INTRODUCTION

The edentulous patients who receive dentures always have problems with the stability and support for these dentures. The longer that the patients wear dentures, the more difficulties they will face, as the dental ridges become increasingly atrophied. By time this atrophy is considerably worse when the patient wears a mandibular complete denture due to forces from tongue movement. Other problems in the neuromuscular system and the ability of the denture to form a tight seal with the surrounding soft tissues, patients express much more dissatisfaction with the mandibular complete denture.

Dental implant treatment became popular to overcome the drawbacks of the conventional dental treatments and the problems of the conventional dentures. Selection of ideal implant site as well as optimal implant for a particular site is the first step in achieving functionally and esthetically successful implant prosthesis.

Stereolithographic surgical guides can simplify the technique- sensitive and operator-dependent surgical procedures in implant- supported restorations, which is benefit for both patient and dentist. When stereolithographic surgical guides were used, the accuracy of implant placement were increased, compared to using conventional guides. The use of mucosa-supported stereolithographic surgical guides in edentulous patients were increased along with the demand for implant-supported restorations in edentulous patients, as shorter surgery duration and less discomfort after surgery were recorded when they were used. [(1)]

Although conventional surgical templates allow guiding the bone entry of the drill, they do not provide exact 3-dimensional guidance. The templates are fabricated on the diagnostic cast without knowledge of the exact anatomy below the surface. Thus, when conventional implantation techniques are used, the clinical outcome is often unpredictable, and even if

the implants are well placed, the location and deviation of the implants may not meet the optimal prosthodontic requirements. To overcome these limitations, computed tomography (CT), 3D implant planning software, image guided template production techniques, and computer-aided surgery have been introduced. It allows one to format a volumetric dataset in axial, coronal, and sagittal cuts and to build multiple panoramic views.[2]

The advantages of computer-aided oral implant surgery include; the possibility of operating with a minimally invasive approach (without flap elevation), which has been associated with shorter surgical time , reduction of patient morbidity, the integration of the restorative determinants into the surgical planning, resulting in predictability of the prosthetic outcome and allowing for the production of the prosthesis before the surgery, thereby simplifying immediate loading protocols, and simplification of the technique-sensitive and operator-dependent surgical procedure, which can have a profound impact on current implant practices.

A stereolithographic guided surgery system mainly consists of a stereolithographic surgical guide with implant system-related mounts for fixture installation, additional guide sleeves for fixation screw installation, drill keys of different heights, and depth-calibrated drills to prepare the osteotomies.

Most systems allow the fabrication of a skeletal-, dental-, or mucosal-supported surgical guide. Dental- and mucosal-supported guides can be useful for application of flapless surgery. This in contrast with the use of a bone-supported guidance system where flap surgery remains inevitable. Flapless implant surgery has the main advantage that the postoperative discomfort is reduced as shown in a study of Fortin. On the other hand, lack of visibility of anatomical features and critical structures, such as nerves and blood vessels, imposes careful implementation of this technique. Additionally, possible deviations between the preoperative plan and the postoperative.[3]

REVIEW OF LITERATURE

Tooth loss is "an oral disease which relates to the patient's attitude and the amount of their care" [4]. Edentulism is defined by the World Health Organization (WHO) as" poor public health outcome that substantially affects oral and general health status, as well as the quality of life" [5].

Edentulism is considered as an irreversible and debilitating condition which is described as the "final marker of disease burden for oral health". A lot of factors control the incidence of the edentulism like economic situation, the level of education, lifestyle, oral health knowledge and dental care. Studies showed that there was a close relation between edentulism and socioeconomic status, so it appears to be more prevalent in poor populations and females. Edentulism has adverse effects on the patient's social life, functional activity, physically and psychologically[6,7]

I. Impact of edentulism

a. Impact of edentulism on oral health:

Bone loss is starting to increase after the patient losing his teeth which affect the mandible four times than the maxilla. Edentulism accelerates the rate of ridge resorption, which results in reduction of the height of the alveolar bone, narrowing of the denture bearing area and changing in the facial height and appearance [8].

The soft tissue contour also changes per the loss of the alveolar bone and result in protrusion of the mandible. Masticatory efficiency has been decreased due to the reduction of the number of the occluding units. The fully dentate people have biting force five times stronger than denture wearers. Salivary glands, oral mucosa and muscles of mastication's may be affected

due to tooth loss. These effects include denture stomatitis, angular chelates, oral candidiasis, and traumatic ulcers [9].

b. Impact of edentulism on general health:

General health is affected by losing teeth as evident from many studies. The rate of cholesterol and fats are increased because of decreasing the rate of vegetables and fruits intake thus increase the incidence of cardiovascular diseases and obesity. Peptic and duodenal ulcers, inflammation of the gastric mucosa and pancreatic cancers are complications that could happen. Hypertension, heart failure, stroke and valve sclerosis incidences are increased, in addition to the increased risk of chronic kidney diseases. Obstructive sleep apnea and other sleep disorders may have a relation with the tooth loss. [10,11]

c. Impact of edentulism on the quality of life:

Life state, functional activity and the health state are defined as quality of life. It is the individual's perception of his or her position in life, in the context of the culture and value systems in which they live, and in relation to their goals, expectations, and concerns [12]

The social life of edentulous people is affected as they are embarrassed to speak, eat and smile so they might be isolated. Lots of patients can accommodate with the limitations of the conventional dentures but some of them don't. Self-confidence, changing in behavior, aging and closed social life are adverse effects of edentulism.[13]

II. Complete denture

Removable complete dentures have been considered as a traditional and common way to restore edentulous patients. However, the progressive

bone resorption of the edentulous alveolar ridge is the main concern when rehabilitation of the edentulous patients using the removable complete denture is considered. [14]

Edentulous patient with severely resorbed mandible often experiences problems with their conventional complete denture, especially with regard to mandibular denture. These problems include difficulty with prosthesis retention, stability and comfort which in turn may negatively affect functional abilities such as speech, aesthetic and mastication. [15]

Although many maxillary dentures exhibited enough retention and stability, mandibular dentures usually presented a major challenge to an extent that over 50% of mandibular complete dentures have problems with stability and retention. This was partially attributed to the location of the seal area, which was fairly constant in the maxillary denture and did not move during ordinary function of the mouth. On the contrary**,** the seal area in the mandibular denture was not as readily located and showed considerable movement during the ordinary functions of the mouth [16].

Several studies addressed the effect of tissue resiliency on occlusion in complete denture prosthodontics, results revealed that the occlusion is difficult to establish and stabilize with completely soft tissue supported prosthesis because the mandibular prosthesis may move as much as 10 mm or more during function [17,18].

The common reasons for dissatisfaction with conventional complete denture are pain, sore spots, poor denture stability, and eating difficulties. The increased mobility of conventional complete dentures not only affects the masticatory function, but also adversely affects the patient's confidence and social life. [19]

III. Dental implants:

Many problems will arise and face the dentist, some of them could be managed during construction of complete denture, others will be difficult. Although the prevalence of edentulism is decreasing but hasn't been terminated. Dental implants have been introduced by Branemark in 1975, offering many treatment options in the field of dentistry. Fixed implant restorations either screw or cement retained, implant supported over denture, implant retained over denture are some of these options. [20]

IV. Implant overdenture:

Overdenture is defined according to the Glossary of Prosthodontic terms as "A removable dental prosthesis that covers and rests on one or more remaining natural teeth, roots and /or dental implants. Various names have been used as overlay denture, overlay prosthesis and super imposed prosthesis". Since most implant prostheses are inherently retained and stabilized by their respective implants, it is more logical to classify implant prostheses according to the nature of their support. This method has been used traditionally to classify conventional removable partial dentures as tooth-supported or tooth-tissue–supported. Thus, implant prostheses could be described as implant-supported or implant-tissue–supported. [21]

Similarly, restorations combining natural teeth and dental implants could be termed implant-tooth supported. [22]

Advantages of implant over denture:

It enhances denture stability, due to the utilization of attachment systems those limit the denture movement possibilities, reduce the mucosal abrasion, enhance chewing efficiency, better facial tissue support, better esthetics and improve the neuromuscular control. Bone resorption under

implant assisted dentures is significantly less than under conventional dentures during the first year and the successive years in function. furthermore, this treatment option of implant assisted dentures has the highest survival rate among all treatment options including implant fixed complete dentures and fixed detachable prosthesis. [23]

Indications of implant over denture:

New denture wearer who are not accustomed to denture prosthesis and frequently presented with denture complaints related to reduced stability and flange extensions. Other cases with morphological compromise of denture supporting areas that significantly undermine denture retention like sever resorption, congenital and acquired defect. The condition of diminished neuromuscular coordination as a consequence to age and certain medical conditions like myasthenia gravis hinder the performance of the mucosa borne dentures low tolerance of mucosal tissue.[24]

Implant overdentures classified according to support into:

a. Implant-assisted overdentures:

It is an overlay prosthesis drives its support from the ridge and the implants. In most cases it utilizes less number of implants, usually two inter-foramina implants.

This treatment option involves a hybrid form of support, both of implant and soft tissue contribute to support the denture. The denture is supported anteriorly by the implant/s and it drives support posteriorly from the ridge. The number of implants utilized for this approach varies according to the amount of the required support, availability of bone and affordability of the patient. The success rate of this treatment option increases with the increase of the number of implants implemented to the design. [25]

b. Implant-supported overdentures:

It's an overlay implant prosthesis that sustain the entire occlusal load and transmits it to the implant behaving like a fixed prosthesis**.** Four or more implants are utilized to provide total support for prosthesis. The mucosa does not contribute to any load sharing.

Overdentures were developed to help both partial and fully edentulous patients regain a quality of life, which most likely has been missing since they lost their teeth. (26)

The overdenture is completely supported by bars and implants. The overdenture base may actually contact the mucosal tissue, but any support is inadvertent. Because this overdenture is completely implant supported, it requires the same number of implants for support as a fixed prosthesis. A minimum of four implants is planned for the mandibular arch, whereas six are planned for the maxilla. This all depends on many factors, and many practitioners will go for six implants in the mandible and eight in the maxilla, just to ensure that the implants are not overloaded. Other reasons for planning a fully implant supported prosthesis include the sever compromise of the posterior ridge anatomy, dehiscence of the mandibular canal and presence of the mental nerve on top of the crest as a result of resorptive process. The design is primarily formed of a metal substructure splinting all the implants together and contains the retentive element either stud form of attachment or bar designs and the super structure that is composed of a denture containing the receptacles of the retentive elements and frequently a cast strengther, the prosthesis constructed following the design concept behaves as a fixed prosthesis yet they are removed on daily basis at night so preventing the overloading and protects the implants from the noxious effect of parafunction.(27-29)

- **Hybrid prostheses (fixed denture):**

The all-on-four **(all-on-4)** technique, developed by Prof. Dr. Paulo Maló, is a system that allows complete rehabilitation with maxillary and / or mandibular implants in the toothless patient. The technique involves the insertion of 2 mesial straight implants and 2 distal tilted implant so, the tilting will miss the anatomical structures as the mental nerve and maxillary sinuses. Its name comes from the use of 4 implants for maxilla, although 5 or 6 may be necessary in certain cases of the maxilla.

One of the most attractive points of the technique is that they can be applied in a high percentage of cases with success rates above 95%. Placement of fewer implants eliminates the need for peri-implant surgeries, facilitates hygiene and reduces cost. When used in the mandible, tilting of posterior implants makes it possible to achieve good bone anchorage without interfering with mental foramina. In severely resorbed maxillae, tilted implants are an alternative to sinus floor augmentation. [30]

General considerations of all on 4 concept:

Achieving primary implant stability (35 to 45 Ncm insertion torque), needs minimum bone width of 5mm and minimum bone height of 10mm from canine to canine in maxilla and 8mm in mandible, If angulation is 30^{o} or more, the tilted implants can be splinted. For tilted posterior implants, the distal screw access holes should be located at the occlusal face of the first molar, the second premolar, or the first premolar.[31]

A retrospective clinical study including 242 patients with 968 immediately loaded implants supporting fixed complete arch maxillary all-acrylic prosthesis demonstrated a high survival rate 93% at patient level and 98% at implant level after 5 y of follow up[32]. Recent studies encouraged the

use of All-on-4® concept emphasizing that when planning a fixed rehabilitation in an edentulous maxilla using four implants, the quality of bone, the length of implants, the patient's habits and the length of expected cantilever should be considered [33,34].

If an implant is part of a multi implant supported prosthesis, the spread of implants and stiffness of the prosthesis will reduce bending of the implant. The more distal position of the posterior implant and the resulting shorter cantilever may have a role in reduction of stress values in the implant. Strain gauge measurements performed by **Krekmanov** showed no significant differences in forces and bending moments between titled and axial implants. Theoretical models show that an increased prosthetic base, due to the inclination of implants can reduce the force acting over the implants. Therefore, from biological point of view, the position of the neck of the implant can be more important than the inclination of the implants themselves. **Bevilacqua et al**., demonstrated that tilting of the distal implant by 30^{o} in a fixed Implant restorations decreased the level of stress by 52% and 47.6% in compact bone and cancellous bone respectively, when compared to vertical implants supporting fixed Implant restorations with longer cantilevers. [35,36]

Loading of the cantilevered prosthesis can cause a hinging effect that induces considerable stresses on the implants closest to the load application. When the distal cantilevers of fixed Implant restorations are excessive in length, deformation of the framework can result in fracture of the prosthetic screw, the acrylic resin teeth or even the framework itself.[37]

The splinted tilted implants showed lower stresses than the axial implant with cantilever and the reduction of the stresses generated with the prosthesis might help reduce maintenance problems of fixed Implant

restorations s versus those that employ a conventional implant configuration. When a vertical load was applied to the first premolar of the tilted implant, the two neighboring implants mostly shared the load, as the prosthesis was loaded between the mesial and distal implants load was distributed to both supporting implants through the prosthesis, the tilted implant configuration did not show over loading or bending.[38]

Implant overdenture attachments:

Attachments based on resiliency are classified into six types:

- Rigid non resilient attachment: In such attachments, no movement is seen between the abutment and implant. It is recommended only when sufficient implants are available. They are rigid and do not provide any relief to the supporting implants
- Restricted vertical resilient attachment: Such attachments will not allow any lateral tipping or rotary movements. They provide 5-10% of relief to the supporting implants by allowing vertical movements of the attachments
- Hinge resilient attachment: They resist lateral tipping and rotational forces. They provide 30-35% of load relief to the supporting implants
- Combination resilient attachment: They allow unrestricted vertical and hinge movements. They provide 45-55% of load relief to the supporting implants by uniformly transferring masticatory forces to the residual ridges
- Rotary resilient attachment: They allow vertical, hinge, and rotation movements. They provide 75-85% of load relief to the supporting implants
- Universal resilient attachment: Almost all kinds of movements are permitted. They provide 95% of load relief to the supporting implants.[39]

1-Stud attachments include

- **O-rings attachment**

It is consists of a titanium male unit and an easily replaceable rubber-ring female unit that is retained in a metal retainer ring. It transfers the amount of stress to the abutments and provides an excellent shock resorbing effect during function .Some studies evaluated the retention force of an O-ring attachment system in different inclinations to the ideal path of insertion and concluded that when the O-rings attachments were properly placed parallel each other, the retention were adequate for longer time and the retentive capacity of O-ring was affected by implant inclinations [(40)].

- **ERA attachment**

It is an extra-radicular attachment with two design systems. The first is a partial denture attachment for placement on the proximal (mesial/distal) aspects of artificial crowns, while the second is an axial (or over denture) attachment, either for placement inside the prepared roots or the ERA implant abutment for over denture prosthesis. The abutments are available in two types, first is the straight one-piece abutment type and second are the two-piece angulated abutment type (5°. 11° and 17 angles). Each ERA retentive system is available in four color codes, (white, orange, and blue, gray), that provide different degrees of retention from light to heavy. It's indicated when resiliency is required as it provides vertical resiliency & universal stress relief [(41).]

- **Ball attachments**

The ball and socket attachments consist of a metal ball (male portion) which is screwed into the fixture, where the female part is incorporated in the fitting surface of the denture. The female part may be one of the following types:

(a) The O-ring in which the retentive element is rubber ring. It's better to have parallel implants otherwise the rubber ring will wear within a few weeks.

(b) A metal part as in dalbo system. This permits less resilience however the retentive forces are almost twice those obtained with the O-ring system.

(c) A spherical metal anchor in which the female part contains a spring. These attachments have advantage of being resilient and easily activated [42].

Ball attachments are among the simplest of all stud attachments widely used because of their low cost, ease of handling, minimal chair side time requirements and their possible applications with both root and implant-supported prostheses . Many authors agree that for unsplinted implants, the most common attachment used is the ball attachment. This attachment system is a practical, effective, and relatively low-cost prosthetic concept [15,20,21]. Solitary balls were claimed to be less costly, less technique sensitive and easier to clean than bars. Moreover, the potential for mucosal hyperplasia was more reduced with solitary ball attachments. However bars were shown to be more retentive[43,44]. Naert et al [45] concluded that the ball attachments are the best regarding soft tissue complications, and patient satisfaction when compared to the bar attachment and the magnet attachment. One of the studies done, that compared load transfer and denture stability in mandibular implant retained over denture retained by ball, magnet, or bar attachments, suggested that the use of ball attachment was advantageous with regards to optimizing stress and minimizing denture movement [46]. Another study was done to compare the retention of bar/clip, ball and magnet attachment in mandibular implant retained over denture. The ball and socket attachment recorded the highest value followed by the bar/clip then the magnet attachment. In comparison, done between over dentures retained by ball and socket attachment and another

design retained by two clips on a bar connecting the two implants, regarding stresses on the peri implant bone. The result revealed that stress on peri implant bone was greater with the clip/bar than that of ball attachment . After 3-years of prospective study for Implant-supported mandibular over dentures either retained with ball, bar or telescopic attachments**,** the authors found that implant success and peri implant condition did not differ between both attachments but the ball attachment showed significantly higher frequency of technical complications than that of telescopic and bar attachment in implant supported overdentures [47,48].

- **Locator (self-aligning) attachment**

The locator attachment system is an attachment system with self-aligning feature and has dual retention (inner and outer). Locator attachments come in different colors (white, pink and blue) and each has different retentive value. Additional features are the extended range attachments, which can be used to correct implant angulation up to 20^{o} they are offered in green, which has standard retention, and red, which has extra-light retention[49]. The reduced height of this attachment is an advantagous for cases with limited interocclusal space or when retrofitting an existing old denture . A laboratory study investigated the properties of this attachment founded that short profile distance of locator may affect the load transfer to the implant. The rounded edges of the abutment help to guide the nylon male within the denture into place (self-aligning feature) [50]. Locator attachment will also accommodate divergent implants up to 20 degrees. A variety of abutment heights, angulations correction and different levels of retention are available that help to create the optimum overdenture restoration for each case. In a study evaluating the clinical performance as well as patient and clinician satisfaction on two different prosthodontic retention systems (locator and bar) for implant-over dentures in

the mandible, the authors emphasized that patient satisfaction was similar in both groups; the locator system demonstrated better soft tissues scores, however, the frequency of chronic inflammations around the implants was more around bars attachment group[51].

2-Magnet attachments

Magnetic retention is a popular method of attaching removable prosthesis to either retained roots or osseo integrated implants. The magnet is usually cylindrical or dome shaped attached to the fitting surface of the acrylic resin base of the over denture. The magnetic keeper casted to a metal coping cemented to root surface or screwed over the implant fixture. The magnet system used for over denture retention incorporates the magnet into the overdenture which is a neodymium-iron-boron alloy or a cobalt-samarium alloy. The second part of the magnetic system is the ferromagnetic keeper which is screwed into the implants . The retention force of magnet attachments in implant-retained mandibular overdenture treatment is markedly less than the retention force of ball and bar-clip attachments[50,51]. The immediate loading of magnet attachment-retained mandibular implant overdentures is considered as a viable treatment option in cases of complete edentulous patient that increase retention and stability of conventional dentures [51].

3-Bar attachments

The bar attachment consists of a metallic bar that splints two or more implants or natural teeth spanning the edentulous ridge between them and a sleeve (suprastructure) incorporated in the over denture which clips over the original bar to retain the denture. The bar attachments are available in wide variety of forms, they could be prefabricated or custom made. There are two basic types based upon the shape and the action performed**.** Bar joint that permit some degree of rotation or resilient movement between the two