Republic OF Iraq

Ministry of Higher Education

And Scientific Research

University of Baghdad

College of Dentistry

Clasp types and design in flexible denture

A project submitted to College of Dentistry, University of Baghdad in partial fulfillment of the requirement for a B.D.S. degree

By:

Esraa Barraq Mohammed Saeed

Supervised by:

Lect.Zainab A. Azeez

B.D.S., M.Sc. Prosthodontics

2022 A. **1443 A.H.**

بسم الله الرحمن الرحيم

{ يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ }

صدق الله العظيم

Declaration

I certify that this project entitled **"Clasp types and design in flexible denture"** was prepared by **Esraa Barraq** under my supervision at the College of Dentistry / University of Baghdad in partial fulfillment of the graduation requirements for B.D.S degree.

Lect. Zainab A. Azeez

B.D.S., M.Sc. Prosthodontics

DEDICATION

It's an honor to dedicate this research primarily to my beloved parents, they have been my source of inspiration and gave me strength every time I thought of giving up, who continually provided their moral, spiritual, emotional and financial support.

To everyone who taught me even a single letter; I appreciate all that you have done for me. To my brothers, sisters, friends and classmates who shared their words of advice and encouragement through all of my life.

ACKNOWLEDGMENT

First and lastly, all gratefulness, faithfulness, and thankfulness to ALLAH for providing me with patience, perseverance and the ability to undertake and finally complete this study. I want to express my great thanks with respect to Dr. Raghad Abdul-Razaq Al-Hashimy, Dean of the Collage of Dentistry, University of Baghdad for his support to the research student's program. I would like to thank Dr. Abdalbasit Ahmed Fatihallah, the head of Prosthodontics Department, for its scientific support, encouragement and advice. Also I would thank my supervisor Dr. Zainab A. Azeez, for his continuous support.

Finally, I would like to thank all of our prosthodontics department seniors, whom never scrimp any of their knowledge to teach us.

LIST OF CONTENT

LIST OF FIGURES

Introduction

The immediate consequences of tooth loss are functional (the person is unable to chew or speak properly) as well as cosmetic (facial appearance is adversely affected).In the long term, tooth loss often impairs the person's self-image, emotional balance, and overall quality of life (Wiskott, 2011).

The choice between several treatment options for replacing missing teeth is influenced by clinical, dentist- and patient-immanent factors. Replacement of missing teeth is one of the most important needs for patients attending clinics to restore esthetics and/or function. Many treatment modalities are available for replacing missing teeth; removable partial denture, fixed partial denture or dental implant (Atulya and Shashidhara, 2004).

Since ages, polymethyl methacrylate (PMMA) has been used to fabricate the dentures. Metal cast / metal frame / metal base dentures are also fabricated to restore the defects. Some of the problems with acrylic are difficult to address, such as insertion in undercut areas, brittleness of methyl methacrylate which leads to fracture, and allergy to methyl methacrylate monomer (Atulya and Shashidhara ,2004).

The application of nylon-like materials to the fabrication of dental appliances has been seen as an advance in dental materials. This material generally replaces the metal, and the pink acrylic denture material used to build the framework for standard removable partial dentures (Negruţiu et al. 2004).

Flexible dentures are an excellent alternative to conventionally used methyl methacrylate dentures, which not only provide excellent aesthetics and comfort but also adapt to the constant movement and flexibility in partially edentulous patients (Singh et al. 2011).

AIM OF THIS REVIEW

The aims of this review are:-

1. To clarify different materials of flexible partial dentures.
2. To review various design of clasps in flexible partial denture for treatment of partially edentulous patient.
3. To compare the flexible with other type of Partial denture treatment modality.

CHAPTER ONE

REVIEW OF LITERATURE

1.1 Prosthodontics

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 (Stewart's, 2008).

There are four major divisions of prosthodontics:

1. Fixed prosthodontics.

2. Removable prosthodontics.

a) Complete denture prosthodontics.

b) Partial denture prosthodontics.

3. Implant prosthodontics.

4. Maxillofacial prosthetics (Stewart's, 2008).

1.2 Classification for partial edentulous arch:-

The Need for Classification There may be over 65,000 possible combinations of teeth and edentulous spaces. A classification system facilitates communication between dentists. Since there are several methods of classifying partial dentures, the use of non-standard classifications could lead to confusion. Therefore, the Kennedy system has been adopted by most dentists (Loney, 2011).

1.2.1 Kennedy Classification:-

In 1923, Kennedy devised a system that became popular due to its simplicity and ease of application. A tremendous number of possible combinations can be reduced to four simple groups (Loney, 2011).

Class I - bilateral edentulous areas located posterior to all remaining teeth as in (figure1.1).

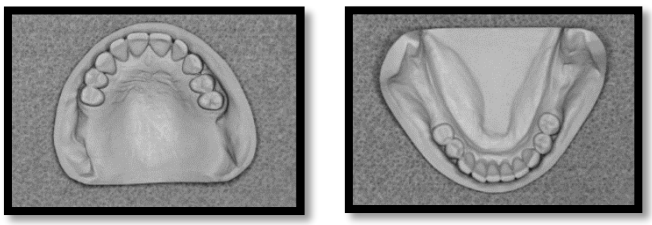

Figure 1.1Maxillary and Mandibular Kennedy class I (Loney, 2011).

Class II - unilateral edentulous area located posterior to all remaining teeth as in (figure1.2) (Loney, 2011).

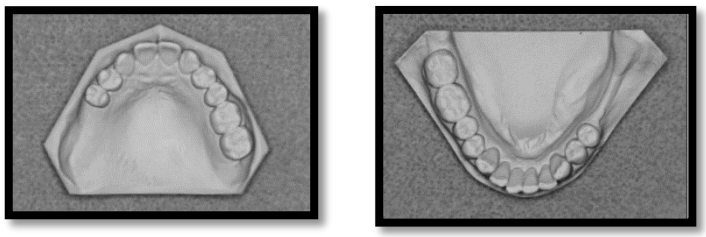

Figure1.2 Maxillary and Mandibular Kennedy class II (Loney, 2011).

Class III - unilateral edentulous area bounded by anterior and posterior natural teeth As in (figure 1.3) (Loney, 2011).

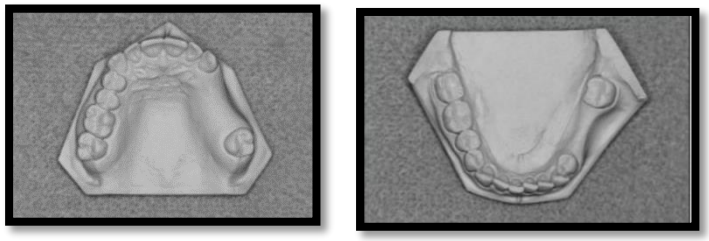

Figure 1.3 Maxillary and Mandibular Kennedy class III (Loney, 2011)

Class IV - a single, but bilateral(crossing the midline) edentulous area located anterior to remaining teeth as in (figure 1.4)(Loney, 2011).

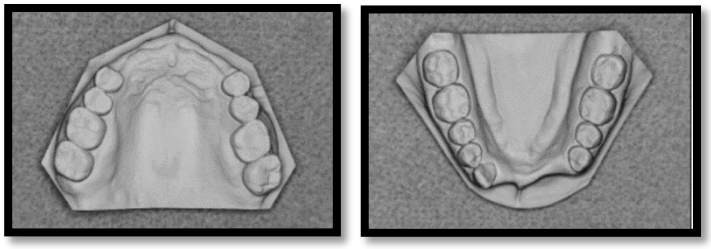

Figure 1.4 Maxillary and Mandibular Kennedy class IV (Loney, 2011)

1.3 partial denture prosthodontics classification according to the materials:

1.3.1 Acrylic partial dentures (temporaries):

Acrylic partial al denture (APD) is one option for replacing missing teeth and is also the most cost effective treatment option . Dentist are faced with the demand for replacing missing teeth from patient with limited financial resources; therefore the replacement of missing teeth with an APD is a common occurrence. One of the disadvantages of APD's is its poor strength.The construction of APD's is one way of replacing missing teeth in a partially edentulous patient. However, it is generally not considered a permanent treatment option for replacing missing teeth (Walmsley, 2003).

1.3.2 Cast metal partial denture:

This partial denture is one of the most common options. It comprises a rigid, ultra-thin metal base holding a set of acrylic teeth. Like acrylic partials, metal clasps attach the denture to existing teeth. With this option, many people opt for precision

attachments, which are more aesthetically appealing than metal clasps. With proper care, cast metal partials are highly durable (Walmsley, 2003).

.1.4 Flexible partial denture:

Flexible denture are custom-made dental installations that rely on unique products to achieve a less rigid design. These new kinds of dentures are popular for those who struggle with the conventional acrylic base of dentures that may wear, irritate the gums, induce allergic reactions or generally fail to provide a comfortable result. Dentists and their patients are often interested in what these newer and more versatile products can do to better outfit those with a history of tooth decay or who need dental prosthesis to function or who want to avoid the discomfort due to the rigidity of the denture base (Lowe, 2004).

1.4.1 Advantages of Flexible Partial Dentures:

Metal-free restorations and prosthesis are future of dentistry. Flexible partial is the optimal choice whenever partial is the choice of treatment or the patient prefers not to use a fixed restoration Following are some of the advantages of a flexible partial denture:-

1. More acceptable esthetics, since there are no metal clasps.
2. The material has good flexibility like Titanium. Therefore, even if there is a little bit of bending, it comes back to the original shape and position.
3. Ease of insertion in the mouth with alveolar undercuts because of the flexibility.
4. Even if there is slight shifting of the remaining teeth over time, the flexibility of the denture material, allows the use of prosthesis with little adjustment.

5. There is no need of modification of the remaining teeth to receive occlusal rests as for the metal clasps.
6. In cases of undercut due to tilted teeth, flexibility of the material makes it possible to insert the prosthesis over the angulated teeth.
7. The denture can be heated up in hot water for about a minute and can easily be adjusted and inserted in the undercut area.
8. Rebasing (Changing the entire plastic / tissue area except the acrylic teeth) is possible.
9. A real boon for patients with compromised oral conditions**.** (Phoenix et al, 2004).

1.4.2 Disadvantages of Flexible Partial Dentures:

1. Being a plastic material, it cannot be made into thin sections like metal. It is likely to break if cut thin sections.
2. Since they need to be made bulkier than cast partials, it may take longer to get used to a flexible partial denture.
3. It does not conduct heat and cold like metal. Therefore, the patient may not enjoy certain food like hot soup or ice cream.
4. Since flexible dentures utilize the gaps (because of some missing teeth) for the 'Retento-Grip Tissue-bearing Technique' for retention, the remaining teeth have to be in fairly good periodontal health.
5. The patients that have periodontal problem may have several teeth that are mobile due to bone loss. Therefore, the whole area keeps on flexing causing unfavorable forces that in turn result in more bone loss.
6. Requires more chair-side time for adjustment.

7. Requires special instruments (knives and polishingkit) to make the adjustment.
8. A Flexible denture is very hard to repair if fractured. No additions can be made onto it. In such cases, rebasing is recommended.
9. The laboratory fee is a little higher.
10. The valplast shows clinically significant chromatic instability, so the flexible removable partial denture might show staining and discoloration with time (Negrutiu et al, 2005; Dhiman and Chowdhury, 2009).

1.4.3 Indications for flexible partial denture:

1. The appropriate and acceptable uses for a flexible partial denture include all cases of conventional partial denture indications.
2. Patients with maxillary tuberosity undercuts often pose challenges in denture fabrication. Flexible denture flanges for patients exhibiting undercut tuberosities can solve this problem.
3. The unique physical properties of the material also make it more adaptable in challenging cases and situations involving pediatric patients, cancerous mouths and cleft palates. Because of its excellent biocompatibility.
4. It is also an ideal replacement for acrylic when patients are allergic to denture acrylics. Because of its excellent biocompatibility.
5. Flexible partials could be a treatment of choice in cases of patients having a history of repeated partial denture frame breakage.

6. They can also be used as an easy and affordable alternative to implants or fixed partial dentures and also for tooth or tissue-coloured clasps in high esthetic areas.

7. The areas where conventional partials are limited or contra-indicated. Flexible denture materials like Valplast are available in five natural tissue shades as well as in additional un-pigmented option for special applications **(Lowe, 2004).**

1.4.4 Contraindications:

Contra-indications include patients who simply should not or would not wear any type of removable appliance. However, Flexible partials are not advisable in cases of:

1. Patient s with insufficient interarch space (< 4mm space for placement of teeth), prominent residual ridges where there is less space for placement of teeth.
2. Flat flabby ridges with poor soft tissue support which require more rigid prosthesis
3. Little remaining dentition with minimal undercuts for retention.
4. Bilateral free-end distal extensions with knife-edge ridges or lingual tori in the mandible.
5. Bilateral free-end distal extension on maxilla with extremely atrophied alveolar ridges (Antonelli, and Hottel, 2001).

1.4.5 Types of flexible denture material:-

1.4.5.1Thermoplastic polyamide (nylon):

Thermoplastic nylon is a polyamidic resin derived from diamine and dibasic acid monomers. Nylon is a versatile material, suitable for a broad range of applications. Nylon exhibits high flexibility, physical strength, heat and chemical resistance. It can be easily modified to increase stiffness and wear resistance. Because of its excellent balance of strength, ductility and heat resistance, nylon is an outstanding candidate for metal replacement applications. They are used primarily for tissue supported removable dentures because their stiffness makes them unsuitable for usage as occlusal rests or denture parts that need to be rigid. Because of its flexibility, it cannot maintain vertical dimension when used in direct occlusal forces. Nylon is a little more difficult to adjust and polish, but the resin can be semi-translucent and provides excellent esthetics **(**Donovan and Cho, 2003).

1.4.5.2Pro-flex:

Pro-flex is the flexible denture base material, which can be used for Full & Partial flexible denture. Pickett Dental Laboratory has been offering pro-flex full and partial flexible dentures since 1998. Pro-flex is easy to work with the quality, aesthetics and most importantly the results. Pro-flex denture material may be indicated in some of the anatomical considerations where tooth and tissue undercuts are a hindrance. It enables the material to effectively engage those undercuts. Also pro-flex being hypoallergenic is recommended for patients with known acrylic or metal sensitivities. Aesthetically the material is semi-translucent, allowing the prosthetic to better blend with the colour of the natural gum tissue. With pro-flex flexible

partials, there are no metal clasps. Pro-flex full and partial flexible dentures are easily adjusted by the dentis (Lowe, 2004).

1.4.5.3 Sunflex:

Sunflex Partial Dentures are made from a strong biocompatible nylon thermoplastic, and are unbreakable, yet lightweight and translucent which allows natural tissue to show through. The sunflex flexible denture base materials are virtually Invisible, unbreakable, metal free, lightweight and comfortable to wear (Thumati et al. 2013).

1.4.5.4 Acetal:

Acetal as a homopolymer has good short-term mechanical properties, but as a co-polymer has better long-term stability. The material has been shown to have good biocompatibility and this has fostered its use in total hip replacement and as artificial heart valve occluders. Acetal resin is very strong, resists wear and fracture, and is quite flexible. They also exhibit high creep resistance and high fatigue endurance as well as hydrophobicity, which mean that the material will not absorb water or saliva. They are monomer free and offer an innovative and safe treatment alternative for patients who are allergic to conventional resins. They have little or no porosity, which reduces the accumulation of biological material like plaque and it also resists odor and stains. For a clasp in RPD, the stresses encountered should be below that limit to prevent plastic deformation of the clasp in function. The fatigue of a denture clasp is based on the repeated deflection of the clasp during insertion and removal of the RPD over the undercuts of the teeth as in (Figure 1.5) (phoenix et al. 2004).

(Figure 1.5)Metal free removable partial denture (Ardelean et al. 2007).

1.4.5.5Thermoplastic polyester:

Another group of thermoplastic materials used in dentistry are polyester resins. Polycarbonate resins are particular polyester materials. They exhibitmfracture strength and flexibility, but the wear resistance is lower when compared to acetal resins. However, polycarbonates have a natural translucency and finishes very well, which make them proper for producing temporary restorations. They are not suitable for partial denture frameworks (Negrutiu et al. 2005).

1.5 Properties of flexible partial denture material:-

Thermoplastic resins are used for the fabrication of flexible dentures.A thermoplastic is a plastic which becomes pliable or moldable above a specific temperature and returns to a solid state upon cooling. There are different kind of thermoplastic resins available like Because of inherent flexibility of thermoplastic nylon, it is used primarily for flexible tissue borne partial dentures. Chemically, nylons are condensation copolymers formed by reacting equal parts of a diamine and a dicarboxylic acid. Chemical elements included are carbon, hydrogen,

nitrogen, and oxygen.Nylon is a versatile material with characteristics like high physical strength, heat resistance and chemical resistance. It can be easily modified to increase stiffness and wear resistance. Because of its excellent balance of strength, ductility and heat resistance, nylon is the most suitable material available for flexible RPDs (Negrutiu et al. 2005).

When compared with PMMA, valplast (the most commonly used thermoplastic nylon) has higher transverse strength as well as impact strength (KoraySoygun et al. 2013).

1.6 Diagnosis and treatment plan:

Many failures in removable partial denture treatment can be traced to inadequate diagnosis and incomplete treatment planning. Therefore, a thorough, properly sequenced treatment plan is essential to successful removable partial denture therapy. The formulation of an appropriate treatment plan requires careful evaluation of all pertinent diagnostic data. Information must be obtained from patient interviews, radiographic evaluation, oral examination, diagnostic mounting of casts, preliminary survey and design procedures, and appropriate consultations with medical and dental specialists. Too often, the design of a removable partial denture is determined after all other phases of patient treatment have been completed. This approach generally results in failure. Decisions regarding teeth to be retained, surgical procedures to be employed, and restorations to be placed must be made with the ultimate design of the prosthesis in mind. Hence, survey and design procedures must be considered key elements in the diagnostic phase of treatment (Stewart's, 2008).

The partial denture must be designed so that:-

(1) It will not stress abutment teeth beyond their physiologic tolerance.

(2) It can be easily placed and removed by the patient.

(3) It will be retained against reasonable dislodging forces.

(4) It will not create an unfavorable appearance (Stewart's, 2008).

1.6.1 Survey:-

A surveyor is defined as a tool used to determine the alignment of two or more surfaces of the tooth or other portions of the dental arch, which modifies the surface of the tooth, to accommodate the placement of component parts of partial denture in the ideal positioning of tooth, which will help with prognosis. Surveyors are essential for planning, execution and examination of oral changes for partially removable dentures**.** The success in designing a partially removable denture with a flexible component depends on the most appropriate position to achieve good and strong resistance. We need to determine the path of artificial tooth insertion so that there is no obstacle when entering through this path; first step is to mark the height of the contour on the area (hard and soft tissue) above the undercut, and then marking the survey line (the height of contours on the teeth) and marking an undesirable undercut where a denture is not allowed to pass through the area. As in most things in dentistry, the FRPD begins with an accurate diagnostic model. An accurate opposing model is also essential since the occlusion will dictate the placement of components; and because success can only come through careful consideration and incorporation of the occlusion into the final design.Survey the teeth on the stone model: level the plane of occlusion, stabilize the surveyor table, and run the carbon rod around the teeth. That is the survey line. It sounds dangerously traditional, but is now a new concept. Metal clasps were all about survey lines, being above them or being below them. This concept, although important, is different with flexible partials. Polynylon/Valplast likes a "survey zone," not a survey line. The survey

line just indicates to you where you are going to take a fine-tapered diamond and do a little enameloplasty (Figure 1.6). Think of it as making a 2.0 mm guideplane that goes around the tooth. That survey zone, or circumferential guideplane, is the generator of the required stability and retention (Kaplan, 2008).

Figure (1.6) Establish zone of guide plane/fit following survey and design (Kaplan, 2008).

During the survey process, the practitioner determines the most favorable tilt for a dental cast, completes the tripodization process, places survey lines, and accurately marks the desired mechanical undercuts. At this stage, the practitioner is ready to begin the design process.The completed design will serve as a blueprint for removable partial denture construction. Therefore, the design process must be completed with great care. The mechanical characteristics of the removable partial denture must be considered. Components must be neatly drawn and accurately positioned (Stewart's, 2008).

1.7 Flexible denture design and components:

1.7.1Flexible denture components:

The design of flexible removable partial denture made from thermoplastic materials depends on the following:-

First: Support

Thermoplastic material is used primarily for tissue supported removable dentures because its flexibility makes it unsuitable for usage as occlusal rest denture parts that need to be rigid.The support of such a partial denture is derived entirely from the residual and no support is gained from the natural teeth.Thus this type is tissue supported whether for hounded or in distal extension cases.

Second: Connection

The main types of major connectors for the maxillary arch are the full palatal coverage and U-shaped major connectors. For the mandibular arch, the only major connector used is lingual plate.The borders of major connectors should be placed adjacent to the palatal and lingual surfaces of natural teeth without any gingival relief.

Third: Retention

There is no metal clasps used in FRPDs. The clasps are also made up of flexible thermoplastic material with excellent esthetics. The clasps can be placed labially (buccally) or lingually (palatally) depending on the undercuts areas present.

Fourth: Reciprocation

There should be reciprocation for retentive clasp arm is and this is achieved with the nylon plate lingually (palatally) or labially (buccally) to the abutment tooth. This plate should come in contact with the palatally or lingually surface of tooth on or above the survey line to provide stability.

Finally: Outline of edentulous areas

The outline of edentulous areas that will be covered by denture bases supporting the artificial teeth. The distal extension bases should be extended to retromolar

pads and the maxillary tuberosities as these structures provide comfort and a peripheral seal for retention (Khalaf, 2016).

1.7.2 Design considerations:

The realities of dental practice often preclude fabrication of diagnostic casts, survey and design. While it is true that experience can often take the place of careful consideration and planning, it is also that nothing can guarantee long term success as much as careful consideration of good diagnostic easts surveyed with even the most simple devices, a careful application of the clasp design considerations by modest tooth preparation. the fabrication of an accurate master cast, and the generation of clear instruction for the dental laboratory team. The successful use of the clasps depends on a relatively consistent survey line around the tooth designing of future denture and marking out future borders of the frame is an extremely important stage (Kaplan, 2012).

All maxillary casts should be beaded at posterior border line and any undercuts in the rugae area should be relieved, block out all non- flexing undercuts that would affect the path of insertion. In cases of free end partials there is no need to block out the distal undercut of last tooth this will give the partial some added retentive stability Minor enameloplasty will provide 1 to 2 mm band around the tooth which the flexible circumferential clasp may accurately and passively fit (Kaplan, 2012).

Use a tapered diamonds to tightly create the guide plane and zone of fit for circumferential clasp. Finish by using a fine finishing diamond with copious amount of water. As in all removable partial design, a certain amount of creativity is a necessity, which is individually expressed. For that reason, it may be expected that, given any particular situation, several designs may be possible; however, certain

basic elements of design may be neglected only at the peril of long-term restoration (Kaplan, 2012).

1.8 Flexibility of FRPDs:-

The FRPDs have ability to engage undercuts for retention (Kaira et al. 2012).

The resins currently in use have high flexibility and softer surface compared with acrylic resin, meaning that patients feel better when worn. There is also appears to be no problem with fit. As there is a low risk of breakage of dentures made solely resin, which are highly elastic and not at all rigid, the denture base can be made thinner. This makes them lighter and thinner than RPDs using an acrylic resin or metal framework to ensure rigidity (Fucki el al. 2012).

The strong and flexible nature of material is perfectly suited to the variety of natural conditions in the mouth, simplifying design and enabling the flexible nylon resin to act as a built-in stress-breaker in order to provide superior function and stress distribution in a removable partial denture (Thakral et al. 2012).

1.9 FPDs versus other types of RPDs:

1.9.1 FRPDs versus Cast partial dentures:

If we compare the both from the viewpoint of a dentist, time consuming mouth preparations are needed followed by some high skilled surveying techniques in the fabrication of cast partial dentures (Kaplan, 2008).

On the part of patients, he/she finds the cast partial dentures much expensive than the FRPDs. Further, the cast partial dentures are quite heavy as compared to the FRPDs and hence relatively uneasy to wear. The next big comparison between the two is esthetics. The thermoplastic nylons are translucent material that allow the

underlying tissue to be seen resulting in excellent esthetics. Moreover, in FRPDs there are no metal clasps at all. Clasps are also made up of thermoplastic nylons. So clasps can be given on canines without compromising esthetics which is not possible in cast partial dentures. Flexible dentures that do not include a metal structure and are not as rigid as the metal dentures are indicated as interim dentures or spare dentures for patients with metal allergy and patients for whom esthetic must be given top priority (Feuki et al, 2012).

Part of the problem for some to accept FRPDs is that they do not just violate many of the "rules" of RPDs, they simply ignore them. And yet, despite this, they are still successful . There are no rest seats transmitting the axial load down the long axis of the tooth. There are no infra-bulge clasps and supra-bulge clasps (in the traditional sense), and the tissue does not seem to care that these devices are non-rigid. And yet, there are rapidly growing number of these appliances being delivered to patients every year (Kaplan, 2012).

The flexibility of these dentures provides several advantages over the traditional RPD alternatives made of rigid materials.Flexible, nylon-based can look realistic, stay securely in place and be RPDS more comfortable to wear.Instead of metal clasps, they have thin finger-like extensions that fit or snap into natural concavities in the crowns of the teeth near the gun line act as pressureless retention of prosthesis. The flexible RPD also provides an option for cosmetic improvement of adjacent teeth that appear elongated due to gum recession. The realistic-looking, gum-colored base can be made to cover areas where natural gum tissue has receded (shrunk down) and partially exposed tooth roots so that flexible RPDS provide a smile improvement and offer an instant aesthetic solution. As these dentures materials are highly elastic and not at all rigid, the denture base can be made thinner. This makes them lighter and thinner than metal RPDs to insure rigidity (Fucki et al. 2012).

Comparison of ultimate tensile strength, yield strength, percentage of elongation and modulus of elasticity between flexible material and cobalt chromium alloy reveals that the highest mean value of percentage elongation for flexible nylons, while cobalt chromium alloy has the highest values of ultimate tensile strength, yield strength and modulus of elasticity (A1-Wadi, 2012).

Lower thermal conductivity of flexible materials makes the patient not. Enjoy certain food as in (Fig 1.7) (Thakral et al. 2012).

Figure (1-7) Comparison of estheties in cast partial denture and flexible denture (Kaplan, 2008).

1.9.2 FRPDs versus conventional rigid acrylic rpd (temporaries):

Dentures with thermoplastic nylon do not fracture even if are thrown intentionally from some height whereas patient with full acrylic partial or complete dentuers often visit the dentist with broken or fractured prosthesis as these are brittle. FRPDs show excellent biocompatibility but Acrylic dentuers cause allergic reactions due to free monomer content, high porosity, high water sorption, foul smell and are difficult to insert when undercuts are present. Moreover, laboratory techniques used in the fabrication of FRPDs are more stable and accurate than those used in full acrylic dentures.

Effect on oral mucosa: Flexible dentures exhibit viscoelastic behaviour that lead to improvement in masticatory function and patients comfort compared with hard dentures .Flexible dentures show little effects on the mucosa of denture bearing area and little changes on the mucosa. Denture bearing area of flexible denture are more healthy with less tissues changes compared with traditional acrylic denture. Flexible removable partial dentures can adapt to the shape and movement of mouth and for this reason, these are far more comfortable to wear. (Mustafa et al. 2013).

In a study, conducted about the preference among the two types of denture base material; flexible dentures versus conventional acrylic, 100% patients preferred the flexible dentures over customary methyl methacrylate dentures (Singh et al. 2011).

1.10 Clasps of flexible partial dentures:-

1.10.1Terms and definitions:-

According to the GPT-8, a clasp is defined as "the component of the clasp assembly that engages a portion of the tooth surface and either enters an undercut for retention or remains entirely above the height of contour to act a reciprocating element, Generally it is used to stabilize and retain a removable dental prosthesis." According to this definition, a "clasp" is not described as being made of metal.The resin retentive elements known as arms, fingers, and wings may thus be regarded as genuine clasps according to this definition, as they use undercuts to retain and stabilize RPDs,and they are also known as "resin clasps" or "esthetic clasps" (Kaplan, 2008).

During function, the RPD is to subjected to functional movements. A well designed denture should have components that resist these movements. The component that prevents the RPD from dislodging away from teeth and tissue is called direct retainer. Direct retainer is responsible for primary retention of the

prosthesis and there are many types of direct retainers of which are clasp retainers (Carr and Brown, 2011).

1.10.2 Clasp design:

This basic principle of clasp design offers a two-way benefit, First it ensures the stability of the tooth position because of the restraint from eneirclement , and second, it ensures stability of the clasp assembly because of the controlled position of the clasp in three dimensions (Carr and Brown, 2011).

It was found that clasps made of nylon had to be rather bulky in order to function efficiently. Thin clasps which were adequate for retention when the denture was first fitted tended to warp away from the teeth after a few weeks wear. This was probably due to slow release of strains which had been induced during molding. Owing to the flexibility of the base it was possible to utilize undercuts for retention which would normally have to be blocked out on acrylic or metal base. The clasps are built to curl around the necks of the teeth and they are particularly indistinguishable from the gums that normally surround the teeth due to its opalescence. This type of partial denture is extremely stable and retentive, and the elasticity of flexible plastic clasps keeps them away indefinitely (Shivani et al, 2013).

The thickness of the prosthesis should be less than 2 mm. Thin finger like extension of material engage into undercuts acting as a clasp and help in pressurless retention of the prosthesis. The clasps are fabricated from the same material providing better esthetics (Singh et al. 2012).

1.10.3 Material considerations in clasp design:

The strength of any clasp is in the design of the clasp, and the material from which it is made. The majority of clasp designs, regardless of the material,are

cantilever, gaining strength by connection of only one end. A cantilever can be strong if it is short, massive, externally braced, or a combination of these factors. The original designs of flexible clasps sought to achieve strength by use of a broad and relatively flat clasp. Gaining strength through size, strength was limited due to its single-plane design and flexible nature. However, the flexible partial clasp may gain much more strength that is effective by a combination of external bracing, which effectively shortens the flexible component and introduces a second plane of resistance (the combination clasp) or by external bracing (circumferential clasp; continuous clasp) (Kaplan, 2012).

1.10.4 Clasp function in removable partial denture:

Retention is defined as that quality inherent in the dental prosthesis actingto resist the forces of dislodgment along the path of placement (GPT 8, 2005).

In removable prosthesis, retention is aunique concern when compared with other prostheses. Forces acting to displace the prosthesis from the tissue can consist of gravity acting against a maxillary prosthesis, the action of adherent foods acting to displace the prosthesis on opening of the mouth in chewing, or functional forces acting across a fulcrum to unseat the prosthesis (Carr and Brown, 2011).

Retention of an RPD can be achieved by:

1. Using the inherent physical forces which arise from coverage of the mucosa by the denture.
2. Physiologic factors: Harnessing the patient's muscular control acting through the polished surface of the denture.
3. Using mechanical means such as clasps which engage undercuts on the tooth surface (Fayad, 2011).

Physical means of retention:

1. Adhesion: is the attraction of the saliva to the denture and the tissues.
2. Cohesion: is the attraction of saliva molecules to each other.
3. Interfacial surface tension: is the attraction of the surface molecules.
4. Atmospheric pressure: Which is dependent on a border seal and results in a partial vacuum bencath the denture base when a dislodging force is applied. The difference between the greater pressure acting on the polished surface of the denture and the lesser pressure acting on the fitting surface causes a positive force, which helps in retaining dentures. The effect of atmospheric pressure in retaining partial dentures is limited because a complete border seal cannot be obtained as can be accomplished with complete dentures.
5. Gravity: The effect of gravity tends to seat lower dentures, but displace upper dentures.
6. Plastic molding between tissues / denture polished surfaces aid to little extent in retention of partial denture (Fayad, 2011).

The effect of physical forces is less applicable to lower dentures than upper denture because:

a. Lower dentures have less surface area.
b. Lower dentures are bathed in saliva.
c. Strong movements of the tongue tend to break the seal in lower dentures.

Physiological means of retention: The physiologic molding of the tissues around the polished surfaces of the denture helps to perfect the border seal.

Neuromuscular control: The patient ability to control the denture with the lips,Cheeks. and tongue can be a major factor in the retentiveness of the denture (Fayad, 2011).

1.11 Clasp types of flexible denture:

1.11.1 Wrap-Around Clasp:

The wrap around clasp is a type of retainer that rests on the surfaces of the natural gum tissues in order to hold a flexible partial denture in place. It is the most common type of clasp used for partial denture. The wrap-around clasp originates from the buccal or labial flange of the denture base and traverses soft tissue to approach the abutment tooth from a gingival direction. For aesthetic purposes, this type of clasp often terminates ≤ 1mm onto the abutment tooth from a gingival direction, the tip of which falls into the embrasure between the abutment tooth and the next proximal tooth to it. It is essential to recognize incorrect clasp design and placement to understand better how a correctly designed clasp will provide predictable results and proper function. This type of clasp is very retentive as it makes use of both tooth and tissue undercuts. It is a good choice for retaining distal extensions and long spans of replacement teeth. In order to ensure patient comfort, it is important to note that these clasps do not actually compress the tissues for retention, but should always be resting in direct contact with tissue while in a relaxed position. If a gap is created by over-relief between the clasp and tissue, irritation could develop as in (figure 1-8) (Alan et al. 2005).

Figure (1.8) the wrap around clasp (Alan et al. 2005).

1.11.2 High Spur clasp:

In cases where the abutment tooth tilts to create a severe undercut making a wrap around clasp unfeasible, a high spur may be placed on the natural tooth. As this is not ideal for aesthetic considerations, it is used mainly in posterior regions. The high spur is a common retainer for Kennedy Class III cases and modifications where natural posterior teeth bound the edentulous span. The high spur should be placed so that it enters along the height of contour and terminates in the infra bulge area of the abutment tooth as in (figure 1-9) (Alan et al. 2005).

Figure (1.9) high spur clasp (Alan et al. 2005).

1.11.3 Low Spur clasp:

Low spurs are placed on the natural abutment tooth next to the replacement and positioned close to the neckline in a roughly triangular form so as to appear as natural interproximal papillae. As they are more aesthetic than high spurs, they are mainly used in anterior areas. Because they are placed so low on the labial surface of the natural abutment teeth they are seldom used in cases where the abutment teeth are tilted or flared to create severe undercuts as in (figure 1.10)(Alan et al. 2005).

Figure (1.10) low spur clasp (Alan et al. 2005).

1.11.4 Split Clasp:

The split clasp is used whenever the supra bulge portion of the abutment tooth is very wide and narrows substantially towards the infra bulge area, or when a flared or tilted condition of the abutment tooth requires that the retentive arm pass over a very severe high point before engaging undercuts. The split clasp resembles a roach clasp (from metal frame RPD design) in concept and basic design structure, with flexibility along both the vertical and horizontal axes of the junction as in (figure 1.11)(Alan et al. 2005).

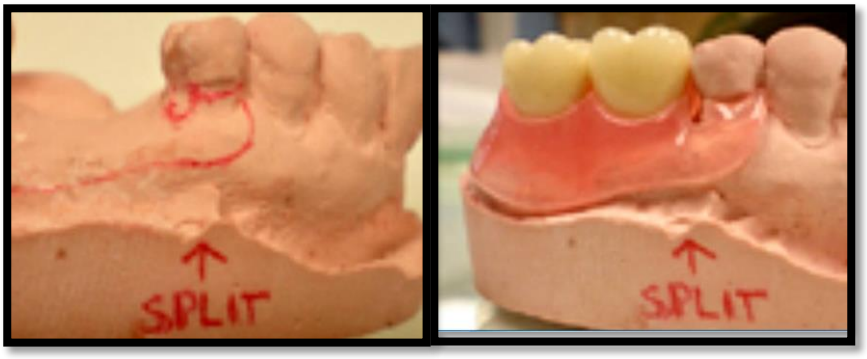

Figure (1.11) split clasp (Alan et al. 2005)

1.12 Clasp variations and alternate retention:

1.12.1 Anchor Clasp:

A seldom used but occasionally useful design is the labial or buccal anchor clasp. This clasp type is used mainly on maxillary full dentures in the labial region when large undercuts are present. These should extend a two-tooth length from the junction point where the clasp meets the adjoining buccal or labial flange as in (figure 1.12) (Kaplan, 2008).

Figure (1.12) Anchor clasp (Alan et al. 2005)

1.12.2 Labial Strap:-

In cases where abutment teeth exhibit a high degree of mobility, they may be splinted by use of a thin, flexible labial (or buccal) strap. the labial strap may be fabricated with what is essentially a series of continued split clasps so as to avoid placing excessive strain on the abutment teeth upon insertion and removal of the denture as in (figure 1.13)(Alan et al. 2005).

Figure (1.13) Labial Strap clasp (Alan et al. 2005)

1.12.3 Circumferential Clasp:

The circumferencial clasp was first suggested by Dr. Paul Kaplan, a U.S. Army Prosthodontist in his 2008 article “Flexible Removable Partial Dentures: Clasp & Design Concepts.” This type of clasp completely encircles an abutment tooth for retention - ideal for free standing distal abutments as in (figure 1.14) (Kaplan, 2008).

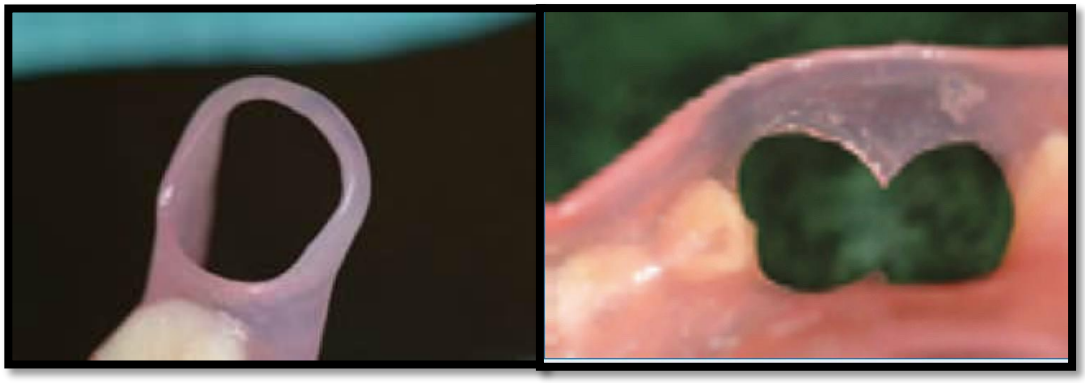

Figure (1.14) circumferential clasp (Kaplan, 2008)

1.12.4 Combination Clasp:

Another Kaplan design, this clasp is a combination of wrap-around and circumferential clasps that connect palatal/lingual and buccal components by crossing the occlusal table. This clasp may provide more retention of the denture and stability of free end saddles than a standard wrap-around clasp, but does require some tooth preparation in order to be placed correctly as in (figure 1.15) (Kaplan, 2008).

Figure (1.15) Combination clasp (Kaplan, 2008)

1.13 Clasp designs to be avoided:

1.13.1 The reach around clasps:

It is the almost the single worst design concept. It has to be waxed thick for adequate strength,and as a result,it becomes bulky and uncomfortable. This type of clasp is usually done by dental technician that simply does not understand the concept of crossing the occlusal table for strength, rigidity and retention as in(figure 1.16) (Kaplan, 2008).

Figure 1.16 the reach around clasps (Kaplan, 2008)

1.13.2 The separated clasp:-

Are also a waste of strength and retention. These are clasps from a laboratory in which the prosthetic technician still thought clasp were made of metal and had to be separate. This technician sacrificed all the strength of the circumferential clasp and gained nothing in exchange as in (figure 1.17) (Kaplan, 2008).

Figure 1.17 the separated clasp (Kaplan, 2008).

1.13.3 The 2-teeth clasp:

Clinically it will always be a failure. This is because the physics will force the unsupported end to hinge away from the tooth surface when it is seated. It will have

absolutely no function, no retention and to be of no use. The only thing possible here was remove it as in (figure 1.18) (Kaplan, 2008).

Figure 1.18 the 2-teeth clasp (Kaplan, 2008).

1.14 Clasp adjustment:

The flexible dentures do not need repeated adjustment to keep them in place.The hot water treatment permits a very smooth initial insertion and a good adaptation with natural tissues in the mouth. If the patient senses any discomfort because of the tightness of a clasp, the clasp may be loosened slightly by immersing that area of clasp in hot water and bending the clasp outward.If the clasp requires tightening, the clasp is immersed in hot water bent inward to tighten it (Singh, 2012).

1.15 Breakage of resin clasp:

Frequent breakage of retentive elements after deterioration of material due to environmental factors, improper handling and improper design. Design guidelines based on differences in materials, physical properties would therefore de desirable, this has led to improvement in their physical properties. Clasp wires were buried in the retentive parts with the aim of ensuring continued retention and preventing breakage (Feuki et al. 2014).

Chapter two

Conclusion

From our review, we conclude the following:-

1. The use of flexible partial denture in growing.
2. This type of dental prosthesis can be considered as an excellent choice available.
3. Patient success is high, since these appliances can be extremely esthetic.
4. Careful attention must be given to the basic concept of diagnosis and design also different approach clasp design is essential.
5. Flexible denture can be good option of replacement missing teeth especially when the patient is about esthetic, but the main disadvantage is staining of prosthesis, so the care is need; otherwise the esthetic will be affected.
6. Generally flexible partial denture is not used as a long-term prosthesis, treatment is mainly considered as temporary prosthesis, so many investigations about the properties of materials used and the design concept to improve the longevity of the prosthesis.

REFERENCES

A.

- Antonelli, J.R., Hottel,T.L.(2001).The"flexibleaugmented flange technique" for fabricating complete denture record bases.*Quintessence Int. May*;32(5):361-4.
- Atulya, S., Shashidhara, H.S. (2014). A Review: Flexible Removable Partial Dentures. *Journal of Dental and Medical Sciences*, 13(12), P. 58-62.
- Al- Wady, Al.M.(2012)."Comparision of certain, mechanical properties including deflection a fatigue resistance of cobalt chromium alloy and nylon tooth colored clasping material". University of Baghdad, College of dentistry,Department of prosthodontics.

C.

- Carr, B., McGivney, P., Brown, T. (2005). Removable Partial Prosthodontics,11th ed.
- Caesar, HH., Lehmann, KM. (2002). Die Teilprothese – Grundlagen, Konstruktion und zahntechnische Ausführung, 3. überarbeitete Auflage, Verlag Neuer Merkur GmbH, München.
- Carr, A.B., Brown D.T. (2011). " McCracken's removable partial prosthodontics". 12th ed.; Missouri, Mosby, *Elsevier*, Inc.

D.

- Dhiman, RK Col., Roy Chowdhury, SK. (2009). MidlineFracture in Single Complete Acrylic vs Flexible Dentures.65. Mjafi.141-145.
- Donovan, TE., Gho, G.C., (2003). Esthetic consideration with removable partial denture. *J.Chief Dent Assoc*, 31(7), 551-7.

F.

- Fayad, M. (2011):" Removable partial denture: theory and practice". 2nd ed., Cairo. Al-Azhar University.

- Fueki, K., Ohkubo, Ch., Yatabe, M., Araka, I., Arita, M.D.D.S., Ino, S., Kanamori, T., Kawai, Y., Kawara, M., Komiyama, O., Suzuki, T., Nagata, K., Hosoki, M., Masumi, S., Yamauchi, M., Aita, H., Ono, T., Konodo, H., Tamaki, K., Matsuka, Y. Tsukasaki, H., Fujisawa, M., Baba, K., Koyano, K., Yatani, H. (2014): "Clinical application of removable partial dentures using thermoplastic resin-part 1 Definition and indication of non-metal clasp dentures ". *Journal of Prosthodontics Research*, (58), p. 3-10.

G.

- GPT. (2005)."The Glossary of Prosthodontic Terms', 94:10–92.

K.

- Kaplan, P. (2008). "Flexible Partial Denture: Design and clasp". *Dentistry Today*, (27), p. 122-123.
- Kaplan, P. (2012). "Flexible Partial Denture Variations : The use of Circumferential, Combination, and Continuous Clasp Designs*".* *Dentistry today Journal*, 31 (6), pp:38-41.
- Khalaf. (2016). "Flexible Denture Design" third stage lab. University of Baghdad, College of dentistry.

L.

- Lowe, LG., (2004). flexible denture flanges for patient exhibiting undercut tuberosities and reduced width of the buccal vestibule: a clinical eport. *J Prosthet Dent*, 92(2), 128- 131.
- Loney, R. (2011). Removable Partial Denture Manual.1. Halifax:4.

M.

- Mustafa, G.M., Abed AlBaki, M.A., Naji, S.A. (2013): "Comparing the Effects of Denture base materials on Hygiene of Mucosal Denture Bearing Area". *Tikrit Journal for Dental Sciences*, (1), pp 71-76.

N.

- Negruţiu, M., Sinescu, C., Liliana, S. (2004). Guidelines of removable partial dentures, Ed. Marineasa, Timişoara.
- Negrutiu, M., Bratu, D. and Rominu, M. (2001):" Polymers used in technology of removable dentures". *Romanian Journal of Stomatology*, (1), pp. 30-41.
- Negrutiu, M., Sinescu, C., Romanu, M., Pop, D., Lakatos, S. (2005). Thermoplastic resins for flexible framework removable partial dentures. TMJ, timisora *medical journal*.
- Negrutiu, M., Sinescu, C., Romanu, M., Pop, D., Lakatos, S.(2005). Thermoplastic resins for flexible frame work removable partial dentures. 55, 295-299.

P.

- Phoenix, D., Cagna, R., DeFreest, F. (2008).Stewart's clinical removable partial prosthodontics. 4th ed. *Quintessence Publishing Co Inc,p* 14-15.
- Phoenix, RD., Mansueto, MA., Ackerman, NA., Jones, RE. (2004). Evaluation of mechanical and thermal properties of commonly used denture base resins. *Journal of Prosthodontic*,13(1),17-27.

S.

- Soygun, k., Bolayirm G., Boztug, A. (2013). Mechanical and thermal properties of polyamide versus reinforced PMMA denture base materials. *J AdvProsthodont* ,5,153-60.
- Singh JP, Dhiman RK, Bedi RP, Girish SH.(2011). Flexible denture base material: A viable alternative to conventional acrylic denture base material. *Contemp Clin Dent*, 2, 313-7.
- Singh K. and Gupta N. (2012): "Injection Molding Technique for Fabrication of Flexible Prosthesis from Thermoplastic Denture base Materials". *World Journal of Dentistry*, 3(4), pp:303-307.

T.

- Thumati P, Padmaja S, Raghavendra RK. (2013). Flexible dentures in prosthodontics--an overview. *Indian Journal of Dental Advancements*, 1,5(4),1380-6.
- Thakral G.K., Aeran H., Yadav B. and Thakra I.R. (2012): "Flexible Partial Dentures -A hope for the Challenged Mouth ".*People's Journal of Scientific Research*; 5(2).

W.

- Wiskott, HM. (2011). Principles and Clinics. *London: Quintessence.*
- Walmsley, AD. (2003). Acrylic Partial Dentures, 30, 424-429.