Introduction

Edentulism is often regarded as the main feature of premature ageing. It is still considered till today as a major public health problem disturbing life of millions of people all over the world and removable dentures are still considered a reality of life.(1)

One of the challenges in dentistry is the provision of complete removable dentures that satisfy all functional and esthetic requirements of patients. Conventional complete denture wearers experience a number of problems on a daily basis, such as instability of their mandibular dentures, inability to comminute foods, decreased self-confidence, quality of life, social contact and satisfaction. (2)

Using implants to retain and support mandibular overdentures has helped to fulfill the functional requirements of patients with this challenging treatment indication thus implant retained overdentures present an opportunity to improve denture retention, stability and to improve patient's satisfaction and quality of life.

Mini dental implants (MDIs) are root-form implants with diameters ranging from 1.8 to 2.4 mm, lengths ranging from 10 to18 mm. They are minimally invasive, can be placed in a single stage surgical procedure. The insertion of these implants does not require the raising of a flap and full-depth osteotomy, only using a

pilot drill to make a hole into the bone, but not a prepared bone site thus bleeding and post-operative discomforts are minimally reduced and healing time is shortened. Generally, MDIs can be loaded immediately as long as primary stability is achieved.

Successful implant treatment depends on several factors. These factors become even more critically important when immediate or early loading is planned for. Biomechanical factors are considered one of the most important factors that play a significant role in the long term survival of oral implants.

As it was reported that the intensity of the resulting stresses around an implant would be a function of the physical qualities of the occlusal material used thus occlusal materials can be considered as one of the biomechanical factors that may affect the transmission of forces and the maintenance of occlusal contacts.

Digital panoramic imaging method is comparable to conventional panoramic radiography but the receptor, processing, display, storage and printing capabilities differ from film-based imaging. It offers many advantages such as, electronic image storage, the ability to enhance the resulted image with various tools such as density, contrast, measurement and teleradiography capabilities for the purposes of consultation. It is a simple method that can be easily integrated. [3]

Since immediate loading is planned for in this study, acrylic and composite resins were chosen as it was claimed that

resilient occlusal materials protect the implants from occlusal trauma. A question now arises; which of these resins is better and more protective for the mini- implants and the overdenture supporting structures?

Review of literature

I-Implant overdenture

The extraction of the last remaining teeth and the replacement with complete dentures has many consequences. The patient has to accept edentulousness, which may lead to psychological problems and social isolation. According to many case reports in the literature, it was found that edentulous patients were dissatisfied with their complete mandibular dentures. [4, 5]

An overdenture can be defined as "a partial or complete denture that covers or is attached to one or more natural remaining teeth, roots and / or dental implants, aiming at improving patient's masticatory function, ethetics, phonetics and comfort". These types of implant- or tooth-retained prostheses may be rigid or semi-rigid. [6]

The concept of overdentures was presented at the World Dental Congress in 1861 by Butler, Roberts and Hays who presented history of 12 years treatment results. At 1970, overdentures were presented at the American Dental Association annual meeting in Las Vegas. It was not accepted worldwide that time untill new clinical procedures in the field of periodontology and endodontics appeared which significantly prolonged the lifetime of the remaining teeth. [7, 8]

There are many advantages of overdenture as opposed to complete denture, the main advantage is the preservation of

alveolar bone which resorbs after teeth extraction, it distributes the masticatory loads between the edentulous ridge and the abutment teeth and prevents occlusal overload due to the function of proprioception found in the periodontal ligament of abutment teeth. [7, 9, 8]

Stability and support were enhanced greatly with overdentures than with complete dentures. The chewing efficiency of patients with natural dentition was found 90%, at complete denture wearers 59%, and at patients wearing overdentures 79%. [10]

Overdenture treatment makes a gradual transition from a natural dentition to complete dentures as leaving some teeth to act as overdenture abutments prevents the negative feeling of being totally edentulous and allows the patient to adapt more easily to the idea of denture wearing. [4, 11]

Implant supported overdenture

A fixed prosthesis on 5-6 implants was presented by Brånemark as a viable treatment for edentulous jaws, and this concept lasted for many years after that with very successful long-term results. However treatment with implant mandibular overdentures were introduced in the mid 1980's and became popular in many countries due to their lower costs and complications than fixed treatments. [12, 13]

It was reported that overdentures supported by 2 implants achieved a 100% success rate with mean marginal bone

loss 0.5 mm after 5-years. In general maxillary implant overdentures on few implants have been found less successful than the mandibular 2-implant overdentures, this can be attributed to the limited area of bone for implant placement remaining after atrophy of the maxillary bone while in the mandible, the remaining basal bone is sufficient both in depth and width to accommodate implants. In addition, maxillary bone consists of looser arrangement of trabecular bone which is less capable of stabilizing and supporting implants.[14,15,11]

When implants were placed anteriorly in the mandible to support an overdenture, they achieved great improvements in masticatory function, speech, quality of life and nutrition. Implant-retained overdentures with ball attachments enable the patients to feel more comfort than with complete dentures and to be more satisfied as the retention and stability provided by the attachment enable them to return to their normal social life. [16]

Patients rehabilitated with implant-supported prostheses showed less bone loss than those with conventional dentures, probably due to more adequate functional stimulus to the bone via implants than through dentures. New bone apposition was formed in jaws with fixed implant-supported prostheses.[17, 18]

Occlusion is found to be difficult to be established and stabilized with total mucosa supported prosthesis but implant supported prosthesis is stable and allows patient to return consistently to centric relation rather than adapt to variable positions because of the instability of the prosthesis. [19]

Implant overdenture is a good alternative to fixed implant-supported prosthesis for its relatively low cost and clinical need in cases of difficulty of placing multiple implants with appropriate number and arrangement in the arch to support a fixed prosthesis. It also allows easier cleaning as they are removable and supported by fewer number of implants. It provides support of facial profile by the flanges of the denture which is a great advantage over a fixed prosthesis. [20-22]

It was concluded in a study that two implants offered the same quality of retention as 3 or more implants for hybrid dentures in the edentulous mandible. In another study, the authors failed to find any clinical or radiographic differences between 2 and 4 implants over 5 years of follow-up. [23-25]

A mandibular implant overdenture on two implants can be considered an effective treatment option for a long term period of time and it has even been suggested to be the first choice of treatment for the edentulous mandible.[26, 27]

Mini implant supported overdenture

The Glossary of Oral and Maxillofacial Implants [28] have defined mini implant as an "implant fabricated of the same biocompatible materials as other implants but of smaller dimensions. They can be made as one piece to include an abutment designed for support and/ or retention of a provisional or definitive prosthesis."

The use of mini-implants started in orthodontics with the purpose of providing anchorage and had proved to be an excellent alternative. The results were so motivating to allow these devices to be widely used. [29]

The ultra-small one piece implant of 1.8 mm in diameter was used by Sendax [30] as primary intention to support a temporary prosthesis. It was expected to remove these implants easily after that but this was not the situation as when they tried to remove the implants, they were osseointegrated to bone. Since that time, many implant manufacturers have produced small diameter implants to be widely used for narrow ridges and for definitive prothesises. [31, 32]

The use of mini-implants has been approved by the United States Food and Drug Administration (FDA) to be used in the human jaw for both interim and long-term prosthodontic treatment. [33]

Mini dental implants are root-form implants ranging from 1.8-2.4 mm in diameter. Their lengths range from 10mm – 18mm. The selection of mini-implant length should be as anatomically possible to overcome their small diameter and to increase the bone-presenting profile and to lessen the per square millimeter force applied to the bone under load.[35]

The minimum accepted number of mini implants for retention of complete dentures may be 6 in the maxilla and 4 in the mandible. They should be placed parallel to each other and the

parallelism should not exceed 20^{o} to avoid non seating of the denture and conversion of axially directed loads to off-axial loads by the angled position of the implant. [35, 36]

It was reported in a study used 2,514 mini-implants with diameters range from 1.8 to 2.3 mm in 531 patients that they approved to be successful with a 94.2% survival rate after 2.9 years. [37]

The results of a retrospective 5-year study concluded that insertion of 52 small diameter implants for single tooth replacement in 44 patients after 2 years achieved a 94.2% survival rate. [38]

A study observed that placement of 116 small diameter implants in the anterior mandible in 13 months, 113 of the implants remained in service for a success rate of 97.4% in addition to improved comfort, chewing ability, speech, and retention as reported by the patients. [39]

i. Indications of mini implants

Mini-implants have been indicated for use in many fields of dentistry, for example in orthodontics, they were used as temporary anchorage devices for more rapid and more complicated tooth movements and that was confirmed after a systematic review which concluded that this was a suitable treatment modality. [40]

Mini-implants may be the absolute solution for single implant supported crown in many cases such as insufficient bone interdentally or bucco-lingually, a thin alveolar crest and where teeth have narrow cervical diameters. [41, 42]

The problems of distal and anterior extensions partial dentures could be solved by mini-implants using precision attachments, O-rings or a soft reline material. [43]

Combination syndrome can be successfully treated by using mini-dental implants which can be inserted posteriorly in the mandible to provide posterior support for the upper complete denture. Although the posterior atrophied mandibular bone is narrow but it has enough height to accommodate the mini-implants and to avoid the neurovascular canal injury.[34]

Mini implants can solve the problems of completely edentulous patients having narrow ridges due to the reduced surgical invasiveness associated with their placement especially in patients with general systemic risk factors. They also can be beneficial with the elderly patients instead of using the conventional implants requiring extensive augmentation procedures. [44, 45]

ii. Advantages of using mini implants

It was concluded that mini-dental implants were a highly successful implant option and that implants were relatively affordable based on a study involving placement of 116 mini-implants in 30 patients with a success rate over 97%. The results

of the study showed that patient's satisfaction; denture retention, comfort, chewing ability and speaking ability were all improved. Mini-implants can provide an alternative treatment when osseous conditions preclude using a standard sized implant approach.[39,46]

Mini-implants may be placed using flap or a flapless technique. The flap one carries the advantage of direct visualizing the bone before making the osteotomy and reshaping of bone and soft tissue if needed, but it is more invasive with prolonged recovery and healing times. On the other hand flapless technique can be done trans-mucosally carrying the advantages of being less invasive, maintaining the alveolar bone level, shorter healing time and avoiding patient discomfort. [47, 48]

Mini-dental implants are highly indicated in edentulous patients being unsatisfied by their conventional dentures due to denture instability, pain and discomfort especially with systemic conditions that limits the extent of the surgery or that refuse complex and expensive medical interventions.[49]

Denture stability was improved when using mini-implants to support and retain complete dentures and that was reflected on improving the masticatory efficiency which led to better nutrition, phonation and comfort. So mini-implant treatment may be considered preventive treatment for reducing the side effects of ill-fitting conventional dentures.[50, 51]

Mini-implants may be immediately loaded to retain an overdenture when they are placed in denser bone and the insertion

torque not less than 30 Ncm. The patient immediately has a stable functional denture. [34]

As mini implants are one piece, there is no microgap between the endosseous implant and the abutment and this leads to less peri-implant bone resorption as compared to two-piece conventional implants .[34]

Mini-implants could be used to support and retain implant supported obturator prosthesis after partial maxillectomy instead of using conventional implants due to limited available bone in the resected area required for the conventional implants. The rehabilitation of that case was done using mini-implants with a simple surgical procedure and achieved great improvement in restoring the lost functions and led to patient satisfaction and self confidence. [52]

iii. Disadvantages of using mini-implants

There are some disadvantages associated with mini-implants for its use as a definitive prosthodontics treatment. These disadvantages include, the need for multiple number of mini-implants due to the lack of good predictability of their use, the potential for fracture of the implants during placement, the limited scientific evidence about their long-term survival and disadvantages related to the flapless surgical technique (if used) as lack of bone visibility and inability to irrigate the bone.[53]

One of the major disadvantages of mini-implants is the limited surface area which prone them to be less resistant to occlusal loads. [54]

Mini-implants may fail due to subjection to greater forces as the mini-implants exert greater force per square millimeter on the supporting bone than standard-diameter implants during their insertion. These forces may also overload or fracture the supporting bone. [46]

It may be incapable to use mini-implants in the posterior part of the maxilla due to presence of thin cortical bone with loose underlying trabeculations as in types III and IV bones, where there is decreased osseous matrix necessary for osseointegration. [55]

Implant attachments

An attachment is defined as “a mechanical device for the fixation, retention, and stabilization of a prosthesis, a retainer consists of a metal receptacle (the female part) which is usually present within the normal or expanded contours of the crown of the abutment tooth and a closely fitting component (the male part) is attached to a pontic or the denture framework”.[6]

Attachments were found to enhance retention, stability and support of implant overdentures, thus extending their longevity. Attachment systems used for the 2-implant overdenture can be divided into splinted and un-splinted ones. The splinted systems use an interconnecting bar and a retentive clip; for the un-splinted implants there are several types available such as ball attachments and magnets. There is no strong evidence for the superiority of one system over the others regarding patient satisfaction, survival, peri-implant bone loss and clinical behavior. All systems require substantial prosthodontic maintenance with time and cost implications, which should be considered in the economic aspects of the treatment. [56]

Attachments can be classified according to type of retention into frictional, mechanical, frictional and mechanical and magnetic attachments. The locator, ball and magnetic attachments can gain their retention through mechanical interlocking, frictional contact or magnetic forces of attraction between the male and female parts. Attachments can be fabricated either by machine milling an alloy or custom casted from plastic

patterns. Machine-milled attachments are commonly used on the individual implant, while custom-cast attachments are common as in the bar design. Both designs showed satisfactory results in terms of implant success and patient satisfaction. [57,58]

The selection of the type of the attachment system for an implant retained overdenture was found to depend on several criteria such as, amount of retention needed, amount of available bone, maxilla-mandibular relationship, inter-implant distance, status of the antagonistic jaw, expected level of oral hygiene, patient's social status, patient's expectation and cost effectiveness.[60]

Types of attachments

1) Stud attachments

Stud attachments consist of a female part which is frictionally retained over the male stud and incorporated into the fitting surface of the denture either indirectly by the means of a transfer coping system and the creation of a master cast or directly in the mouth using self-cured or light polymerized resin.[61]

Stud attachments can be classified according to function into resilient and non-resilient attachments. Resilient attachment permits some tissue ward vertical and rotational movements, so it protects the underlying abutments or implants against occlusal overload. However, resilient attachments usually require a large space and might cause posterior mandibular resorption with the vertical movement of the denture. On the other hand, non-resilient