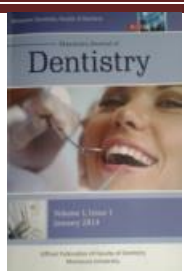


Two different designs of the 4-implants used for assisting mandibular complete overdentures: Clinical evaluation

Alaa M Aletribi*, Fatma El-Waseef**, Mohamed M Anees, Mohammed M Fouad*****
*BDS, Faculty of Dentistry, Mansoura University
**Associate Professor of Removable Prosthodontics, Faculty of Dentistry, Mansoura University
***Associate Professor of Periodontology and oral medicine, Faculty of dentistry, Mansoura University
****Professor of Removable Prosthodontics, Faculty of Dentistry, Mansoura University

Abstract:
Objectives: The aim of this study was to compare between two different designs used for assisting mandibular complete overdentures. One design was with four axially placed implants and the other was "all-on-four design" concerning peri-implant soft tissue health and implant stability.
Methods: Ten completely edentulous male patients were eligible for the present study. All patients received mandibular complete overdentures supported by 4 implants opposed by single maxillary dentures. The patients were randomly classified into 2 groups. Two axially placed implants were inserted at canine areas for both groups. Two implants were placed posteriorly, for group A two axially parallel implants in 2nd premolar regions while for Group B the patients received two distally inclined implants of 30° in the 1st premolar regions. All implants were attached to the mandibular overdentures through ball and socket attachments. Peri-implant soft tissue health and implant stability evaluation were carried out immediately, 3 months and 6 months after insertion of definitive overdenture.
Results: There was no significant difference between both groups when comparing peri-implant gingival, plaque, bleeding indices, probing depth and implant stability. Nonetheless, there was an improvement of all scores values and measures of all tested aspects through all time intervals in each group. Better values were noticed for anterior implants compared to posterior ones for both groups through all time intervals.
Conclusions: The results of the study boost that both designs; four axially inserted implants and All-on-four design could be successful treatment options for assisting mandibular complete overdentures. Yet both designs revealed comparable results with respect to the standard levels of peri-implant soft tissue health and implant stability, All-on-four design could be a promising alternative when being indicated.
Recommendations: More long term studies of variant evaluation methods are thus required to validate the results of this study.
Keywords: Implants, Complete Overdenture, Distal inclined implants, gingival index, plaque index, probing depth, bleeding index, stability.

Introduction

Patently, complete dentures have been a traditional and common way to restore edentulous patients for many years. However, the progressive bone resorption of the residual alveolar ridge is the main concern when rehabilitating the edentulous mandible using a removable complete denture more than in the edentulous maxilla. The common reasons for dissatisfaction are pain, sore spots, poor denture stability, and eating difficulties.

The use of implants has been recommended to assist mandibular overdentures in situations that require increased retention and stability. Implants can be used with different prosthetic treatment modalities; of these, the use of inter-foraminal implants for assisting the prosthesis with or without long distal cantilevers, the use of short dental implants above the mental foramina, the use of widely distributed axially inserted four implants (anterior and posterior) and the combined use of both axially placed and tilted implants.(1)

The design of using the tilted posterior implants simplifies the surgical procedure and reduces morbidity, time and cost, avoids anatomical structures, allows implant anchored in better quality bone and obviates bone grafts in majority of cases with high success rates. Also, this design creates a wider distance between the anterior and posterior implants resulting in improved load distribution and significantly reduces the distal cantilever size or completely eliminates it.(2)

The retention and stabilization of implant assisted mandibular overdenture are provided by the attachment components and structures of the denture-bearing area. The ball attachment was reported to be less technique sensitive, less costly, easier to clean than bars and less fracture or wear of the component than bars made from gold alloys. It was also elaborated using the ball attachment may be more beneficial for implant-supported overdentures considering minimizing denture movement and optimizing stress.(3)

The tilted implants were exposed to about twice strain that subjected to perpendicular implants to the occlusal plane. This strain may be decreased by adjusting the angle of the abutment by making it perpendicular to the occlusal plane. The angled multi-unit abutments provide more surgical flexibility for allowing tilting of dental implants when indicated. These abutments have great benefits for reconstructions where the All-on-4 protocol is the choice of treatment.(4)

Early or immediate loading can have a lot of advantages as it allows the patient to resume normal masticatory efficiency as soon as possible after surgery. It also avoids

the necessity for a temporary prosthesis, improves treatment efficiency and immediately enhances the esthetic appearance of the patient. [(•)]

Few handful studies compared the four axially placed implants (anterior and posterior) to the combined axial and distally inclined intra-foraminal implants used for assisting mandibular overdentures. Hence, the objective of the current study was to compare and evaluate both designs regarding the peri-implant tissue health and implant stability.

Materials and methods

Ten completely edentulous male patients (age ranged from 50 to 60 years) were selected for this study from the clinic of Prosthodontic Department, Faculty of Dentistry, Mansoura University according to the following criteria: completely edentulous jaws (at least 6 months from last extraction), healthy patients and free from any systemic diseases related to bone resorption, sufficient height and width of mandibular residual alveolar ridge covered with healthy firm mucosa, good quality and quantity of alveolar bone, suitable interarch space and normal maxillofacial relationship (Angle's class I).

Exclusion criteria were patients had local or general contraindications for surgical procedures, parafunctional habits (bruxism or clenching), heavy smokers and alcoholism, history of radiotherapy in the head and neck region, non-cooperative patients, poor neuromascular coordination or patient with TMJ disorders.

For each patient, conventional complete denture was constructed, inserted and the patients were instructed to wear the dentures for one month before implantation with weekly follow up visits till no complaint. The stereolithographic surgical guide was constructed to determine the exact location, parallelism and inclination of the implants. Two parallel implants were surgically inserted in canine regions (13mm length×3.75mm diameter), two parallel implants inserted in the 2nd premolar areas (10mm length×3.75mm diameter) for group A and two 30^0 distally inclined implants inserted in 1st premolar areas (16mm length×3.75mm diameter) for group B. The one stage surgical technique of implant placement and immediate loading protocol were followed. **Fig1 (a,c)**

Ball attachments with 2 mm gingival height were screwed in the parallel fixtures. For group B, 30^0 angled ball attachments were used to be parallel with the axial attachments (composed of multiunit abutment with 30^0 angulation screwed firstly in the fixture then screwing the ball over the abutment). Relief in the site of the female housing of the ball attachment and Small vents were made lingual to the prepared cavities for easy escape of the excess resin. The female housings were picked up using auto-polymerized acrylic resin while the patient closed in centric occlusion. The denture was removed, finished and polished. Intraoral readjustment of occlusion was done. The patient was instructed of oral hygiene measures. **Fig1 (b,d)**

Peri-implant tissue health was clinically evaluated at 2 weeks (T0), 3 months (T3), and 6 months (T6) after implant loading. Plaque, bleeding and gingival scores were assessed using the modified plaque (MPI) , bleeding (MBI) and gingival (MGI) indices(6,7), respectively. MPI, MBI,MGI and probing depth (PD) were recorded around each implant at 4 locations: lingually ,mesially, buccally, and distally .Also, implant stability (IS) was assessed at the time of implant placement and at subsequent visits using Periotest (Periotest S, Medizintechnik Gulden e.K., Modautal, Germany)[(8,9)]. **Fig1 (e,f)**

The measurements were made at the abutment level with the rod held perpendicular to the longitudinal axis of implants. The Periotest values (PTV) scale ranged from _8 to 50. The smaller the value level, the higher the stability of the measured implant. Periotest values ranged from _8 to 0 and indicated adequate osseo-integration. For reasons of objectivity, evaluations of clinical parameters were performed by a periodontist (A) who was blind to the study groups after instruction and calibration with two different dentists (B and C).

Results

Inference comparing the gingival indices of the studied groups (A & B); showed that no significant difference neither for anterior implants nor posterior ones relevant to all intervals as shown in **table (1)**. In addition, there is no significant difference when comparing the plaque indices of the two groups neither anteriorly nor posteriorly after 6 months of study as shown in **table (2)**.

Moreover, there was no significant difference between the two groups neither anteriorly nor posteriorly throughout all time intervals of the study when comparing bleeding indices as shown in **table (3)**.

Comparing the studied groups (A & B) with respect to probing depth showed that no significant difference was observed neither for anterior implants nor posterior ones relevant to all intervals of the study **(Table 4)**.

Regarding stability values, no significant difference was observed between both groups neither anteriorly nor posteriorly through all observation times as shown in **table (5)**.

Table (1): Comparison between the two groups regarding the gingival scores of anterior and posterior implants during all observation times

	Group / Intervals	Group A	Group B	P Value
Anterior	T0	1.25 (0.75-1.5)	1.25 (0.5-2.25)	0.39
	T3	0.875 (0.5-1.25)	0.75 (0.25-1.00)	0.194
	T6	0.50 (0.25-1.25)	0.50 (0.25-0.75)	0.094
Posterior	T0	1.25 (0.75-1.5)	1.375 (1.0-2.25)	0.168
	T3	1.00 (0.5-1.25)	0.75 (0.5-1.00)	0.071
	T6	0.75 (0.5-1.00)	0.50 (0.25-0.75)	0.06

Table (2): Comparison between the two groups regarding the plaque scores of anterior and posterior implants during all observation times.

	Group / Intervals	Group A	Group B	P Value
Anterior	T0	0.5 (0.25-1.00)	0.50 (0.25-0.75)	0.093
	T3	0.375 (0.25-0.75)	0.5 (0.25-0.5)	0.865
	T6	0.375 (0.25-0.5)	0.25 (0.125-0.5)	0.282
Posterior	T0	0.875 (0.50-1.0)	0.875 (0.50-1.0)	0.68
	T3	0.75 (0.25-1.00)	0.5 (0.25-0.75)	0.23
	T6	0.5 (0.5-1.00)	0.375 (0.25-0.75)	0.054

Table (3): Comparison between the two groups regarding the bleeding scores of anterior and posterior implants during all observation times.

	Group / Intervals	Group A	Group B	P Value
Anterior	T0	1.00 (0.25-1.00)	1.00 (0.50-1.00)	0.473
	T3	0.50 (0-1.00)	0.50 (0.25-0.75)	0.903
	T6	0.50 (0.25-0.75)	0.25 (0.25-0.50)	0.147
Posterior	T0	0.875 (0-1.00)	1.00 (0.75-1.00)	0.108
	T3	0.50 (0.25-0.75)	0.625 (0.25-1.0)	0.378
	T6	0.50 (0.25-1.00)	0.50 (0.25-0.75)	0.905

Table (4): Comparison between the means of the two groups regarding the probing depth of anterior and posterior implants during all observation times.

	Group / Intervals	Group A	Group B	T value	P Value
Anterior	T0	1.4653 ± 0.5123	1.9380 ± 0.7859	-1.59	0.128
	T3	1.2494 ± 0.5874	1.0962 ± 0.5687	0.59	0.561
	T6	0.7832 ± 0.3152	0.6551 ± 0.3507	0.86	0.402
Posterior	T0	1.7952 ± 0.7735	2.1322 ± 0.6495	-1.05	0.305
	T3	1.5144 ± 0.7166	1.2490 ± 0.4536	0.99	0.336
	T6	1.0501 ± 0.4584	0.8342 ± 0.4351	1.08	0.294

Table (5): Comparison between the means of the two groups regarding the stability of anterior and posterior implants during all observation times.

	Group / Intervals	Group A	Group B	T value	P Value
Anterior	T0	-2.7370 ± 1.7727	-3.2310 ± 1.0530	0.76	0.4585
	T3	-3.0700 ± 1.3734	-3.6210 ± 0.7908	1.10	0.2861
	T6	-3.3440 ± 1.1403	-3.8560 ± 0.7554	1.18	0.2520
Posterior	T0	-1.5967 ± 1.1800	-1.2180 ± 0.6159	-1.14	0.2684
	T3	-2.4103 ± 1.0530	-1.2490 ± 0.4536	-1.20	0.2442
	T6	-2.9720 ± 0.7908	-2.0580 ± 1.0293	-1.85	0.0814

Discussion:

In the present study, no significant difference was found when comparing GI, PI, BI and PD scores between Group A and B considering both anterior and posterior implants through all observation times. Nonetheless, slight better indices values were recorded for group B than group A. These better results for group B can be attributed to the advantage of more anterior (1st premolar) location of implants over the more posterior (2nd premolar) ones of group A. Eventually, the more posterior implant showed difficulty in performing oral hygiene measures. This explanation was concurred with the conclusion of **Gibreel et al**[10]**.**

In this sense, periotest values showed no significant difference between groups with respect to anterior and posterior implants at all observation times. This could be related to the immediate loading protocol used permitted the implant under functional loading to achieve a greater density of bone at the crestal level. The lack of difference in implant mobility between groups reflects the increased bone density in the inter-foraminal region and the increase of implant anchorage to the bone due to new bone formation. This seems to be consistent with **Pae et al.**[11]

BI, GI, and PD scores showed a significant enhancement for each group over all time intervals of the study. This could be contributed to the declared post-surgical inflammatory reactions as well as enhancement of oral hygiene measures. This might be attributed to the elevated oral hygiene measures maintained around the implant which were clearly shown by the decreased plaque indices. These indices are responsible for negative mucosal response as bleeding and inflammation. This is concurred with **Kuo-Yang Liao et al**[12] and **Visser et al.**[13] Also, **Turkyilmaz et al**,[14] considered decreasing of probing depth values to the shrinkage of the gingiva after surgery as a result of natural healing.

The results of this study showed non-significant difference in plaque indices in group A regarding the advancement of time intervals. While this result showed a significant decrease in plaque scores in group B at the end of the study.

For each group (A,B) the results revealed significant increase of posterior implants stability values at the end of the study. From the results of this study it was appeared that implant stability values at baseline were noted to be reasonably accepted. That could be due to the primary stability and tend to increase as soon as healing process and bone remodeling starts. Stability increased until it reaches osseointegration peek at 6 months. This was coping with **Monje et al**[15]. Also, **Ichikawa et al** [16] suggested that increased stability could be related to the increased quality of remodeling bone over time.

There was no significant difference in GI, BI and PD scores between anterior and posterior implants in each group through all observation times. However, it could be noticed that indices values of anterior implants in both groups deemed to be better than indices of posterior ones. That observation could be related to the difficulty in achieving good oral hygiene measures in posterior regions. Consequently, gingival inflammation would occur. This elaboration was coping with the reports of **Behneke et al**[17]. Additionally, the plaque indices of each group showed a significant decrease of anterior implants scores in comparison with posterior implants. This could be related to the difficulty of performing oral hygiene measures for posterior implants in comparison to the accessible anterior ones as proclaimed by **behenke et al**.[6].

Moreover, **Toljanic**[18] demonstrated a significant positive effect for implant position on plaque scores, with higher scores obtained for implants placed in the posterior area as opposed to anteriorly placed implants. These findings suggest that posteriorly positioned implants and implants in function in the oral cavity for longer periods of time are at greater risk for plaque induced inflammation. Posterior positioning of implants could make visualization and access for adequate plaque removal more difficult. Eventually, resulting in an increase in peri-implant soft tissue inflammation. Furthermore, compliance with proper home care as instructed might decrease over time, leaving patients at risk for increased plaque-induced peri-implantitis.

In agreement with **Roshanak Baghai et al**,[19] anterior implants in this study were found to have higher stability values than those of posterior implants in both groups. This could be related to the superior bone quality of the anterior segment of the mandible over the posterior areas as mentioned by **Monje et al.**[15] Also, **Turkyilmaz et al**,[14] referred high implant stability values for implants placed in the canine regions of mandibles to the bone density which is relatively high in anterior mandibles. This high bone density results in high primary stability. Moreover, the same authors [4] added that the concentrated stresses over posterior implants could affect their stability as the proximity of those implants to the stress area aggregates more strain over them.

Stability values of anterior implants were found to be significantly increased than posterior ones in group B. This could be related to the lower stability values of posterior implants as a result of elevated strain around tilted implants and less stress distribution unlike axial ones. This was in agreement with **Chun-Li Lin et al**.[20]

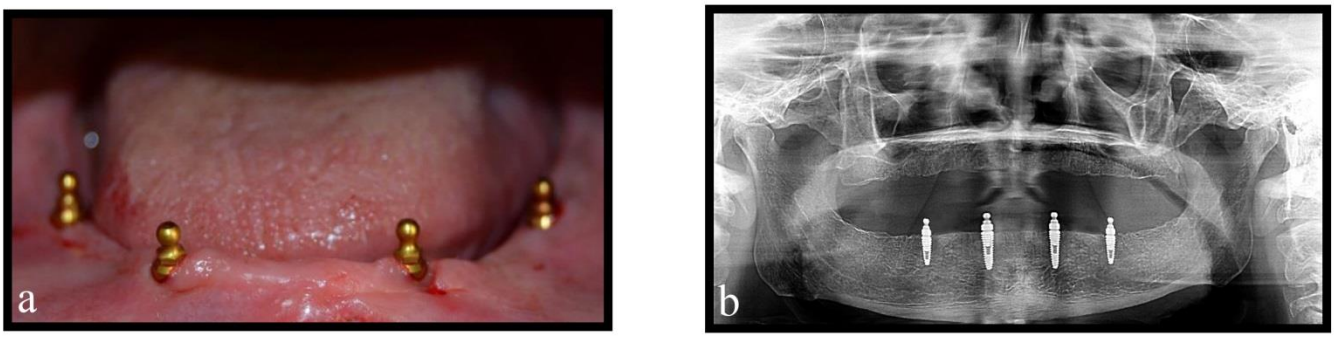
Conclusions

On the light of the current study results, one could conclude that:-

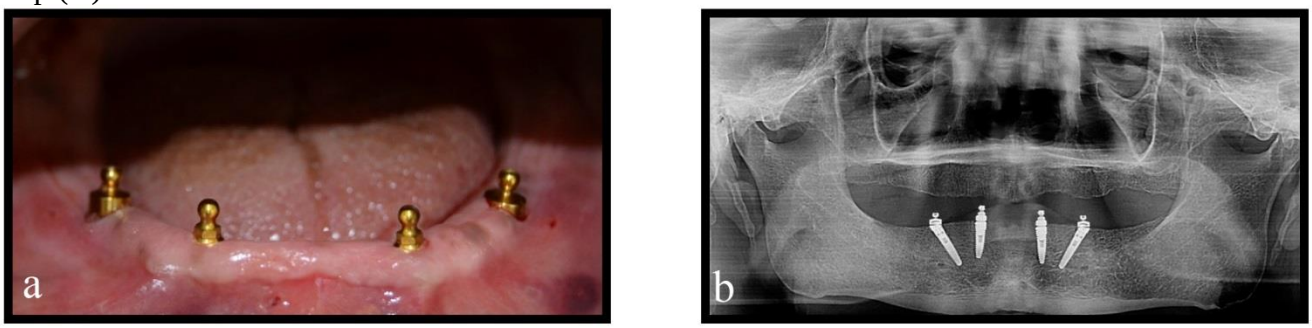
- Our findings boost that both designs; four axially inserted implants and All-on-four design could be successful treatment options for assisting mandibular complete overdentures.
- Yet both designs revealed comparable results with respect to the standard levels of peri-implant soft tissue health and implant stability, All-on-four design could be a promising alternative when being indicated.

Recommendations

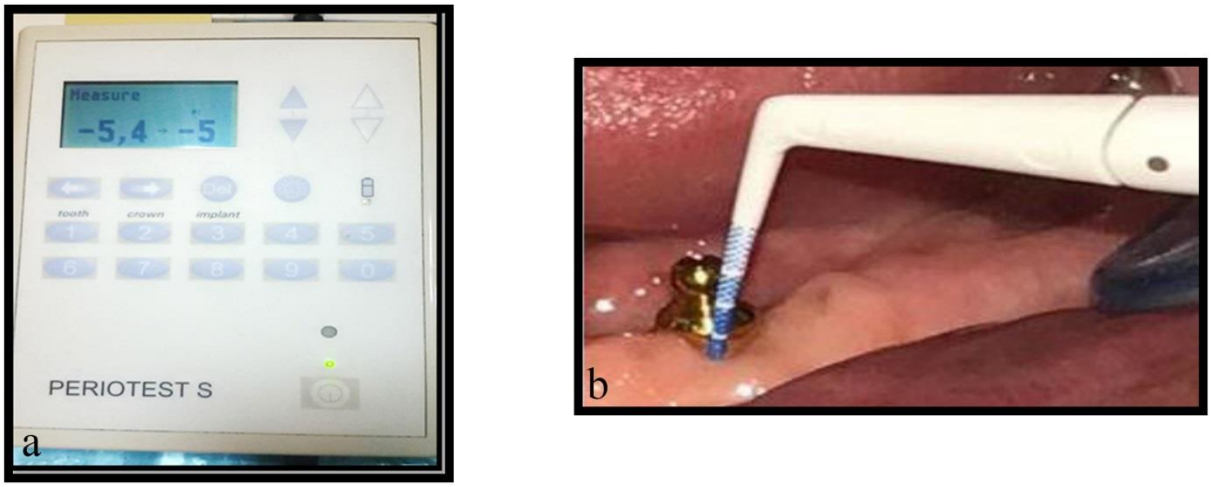
More long term studies of variant evaluation methods are thus required to validate the results of this study.



Fig(1): a) Ball attachments screwed into their implants and **b)** Post-surgical panoramic radiograph in group (A)



Fig(2): a) Ball attachments screwed into their implants and **b)** Post-surgical panoramic radiograph in group (B)



Fig(3): a) Periotest for measuring stability and **b)** plastic periodontal probe for peri-implant clinical evaluation

References

1. Galindo DF, Butura CC. Immediately loaded mandibular fixed implant prostheses using the all-on-four protocol: a report of 183 consecutively treated patients with 1 year of function in definitive prostheses. Int J Oral Maxillofac Implants. 2012;27(3):628–33.
2. Barnea E, Tal H, Nissan J, Tarrasch R, Peleg M, Kolerman R. The Use of Tilted Implant for Posterior Atrophic Maxilla. Clin Implant Dent Relat Res. 2016 Aug;18(4):788–800.
3. Jemt T, Chai J, Harnett J, Heath MR, Hutton JE, Johns RB, et al. A 5-year prospective multicenter follow-up report on overdentures supported by osseointegrated implants. Int J Oral Maxillofac Implants. 11(3):291–8.
4. Wolfinger GJ. The Use of Multi-Unit Abutments for All-on-4 Treatment. Incl Mag. 2018. p. 5.
5. Ganeles J, Zöllner A, Jackowski J, ten Bruggenkate C, Beagle J, Guerra F. Immediate and early loading of Straumann implants with a chemically modified surface (SLActive) in the posterior mandible and maxilla: 1-year results from a prospective multicenter study. Clin Oral Implants Res. 2008 Nov 1;19(11):1119–28.
6. Mombelli A, Marxer M, Gaberthüel T, Grunder U, Lang NP. The microbiota of osseointegrated implants in patients with a history of periodontal disease. J Clin Periodontol. 1995 Feb;22(2):124–30.
7. SILNESS J, LOE H. PERIODONTAL DISEASE IN PREGNANCY. II. CORRELATION BETWEEN ORAL HYGIENE AND PERIODONTAL CONDTION. Acta Odontol Scand. 1964 Feb;22:121–35.
8. Sennerby L, Meredith N. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. Periodontol 2000. 2008 Jun;47(1):51–66.
9. Olivé J, Aparicio C. Periotest method as a measure of osseointegrated oral implant stability. Int J Oral Maxillofac Implants. 1990;5(4):390–400.
10. Mona Gibreel, Mohammed Fouad, Fatma El-waseef, Nesma El-amier HM. Clips versus resilient liners used with bilateral posterior prefabricated bars for retaining four implant supported mandibular overdentures. J Oral Implantol. 2017;
11. Pae A, Kim J-W, Kwon K-R. Immediate Loading of Two Implants Supporting a Magnet Attachment-Retained Overdenture: One-Year Clinical Study. Implant Dent. 2010 Oct;19(5):428–36.
12. Liao K-Y, Kan JY, Rungcharassaeng K, Lozada JL, Herford AS, Goodacre CJ. Immediate loading of two freestanding implants retaining a mandibular overdenture: 1-year pilot prospective study. Int J Oral Maxillofac Implants. 2014;25(4):784–90.
13. Anita Visser, Gerry M. Raghoebar, Henny J. A. Meijer, Rutger H. K. Batenburg AV. Mandibular overdentures supported by two or four endosseous implants A 5-year prospective study. Clin Oral Implants Res. 2005;16:19–25.
14. Ilser Turkyilmaz, Tolga F. Tozum, Celal Tumer ENO. A 2-Year Clinical Report of Patients With Two Loading Protocols for Mandibular Overdentures: Early Versus Treated Conventional Loading. J Periodontol. 2006;77:1998–2004.
15. Monje A, Suarez F, Garaicoa CA, Monje F. Effect of Location on Primary Stability and Healing of Dental Implants. 2014;69–73.
16. ICHIKAWA, T. Clinical evaluation of Periotest for two-piece apatite implants. Int J Oral Maxillofac Implant. 1994;9:461–7.
17. Behneke A, Behneke N, D'Hoedt B. The longitudinal clinical effectiveness of ITI solid-screw implants in partially edentulous patients: a 5-year follow-up report. Int J Oral Maxillofac Implants. 2000;15(5):633–45.
18. Toljanic JA, Ward CB, Gewerth ME, Banakis ML. A Longitudinal Clinical Comparison Plaque-Induced Inflammation Between Gingival and Peri-Implant Soft Tissues in the Maxilla. J Periodontol. 2001 Sep 1;72(9):1139–45.
19. Naini RB, Nokar MSS. Tilted or Parallel Implant Placement in the Completely Edentulous Mandible ? A Three-Dimensional Finite Element Analysis. 2014;(June).
20. Lin C, Wang J, Ramp MSLC, Liu P. Biomechanical Response of Implant Systems Placed in the Maxillary Posterior Region Under Various Conditions of Angulation , Bone Density , and Loading. 2008;57–64.