Stress analysis for the mandibular screw retained full arch prosthesis with different cantilever extension (3D Finite element analysis)

تحليل الجهد في الاطقم السفلية المحمولة على اربع غرسات باستخدام اطوال ناتئة مختلفة
دراسه تحليل العناصر ثلاثيه الابعاد

Protocol submitted to Faculty of Dentistry, Cairo University for partial fulfillment of the requirements for the Master Degree in dental implantology

By

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Code:

Supervisors' signature Head of department's signature

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Date

I. Administrative information:

1. Title:

Stress analysis for the mandibular mandibular screw retained full arch prosthesis with different cantilever extension (3D Finite element analysis) .

2. Protocol Registration:

No clinical trail

3. Protocol version:

First version

4. Funding:

This trail is self funded

5. Roles and responsibilities:

1. **Prof.Dr . Hamdi Abo Alfotoh (Main supervisor)**

- Professor in department of removable prosthodontics- Cairo university
- Main supervisor
- Responsible for data auditing, study selection , and Data monitoring

2 . **Dr . Doaa Amr (co-supervisor):**

- Lecturer in department of removable prosthodontics- Cairo university
- Co-supervisor
- Responsible for data auditing, and Data monitoring

3 . **Moaz Mostafa Farrag (Main research):**

- Principle investigator responsible for screening and handling lab work
- Writing of protocol.
- Collection, management, analysis and interpretation of data..
- Submitting the report for publication.

II. Introduction:

6. Background and rationale:

6A- Scientific background:

Conventional complete dentures have been the standard option of care for more than a century . Complete denture wearers are usually satisfied with the upper denture but the majority of them often struggle to eat with the lower denture because of the lack of retention [1]

Edentulous patients with severely resorbed mandibles often experience problems with complete dentures, such as insufficient retention and stability during masticatory function [2]

According to McGill consensus statement , the first choice “standard of care” for edentulous mandible is a 2-implant over-denture. However, a major limiting factor for the spread of implant retained overdentures is the high costs and the invasive nature of implant surgeries . [3]

The mandibular 2- implant overdenture was considered as first choice standard of care for edentulous patients In order to achieve retention and stability of overdenture, different attachments systems have been utilized. Various types of attachments have been successfully used to connect implants to overdentures . [1]

Since loosing teeth lead to bone atrophy with time the resulted resorption leaves less amount of bone above the inferior alveolar nerve which hinder placing of implants with favorable length to avoid nerve injury that might end in loss of sensation. [4]

Moreover, a systematic review concluded that there is no sufficient evidence to support a single treatment modality for edentulous mandible. Unlike the conventional complete denture, implant retained overdentures have excellent clinical results for maladaptive denture patients with promising long-term evidence supporting their effectiveness. [5]

The restoration of the edentulous arch with an implant-retained prosthesis results in d preservation of the alveolar ridge height , better masticatory performance and better patient acceptance when compared to complete dentures .[6]

The improved retention associated with implant overdenture allows for reduction in the prosthesis volume which is a great benefit for new denture wearers , gaggers and patients with tori , minimizing soft tissue coverage, allows for improved taste sensation. [7]

The lower jaw anatomy usually favours inter-foraminal implant placement which results in a posterior cantilever that causes mechanical overload due to the increased bending moment. Mechanical overload can result in biological complications manifested mainly with bone loss at the most distal implant. Bending moments has been also blamed for many prosthetic complications as screw loosening, screw fracture, prosthesis fracture and in few cases fracture of the implant body . [8]

The magnitude of the detrimental stresses resulting from such cantilever depends on many factors; namely, the cantilever length, quality of bone, Opposing occlusion, antero-posterior implant (AP) spread, geometry, number and tilt of the implants and height and design of the prosthesis . [9]

The increase in the cantilever length has been regarded as a major force magnifier. The “All-On-4” strategy shortens the cantilever length by directing the collar of the most posterior implant distally to emerge at the second premolar region instead of the first premolar while keeping the implant apex away from the inferior alveolar nerve . [10]

The consensus that cantilever length should be decreased evoked some ideas to achieve this concept .One of commonest ideas is to imply the shortened dental arch concept where the restoration is determinated at the second premolar region with no need for distal further extension . Another common approach to shorten the cantilever length is to tilt the most posterior implant shifting its restorative platform to a more distal position while keeping the implant apex in a safe anatomic position .[11]

6B. The main objective:

Compare the stress distribution pattern in two different cantilever length in mandibular screw retained prosthesis by computing the distribution of stresses in Bone/implant interface in different zone, magnitude and Direction of force applied using finite element analysis software.

Research Question:

Will increasing the cantilever length to 20 mm has favorable effect as standard length?

The Null hypothesis:

The hypothesis of this study that there will be no difference between 10mm 16mm and 20mm cantilever length in mandibular screw retained prosthesis.

- **External validity:**

- **Benefit of research to the patient:**

to get restoration that provides most reliable, and durable screw retained prosthesis regarding the patient.

- **Benefit of research to the clinician:**

use of most safe cantilever length that exhibits favorable pattern of stress distribution, Raise the quality of treatment, and less prosthetic complications of implant retained prosthesis.

- **Searched databases:**

Search was conducted on PubMed and google scholars using the following keywords in attempts to find literature in the context of my study. Keywords used were; implant retained overdenture, spread line ,cantilever length, and stress distribution .

Study design:

- Finite element analysis.
- Comparative study.

Study setting:

Study is to be conducted in external research lab that equipped with all needed devices and software for the study.

- **Data management and analysis:**

-All data will be entered electronically.
-study file is to be stored in secure and accessible place.
-All data will be maintained in storage after completion of the study.

III. Methods:

A) Samples , intervention and outcome :
7) Calculated sample size :

Finite element analysis is a computer simulation whereby all co-founders can be controlled. Thus, upon repeating the test many times the same result is achieved. Therefore, no sample size is required for finite element analysis studies .

8) Description of study sample :

Eligibility criteria:

- Finite element analysis.
- Eligibility criteria is not applicable

9) Intervention for each group

A. General study procedures

3D Object modeling:

3D virtual model of a complete edentulous human mandible arch construction obtained from of mandibular edentulous arch. Determining and simulation all parts of the jaw including cancellous , cortical bone, and covering mucosa. Four virtual dental implants size (3.5m x 10mm). The virtual dental implants will be inserted in (lateral and first premolar) of each side. Construction of virtual over denture with 10mm, 16mm, and 20mm cantilever length.

-In the control group:

Edentulous mandible will be restored with screw retained overdenture by four implants with 10mm cantilever length .

-In intervention group:

Edentulous mandible will be restored with overdentures retained by four implants with 16mm and 20mm cantilever .

Meshing:

The 3D virtual model will be meshed into small tetrahedral solid .

- **Defending the material properties:**

All properties of bone, implant, mucosa will be added to the software. The amount of 100

N load in deferent directions (vertical and oblique) will performed resembling masticatory forces.

- **Calculating and data collection:**

Finite element analysis software will compute and analyze the distribution of stresses in Bone/implant interface in different zone, magnitude and Direction of load applied.

Data will be collected and interpreted.

B. Criteria for discontinuing or modifying intervention:

No protocol for discontinuation of the procedure.

C. strategies to improve adherence to intervention:

- Monthly Face to face adherence reminder session with supervisor will take place
- E-mail the study updates (if any) to supervisors every 2 weeks.

PICO :

- **population:**

Virtual model of complete edentulous mandibular jaw.

- **Intervention:**

Screw retained overdentures on four dental implants .

- **Control:**

Screw retained overdentures on four dental implants.

- **Outcome:**

Name of outcome	Measure unite	Calculation Tool
Primary outcome: Stress distribution in implant\bone interface	Mega Pascal (MPA)	Finite element software

10) Outcome:

The primary outcome will be calculating the stress distribution in implant\bone interface. It will be measured in mega Pascal unit, by applying forces at different zone, magnitude and Directions. Using a finite element analysis will give an accurate result for measuring and analyze the outcome data.

B) Assignment to intervention

11) sequence generation

Not applicable in this study

12) Allocation concealment Mechanism:

Not applicable in this study

13) Implementation:

All steps will be done by the researcher and assistant specialist engineer to handle the software under supervision of main and\or co-supervisor

C) Blinding:

14) Blinding

Blinding not applicable and can’t be applied in this study because all the analysis is done by computer software. So, there is no risk of bias.

D) Statistical method:

15. Statistical methods for comparisons of groups.

Only descriptive values will be required with independent sample t-test will be used to compare variables between three groups that have different average values of primary outcome (stress distribution). There is no need of other statistical methods because there is no sample.

VI. References

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