Effect of mini implant number and distribution on the supporting structure of implant retained mandibular overdentures

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Introduction

Edentulism is defined as loss of all permanent teeth. It affects millions of people and considered to be an unresolved issue of sustained significance in the old age. It is considered to have several negative effects on the patient. It is associated with a residual ridge resorption, altered facial form, diminished masticatory function and subsequently a reduced general health and quality of life [(1)].

The classical treatment option for the edentulous patients is the conventional complete denture. While this treatment option is inexpensive and restores most functions, it has several drawbacks in regard to the supporting structures, retention, and stability. Many patients are satisfied with implant supported overdenture that is simple, less invasive and less expensive [(2)].

The main limitation of using implant overdentures utilizing conventional diameter implants is that the bone volume may be insufficient for conventional diameter implants without some interventions like bone augmentation which will increase the cost and time of the treatment [(3)].

Researches and investigations were done on edentoulous ridge rehabilitation using mini-implants or narrow diameter implants focusing on survival rates, surgical techniques, and bone resorption. Moreover there was no statistically significant difference between the survival rate of narrow diameter implants with conventional implants [(4)].

Although four mini dental implants have been recommended to support the mandibular overdentures. There are several studies that

reported good results of using only two or three mini dental implants to support the mandibular overdentures [5].

So, this study was conducted to evaluate the effect of different numbers and distributions of mini dental implants on the supporting structures of mandibular implant supported overdenture.

Review of Literature

The final outcome of edentulism is considered as a multifactorial process involving biologic processes (caries, periodontal diseases, pulpal pathology, trauma, oral cancer) as well as nonbiological factors related to the dental procedures as access to care, patient preferences, treatment options [6].

It was estimated that more than one fourth of the population older than 65 years of age is edentulous [7]. The number of the edentulous patients is decreasing in most industrialized countries, probably due to the economic welfare, changes in the attitudes toward the oral health, use of fluorides, and the availability of the health care services [8] but with the growing numbers of the older people there will be a net increase in the number of the edentulous people therefore the need for treatment of the edentulous patients are also expected to grow [9].

Consequences of edentulism

A) Bony consequences:-

The residual ridge consists of a denture bearing mucosa, submucosa, periosteum, and the underlying bone. After teeth loss, the bone sockets become filled with a new bone and form the residual alveolar processes [10].

The residual ridge resorption is a term used to describe the decrease in the quantity and quality of the residual alveolar ridge after teeth extraction. There is a progressive reduction of the residual alveolar

ridge and this reduction is usually greater in the transverse direction than in the vertical dimension [11].

After tooth loss, the residual alveolar bone undergoes a rapid resorption for about ten weeks then the rate of the resorption slows down, but remains progressive resulting in a decrease in the denture bearing area [12]. The most statistically significant loss of the tissue contour occurs during the first month after the tooth extraction and can average up to three to five mm in width by six months [11].

The rate of the resorption of the mandibular edentulous ridge is greater than that of the maxillary edentulous ridge by four times; this may be due to the damping effect of the bone and the overlying mucoperiosteum in the maxilla [6, 13].

Bone needs stimulation to maintain its form and density. Teeth transmit compressive and tensile forces to the surrounding bone. When a tooth is lost, the physiological masticatory forces applied via the perioceptors of the periodontal ligaments of the teeth to the cancellous alveolar bone are no longer persist [14].

The loss of teeth and their periodontal support results in the removal of an important sensory mechanism and a change in the loading pattern of the alveolar bone from tensile to compressive with the forces being predominantly vertical as well as horizontal. According to the Wolff's Law, the disuse and the loss of the mechanical stimulation is followed by a reduction in the bone mass, reduction in the trabeculae and bone density in the area, and a loss in the external width then height of the bone volume [15].

The continuous reduction in the alveolar ridges has anatomical, metabolic, prosthetic, and functional causative factors, the causative factors can be divided into two major groups which are the systemic factors depending on a hereditary and general health conditions as the systemic diseases such as osteoporosis, thyroid disease, and hormonal imbalance, and the local factors depending on the chewing habits, and the amount of the occlusal stresses transmitted through the removable prostheses to the underlying hard and soft tissues [6,12].

B) Soft tissue consequences:-

The extraction of the teeth not only affects the alveolar bone and its architecture, but also affects the overlying soft tissues. The changes in the contour of the mucosa depend on the corresponding changes in the external profile of the alveolar bone surrounding the extraction site [16].

The mean area of the mucosa available for the denture support has been calculated to be 22.96 cm^2 in the maxilla and approximately 12.25 cm^2 in the edentulous mandible while the periodontal ligament surface area is 45 cm^2 and this represents the great impact of the teeth extraction on the surface area of the tissues available for the support [10].

Clinically, the soft tissues overlying the residual ridges that have undergone a reduction may range from normal to inflamed, edematous, ulcerated, indented, or otherwise abused tissues [13].

C) Masticatory consequences:-

The bite force for the individuals of 75 years and over was reported to be 40% lower than that for those of 35-44 years. The main

reason for the reduced bite force is thought to be the atrophy of the jaw's closing muscles [17].

The difference in the maximum occlusal forces recorded in a person with natural teeth and one who is completely edentulous is dramatic. A patient who grinds or clenches the teeth may exert a force that approaches 1000 psi while the maximum occlusal force in the edentulous patient is reduced to less than 50 psi [14].

The loss of all teeth, even with dentures, reduces the masticating efficiency and affects the food taste, food preferences, and the food consumption patterns. The altered food choice, predominantly the soft and easy to chew foods, may result in the lower intakes for the key nutrients as the iron and fibers [18, 19].

D) Esthetic consequences:-

Facial changes occur naturally by the aging process, these changes can be accelerated when the teeth are lost with a subsequent resorption of the alveolar bone and decrease in the vertical dimensions and facial height. Aging appearance starts when deepening of the labio-mental angle and other vertical lines in the lip and face occurs. Deepening of the naso-labial groove occurs normally with aging process but accelerated with bone loss leading to an increase in the columella-philtrum angle and making the nose appear larger [14].

Pseudo class III malocclusion occurs with the decrease in the vertical dimensions, the chin begins to rotate forward and give a prognathic appearance with a subsequent decrease in the horizontal labial

angle at the corner of the lips which gives the unhappy or the anger appearance [14].

E) Psychiatric consequences:-

It is believed that the compromised oral health especially missing teeth can affect the nutritional status, self-image, physical and mental wellbeing, pleasure in participating in an active social life and consequently leads to a reduction in the quality of life [20, 21]. This means that the total tooth loss can increase social and psychological problems in coping with the improper mastication, speech impairments, and the abnormal socialization [22, 23].

Management of edentulism

i) Conventional complete dentures:-

The prosthetic management of the edentulous patient has long been a major challenge in dentistry. The classical treatment plan for the edentulous patients is the removable complete dentures, this treatment is relatively inexpensive. It can restore the function, improve esthetics, enhance self-esteem but cannot fully compensate the functional impairment after loss of teeth as the patients adapt their food choice and limit their mandibular movements to the range which precludes the denture displacement or pain [10, 24]

- **Problems of the conventional complete dentures:**

A) In relation to support:

1) Problems of the resorbed alveolar bone:-

Bone loss causes decreased bone width leading to narrowing of the remaining residual ridge and when the thin overlying soft tissue is loaded by a soft tissue borne removable prosthesis, this causes pain and discomfort as the tissue is compressed between the prosthesis and the ridge which acts as a knife [(14)].

In the posterior mandible, the continued atrophy causes a prominent mylohyoid muscle and the internal oblique ridge is covered by thin, unattached and movable mucosa which cannot support the prosthesis without causing pain and discomfort [(14)].

Bone loss in the maxilla or mandible is not limited to the alveolar bone but portions of the basal bone may be resorbed especially in the posterior aspect of the mandible. The bone loss may reach to more than 80%, this may lead the mandibular canal or the mental foramen to become dehiscent and serve as a part of the support area of the prosthesis, as a result, acute pain and transient to permanent paresthesia of the areas supplied by the mandibular nerve are possible. The body of the mandible is also at increased risk of fracture even under very low-impact forces [(14)].

2) Problems of the soft tissues:-

The use of the removable dentures can injure the oral tissues and is associated with a high frequency of the oral mucosal lesions. The denture related oral mucosal lesions may be acute like traumatic ulcer, allergic reaction and acute infection or chronic like denture stomatitis, angular