Effect of Abutment Angle on the Stresses Induced in the Supporting Structures of Mini Implant Retained Mandibular Overdenture

(Strain Gauge Stress Analysis Study)

Thesis Submitted to Removable Prosthodontic Department, Faculty of Dentistry, Ain Shams University; In Partial Fulfillment of the Requirements for the Master Degree in Oral and Maxillofacial Prosthodontics

Presented by

Mona Abdel Hakim Faheem

B.D.S (2004)
Cairo University

Faculty of Dentistry
Ain Shams University
2018

Supervisors

Prof. Dr. Amal Hussein Mubarak

Professor of Prosthodontics

Faculty of Dentistry,

Ain Shams University

Dr. Ahmed Mohamed Osama

Assoc. Professor of Prosthodontics

Faculty of Dentistry,

Ain Shams University

بسم الله الرحمن الرحيم

DEDICATION

To my beloved family

I dedicate this work to my father (may Allah mercy him) and my mother who taught me to trust in Allah, believe on hard work, and always inspiring me to be strong.

To my husband for supporting and encouraging me to believe on myself and to go on every adventure, especially this one.

And to my kids for whom any effort is being devoted.

ACKNOWLEDGMENT

*First and above all, my deepest gratitude and thanks to **"Allah"** for achieving any work on my life.*

*I would like to express my sincere and deep gratitude to **Prof. Dr. Amal Hussein Mubarak** Professor of prosthodontics Faculty of Dentistry, Ain Shams University; She was supportive from beginning to end and always encouraging me to follow through , She was willing to give help all the time; and my great thanks to **Prof. Dr. Ahmed Mohamed Osama** Assistant Professor of prosthodontics Faculty of Dentistry, Ain Shams University; for his great help, valuable instructions and kind encouragement to complete my work; to **Prof. Dr. Magdy Eid Mohamed** Professor of prosthodontics Faculty of Dentistry, Ain Shams University; for his kind support and continuous guidance all through my work.*

They have kindly offered me much of their time and experience. This kind effort and support that made achievement of this work possible.

Thank you

Mona Abdel Hakim

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INTRODUCTION

Teeth loss leads to lack of stimulation to the residual bone causes a decrease in the trabeculae and bone density, thus causing residual ridge resorption [(1)].

The loss of bone first causes decreased bone width followed by bone height; leaving a remaining narrow residual ridge. Thus over 50% of mandibular complete dentures have problems with stability and retention [(2)] together with soft tissue complication [(3)].

Problems arise from inadequate supporting tissues volume for mandibular denture treatment; denture adhesives can sometimes be proved inadequate [(4)]. In the past, treatment solutions have generally focused on providing increased supporting tissue volume. Alveolar ridge augmentation and vestibuloplasty have been used for this purpose. These treatments have provided mixed long-term success and have occasionally introduced significant complications and morbidity [(5)].

The restoration of the atrophic edentulous mandible with an overdenture supported or retained by implants placed in the interforaminal region has thus become regarded as the first prosthodontic treatment option [(6)]. As disadvantage of tooth supported overdenture treatment includes the need for inevitable treatment with additional time, increased cost and increased caries susceptibility [(7)].

Mandibular implant overdenture treatment can show significantly improved retention and stability characteristics as compared with conventional mandibular complete denture [(4)].

The use of narrow diameter implants (approximately 1.8mm to 2.4mm in diameter) has been suggested in order to reduce trauma for elderly patients using standard-sized implant would require bone reshaping or grafting [(8)].

Multiple manufacturers offer mini implants with a ball attachment as a one-piece implant. The limitations to a ball attachment include a greater inter-arch space requirement due to the taller supragingival attachment portion of the implant. One-piece implants with lower profile attachments like the ERA® allow less required inter-arch space and additionally permit a greater thickness of denture material over the attachment for improved strength. This also means the implants need a greater degree of parallelism to avoid a difficult seating of the prosthesis as well as lateral loads placed on the implants when the prosthesis is seated [(9)].

As an alternative, Sterngold reduced the size of their widely used ERA® attachment, creating a micro ERA® that is 20% smaller than the standard ERA®. This is offered as a mini implant in a 2.2-mm diameter in either a one-piece implant or as a two-piece implant—where the attachment can be placed either immediately or with a delayed approach and as a 3.25-mm two-piece implant [(10)].

The micro ERA® is offered in 0°, 5°, 11°, 17°, 23°, and 30° degree angulations options to allow the practitioner to correct implant placement that has been dictated by the angulation of available bone .This overcomes a common issue observed with ball- attachment mini implants, in which lateral loading results when the

implants are divergent and stresses are placed on the implants both during insertion and while the prosthesis sits intra-orally on the arch [9]. In addition, the "all-in-one" surgical kit from Sterngold provides these in a single kit to minimize the number of kits needed for a wide range of clinical applications , thereby giving practitioners flexibility when treatment planning [10].

However, increased stresses on implants and bone have been associated with use of angled abutments. In this regard, there are unresolved issues concerning implant survival and potential prosthetic complications that can arise when angled abutments are used to align prosthetic positions.

Many types of studies reviewed the authors searched the dental literature for clinical trials that appraised the survival rate and complications (biological and technical) associated with prostheses that are supported by angled abutments. The results of photoelastic stress assessments, finite element analysis and strain-gauge studies indicated that increased abutment angulations result in the placement of a greater amount of stress on prostheses and the surrounding bone than that associated with straight abutments.

However, survival studies did not demonstrate a significant decrease of prostheses' longevity associated with angled abutments. Furthermore, there was no additional bone loss adjacent to implants that supported angled abutments compared with straight abutments, and angled abutments did not manifest an increased incidence of screw loosening.

Clinical Implications:

The use of angled abutments facilitates paralleling nonaligned implants, thereby making prosthesis fabrication easier. These abutments also can aid the clinician in avoiding anatomical structures when placing the implants. In addition, use of angled abutments can reduce treatment time, fees and the need to perform guided bone regeneration procedures [(11)].

I. EDENTULISM

Oral health is a definite factor in general health, quality of life and economy [12]. Teeth are necessary for development and maintenance of alveolar bone through stimulation of bone which is mandatory to keep its density and volume [13]. Loss of teeth result in mechanical and esthetic adverse consequences such an effect is aggravated when this loss encompasses all the teeth resulting in the debilitating and anesthetic condition called edentulism [14].

Edentulism is a debilitating and irreversible condition and is described as the "final marker of disease burden for oral health" [15]. Although the prevalence of complete tooth loss has declined over the last decade, edentulism remains a major disease worldwide, especially among older adults [16].

In the United States, the number of edentate individuals is likely to stay stable at 9 million and, according to the most recent information; the prevalence of edentulism amongst adults over 60 years of age was 25% [17]. Studies show that edentulism is closely associated with socioeconomic factors and is more prevalent in poor populations and in women [18].The most common causes of complete edentulism are tooth extraction due to caries and periodontal diseases [19].

i. Impact of Edentulism on Oral Health:-

Edentulism results in deterioration of oral health besides psychological effects of edentulism are complex and ranges from minimal to states of neuroticism [20].

- **Modifier of Normal Physiology**

Bone loss is an ongoing process following tooth loss, affecting the mandible four times more than the maxilla [21]. Edentulism was found to have a significant effect on residual ridge resorption [22], which leads to a reduction in the height as well as the width of alveolar bone and the size of the denture bearing area. This reduction affects face height and facial 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 [23].

- **Risk Factor for Impaired Mastication**

The number of teeth has been chosen as a key determinant of oral function and oral health status [24,25]. Several studies using different methodologies have demonstrated that an important indicator for masticatory efficiency is the number of functional tooth units [26]. According to a systematic review evaluating the relationship between oral function and dentition, tooth numbers below a minimum of 20 teeth, with nine to 10 pairs of contacting units, are associated with impaired masticatory efficiency, performance, and masticatory ability (an individual's perception of his/her ability to chew) [24].

- **Determinant of Oral Health**

Edentulism can be accompanied by functional and sensory deficiencies of the oral mucosa, oral musculature, and the salivary glands. Decreased tissue regeneration and decreased tissue resistance are expected in the edentulous population, which can impair the protective function of the oral mucosa. Associations have been reported between aging, denture use, and oral mucosal