, 2015).**

Therefore, esthetic interpretation during oral reconstruction should not be simply a subject of personal taste, from either the clinician's or patient's point of view. The patient's perception of his/her oral health status, including esthetic perception as a subjective measure, is a significant component for measuring treatment outcomes **(Michaud *et al.*, 2012).**

This subjectivity makes the assessment of esthetics challenging because the final result has to satisfy the patient's esthetic perception, which should be one of the outcomes measured in prosthodontic treatment**(Leles *et al.*, 2008).**

Clinical assessment is an important process to ensure successful prosthodontic treatment outcomes. Generally, esthetic analyses of prosthodontic treatment consist of several parameters, including facial, dentilabial, tooth, gingival, and smile analyses**(van der Geld, 2009).**

Some experts have separated dental and facial esthetics into macro elements and microelements **(McLaren and Culp, 2013).**

A previous study established seven quantifiable parameters for orofacial esthetics from a literature review: smile line, lip line, incisal offset, location of the dental and facial midline, incisor angulation, and width-to-height ratio of anterior maxillary teeth, gingival contour and root coverage, and papilla height**(Frese, Staehle and Wolff, 2012).** However, there are no specific esthetic guidelines developed by a consensus of esthetic experts and the clinical evaluation; therefore, it often varies.

Esthetic perception is subjective for both clinicians and patients. Age, gender, and psychosocial factors influence patients' perception and both gender and culture have been reported to influence the clinician's judgment of esthetics**(Mehl *et al.*, 2011).** The esthetic conception is abstract and subjective; therefore, formulating a concrete treatment goal and good communication between dentists and patients is essential. Valid and reliable instruments are needed to systematize and accelerate this process**(Mursid, Maharani and Kusdhany, 2020).**

Figure 1.1 Photograph of a smile with normal aesthetic parameters(Mursid, Maharani and Kusdhany, 2020).

1.2 RPD Design

Providing a useful and comfortable RPD requires careful diagnosis, planning, and maintenance**(Benso *et al.*, 2013).**

Previously noted failure rates of RPDs have led many to conclude that RPDs are harmful to periodontal tissue and may contribute to carious lesion formation**(Mojon, Rentsch and Budtz-Jørgensen, 1995).** However, more recent studies have concluded that while the risk of root caries and gingivitis increases, periodontal diseases generally occur only in patients with poor hygiene and/or a poorly constructed RPD**(Benso *et al.*, 2013).**

Poor RPD design can exacerbate plaque retention problems, so practitioners should always consider the partial denture design that will best preserve the abutment teeth and edentulous ridges**(Davenport *et al.*, 2000).** The steps involved in RPD-related therapy include the evaluation of abutment teeth, abutment tooth position, abutment preparation, adapting the RPD metal framework, relating the edentulous areas to the metal framework, communication with the laboratory, patient education for home care and maintenance, and regular professional recall**(Bohnenkamp, 2014).**

Because partially dentate patients may have lost their teeth because of poor oral hygiene, home maintenance hygiene, caries intervention strategies, and

appropriate use of their removable prosthesis are important for minimizing future complications**(Featherstone, Singh and Curtis, 2011).**

Accurate custom planning and fabrication of the RPD for each patient is a critical component of success. Variables such as hard/soft tissue anatomy, occlusal relationships, tooth position, and patient desires for esthetics and comfort should dictate the RPD design that can best meet the individual patient's needs**(Bohnenkamp, 2014)**

Traditional RPD design involves the production of stone casts, geometric characterization of the tooth and soft tissues related to the path of insertion, and careful designation of RPD components (major and minor connectors, rests, clasps, and base retention) using a direct waxing method(Viswambaran and Sundaram, 2015). Current digital technologies enable the design of RPD components on 3-dimensional (3D) representations of the patient instead of stone casts by using geometric analysis tools that create designs of micrometer-level accuracy that can be viewed in cross section. The virtual model can then be used to print wax for casting metal frameworks or the direct printing or milling of metal or resin frameworks**(Campbell *et al.*, 2017).**

Figure 1.2 Labial view of a different RPD with an equipoise clasp on tooth 22, satisfying the aesthetics as the clasp assembly is inconspicuous(Campbell *et al.*, 2017).

1.3 Materials and their impact on esthetic RPDs

1.3.1 Metal-based frameworks

The earliest dentures were often fabricated with metal(Becker, Kaiser and Goldfogel, 1994). Biocompatible metals such as cobalt-chromium or titanium are the current metals of choice for RPD frameworks**(Schwitalla *et al.*, 2015).**

The benefits of metal-based frameworks over acrylic resin are that they are used in thin sections and are less bulky, provide high strength and stiffness, conduct heat and cold for a more natural experience, enable designs that minimize the covering of the gingival margins allow for a stable denture base, undergo repassivation, and are resistant to corrosion**(Wiesli and Özcan, 2015).**

The use of titanium to form RPDs has increased and is often recommended for large RPDs(Ohkubo, Hanatani and Hosoi, 2008)Although titanium has become a proven biocompatible metal, it can cause inflammatory reactions in an estimated 0.6% of patients**(Schwitalla *et al.*, 2015).**

In addition to potential hypersensitivity other disadvantages of metal RPDs include esthetic issues with metal display, oral galvanism, adverse tissue reactions, osteolysis of abutment teeth, and biofilm production **(Wiesli and Özcan, 2015).**

Although cobalt-chromium is widely considered the best material for a denture framework, the physical properties of the material itself are not ideal. Keltjens et al investigated the fit of retainers after 8 years of normal use and found that the majority of metal clasps were distorted and that over time they did not fit the abutment correctly**(Keltjens *et al.*, 1997).**

Another group later investigated the physical properties of cobalt-chromium clasps and applied a validated nonlinear finite elemental model that revealed the patterns of stress and strain distributions of different metals during RPD use**(Mahmoud, Wakabayashi and Takahashi, 2007).**

Through this method, they were able to characterize how cobalt-chromium distorts under the stress produced during RPD use and outline the physical limitations of the material for use in retentive clasps**(Mahmoud, Wakabayashi and Takahashi, 2007).**

1.3.2 Polymer-based frameworks

Because of the drawbacks of metal-based frameworks, the use of metal-free Materials, including high-performance polymers such as polyethylene glycol polymethyl methacrylate, and aryl-ketone polymers, has been investigated**(Wiesli and Özcan, 2015).**

Some advantages of polymer-based frameworks over those made of metal are that they improve esthetics because of their translucency and color, are more cost-effective, have higher elasticity, are straightforward to produce, are lightweight, have low water sorption and solubility, and are easily repaired and reproduced**(Campbell *et al.*, 2017).**

Table 1.1 Advantages and disadvantages of metal and polymer RPDs (Najeeb *et al.*, 2016),(Vojdani and Giti, 2015),(Zohdi, Emami and Shahverdi, 2012).

Characteristics	Metal rpds	Polymer rpds
Esthetic	Less desirable none esthetic clasps and frames	More desirable potentially translucent or tooth/ gingival colored
Cost effectiveness	More expensive	Less expensive
Elastic modulus	More desirable	More desirable
Flexural strength	More desirable , 2500 mpa	Less desirable , 100 mpa
Ease of repair	Alloy requires soldering, and repairs are difficult and unpredictable.	Unknown.
Ease of formation	Less desirable Difficult to form, requiring special equipment	More desirable compatible with existing digital milling and design platforms.
Ease of handling	Less desirable Difficult to polish, requires special equipment, difficult to adjust.	More desirable Easy to polish and adjust.
Toxicity	More desirable sensitization to nickel and possibly cobalt	More desirable Generally no cytotoxicity and rare severe reactions/allergic reactions
Others	More desirable Conducts heat/cold, oral galvanism	More desirable no metallic taste, good thermal insulator

1.4 Meaning of esthetic for removable partial denture

Esthetic for removable partial dentures refers to the appearance of the denture when it is in place. It is important to ensure that the denture is in harmony with the patient's facial features, such as the interpapillary line, eyebrows, and hairline. Additionally, the occlusal plane should be parallel to the patient's ala-tragus line (Camper's plane). The length and positioning of the lateral incisors can also affect the esthetic of the denture; as slight variations can create a soft or bold effect**(Aschheim, 2014).**

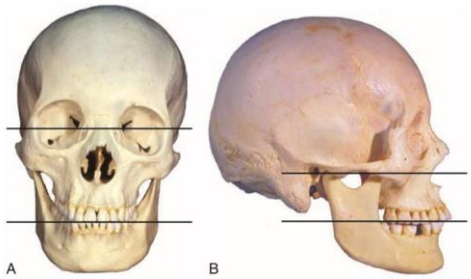

Figure 1.3 The ideal occlusal plane viewed in the frontal (A) and sagittal (B) planes(Aschheim, 2014).

1.5 Color matching and size, shape, contour and shade selection in RPDs

When fabricating a removable partial denture, the teeth selected should match the size, shape, shade, and contour of the adjacent teeth. In some cases, it may be necessary to contour or stain the artificial tooth to match the adjacent teeth.

There is also a technique to modify the shade, contour, and occlusal contacting surfaces of denture teeth with light-polymerized composite resin, which can be used to improve the esthetic appearance of the prosthesis.

The acrylic denture base resin should be contoured to match the size and contour of the adjacent teeth, and the artificial teeth should be positioned to simulate

the position of the natural teeth. If natural teeth remain, they may be used as a guide for placing the artificial teeth in a harmonious arrangement.

Overall, the goal is to create a prosthesis that is esthetically pleasing and blends in with the patient's natural dentition**(Goldstein *et al.*, 2018).**

1.6 Facial and dental esthetic considerations in RPDs

Firstly, the design of an RPD must value both the mechanics and the biologic considerations. The structures supporting a partial denture, teeth, and residual ridges are "living things" subjected to forces. The attributes, frequency, and magnitude of the force will foretell the success or failure of the RPD and remaining dentition.

Secondly, the design of an RPD must take into account the patient's expectations for the appearance of their teeth. Poorly designed RPDs can result in functional or esthetic deficiencies, which can lead to patient dissatisfaction and complaints.

Thirdly, the design of an RPD must consider tooth morphology when evaluating potential abutment teeth. Clinical crown contours and occlusion will often dictate direct retainer, major and minor connector selection, and rest seat placement. Fourthly, the design of an RPD must consider the use of dental attachments to minimize metal display and enhance esthetics. Camouflaging of RPD clasps, including the addition of acrylic or composite resin, has been reported in the literature.

Finally, the design of an RPD must consider the use of a surveyor for diagnostic cast analysis, contouring abutment tooth restorations, placement of attachment retainers, and milling internal rests and reciprocal elements. The survey objectives include the determination of an acceptable path of insertion to eliminate interference with placement or removal of either hard or soft tissues, identification of proximal tooth surfaces to be made parallel to act as guiding planes for placement

and removal, location and measurement areas of teeth for undercut and suitable esthetic clasp placement, delineation of heights of contour, and recording of cast position, or tripod, for future reference**(Goldstein *et al.*, 2018).**

1.7 The importance of esthetic reference plane

The Esthetic Reference Plane (ERP) is an important concept when fabricating a restoration. It is the ideal plane established by the incisal and occlusal surfaces of the teeth, or in the case of edentulous patients, the surface of wax occlusion rims contoured to guide in the arrangement of denture teeth.

It is critical to the esthetic success of the restoration that the patient's ERP be recorded by the clinician and then communicated to the technician. The ERP helps to ensure that the denture is in harmony with the patient's facial features and is parallel to the patient's ala-tragus line**(Aschheim, 2014).**

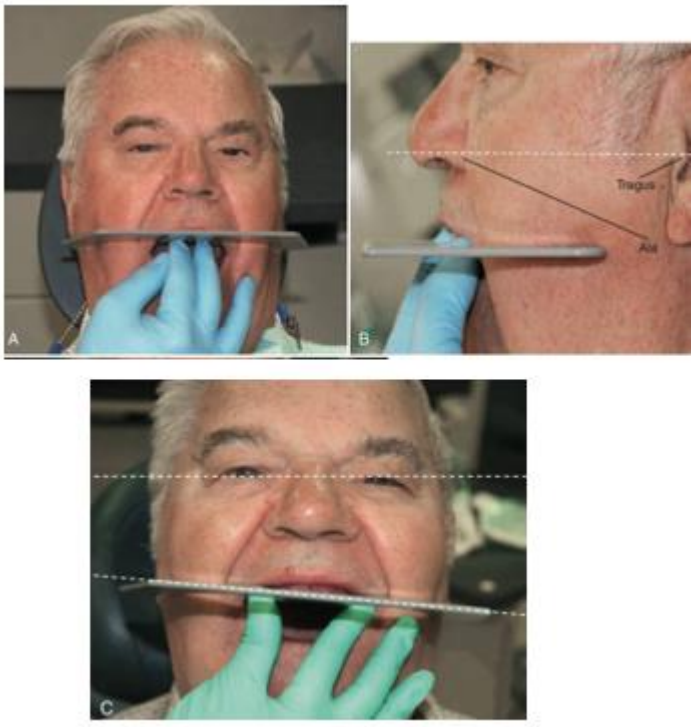

Figure 1.4 The establishment of ERP(Aschheim, 2014).

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Figure 1.4 shows (A) Frontal view of patient with Bite plane demonstrating an acceptable parallel to the patient's interpupillary line. (B) Sagittal view of patient with Bite plane demonstrating an acceptable parallel to the patient's ala-tragus line (Camper's plane). (C) Bite plane demonstrating that the occlusal wax rim is not parallel to patient's interpupillary line**(Aschheim, 2014).**

1.8 Esthetic criteria for tooth position

Esthetic criteria for tooth position includes mesial inclination, labiopalatal inclination, and rotation. A slight mesial inclination is most common for the lateral incisors and creates a soft effect, while no inclination will produce a bold effect.

Positioning the lateral incisor with a labial inclination greater than that of the central incisors creates a soft effect, while a labiopalatal inclination similar to that of the central incisor creates a bold effect. Rotation of the lateral incisors can also create a soft or bold effect, depending on the degree of mesial flare**(Aschheim, 2014).**

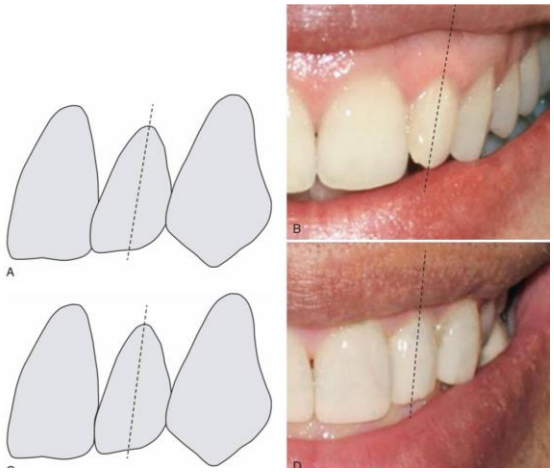

Figure 1.5 soft effect of the lateral incisor (A). the bold effect of the lateral incisor (B)(Aschheim, 2014).

As shown in Figure 1.5, The lateral incisor is set with a mesial inclination creating a soft effect (A). The lateral incisorsare set with no mesiodistal inclination creating a bold effect(B)**(Aschheim, 2014).**

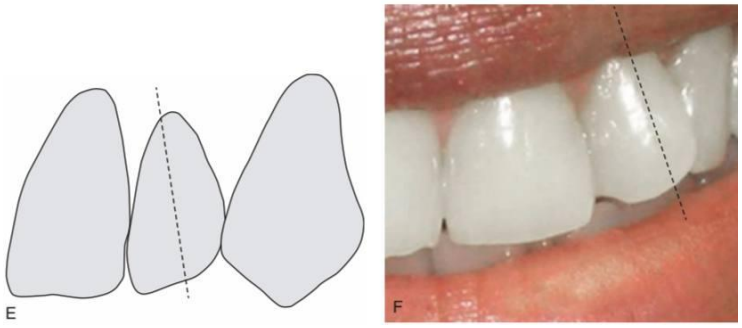

Figure 1.6 undesirable esthetic effect(Aschheim, 2014).

The lateral incisoris set with adistal inclination creating an undesirable esthetic effect as shown in Figure 1.6 **(Aschheim, 2014).**

Figure 1.7 a bold effect of the lateral incisor (A). a soft effect of the lateral incisor (C)(Aschheim, 2014).

Figure 1.7 shows the Lateral incisors set with a labiopalatal inclination similar to the centralincisors creates a bold effect(A). Lateral incisors set with more labial inclination than the central incisors creating a soft effect(C).

While figure 1.8 shows (A) creates a soft youthful appearance (B) the lateral incisor with no inclination and no elevation, which creates a bold effect. (C) the labiopalatal inclination is determined by its relationship to the labiopalatal of the lateral incisor inclination of the central incisor and is easily visualized using the surface of the table as a reference plane. (D) Lateral incisor labiopalatal inclination set simi-larto central incisor. (E), (F). Lateral incisors set with slight mesial flare accentuating mesial highlights**(Aschheim, 2014).**

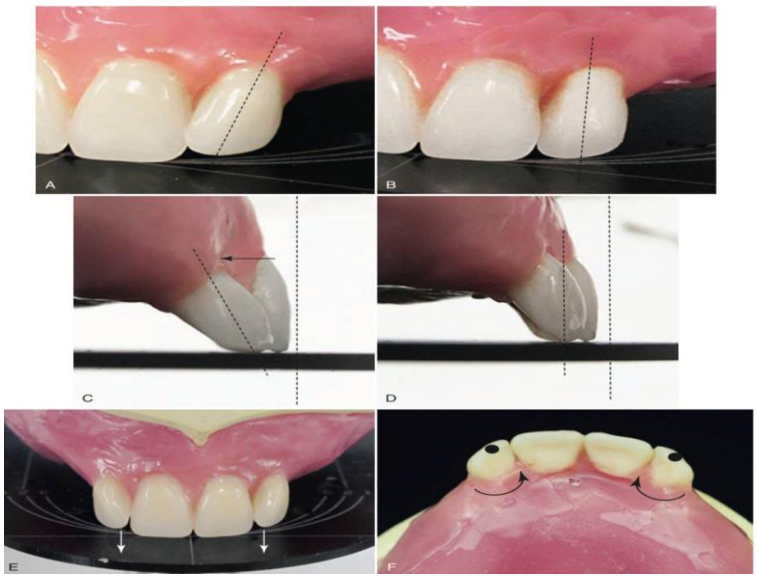

Figure 1.8 a soft youthful appearance (A) a bold effect (B)The labiopalatal inclination (C)Lateral incisor labiopalatal inclination (D) Lateral incisors set with mesial flare (E), (F)(Aschheim, 2014).

Maxillary	Central	Lateral	Canine
Mesial-distal inclination 	No-inclination	**Soft** Mesial **Bold** No **Never** Distal	**Soft** Mesial **Bold** No **Never** Distal
Labial-palatal inclination 	**Class 1** none **Class 2** palatal **Class 3** labial **Both centrals same inclination**	**Soft** Labial **Bold** No **Never** Palatal	**Always** Palatal **Never** Labial
Rotation 	**Soft** Follow arch-form **Bold** Distal-flare **Never** Mesial flare	**Soft** Follow arch-form **Softer** Mesial flare **Bold** Distal-flare	**Always** Follow arch-form **Never** Distal-flare
Height 	No-elevation	**Old** No-elevation **Youth** Degrees of elevation	No-elevation

Figure 1.9 The various tooth positions and their esthetic effects for the maxillary anterior teeth(Aschheim, 2014).

1.9 Rules of dental esthetic in removable dental prosthesis(Aschheim, 2014)

The rules of dental esthetics in removable dental prosthesis include:

1. the incisal surfaces should have a pleasing parallelism to the patient's facial features;
2. the posterior occlusal surfaces should correspond to an imaginary plane established by the inferior border of the ala of the nose and the superior border of the tragus of each ear (Camper's plane);
3. the incisal two-thirds of the tooth should be perpendicular to the table surface;
4. the incisal and/or occlusal surfaces should be in harmony with the patient's ERP;

5. the length and positioning of the lateral incisors should create a soft or bold effect; and
6. the surface of the maxillary occlusal wax rim should be parallel to the patient's interpupillary line.

The use of a surveyor related to esthetics in the design of removable partial dentures (RPDs)

The surveyor is a fundamental instrument for RPD design and treatment planning. It is also indispensable for the dental laboratory technician to fabricate an RPD and fabricate supportive elements such as surveyed, telescopic, or attachment restorations.

The surveyor is used to determine an acceptable path of insertion to eliminate interference with placement or removal of either hard or soft tissues. It is also used to identify proximal tooth surfaces to be made parallel to act as guiding planes for placement and removal. The surveyor is used to locate and measure areas of teeth for undercut and suitable esthetic clasp placement. The surveyor is also used to delineate heights of contour and record the cast position, or tripod, for future reference. An esthetic determinant of the survey is establishing one path of placement to minimize the retentive element and acrylic resin or denture base display.

Retentive areas may influence the placement of retentive elements, so areas of retention should be selected to enhance the esthetic value of the RPD. In summary, the use of a surveyor is essential in the design of esthetic RPDs It helps to ensure that the RPD is designed properly, taking into account the patient's expectations for the appearance of their teeth. The surveyor helps to determine an acceptable path of insertion, identify suitable esthetic clasp placement, and record the cast position for future reference**(Goldstein *et al.*, 2018).**

Biomechanics related to esthetics in the design of removable partial dentures (RPDs)

The design of an RPD must value both the mechanics and the biologic considerations. The structures supporting a partial denture, teeth, and residual ridges are "living things" subjected to forces. The attributes, frequency, and magnitude of the force will foretell the success or failure of the RPD and remaining dentition.

The forces imparted to the RPD and its supportive elements should be as widely distributed as possible. The periodontal health and support of the natural teeth should be considered in the selection of an attachment design.

The forces should be equitably distributed over as many teeth as possible within the biologic and physiologic capacity of the supportive dentition. The denture bases should offer the broadest support possible for mucosal coverage.

Distal extension situations raise the dilemma of load distribution between the teeth and mucosa. The amount of soft-tissue support and the quality of the residual ridge are important factors in the design of an RPD.

The design of an RPD must take into account the patient's expectations for the appearance of their teeth.

The use of dental attachments is discussed in the text as an alternative treatment modality for esthetic RPDs.

The selection of the attachment type should be based on the biomechanical, physiologic, and functional attributes of the patient or technical expertise of the dental team. The health and morphology of the abutment teeth remain a significant factor in the selection of an attachment.

Short clinical crowns prove to be the foremost contraindication to the use of attachments in the fabrication of RPDs.

In summary, biomechanics is an important consideration in the design of esthetic RPDs. The design must value both the mechanics and the biologic considerations of the supportive structures.

The forces imparted to the RPD and its supportive elements should be as widely distributed as possible, and the design should take into account the patient's expectations for the appearance of their teeth. The use of dental attachments is discussed as an alternative treatment modality for esthetic RPDs, and the selection of the attachment type should be based on the biomechanical, physiologic, and functional attributes of the patient or technical expertise of the dental team**(Goldstein *et al.*, 2018).**

1.10 Smile line esthetics in removable dental prosthesis

Smile line esthetics in removable dental prosthesis includes setting the canine into contact with the surface of the flat mounting table, which creates a soft, youthful appearance.

The labiopalatal inclination of the lateral incisor is determined by its relationship to the labiopalatal inclination of the central incisor and is easily visualized using the surface of the table as a reference plane.

The lateral incisors can be set with a slight mesial flare to accentuate mesial highlights, or with a distal flare to shift the highlights to the middle of the tooth and create a bold effect. Combining mesial and distal flares can also create a special esthetic effect**(Aschheim, 2014).**

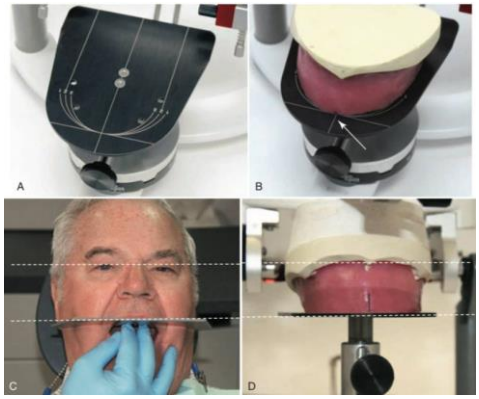

Figure 1.10 the flat mounting table(Aschheim, 2014).

As shown in Figure 1.10, (A) The flat mounting table has etchings that facilitate the average valuemounting of the maxillary cast and individual arch form options. (B), The maxillary occlusal wax rim is positioned to the cross-marks on the flatmounting table matching theclinically marked midline of the maxillary occlusal wax rim to the midline etching of the table. After the maxillary cast is mounted(C), the surface of the flat mounting table represents the patient's ERP(D)**(Aschheim, 2014).**

1.11 Role of esthetic in Removable Prosthodontic Treatment

Esthetics play an important role in removable prosthodontic treatment. Esthetic considerations are important when restoring anterior edentulous extension defects, as the use of an RPD may provide a more predictable esthetic outcome than implant-retained prostheses.

The use of I-bar retainers in the esthetic zone can also help to minimize the visual display of the retainers engaging the anterior abutments. Additionally, the use of provisional restorations and treatment RPDs can help to establish the occlusal vertical dimension and a treatment position. Esthetic considerations are also important when restoring posterior edentulous extension defects, as the use of I-bar retainers can help to limit the visual display of the retainers during a high smile as shown in Figure 1.11**(Orellana and Beumer, 2019).**

Figure 1.11 Minimal metal display of the I-bar retainers offers a superior esthetic outcome in the esthetic zone compared to a circumferential clasp(Orellana and Beumer, 2019).

1.12 Esthetic criteria for Restoration of Posterior Edentulous Extension Defects

Esthetic criteria for restoration of posterior edentulous extension defects include the use of I-bar retainers in the esthetic zone, the use of attachments to eliminate retainers altogether, and the use of retained roots to support and retain anterior edentulous extension overlay RPDs.

Additionally, the use of a diagnostic wax-up/setup can help the clinician identify occlusal issues that need to be addressed as well as the proposed position and contours of the anterior teeth. Splinting the two teeth adjacent to the defect can also reduce the risk of overloading the natural tooth abutments**(Orellana and Beumer, 2019).**

Figure 1.12 (A) A unilateral distal-extension RPD. (B) Facial view(C) View with a high smile(Orellana and Beumer, 2019).

As shown in figure 1.12, (A) A unilateral distal-extension RPD. The canine has been fitted with a partial-coverage crown with a cingulum rest. Indirect retention is provided by the positive occlusal rest on the first premolar. (B) Facial view. (C) View with a high smile. Note the minimal display of the I-bar retainer. This is an 18-year follow-up photograph**(Orellana and Beumer, 2019).**

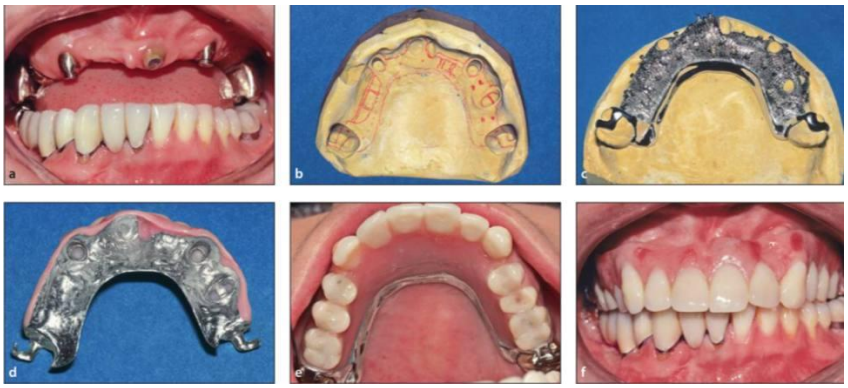

Figure 1.13 The use of retained roots to support and retain anterior edentulous extension overlay RPDs(Orellana and Beumer, 2019).

Figure 1.13 shows (A) Patient presents with posterior molars bilaterally and several retained roots treated endodontically, two of which have been fitted with attachments. (B) The RPD design. (C) The RPD casting. Note the opening through the top of the casting so that the matrix portion of the attachments can be retained in the denture base resin. (D) The intaglio of the definitive prosthesis. Note that all retained roots are covered with metal and that the rests on the molars have been extended onto the buccal surfaces. (E and F) The prosthesis in position. Note that the acrylic resin of the denture base has been characterized**(Orellana and Beumer, 2019).**

1.13 Esthetic clasping options for RPDs

1.13.1 Conventional clasp

The use of conventional clasping in esthetic regions of the mouth can present difficulties with patient acceptance. Proper surveying and mouth preparation may circumvent complications.

The text mentions two types of clasps: suprabulge and infrabulge clasps. Suprabulge clasps may approach undercuts from a suprabulge or infrabulge region. Proper abutment tooth selection for clasps and placement of the clasps far enough into the infrabulge or distal region will maximize the esthetic benefit.

Ideally, suprabulge clasps should be placed in the middle one-third of the tooth in the region of the proximal plate. The retentive tip should be located in the gingival one-third but not encroach on the free gingival margin.

Placing the suprabulge clasp in this manner will improve the esthetic result and diminish the torquing forces applied to the tooth by the clasp. Infrabulge clasps will generally provide more enhanced esthetics, although they may have limitations to their use owing to anatomic considerations.

The height of the vestibule, position of frena and soft tissue, or bony prominences may limit their application or necessitate preprosthetic surgery. The text also describes specific types of clasps, including the circumferential clasp, I-, Y-, T-, or modified T-bar clasp, embrasure clasp, and combination clasp.

The circumferential clasp is generally reserved for tooth-supported abutments in posterior regions of the mouth. The I-, Y-, T-, or modified T-bar clasp optimizes esthetics for patients with reasonably high lip lines or in situations where clasping of maxillary first or second premolars is indicated.

The embrasure clasp will be used in posterior regions of the mouth in the quadrant without an edentulous space, as in Class II situations. The combination clasp consists of a wrought wire clasp arm and cast reciprocal arm.

In summary, specific clasp types are related to esthetics in the design of RPDs. The use of conventional clasping in esthetic regions of the mouth can present difficulties with patient acceptance. Proper surveying and mouth preparation may circumvent complications**(Goldstein *et al.*, 2018).**

1.13.2 The circumferential clasp

The circumferential clasp is generally reserved for tooth-supported abutments in posterior regions of the mouth. It is a cast clasp of either a round or half-round configuration, both of which provide little flexibility. When serving as a retentive element, the circumferential clasp should only engage a 0.25 mm undercut to avoid excessive torquing of the tooth. This clasp may also serve as a bracing or reciprocal element and is positioned above the height of contour. Owing to the relative size (thickness and diameter) of this clasp, use of the clasp above the height of contour for reciprocation should be limited in esthetic regions of the mouth.

In situations where increased flexibility is necessary, but there is no place to remote solder a wrought wire clasp, such as the tooth-supported side of a Kennedy Class II arch, a cast round clasp may be used.

A 20-gauge cast round clasp has been shown to have the same flexibility as a 19-gauge wrought wire clasp.

In summary, the circumferential clasp is generally reserved for tooth-supported abutments in posterior regions of the mouth. When serving as a retentive element, it should only engage a 0.25 mm undercut to avoid excessive torquing of the tooth. This clasp may also serve as a bracing or reciprocal element and is positioned above the height of contour. The use of the circumferential clasp above the height of contour for reciprocation should be limited in esthetic regions of the mouth due to its relative size. In situations where increased flexibility is necessary, a cast round clasp may be used.

The infrabulge approach of this clasp optimizes esthetics for patients with reasonably high lip lines or in situations where clasping of maxillary first or second premolars is indicated. It is generally cast as part of the framework and can achieve undercut engagement of 0.25 mm on either the mesial or distal surfaces of the tooth. However, a common error is to place both tips of the T- or Y-bar clasp into an undercut, which can diminish esthetic value. The modified T-bar clasp eliminates the anterior arm and limits mesial undercut engagement, reducing torque and distal tipping of the tooth**(Goldstein *et al.*, 2018).**

1.13.3 The mesial groove reciprocation (MGR) clasp

The MGR clasp is indicated for maxillary teeth where esthetics is a concern. It incorporates a prepared mesial groove to provide reciprocation and a vertical mesial groove guiding plane 1-2 mm in length is prepared in the mesiolingual surface within the mesial marginal ridge enamel. To complete the abutment modification, the mesial reciprocation groove is extended over the mesial marginal ridge to terminate in a spoon-shaped mesial rest seat. The MGR clasp design is intended to minimize the display of metal and provide a more esthetically pleasing option for patients. However, it should be noted that adequate enamel is required for the preparation of the mesial groove and mesial marginal ridge, and the use of this clasp may not be possible in all cases**(Goldstein *et al.*, 2018).**

1.13.4 The embrasure clasp

The embrasure clasp is a suprabulge clasp that should have an adequate sluiceway prepared through the embrasure of the abutment teeth to allow for proximal rests and emergence of the suprabulge clasp arm elements near the height of contour. Adequate sluiceway depth will also provide for proper metal thickness to ensure rigidity and avoid occlusal interference from the opposing dentition.

The embrasure clasp is used in posterior regions of the mouth in the quadrant without an edentulous space, as in Class II situations, to avoid excessive distal extension of the major connector. However, it should be noted that the embrasure clasp may not be the most esthetically pleasing option for patients, as it is a suprabulge clasp and may be more visible than infrabulge clasps**(Goldstein *et al.*, 2018).**

1.13.5 The Rest-proximal Plate-I-bar (RPI) clasp

The RPI clasp is a conventional clasp that fulfills all requirements of a conventional clasp yet demonstrates minimal tooth coverage, relatively limited metal display, and an infrabulge approach. The mesioocclusal rest stabilizes the tooth and resists distal tipping. The design is indicated for distal extension situations and allows for disengagement of the clasp under occlusal force to the denture base. As with the T- or Y-bar, this infrabulge approach may not be desirable if adequate vestibular height is not present or anatomic structures, such as frena, are present. Infrabulge clasps may be more esthetically pleasing for patients with a low lip line**(Goldstein *et al.*, 2018).**

1.14 The Benefits of Use of I-bar retainers in the esthetic zone

The use of I-bar retainers in the esthetic zone offers a superior esthetic outcome compared to other types of retainers, such as circumferential clasps. The I-bar retainer can be positioned close to the gingival margin and is difficult to see during speech or even when the patient elevates the lip during a high smile. Additionally, the use of I-bar retainers can help to mitigate the visual display of the retainers engaging the anterior abutments in the esthetic zone**(Orellana and Beumer, 2019).**

Figure 1.14 The esthetic display of the I bar retainers during a high smile(Orellana and Beumer, 2019).

Figure 1.14 shows (A) The two central incisors adjacent to the edentulous extension areas have been splinted together, and a cingulum rest has been incorporated within the patient's right incisor. An ERA attachment has been attached to the splinted teeth. (B) The prosthesis in position. Additional bracing is provided by the extension of the framework through the canine-premolar embrasure. (C) The esthetic display during a high smile**(Orellana and Beumer, 2019).**

NOTE; The only clasp in relation to esthetics is the infrabulge approach of the I-, Y-, T-, or modified T-bar clasp, which optimizes esthetics for patients with reasonably high lip lines or in situations where clasping of maxillary first or second premolars is indicated**(Goldstein *et al.*, 2018).**

1.15 Role of attachments in esthetics of removable prosthesis

Attachments can be used to improve esthetic outcomes in removable prostheses. Resilient attachments, such as extracoronal resilient attachments (ERAs), allow up to 0.4 mm of compression into the denture-bearing tissues before the nylon patrix bottoms out within the cast metal matrix portion of the attachment. This helps to minimize the visual display of the attachment during a high smile. Additionally, the use of attachments can help to direct occlusal forces in the edentulous extension

area more vertically, which can help to reduce attachment wear and better direct occlusal forces axially**(Orellana and Beumer, 2019).**

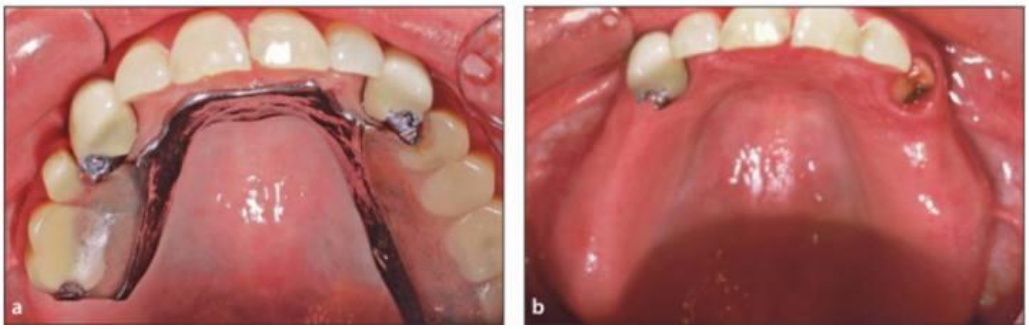

Figure 1.15 The use of the Rigid attachments(Orellana and Beumer, 2019).

Figure 1.15 shows (A and B) A patient with a posterior bilateral distal extension defect. Rigid attachments were used inappropriately on a tooth-mucosa–borne RPD. (B) The extension base portion of the prosthesis delivered can- tilever forces to the abutments, which soon led to the fracture of the abutment on the patient's left canine.

1.16 Esthetic criteria for Restoration of Anterior Edentulous Extension Areas

When restoring anterior edentulous extension areas, laboratory procedures should be followed to ensure optimal esthetic outcomes. The diagnostic cast should be surveyed with a 0-degree tilt to determine the adequacy of the undercut on the mesial surfaces of the anterior abutments and the distobuccal surfaces of the posterior abutments.

The cast should then be tilted upward anteriorly until the undercuts on the mesial surfaces of the anterior abutments are eliminated. Additionally, the type of clasp selected to attain optimal retention should be determined by the amount of undercut needed on the posterior abutment**(Orellana and Beumer, 2019).**

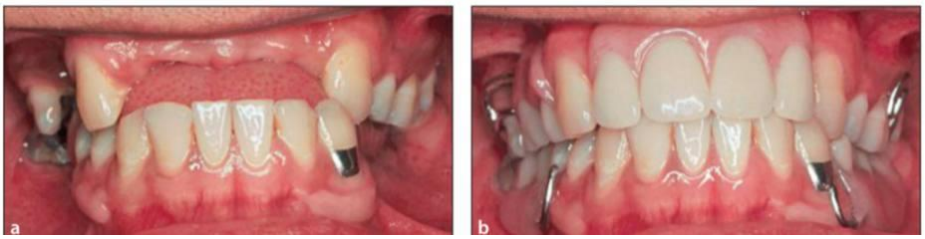

Figure 1.16 (A) A large anterior edentulous extension defect. (B) The anterior dentition was restored with a rotational path RPD(Orellana and Beumer, 2019).

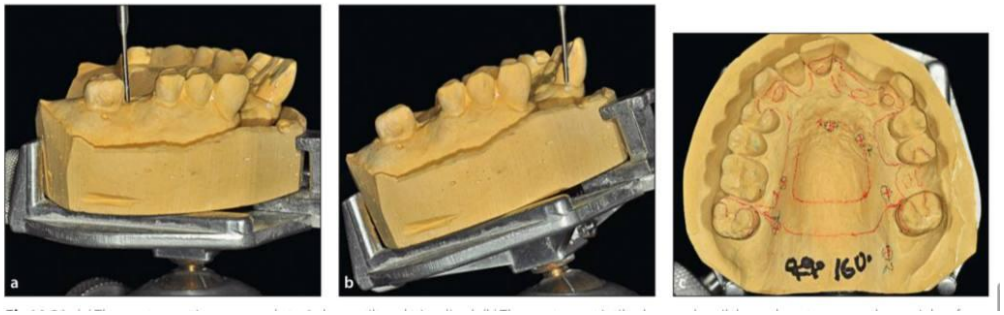

Figure 1.17 Laboratory procedures of the rotational path RPD design(Orellana and Beumer, 2019).

Figure 1.17 shows (A) The master cast is resurveyed at a 0-degree tilt and tripodized. (B) The master cast is tilted upward until the undercut areas on the mesial surfaces of the maxillary right central incisor and left canine are no longer present. A second set of tripod marks is completed. (C) The rotational path RPD design is drawn on the master cast. Note the two sets of tripod marks on the cast indicating both paths of insertion**(Orellana and Beumer, 2019).**

1.17 Esthetic Complications associated with inappropriate use of attachments

The use of attachments can improve esthetic outcomes, but there are some disadvantages and risks associated with their use. If the extension base does not maintain proper adaptation to the extension area, the RPD will act as a cantilever and

deliver torquing forces that could potentially destroy the natural tooth abutments. Additionally, attachment fatigue requires frequent changes of the matrix portion of the attachment apparatus**(Orellana and Beumer, 2019).**

1.18 Role of attachments and retained roots in removable prosthesis esthetics

Attachments and retained roots can be used to support and retain anterior edentulous extension overlay RPDs. The attachment selected must have a low profile to allow proper positioning of the denture teeth. Additionally, the design of the metal framework should ensure that all retained roots, including the tooth-tissue junction, are covered with metal to prevent rapid onset of caries and periodontal compromise**(Orellana and Beumer, 2019).**

1.19 Role of rotational path of insertion in removable partial denture esthetics

The rotational path of insertion is important for achieving optimal esthetic outcomes with removable partial dentures. It allows for an unobstructed path of insertion when rotating the prosthesis into position, which is particularly important when additional edentulous spaces exist posteriorly.

Interferences (tooth or soft tissue) that may impair the rotational path of placement must be adequately blocked out. Additionally, the cingulum rest should be positive in order to control the position of the abutment and direct the occlusal forces along the long axis of the tooth during function**(Orellana and Beumer, 2019).**

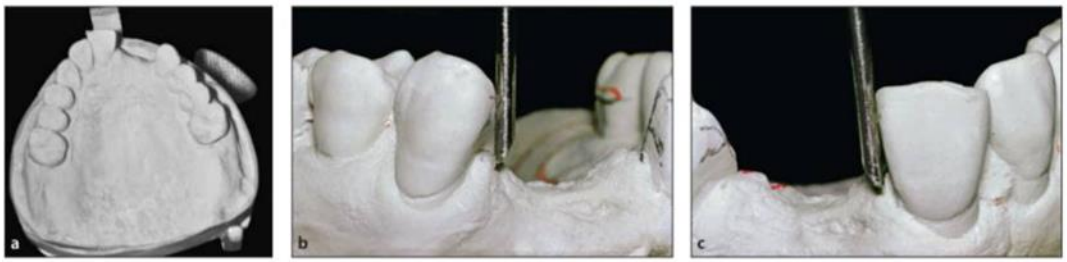

Figure 1.18 Diagnostic cast surveying(Orellana and Beumer, 2019).

Figure 1.18 shows (A) Maxillary diagnostic cast being considered for a rotational path RPD on the surveying table. (B and C) The cast is surveyed at approximately a 0-degree tilt initially, and the analyzing rod indicates undercut areas on the mesial surfaces of the maxillary right central incisor and left canine(Orellana and Beumer, 2019).

Figure 1.19 The cingulum rest(Orellana and Beumer, 2019).

The cingulum rest should be positive in order to control the position of the abutment and direct the occlusal forces along the long axis of the tooth during function as shown in Figure 20**(Orellana and Beumer, 2019).**

1.20 Digital design and esthetic enhancement

RPD-associated problems such as poor patient satisfaction and compromised function, esthetics, and oral health need to be addressed**(Levin, 2008).**

Improvements in the design, fabrication, fit, and esthetics of RPDs are essential and could be facilitated by the development of new materials with adequate strength and flexibility for occlusal rests, indirect retention, and retentive clasp assemblies. RPD frameworks made of novel materials with increased durability, improved strength, the desired balance between flexibility and rigidity, while improving the framework esthetics, would be broadly beneficial.

Digital technology and its application to the design and fabrication of a single tooth to a complete-arch prosthesis is advancing rapidly. Computer-aided design and computer-aided manufacturing (CAD-CAM) systems are being widely used in the design and fabrication of fixed, implant, and removable prostheses. CAD-CAM techniques have been investigated as a method of surveying 3D-scanned dental casts to create RPD frameworks**(Bohnenkamp, 2014).**

Dental laboratory technicians and clinicians are using software to design RPD frameworks from digital impressions obtained from both intraoral and laboratory-based digital scanning strategies. The primary obstacle preventing the broad application of a complete RPD digital workflow has been the difficulty and expense associated with producing the metal frameworks.

Digital dentistry using CAD-CAM technology, high-precision 3D printers and scanners, and industrial casting and production techniques can be expected to improve the fit, esthetics, and functional components of RPDs while reducing costs and labor, thus increasing efficiency and manufacturing outcomes. However, selective laser melting, milling, and other digital fabrication methods for metal frameworks are currently restrictive**(Bilgin *et al.*, 2016).**

Technology such as 3D scanners and denture design software modules promise advancements in RPD production with digitally designed RPDs that can be printed in wax and cast/fabricated conventionally**(Bohnenkamp, 2014).** Open-architecture scanners combined with design software can allow for a precise, digitally designed, machine-produced removable prosthesis that is tailor-made to each individual patient's needs**(Campbell *et al.*, 2017).**

Digital solutions allow the application of advanced materials that would otherwise not be used for RPD fabrication. Polymers would be of special interest because of their ease of milling/fabrication and desirable properties. The ability to design and produce the RPD digitally opens up the entire range of biomedical

polymers for the custom patient application that dentistry dictates. The potential for design control, manufacturing flexibility, and repeatable precision, coupled with the application of advanced materials, promises significant advances in RPD-based therapies**(Campbell *et al.*, 2017).**

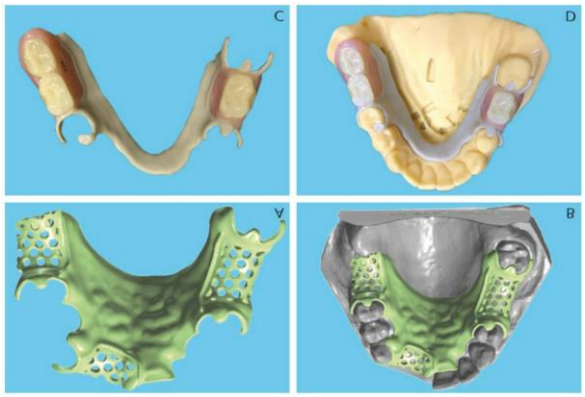

Figure 1.20 Computer-generated image of digitally designed RPD framework(Campbell *et al.*, 2017).

1.21 The use of a detachable 3D-printed diagnostic denture and a removable partial denture with a polyetheretherketone framework to restore missing teeth in a patient with high aesthetic expectations

Polyetheretherketone (PEEK) is a non-metallic material that has been introduced as an alternative framework material for removable partial dentures (RPDs). One of the main benefits of using PEEK as a framework material is its metal-free esthetics.

Unlike metal frameworks, PEEK frameworks are tooth-colored and blend in with the natural teeth, providing a more esthetically pleasing appearance. This can be particularly important for patients with high aesthetic expectations who may be concerned about the appearance of their RPD.

Additionally, PEEK is a biocompatible material that is resistant to corrosion, which can help to prevent the formation of biofilm and reduce the risk of hypersensitivity reactions. While long-term clinical studies are lacking, short-term follow-up studies have shown good outcomes with PEEK frameworks, making it a promising material for dental applications

The use of digital technology reduced the time and cost of the treatment and improved patient satisfaction. the use of polyetheretherketone (PEEK) as a material for removable partial denture (RPD) frameworks, which provides metal-free esthetics and good outcomes in short-term follow-up. However, long-term clinical studies are lacking, and further research is needed to address the limitations of PEEK and improve the accuracy of 3D-printed diagnostic dentures**(Wu *et al.*, 2022).**

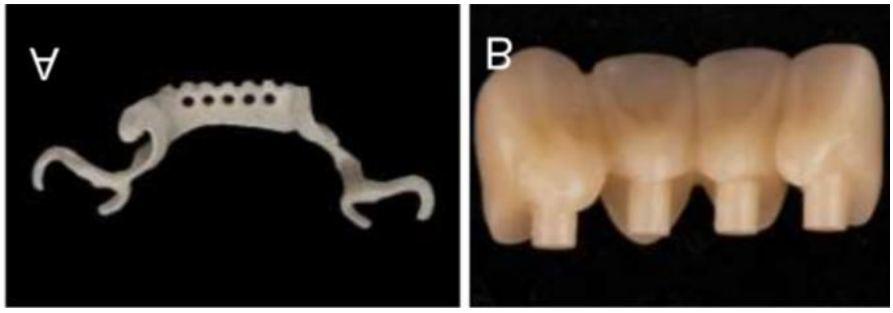

Figure 1.21 The milled PMMA dentition (A) and the PEEK framework (B)(Wu *et al.*, 2022).

1.22 The benefits of using a detachable 3D-printed diagnostic denture include(Wu *et al.*, 2022):

1. Improved patient satisfaction: The use of a 3D-printed diagnostic denture allows the patient to evaluate the possible outcome of the removable partial denture (RPD) and provides a more intuitive understanding of the restoration. This can help to calm the patient's

anxiety about the effect of the restoration and increase their satisfaction with the final result.

2. Reduced treatment time: Compared with traditional waxing, the fabrication of a 3D-printed diagnostic denture is faster and more convenient, reducing the time of the whole treatment.
3. Cost-effective: The use of digital technology reduces the time and cost of the treatment.
4. Accurate fit: The 3D-printed diagnostic denture can be disassembled into two parts, allowing for more accurate duplication of the denture and improving the accuracy of the fit.
5. Metal-free esthetics: The use of a 3D-printed diagnostic denture without metal can give the patient a different feeling from try-in of the waxing with Co-Cr framework, correcting their bad impression of RPDs and anxiety about the outcome.

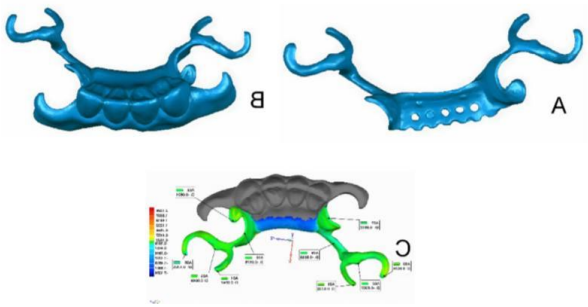

Figure 1.22 Digital model of the PEEK framework (Wu *et al.*, 2022)

1.23 Case report

A 53-year-old female presented multiple missing teeth, including 4 s molars, upper left first molar, four lower incisors and lower right canine. Embrasure clasp grooves had been prepared on lower left canine and lower left first premolar and a rest fossa was on the lower right first premolar. Her main concern is to restore the

lower anterior teeth without any implant involved, due to fear of the surgery, and long-span edentulous space of 5 teeth was not suitable for FDP(McGarry *et al.*, 1999). Previously, the missing teeth had been restored with a RPD in other clinic to the stage of waxing try-in. The waxing consisted of a cobalt-chromium (Co–Cr) alloy framework and 5 commercial resin teeth, but the expected outcome couldn't be achieved after 3 adjustments of the waxing. The patient expressed anxiety because she worried about the treatment effect may be as same as before**(Wu *et al.*, 2022).**

Figure 1.23 Preoperative photographs. Front view (A) and occlusal view (B)(Wu *et al.*, 2022).

Figure 1.24 Waxing try-in. The waxing with metal framework (A), smiling view (B), front view (C), and occlusal view (D)(Wu *et al.*, 2022).

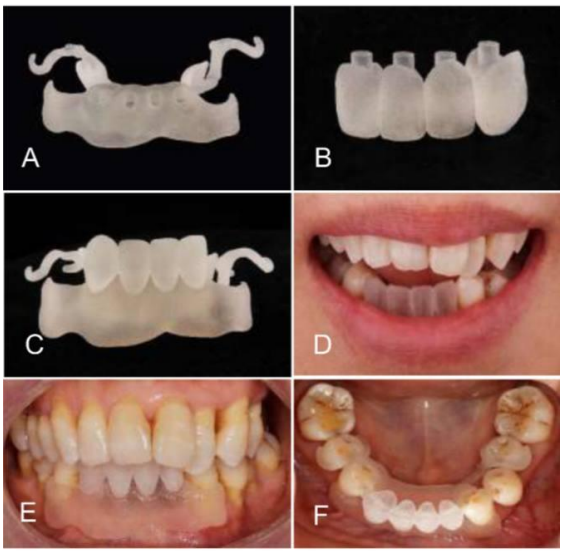

Figure 1.25 Trail of the 3DP diagnostic denture(Wu *et al.*, 2022).

Figure 1.25 shows The base and framework (A). The dentition (B). The two parts were combined together (C). Smiling view (C). Front view (D). Occlusal view (E)**(Wu *et al.*, 2022).**

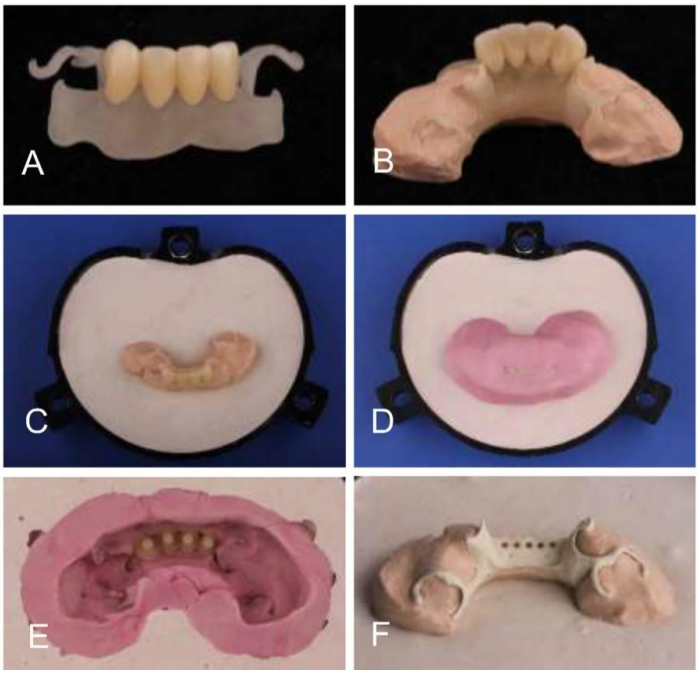

Figure 1.26 Fabrication of the RPD(Wu *et al.*, 2022).

Figure1.26 shows The combined denture, assembled by milled dentition on the 3DP diagnostic denture base (A). The combination containing bottom cast and the combined denture (B). The combination was embedded in the lower part of a flask filled with gypsum (C). Wrapped the combination with silicone impression material (D). The milled dentition was left in the tooth sockets (E). PEEK framework was mounted on the bottom cast (F)**(Wu *et al.*, 2022).**

Figure 1.27 delivered the definitive RPD. The definitive RPD (A). Smiling view (B). Front view (C). Occlusal view (D). (Wu *et al.*, 2022)

1.24 Measurement of patient satisfaction and compliance

Patient satisfaction with the prosthesis can have a profound impact on the success of treatment because dissatisfaction with an RPD will likely lead to underuse and subsequent rehabilitation failure. A retrospective study on factors that affect the continued use and patient satisfaction of RPDs found that 39% of RPDs were no longer used within 5 years and that patient age, location of the edentulous area, number of occluding teeth and rests, and pain all significantly affected patient satisfaction and consequently compliance(Koyama *et al.*, 2010). Additionally, the esthetic appearance of RPDs is particularly valued by patients and should be addressed to prevent lack of RPD use**(Fueki *et al.*, 2014).**

Because dentists tend to focus on the physical function of the teeth while patients are more concerned with the social implications of RPDs, understanding why patients stop wearing their RPDs is critical**(Koyama *et al.*, 2010).** Studies with long-term follow-up on patient satisfaction and compliance and multivariate analyses to control for the influence of multiple possible confounding variables are needed to further understand the impact of RPD therapy**(Ahmed *et al.*, 2020).**

1.25 Psychological effects of esthetic on patient

Oral health is a multifactorial state; according to the American Dental Association, it includes function, structure, esthetic, physiologic, and psychosocial aspects affecting an individual's quality of life. Recently, social media platforms and its influencers play a major role in shaping communities' perception of beauty and facial esthetics**(Dimitrios and Alali, 2014).**

Promoting a variety of methods to increase physical attractiveness and grow self-esteem and prestige, therefore, dental esthetics became a major concern to adults affecting their self-confidence. The psychological impact of dental esthetics is a significant component of oral health-related quality of life. Dental appearance significantly impacts an individual's social, psychological, and career interactions. People with healthy dentitions are perceived to be more socially competent, show greater intellectual achievement, and have better psychological adjustment**(Azodo and Ogbomo, 2014).**

An individual's social and psychological well-being is dramatically affected by their dental esthetics. Nowadays, young adults seek perfection and pursue unnecessary esthetic dental treatments. Therefore, more public awareness programs should be directed to educate our community about natural smile esthetics to help them make better choices when it comes to cosmetic dental procedures**(Ahmed *et al.*, 2020).**

CHAPTER TWO

CONCLUSION

Chapter Two

Conclusion

2.1 Conclusion

- The review concludes that designing Removable Partial Dentures (RPDs) that are both functional and aesthetically pleasing can help patients maintain their oral health and improve their quality of life.
- The design of RPDs is crucial to meet the high expectations of patients for the appearance of their teeth.
- Esthetic criteria for RPDs include color matching, size, shape, and shade selection, as well as facial and dental esthetic considerations.
- The use of diagnostic cast analysis, attachments, and digital design can enhance RPD designs.
- Materials for RPD frameworks, such as metal and polymer, have an impact on RPD esthetics.
- Patients' perception of their oral health status, including their esthetic perception, is a significant component for measuring treatment outcomes.
- Overall, good RPD design can replace the loss of hard and soft tissue and restore masticatory function while maintaining arch integrity.

References

A

- Ahmed, Y. T. *et al.* (2020) 'Dental esthetics and its effect on psychological well-being in a university hospital in Riyadh, KSA', *Saudi Journal of Oral Sciences*, 7(3), p. 189.
- Aschheim, K. W. (2014) *Esthetic dentistry: a clinical approach to techniques and materials*. Elsevier Health Sciences.
- Azodo, C. C. and Ogbomo, A. C. (2014) 'Self-evaluated dental appearance satisfaction among young adults', *Annals of medical and health sciences research*, 4(4), pp. 604–607.

B

- Becker, C. M., Kaiser, D. A. and Goldfogel, M. H. (1994) 'Evolution of removable partial denture design', *Journal of Prosthodontics*, 3(3), pp. 158–166.
- Benso, B. *et al.* (2013) 'Failures in the rehabilitation treatment with removable partial dentures', *Acta Odontologica Scandinavica*, 71(6), pp. 1351–1355.
- Bilgin, M. S. *et al.* (2016) 'A review of computer-aided design/computer-aided manufacture techniques for removable denture fabrication', *European journal of dentistry*, 10(02), pp. 286–291.
- Bohnenkamp, D. M. (2014) 'Removable partial dentures: clinical concepts', *Dental Clinics*, 58(1), pp. 69–89.

C

- Campbell, S. D. *et al.* (2017) 'Removable partial dentures: The clinical need for innovation', *The Journal of prosthetic dentistry*, 118(3), pp. 273–280.

D

- Dannemand, K. and Øzhayat, E. B. (2014) 'Recognition of patient-reported impairment in oral aesthetics', *Journal of Oral Rehabilitation*, 41(9), pp. 692–699.
- Davenport, J. C. *et al.* (2000) 'Removable partial dentures: an introduction', *British Dental Journal*, 189(7), p. 363.
- Dimitrios, X. and Alali, A. S. (2014) 'Investigating the attitude of the average Saudi towards the Social Media', in *The 13th International Conference on Applied Computer and Applied Computational Science (ACACOS'14), Kuala Lumpur, Malaysia*.

F

- Featherstone, J. D. B., Singh, S. and Curtis, D. A. (2011) 'Caries risk assessment and management for the prosthodontic patient', *Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry*, 20(1), pp. 2–9.
- Frese, C., Staehle, H. J. and Wolff, D. (2012) 'The assessment of dentofacial esthetics in restorative dentistry: a review of the literature', *The Journal of the American Dental Association*, 143(5), pp. 461–466.
- Fueki, K. *et al.* (2014) 'Clinical application of removable partial dentures using thermoplastic resin—Part I: Definition and indication of non-metal clasp dentures', *Journal of prosthodontic research*, 58(1), pp. 3–10.

G

- van der Geld, P. A. A. M. (2009) 'Smiling and speaking in a dental perspective. A dental and psychological approach to the smile line, tooth display, and smile attractiveness.' [Sl: sn].
- Goldstein, R. E. *et al.* (2018) *Ronald E. Goldstein's Esthetics in Dentistry*.

John Wiley & Sons.

K

- Keltjens, H. *et al.* (1997) 'Fit of direct retainers in removable partial dentures after 8 years of use', *Journal of oral rehabilitation*, 24(2), pp. 138–142.
- Koyama, S. *et al.* (2010) 'Evaluation of factors affecting the continuing use and patient satisfaction with removable partial dentures over 5 years', *Journal of prosthodontic research*, 54(2), pp. 97–101.

L

- Larsson, P. *et al.* (2010) 'Development of an Orofacial Esthetic Scale in prosthodontic patients.', *International Journal of Prosthodontics*, 23(3).
- Leles, C. R. *et al.* (2008) 'Assessing perceived potential outcomes of prosthodontic treatment in partial and fully edentulous patients', *Journal of Oral Rehabilitation*, 35(9), pp. 682–689.
- Levin, L. (2008) 'Dealing with dental implant failures', *Journal of Applied Oral Science*, 16, pp. 171–175.

M

- Mahmoud, A. A. A., Wakabayashi, N. and Takahashi, H. (2007) 'Prediction of permanent deformation in cast clasps for denture prostheses using a validated nonlinear finite element model', *Dental Materials*, 23(3), pp. 317–324.
- McGarry, T. J. *et al.* (1999) 'Classification system for complete edentulism', *Journal of Prosthodontics*, 8(1), pp. 27–39.
- McLaren, E. A. and Culp, L. (2013) 'Smile analysis', *J Cosmet Dent*, 29(1), pp. 94–108.
- Mehl, C. J. *et al.* (2011) 'Patients' and dentists' perception of dental

appearance', *Clinical Oral Investigations*, 15, pp. 193–199.

- Michaud, P.-L. *et al.* (2012) 'Measuring patient-based outcomes: is treatment satisfaction associated with oral health-related quality of life?', *Journal of dentistry*, 40(8), pp. 624–631.
- Mojon, P., Rentsch, A. and Budtz-Jørgensen, E. (1995) 'Relationship between prosthodontic status, caries, and periodontal disease in a geriatric population.', *International Journal of Prosthodontics*, 8(6).

- Mursid, S., Maharani, D. A. and Kusdhany, L. (2020) 'Measuring Patient's Orofacial Estheticsin in Prosthodontics: A Scoping Review of a Current Instrument', *The Open Dentistry Journal*, 14(1).

N

- Najeeb, S. *et al.* (2016) 'Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics', *Journal of prosthodontic research*, 60(1), pp. 12–19.

O

- Ohkubo, C., Hanatani, S. and Hosoi, T. (2008) 'Present status of titanium removable dentures–a review of the literature', *Journal of Oral Rehabilitation*, 35(9), pp. 706–714.
- Orellana, D. and Beumer, J. (2019) *Kratochvil's Fundamentals of Removable Partial Dentures*. Quintessence Publishing Company, Incorporated.

P

- Parashar, P. *et al.* (2015) 'A complete analysis of quality of life measure and esthetic component in indore population', *Journal of International Oral Health*, 7(10), p. 77.

S

- van der Sanden, W. J. *et al.* (2002) 'Noteworthy Abstracts of the'.
- Schwitalla, A. D. *et al.* (2015) 'Flexural behavior of PEEK materials for dental application', *Dental Materials*, 31(11), pp. 1377–1384.

V

- Viswambaran, M. and Sundaram, R. K. (2015) 'Effect of storage time and framework design on the accuracy of maxillary cobalt-chromium cast removable partial dentures', *Contemporary clinical dentistry*, 6(4), p. 471.
- Vojdani, M. and Giti, R. (2015) 'Polyamide as a denture base material: A literature review', *Journal of Dentistry*, 16(1 Suppl), p. 1.

W

- Wiesli, M. G. and Özcan, M. (2015) 'High-performance polymers and their potential application as medical and oral implant materials: a review', *Implant dentistry*, 24(4), pp. 448–457.
- Wu, Q. *et al.* (2022) 'Esthetic rehabilitation for a Kennedy Class IV patient using detachable 3D printing diagnostic denture and removable partial denture with polyetheretherketone framework', *Heliyon*, 8(10), p. e10834.

Y

- Yeung, C. *et al.* (2020) 'Improving esthetics of removable partial dentures using palatal retentive arms', *Clinical, Cosmetic and Investigational Dentistry*, pp. 391–397.

Z

- Zohdi, H., Emami, M. and Shahverdi, H. R. (2012) 'Galvanic corrosion behavior of dental alloys', *Environmental and industrial corrosion-practical and theoretical aspects*, pp. 157–168.