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Introduction

Rehabilitation using complete dentures with edentulous patients who suffer from a compromised alveolar bone often results in denture soreness, poor retention, instability, disturbed pronunciation, and low chewing efficiency.

Compared to the conventional complete denture, two or more implant-retained mandibular overdentures can promote function and enhance success rates. [1]

Using a single implant in the mandibular midline area with ball or locator attachments to support overdenture produced favorable outcomes. An in vitro model study demonstrated that the single implant-supported overdenture increased retention and stability as compared with the conventional complete overdenture; furthermore, the biomechanical effects were comparable to those observed in a mandibular two-implant retained overdenture [2].

Polymethylmethacrylate (PMMA) was used for many years as denture base material. It can be either heat activated or chemical activated based on the type of activator used. Chemical activated PMMA suffers from incomplete polymerization leading to great amount of unreacted monomer in the denture base causing

decreased transverse strength as well as tissue irritation, while heat activated PMMA does not suffer from the problem of unreacted monomer [3].

Polymethylmethacrylate (PMMA) has been used to fabricate the dentures; acrylic denture base prostheses have their own advantages and disadvantages. Some problems with these prostheses are difficult to address, such as insertion in undercut areas, brittleness of methylacrylate, which lead to fracture, and allergy to methacrylate monomer [4].

Polymerization shrinkage encountered in conventional cured PMMA lead to development of special injection molding technique-using nylon based plastics.

Innovation of the nylon derived denture base material in the 1950s paved the way for a new type of dentures. Thermoplastic materials have almost no porosity, which reduces biological material build up, and stains and exhibit higher dimensional and color stability. All of this factors become important when producing long-term provisional prostheses during implant or when used for permanent removable appliances [5].

Finite element analysis (FEA) is a computer-based numeric technique for calculating the strength and behavior of engineering structures. It is a technique for obtaining a solution to a complex mechanical problem by dividing the problem into a collection of much smaller and simpler domains (element) in which the field variables can be interpolated with the use of shape function. Because the components in a dental implant-bone system are

extremely complex geometrically, FEA has been viewed as the most suitable tool for analyzing them [(6)].

Therefore, this study was carried out as an attempt to assess the effect of flexible denture base and conventional one as an overdenture base of single midline implant supported mandibular overdenture on residual ridge bone changes.

Review of literature

Edentulism is defined as " the loss of all permanent teeth ", which is the terminal outcome of a multifactorial process involving biological processes (caries, periodontal disease, pulpal pathology, trauma, oral cancer) as well as non-biologic factors related to dental procedures[(7)].

It would be inaccurate to state that disease factors such as caries or periodontal disease are the sole causes of patients' edentulism, research has demonstrated that several non-disease factors such as attitude, behavior, dental attendance, and characteristics of health care system play an important role in the decision to become edentulous, in addition, a significant relationship exists between the edentulous state and financial concerns usually associated with low occupational levels. It is therefore reasonable to conclude that edentulism is due to various combinations of cultural, financial, and dental disease attitudinal determinants, as well as to treatment received in the past[(8)].

Impact of edentulism on oral health

Bone loss is continuous process that follows tooth loss, which affecting the mandible four times more than the maxilla, Edentulism was found to have a significant effect on residual ridge resorption that leads to a reduction in the height of alveolar bone and the size of the denture bearing area. This reduction in turn affects facial height and appearance, which are altered following total tooth loss.

The loss of alveolar bone height and width also leads to substantial changes in the soft-tissue profile, such as protrusion of the mandibular lip and chin, All contributing factors are to decreases chewing ability, and masticatory function as well as poor self-confidence and psychological problems[9] .

Edentulism can be accompanied by many deficiencies related to the oral mucosa; such as, angular cheilitis, oral candidosis, and traumatic ulcers [10].

Management of patients who are recently rendered edentulous is much easier and less problematic compared to patients who have been edentulous for a long period. This is due to changes in the oral and circumoral structures accompanying loss of teeth and the neglect of early restoring those [11].

The rate of bone loss varies from one patient to another, although the factors owing to bone loss and resulting patterns are understood well. The main factor is the overall duration of the patient's state of edentulism [12].

In a longitudinal study it has been reported that an average annual alveolar ridge height reduction of approximately 0.4mm in the edentulous anterior mandible resulting from physiologic changes [13].

An ideal denture supporting ridge is defined as "That ridge possessing adequate bone support for denture, bone covered by adequate soft tissues, no undercuts or overhanging protuberances, no sharp ridge, adequate buccal and lingual sulci that doesn't interfere with the normal seating of the denture, no frenula to interfere with the denture periphery absence of soft tissue folds or any hypertrophies on the ridge [14] .

Treatment options for the mandibular edentulous ridge are numerous, including conventional dentures, surgical reconstruction, implant overdentures and complete implant-supported fixed prosthesis.

Treatment options for completely edentulous mandibular ridge :

A-Complete dentures:

In the past the extraction of entire dentitions with complete denture replacements used to be promoted as an inexpensive and permanent solution for oral health care. Removable denture function in fully edentulous patients is often inadequate. In particular, severe resorption of the alveolar ridges frequently makes it very difficult for patients to wear conventional dentures due to the lack of retention and the instability of the denture. Together with the poor load-bearing capacity of the tissues, this situation can lead to oral pain and discomfort and poor oral function [15].

Many ideas were introduced aiming to preserve the ridge; the reduction of the load on the ridge has been a tradition in denture construction, this could be achieved through design, construction technique or denture material[16].

Pre-prosthetic surgeries can be used to reshape the residual ridge in order to give an optimum shape for the future prosthesis. Moreover, they provide sufficient bone volume for the placement of dental implants at an optimal position. Ridge augmentation by autogenous grafts or alloplastic materials, vestibuloblasty, alveolar ridge distraction and guided tissue

regeneration techniques, bony prominences, prominent genial tubercles, undercuts, and spiny ridges removal, all are methods used to enhance anatomical ridge morphology [17-19].

B- Overdenture:

Overdenture is defined as "A removable partial or complete denture which covers and rests on one or more remaining natural teeth, roots and /or dental implants" it can be also called overly denture, overlay prosthesis, superimposed prosthesis [20].

i-Tooth- supported overdenture:

Clinical experience and compellingly documented research have underscored the merits of retaining natural teeth to serve as abutments under complete dentures owing to the difference their presence makes to preservation of alveolar ridge integrity [21].

Tooth supported overdentures have certain advantages and disadvantages. Principle advantage is the conservation of natural teeth and concomitant reduction or slowing of residual ridge atrophy. Stability, support and retention of the overdenture also can be better in comparison with a conventional complete denture. In addition, sensory feedback of the periodontal receptors is maintained and masticatory performance may be enhanced [22].

However, tooth supported overdenture treatment can have some disadvantages such as the need for inevitable treatment, which requires additional time and increases costs [22].

It also includes increased caries susceptibility of the overdenture abutment teeth. Meanwhile, an overdenture not only prevents natural gingival stimulation and cleaning, but also promotes accumulation of

plaque as well as being a source of irritation to the gingiva; leading to periodontal breakdown.

Bony undercuts also present a problem compromising the peripheral seal (either due to blocking out of the undercut, or shortening the flange), as well as the esthetics due to over contoured or foreshortened flange. Another problem is the encroachment of the interocclusal distance, especially in overdentures with some form of attachments [23].

ii- Implant supported overdenture:

Carlson concluded that an ideal method to avoid jawbone resorption was preventive dental care to maintain dental health and avoid tooth total extraction. In case of hopeless dentition or in an already edentulous jaw, the insertion of an implant-supported prosthesis can definitely reduce bone loss and may even promote bone growth [24].

Implant overdenture is an overdenture supported and/or retained by dental implants [25].

The components of the implant retained overdenture are : (1) the implant; (2) the abutment, which contains one of the mating attachment components depending on the system used; and (3) the overdenture, which houses the counterpart attachment component [26].

Dental implant is defined as" a prosthetic device made of alloplastic material(s) implanted into the oral tissues beneath the mucosal or/and periosteal layer, and on/or within the bone to provide retention and support for a fixed or removable dental prosthesis" [25].

Investigations have concluded that the mandibular implant overdenture treatment can show significantly improved retention and

stability characteristics as compared with conventional mandibular complete dentures. Additionally, a direct relationship has been shown between prosthesis retention and stability and patient satisfaction [27, 28].

In fact, even with otherwise successful conventional complete denture treatment in the mandible, it has been shown that it is possible to achieve a higher clinical standard for success with the implant overdenture [29].

Classification of dental implant:

Although dental implants may be classified by their geometrical form into, cylinder, screw, blade, and root form, Dental implants can be classified according to their anchorage component and its anatomical relation to the alveolar bone that provides support and stability into [30]:

a- Mucosal inserts: Mucosal insert is a metal insert attached to the tissue surface of a removable prosthesis which mechanically engages undercuts in a surgically prepared mucosal site. It is also called intramucosal implant, button implant [31].

b- Subperiosteal implants: A custom made implant consists of a cast metallic framework with posts. The framework overly the bone beneath the periosteum and the posts emerges through the mucosa to retain the final prosthesis. This type of implants was indicated primarily for severely atrophied ridges [32, 33].

c- Transosouss dental implants: A metal plate with retentive pins that holds it against the inferior border of the mandible in the symphseal

region. The pins penetrate both cortical plates passing through the full thickness of alveolar bone. They can be also called staple bone implant, mandibular staple implant, and transmandibular implant [34].

d- Endosteal dental implants: a device placed into the alveolar and/ or basal bone of the mandible or maxilla and penetrating only one cortical plate of bone.

The endosteal dental implant is composed of an anchorage component, termed the implant fixture which is placed within the bone, and a retentive component termed the implant abutment which passes through the oral mucosa and serves to support and or retain the prosthesis whether a (fixed , removable, or a maxillofacial prosthesis) [34].

Endosteal dental implants are fabricated from a wide variety of biotolerant materials and different designs. They are the most commonly used type of dental implants. A root form implant is a type of endosteal dental implant designed to mimic natural tooth root. They offer a wide stress distribution over a great surface area, excellent retention and easy surgical procedure with a good healing tendency [35].

Classification of implant supported overdenture:

Implant supported overdenture is classified into three types: mucosa supported, implant supported and a combined mucosa implant supported overdenture [36-38].

1. Mainly mucosally supported overdenture

It was concluded that the mainly mucosally supported overdenture is attached to two implants by means of resilient stud attachment or magnets.

The mainly mucosally-supported overdenture allows for rotation of the overdenture. It is indicated for patients who have a retention problem and new conventional denture will not adequately solve the problem. The cost can also be a deciding factor [39, 40].

2. Combined mucosa implant-supported overdenture

In this type, the prosthesis is supported by the implant and the mucosa, where two to four implants are placed in the anterior region of the mandible and connected with a bar. A retentive clip permits rotation around the bar. It is indicated with severely resorbed mandible [41, 42].

3. Implant-supported overdenture

It requires four to six implants placed in the anterior region of the mandible, rigidly connected by a bar and attached to the prosthesis by a clip. It is indicated for patients with sensitive mucosa, extreme gag reflex and when the opposing arch has natural teeth for reasons of stress distribution [43].

According to the mode of attachment of the prosthesis to the implant abutments, two designs are proposed: cemented prosthesis which is fixed ceramo-metallic prosthesis and used with limited jaw resorption or screw retained prosthesis [44].

Advantages of implant supported overdentures:

The patient gains several advantages with an implant overdenture. The main is minimal bone resorption of the anterior residual ridge. Annual alveolar ridge height reduction in completely edentulous patients was showed to be approximately 0.4 mm in the edentulous anterior mandible, while long-term bone resorption under an implant overdenture may remain at 0.1mm annually [45].

The retention of the restoration is enhanced by the mechanical attachment system of the implant [46].

An overdenture provides improved stability and occlusion. The mandibular denture may move 10mm during function. Under these conditions, specific occlusal contacts and the control of masticatory forces are nearly impossible. An implant overdenture provides stability of the prosthesis, and the patient is able to consistently reproduce a determined centric occlusion [46].

Decrease in soft tissue abrasions, because soft tissue abrasions are more symptomatic of the horizontal movement of the prosthesis under lateral forces; an implant overdenture limits this lateral movement [46].

The ability to replace lost teeth with osseointegrated implants has improved the quality of life for many edentulous patients [47].

Implant-supported or retained removable prostheses offer alternative advantages for rehabilitation of the edentulous mandible. The selection of the overdenture versus a fixed implant prosthesis may be favored on initial cost advantages[48] .

A study of chewing efficiency compared wearers of complete dentures with wearers of implant-supported overdentures. The complete denture group needed 1.5 to 3.6 times the number of chewing strokes compared with the overdenture group. The chewing efficiency with a traditional overdenture is improved by 20% compared with a traditional complete denture [49, 50].

Higher bite forces have been documented for mandibular overdentures on implants. The maximum occlusal force of a patient with dentures may improve 300% with an implant-supported prosthesis [51].