Introduction

Non-metal clasp dentures using thermoplastic resins have recently become a treatment option for partially edentulous patients. Several types of non-metal clasp dentures are available; all with the advantages of superior esthetics and the reduced potential for allergic reactions .Additional advantages of these dentures are their flexibility and highly elastic nature, which decrease the stress on abutment teeth. [١]

The development of resins represented a great step forward in dental technique, the first thermopolymerisable acrylic resins being developed in ١٩٣٦. Acrylic resins are known as polymethyl methacrylate (PMMA). They are synthetically obtained materials that can be modeled, packed or injected into molds during an initial plastic phase which solidify through a thermal reaction-polymerization. [٢] Thermal polymerized PMMA demonstrates high porosity, high water absorption, volumetric changes and residual monomer.

The polymer development, have led to the introduction of thermoplastic resins materials such as polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins etc.The therapeutic use of thermoplastic materials has increased drastically in the late decade. . Current dental applications of thermoplastic materials include: preformed partial denture clasp, flexible tooth born partial denture framework, single cast partial dentures, temporary crowns and

bridges, provisional crowns and bridges, occlusal appliances, implant abutments, orthodontic and sleep apnea appliances. [٣]

The key to the functional advantages of the thermoplastic materials for standard removable partial dentures is in the flexibility of the material that helps to shift the burden of force control from the design features of the appliance to the properties of the base material. The stress distribution in the rigid partial denture is controlled by structural elements of the design; specifically the relationship of the retentive clasp, occlusal rests, reciprocal arm, minor connectors, and guide planes.

The stress distribution of the flexible partial is accomplished by flexibility in the major connector behaving as a stress breaker. Flexibility of the major connector eliminates the fulcrum effect across the arch, reducing the leverage effects of its extensions without compromising retention and support. Flexibility of the partial also acts as a tissue conditioner. The slight movement over the tissue stimulates the blood circulation under the partial and dynamic transfer occlusal forces reduce the atrophy that can set-in beneath a saddle. [٤]

Although numerous researches have been conducted on the influence of different of partial denture design on the abutment supporting structures, studies on the effect of Non-metal clasp dentures using thermoplastic resins are rare in the

literature. Accordingly, this study was conducted to assess the effect of flexible thermoelastic partial dentures on the abutment supporting structures in bilateral posterior bounded cases.

Review of literature

Causes and sequel of partial edentulism:

Oral health environment have been found to influence general health, quality of life and economic yield. Edentulism (partial or complete) is a key indicator of the oral health of a populace. An edentulous space in the dental arch is normally formed by one or multiple missing tooth.

Among the causes of tooth loss are periodontal problems, carious lesions, traumatic injuries, orthodontic and prosthodontic indications; impactions, hypoplasia, supernumerary teeth, loss of tooth material, supra-eruptions, neoplastic and cystic lesions.[٥]

Tooth loss has been reported to be mainly due to dental caries and periodontal disease. History of high tobacco consumption is also a risk factor for tooth loss. [٦]It has been documented that age and tooth loss shows a positive relation. partial edentulism is more common in maxilla than in the mandible, and anterior tooth loss following posterior tooth loss. According to Hoover and McDermount the prevalence of edentulism is higher in males than females.[٧]

The drawbacks of tooth loss are drifting and tilting of adjacent teeth, supra eruption of opposite teeth, altered speech, changes in facial appearance and psychological dissatisfaction. Lack of confidence, weight loss and restricted dietary and

social activities are some of the major impacts adversely affecting the quality of life. [٦]

The design of the prosthesis depends upon the type of saddle area among other things.

A classification of partially edentulous arches helps to identify relation of remaining teeth to edentulous ridges; and facilitates communication, discussion, and comprehension of the suggested prosthetic treatment among dentists, students and technicians. As of its simplicity, application to all semi-dentate situations, immediate visualization of the type of partially edentulous arch being considered and differentiation between tooth borne and tooth tissue borne prostheses, Kennedy's classification is the most widely used and accepted.[٨]

Many patients believe that removable partial dentures are inherently damaging to the natural dentition, and indeed a well-known prosthodontist once wrote, "A removable partial denture is a device for extracting one's teeth slowly, painfully and expensively." This statement is undoubtedly true with poorly designed and fabricated removable partial dentures, and there are several articles that clearly document the potentially deleterious consequences of removable partial dentures [٩]. However, there are also several well-documented studies that indicate that properly designed, fabricated and maintained

removable partial dentures can provide esthetic and functional long-term benefits with minimal negative consequences. [١٠]

Anterior edentulous cases pose a unique challenge for the dental profession and have been managed with short-span adhesive prostheses, as well as fixed or removable partial dentures. All of these methods, when properly selected and prescribed, have yielded good results. However, their inherent invasiveness has been documented to compromise oral ecology, with unpredictable consequences, including the need for frequent dental interventions. [١١]

The treatment of choice for a partially edentulous patient is placement of a fixed partial denture. The advent of dental implants has provided a number of new options for carrying out this treatment modality. However, not all patients are candidates for fixed partial denture therapy, so an alternative form of treatment must be considered; Removable partial denture therapy is considered to be an acceptable form of treatment that provides an increased spectrum of restoration options. [١٢]

Although removable partial dentures have inferior masticatory efficiency, lower esthetics, less adaptability and Longitudinal studies indicated that they have been associated with increased gingivitis, periodontitis, and abutment mobility.

yet in some cases it is considered the most appropriate treatment. [١٣]

Over the years, the concepts of RPD design have been based on clinical conditions, scientific research findings, social acceptance, dogmatic traditions, and philosophical axioms. [١٤, ١٥]

Designing a biomechanically acceptable removable partial denture is important to control and direct forces in a favorable way. [١٦]

Improperly designed RPD transfers destructive stresses to the supporting dental structures resulting in rapid bone destruction. An understanding of the basic fundamentals of stress control enables the partial denture design planner to use a combination of design and construction principles that will reduce the forces and distribute the functional stresses equally between the hard and soft tissues so that the effect of leverage is minimized and neither structure is stressed beyond its physiologic tolerance. [١٧] Stress management is an essential consideration for all removable partial dentures. [١٨]

Esthetic considerations in designing removable partial denture

The emphasis on esthetic dentistry has increased in the past two decad, It is clear that most practitioners pay

meticulous attention to detail when providing services such as porcelain veneers, metal-ceramic and all-ceramic crowns, fixed partial dentures, and basic direct and indirect operative dentistry. However, this meticulous attention to detail is lacking in many practices in the discipline of removable partial prosthodontics. [١٩]

The size and form of the maxillary anterior teeth are important not only to dental esthetics but also to facial esthetics. The goal is to restore the maxillary anterior teeth in harmony with the facial appearance. However, there is little scientific data in the dental literature to use as a guide for defining the proper size and shape of anterior teeth or determining normal relationships for them ,according to Young "it is apparent that beauty, harmony, naturalness, and individuality are major qualities" of esthetics. [٢٠]

Frush and Fischer used the early ideas of Sears to help establish the dentogenic concept of denture construction. It was reported that personality, and age could be used as guidelines for tooth selection, arrangement, and characterization to ''enhance the natural appearance of the individual.''

Other authors have also discussed aspects of natural appearance in denture fabrication. The success of the dentogenic concept coincided with great advances in denture materials. As reliable acrylic resin became available, the ability

to achieve esthetic results improved considerably. Denture teeth, base material, with respect to personality projection remains subjective.. An ability to predict gender or age was not shown. These studies failed to assess the teeth from an extraoral perspective, as they would be seen in public. Frush and Fischer noted that a restoration can only be evaluated in the mouth. Proper analysis of the dentogenic effect would include the patient face and would, therefore, bias the results of the previously mentioned studies. [٢١]

Patients' esthetic demands are increasing daily and now extend to the artificial gingiva of removable dentures. A systematic approach to analyze and reproduce the gingival characteristics. This was reported involves the gingival display of the smile line, gingival pigmentation, and gingival morphology. Different procedures using either polymethyl methacrylate resins and/or composite resins wsa used to reproduce the gingival features. These innovative techniques make it possible to produce highly esthetic complete dentures for edentulous patients presenting with a "gummy" smile, and the results offer satisfactory long-term stability. [٢٢]

The primary esthetic deficiency resulting from removable partial denture therapy is the unsightly display of conventional clasp assemblies. This display is not an inevitable consequence of removable partial denture therapy, and often can be avoided simply by analyzing the patient's smile and

dental display and designing a removable partial denture with the clasp assemblies in nonvisible locations.[٢٣]

Many factors unrelated to the clasp assembly also affect the ultimate esthetic result achieved with a removable partial denture. Some of these factors include proper tooth selection, tooth placement, flange length and contour, and proper interdental papilla contours. [٢٤]

Esthetics is the primary consideration for patients seeking prosthetic treatment, there are three specific strategies have been described to design both functional and esthetic removable partial dentures. These strategies include use of the esthetic clasp assemblies, use of precision and semi-precision attachments, and, when indicated, use of the concept of the rotational path removable partial denture. In addition the appearance of clasp assemblies can also be improved with the use of tooth-colored or pink flexible polymer clasps. [٢٤]

A. Esthetic retainers

١-Hidden clasps/internally braced clasp:

This design is especially suited for cases in which anterior abutment tooth is a crowned canine In this crown a deep cingulum wedge- shape rest is prepared with occlusally diverging walls and rounded floor .The rest and the clasp arm emerge from the saddle to occupy their respective areas on the

crown. An undercut is prepared in the gingivolingual third of the crown to accept the retentive arm of the RPD. The retentive arm engages the lingual undercut and the rest seats accurately in the wedge-shaped preparation. [٢٥]

٢-MGR clasp design:

It is an esthetic extracoronal retainer for maxillary canines. Retention is provided by ١٩ gauges round I-bar and retentive dimple located distobuccally on the tooth. Reciprocation is provided by mesial groove or rest and distal proximal plate. [٢٦]

٣-Esthetic clasp:

The Esthetic clasp is recommended for patients with required abutment teeth in the esthetic zone (incisors and bicuspids). It utilizes the proximal undercuts and encircles the tooth by ١٨١o. Esthetic clasp may be in the form of L-clasp or C-clasp [٢٧]

٤-Spring clasp/Twin flex clasp:

Belles [٢٨] described the use of a Twin Flex clasp as an esthetic alternative. It consists of a wire clasp soldered into a channel that is cast in the major connector .The flexibility of this clasp places less torque on the tooth when the anterior extension is depressed. The ability to adjust this clasp and its

conventional path of insertion provides an excellent design option for retention to an adjacent edentulous segment

٥-Equipoise RPD system:

It has been developed to overcome the negative esthetics of anterior clasping. The Equipoise clasp can be used with success in Kennedy Class IV case if the correct clinical and laboratory procedures are followed. It is a lingual back-action clasp that is fully reciprocated and extremely esthetic with no facial clasp displays. Rests are placed away from edentulous span Vertical inter-proximal reduction of ١mm between abutment and adjacent tooth is done which allows the ridge framework to fit in this area .Optional bucco-lingual retentive groove at mid and gingival third junction on distal surface of abutment tooth is provided[٢٩], it is unsuitable in Class I dentition where posterior stability is poor. Its lingual window can adversely affect oral hygiene and careful patient selection is necessary. [٣٠]

٦-Masking of the clasps with resins and composites;

Masking of clasps can be done using acrylic or composite resins. The difficulty of using acrylic/composite resin to veneer RPD metals lies in the difference between their abilities to flex and their coefficient of thermal expansion .Various methods were used to mask the metallic direct retainer

these include Macro mechanical retention, Micromechanical retention, and Silica coating. [٣١]

B .Rotational path partial dentures:

Dual path of insertion partial denture concept have been introduced by King [٣٢, ٣٣] and Garver [٣٤] in ١٩٧٨, when anterior pontics are present; to eliminate anterior clasping. Rotational path RPDs seat according to an insertion sequence. The first segment contains the rotational center and as soon as the framework has gained access to the desired undercuts, it is rotated into the "second path" of insertion to complete seating the prosthesis .The rotational path could either be Postroanterior rotational path or Anteroposterior rotational path.

The saddle-lock system eliminates facial clasp display while achieving natural esthetics with superior stability and retention. This is achieved by using the available mesial/distal concave surfaces of the abutment teeth for retention instead of the buccal undercuts. [٢٧]

c- Precision and Semiprecision Attachments

Attachments are simply an esthetic replacement for a traditional clasp assembly. Thus, the clinician must analyze each attachment prior to use to ensure that its design will meet all the functions of a traditional clasp assembly. With Kennedy

Class I and II situations, attachments should posses stress-releasing and utilize traditional occlusal or gingival rests to support the attachment and prosthesis. The reality is that very few commercially available attachments meet these specifications, and those that fail to do so should be avoided. [٣٥]

The basic principles applied for construction of good conventional prosthesis are the same for construction of precision attachment retained prosthesis. Attachments begin making patients accept the idea of wearing removable prosthesis as they are more stable and retentive than conventional dentures. [٣٦]

Attachments may be classified according to method of fabrication in to precision or semi precision, according to location in to intracoronal and extracoronal, and according to material in to resilient or non resilient. Precision attachments are machined by the manufacturer, while semi precision attachments are custom fabricated by the laboratory technician. The major disadvantage with intracoronal attachments is that room must be made for the attachment within the crown. Box forms to accommodate the attachment must be prepared within the tooth at the time of tooth preparation. This removes a considerable amount of healthy tooth structure so it is considered unconservative.

One of the most important advantages of attachments is being extremely aesthetic, whether they are intra or extra coronal, no metal display appears in the oral cavity at all. This is an important factor in Kennedy class I RPDs when the last abutments are the canines or first premolars. Being less traumatic to abutment teeth is another advantage of attachments since they direct the masticatory forces along their long axis decreasing the unfavorable horizontal forces. In the normal clasping systems, the direct retainers can act as can openers and eventually lead to the breakdown of their corresponding abutments .[٣٦]

Attachments also have high retentive features, and provide good retention to patients with RPDs especially Kennedy class I cases, leading to increased satisfaction and longer life of the prosthesis. They also offer better distribution of loads if more than one tooth are splinted together with crowns dividing the stresses between two abutments rather than one. [٣٧]

Attachments also could be used in segmenting techniques when abutments on opposite sides are not parallel to each other, instead of too complicated paths of insertion that cause further damage to teeth.

Lastly, having fewer components in the partial denture framework such as minor connectors and clasp retainers, lead