

The Comparison of Axial and Tilted Implants for Immediate Loading

Dr.Muzaffer Aslan

DDS, PHD

(ORCID ID: 0000-0002-2418-9472)

Istanbul Health and Technology University

Faculty of Dentistry

Department of Oral and Maxillofacial Surgery

Seyit Nizam Mah. Mevlana Cad. No:85/1zeytinburnu / İstanbul

Turkey

Tel: (+90) 532 448 41 50

e-mail: muzaffer.aslan@istun.edu.tr

ABSTRACT

Background: The success and sustainability of osseointegration in implant treatment is considered an important factor and therefore the value of Marginal Bone Loss (MBL) is an important consideration.

Method: Thirty eight patients (17 females and 21 males) were included in the study. Immediately loaded fixed prosthesis supported by two axial and two tilted implants were performed for each patient. 36 axial implants and 36 tilted implants were placed in maxilla, and 40 axial and 40 tilted implants were placed in mandible. Loading was performed 24 hours after the operation and final prosthesis was performed after 6 months. Patients were followed up at 6, 12, 24 and 36 months.

Results: According the results of the MBL measurements, there was a statistically significant difference between all results ($p = 0.000 < 0.05$). The value of MBL increased with time and MBL measurements are similar in both tilted and axial implants in maxilla and mandible. In this method, there is no graft cost and augmentation is not required.

Discussion: In our study, it is seen that routine control of the patients and early detection of the problem are important in order to prevent problems related to the implant and prosthesis.

Key Words: Axial Implants, Tilted Implants, Marginal Bone Loss (MBL)

Tob Regul Sci.™ 2021;7(6-1): 7576-7591

DOI: doi.org/10.18001/TRS.7.6.1.76

INTRODUCTION

Some studies with long follow-up reported high success and survival rates in implant-supported full-arc restorations in atrophic jaws.^{1, 2} The implants are placed between the two mental foramen in the mandible, and between the sinuses in the maxilla.

The concept of loading the implants was first applied by loading multiple implants for full-arc restorations in the mandible and good results were obtained.³⁻⁵ Survival rates for immediate implants vary between 80%

and 100% in mandible cases.⁶⁻⁸ Most published studies on immediate loading in the mandible have been done on edentulous patients.⁹ Normally, these patients have to use removable prosthesis during bone healing (4-6 months). This is unacceptable to many patients because of the discomfort and social situation. For patients, dental extraction, implant placement and a functional fixed prosthesis would be ideal to achieve on the same day.

Although grafting and sinus lifting procedures are effective for implant implantation in atrophic maxilla cases,^{10, 11} some complications have been reported in the literature.¹² Also, distal implants are angled to increase the distance between implants and thus to reduce wing length.¹³⁻¹⁵

Penarrocha et al. reported a 100% survival rate in implants applied to the mandible after tooth extraction.¹⁶ In a retrospective study, it was shown that immediate implantation of the four implants immediately placed on the extraction sockets is a valid treatment method for mandibular rehabilitation.¹⁷ When rehabilitating edentulous mandible with dental implants, there are many alternative options in terms of the number and positions of the implant. However, according to the results obtained from the analysis, there are results showing that the four implants placed on the interforaminal area are the most suitable for full arc prostheses.¹⁸ Furthermore, as the number of implants increase, there are difficulties in producing a metal frame that can be fixed on implants and the cost increases.¹⁹ When the implants placed with enough primary stability (> 35 Ncm), the success rate of edentulous mandible is quite high.^{6, 19, 20}

The "All on four" procedure has also been proposed to rehabilitate the edentulous jaws without any bone augmentation procedure.^{21, 22} Implants in the distal, if possible, should be placed in contact with the anterior walls of the maxillary sinus and without rupture of the sinus membrane.²³ This procedure has been accepted in the literature due to its success in both short and medium term.^{15, 22, 24-26}

The criteria for determining success in implant treatment are a matter of continued debate, but the success and sustainability of osseointegration is considered to be an important factor and the Marginal Bone Loss (MBL) value is therefore an important consideration. During the first year after functional loading, 2 mm bone loss around the implant neck was accepted as normal and even considered as a successful result in some classifications and consensus declarations.^{27, 28}

Some authors also claimed that a MBL loss of 1.5 mm or 1.8 mm was acceptable in the first year.²⁹⁻³¹

MBL, which occurs 1 year after loading, is generally expected, but it is unclear whether the "biological hour" that determines this event depends on prosthesis, patient, implant, or occlusal force. In recent years, many studies addressing this issue have clarified some principles and have started to achieve better results with implant design and protocols that minimize these MBL values.³²

The primary aim of this study was to investigate the clinical complications of full-arc maxillary and mandibular fixed prostheses with immediate loading of tilted and axial implants. Secondary goal was to compare marginal bone loss (MBL) changes between axial and tilted implants. In this article, 2-year data on implant survival, clinical complication rates and Marginal Bone Loss (MBL) are reported.

MATERIALS AND METHODS

Our study included patients who were older than 18 years of age and had an unobstructed condition in their general health conditions (coagulation problems, immune system diseases, uncontrolled diabetes, metabolic

diseases affecting bone, pregnancy, chemotherapy or radiotherapy in the last 5 years). The maxilla and mandible of the patients were edentulous or had bad prognosis teeth. Intersinus section of the maxilla and interforaminal section of the mandible had enough bone to 10mm length and 4mm diameter implant. The molar regions of the jaws were atrophic and a sinus lifting operation or augmentation was required for implant placement. Attention was also paid to the absence of acute infection in the process site.

During the clinical examination, the patients underwent orthopantomography (OPG) and computed tomography (CT) (Figure 1). Blood tests and consultations were requested from the patients who were needed according to the history.

Before the operation, vertical dimensions and occlusal recordings of the patients were determined. If any, the teeth were removed from the model and a total prosthesis was prepared on the model.

All operations were performed under intravenous sedation and local anesthesia. An incision was made in the maxilla between the first molar tooth to the other first molar and in the mandible between the second premolars. The teeth with poor prognosis were extracted and the sockets were cleaned. Two distal implants were placed at an angle of about 30 degrees to the occlusal plan and two anterior implants were placed axial. Thus, four implants (Straumann Roxolid, Bone Level Tapered, Basel, Switzerland) were applied to each jaw (Figure 2). The implants were placed with a torque of 50 Ncm to allow for immediate loading. Considering the axes of the implants and the screw outlet holes to be opened in the prosthesis, after the 17 or 30 degree angled multi-unit abutments were installed, the plastic caps were inserted and the tissues were sutured. The prosthesis that prepared before was adapted and the screw locations are marked. Then the plastic caps were removed and the temporary abutments were inserted, and adaption of the prosthesis was checked. After, the prosthesis and abutments were fixed by the resin. The abutment screws were removed and the prosthesis removed. After polishing, the prosthesis was disinfected and screwed on to implants with a torque of 15 Ncm (Figure 3). The screw holes were sealed with teflon and resin.

After the occlusion control and drug prescription the patients were discharged. (Figure 4). An antibiotic (Amoxicillin and Clavulanic acid 1 g), analgesic (100 mg of Filurbiprofen) and mouthwash (Chlorhexidine Digluconate 0.2%) was recommended for 7 days postoperatively every 12 hours. Patients were advised to be fed with soft-liquid diet in the first month. Tissue healing, prosthesis function, and oral hygiene were evaluated at the controls performed every week for the first month. These checks were continued every month until the next 6 months. At each visit, mobility of the prosthesis and occlusion were checked. At the end of the 6-month period, permanent hybrid prostheses consisting of metal skeleton, porcelain teeth and composite gingival sections were performed (Figure 5). He was called for follow-up visits every 6 months after the permanent prosthesis (Figure 6,7). Oral hygiene and complications were evaluated.

MBL Analysis

After implant surgery, during the prosthesis application (6 months after implantation) and at the 12th, 18th and 24th months, digital OPGs (Kodak 8000C digital panoramic; Carestream Dental LLC Atlanta, USA) were obtained. These images were transferred to a computer software program for further analysis (Carestream Dental Imaging Software 6.14.0.4, Atlanta, USA). The magnification values of the OPGs were calibrated using known size and diameter values of each implant. MBL values were calculated according to this calibration.

In addition to OPG, more accurate three-dimensional imaging such as CBCT could be used for this calculation, but only OPGs were measured to ensure that patients were not exposed to more radiation at each control.

RESULTS

From July 2014 to July 2017, a total of 38 healthy patients were included in the study. Of these, 18 were maxillary and 20 were mandibular rehabilitation. 8 of the maxillary 18 patients, were female and 10 were male, with a mean age of 60.83 years. There were 20 patients (9 females and 11 males) in the mandibular group and the mean age was 56.9 years. Both groups received a fixed prosthesis which was immediately loaded onto four implants. A total of 152 implants were placed (length between 10 mm and 14 mm, diameter between 3.3mm and 4.1mm). 76 of them were axial and 76 of them were about 30 degrees tilted. After 24 hours after the operation, fixed temporary prostheses were inserted. Cases were followed in 24 months. Implant survival rate is 100% since there is no implant loss during the study.

In cases of Maxilla; four patients (22.2%) had alveolar mucositis and two patients (11.1%) had periimplantitis. The most common prosthesis complication is the fracture in the temporary acrylic prosthesis (7 patients and 33.3%). Porcelain fracture was observed in a patient's permanent prosthesis (5.5%). Three patients had prosthetic screw loosening (16.6%). Eleven patients had hygienic problems (44.4%).

In cases of mandible; seven patients had mucositis (35%, 8,75% of implants), two patients had periimplantitis (10% of patients, 2.5% of implants). Fracture of the temporary prosthesis was seen in two patients (10%) and no permanent prosthesis fracture was observed (0%). Hygienic problems in eight patients (40%) and screw loosening in three patients (15%) were recorded.

These problems were solved with a better oral hygiene motivation and more frequently followed. No patient dissatisfaction was recorded.

The rates of complications encountered during the study are shown in tables and graphs (Figure 8-9).

MBL Measurements and Analysis:

MBL measurements of 36 axial and 36 tilted implants of maxilla were performed at 6, 12, 18 and 24 months. The mean of the 6th month measurements of axial implants was 0.32 mm, and at the 12th month was 1.09, 1.45 mm at the 18th month and 1.54mm at the 24th month. Tilted implants; The 6th month was 0.54mm, 1.41mm at 12 months, 1.56mm at 18 months and 1.75mm at 24 months.

MBL measurements were recorded in the same period in mandibular implants (40 axial and 40 angled). According to this; the mean MBL values in axial implants were 0.36 mm at 6 months, 1.03 mm at 12 months, 1.30 at 18 months and 1.52 mm at 24 months. In mandibular tilted implants; The mean of the 6th month was 0.48 mm, the 12th month average was 1.23mm, the 18th month average was 1.45mm and the last 24th month was 1.62mm.

According to the results of the analysis; There was a statistically significant difference between all results ($p = 0.000 < 0.05$). When all MBL values were examined without tilted and axial distinction, it was determined that the value in the 6th month was 0.42 mm, the value in the 12th month was 1.19 mm, the value in 18th month was 1.44mm and the value in the 24th month was 1.61mm. Accordingly, it was observed that the value of MBL increased with time (Figure 10-12).

According to the results of the analysis, there was no significant difference between the maxilla and mandible in terms of MBL values ($p = 0.092 > 0.05$). According to this result, the MBL variation between tilted and axial between the implants is similar between maxilla and mandible (Figure 12).

As a result of the analysis of MBL values between tilted and axial implants, no significant difference was found between the application methods ($p = 0.094 > 0.05$). Accordingly, MBL changes in straight and angled implants are similar without jaw difference (Figure 12).

In the comparative analysis of MBL values according to the jaws and the mode of application, the difference was not found significant ($p = 0.449 > 0.05$). According to this result, MBL values are similar in both tilted and axial implants in maxilla and mandible (Figure 11).

DISCUSSION

In this study, mid-term follow-up results, complications and analysis of MBL measurement values have been reported in a group of 4 patients who had implanted maxillary maxilla and mandible. In the literature, the most reported outcome for evaluating the effectiveness of an implant-supported rehabilitation is **survival rate**. Commonly accepted criteria for the **success rate** of implant success were the absence of pain in the function, lack of clinical mobility, less than 2 mm of radiological bone loss and absence of exudate.³³⁻³⁵

In our study, implants showed a 100% survival rate, however some prosthetic and hygienic complications occurred. When the implants with periimplantitis were taken into account, the success rate was 97.2% in the maxilla and 97.5% in the mandible.

In a similar study published in 2017 with 10-year follow-up results, the survival rate of 144 implants was 95.1%. The study also reported that all failures occurred in the first 2 years.³⁶

The results of a biomechanical study of tilted and axial implants in atrophic maxilla revealed higher stress values in tilted implants compared to axial implants.³⁷ In addition, in a study in which 848 patients received 7568 implants, 3-year follow-up data were presented. No difference was found between the implants.³⁸ In our study, no statistically significant difference was found between axial and tilted implants in terms of both clinical complication and MBL values.

It was reported in a 2012 study that the implant survival rate of implant-supported fixed prosthesis applied to 24 patients was 98.96% for 3 years.³⁹⁻⁴⁰ In a retrospective study by et al., 29-month follow-up, the implant survival rate was defined as 99.3%. In addition, the success rate of the final prosthesis was 100%.²⁵ In a study 2017 with 70 implants in 21 patients, the implants were placed flat and angled and the survival rate at the end of 2 years follow-up was 100%. As a result of the study, it was stated that the prosthesis made screwed on the axial and tilted implants in the maxillary posterior region were highly reliable.⁴¹ Malo et al. in another retrospective study, 242 patients treated with two tilted and two axial implants were reported. Accordingly, the 5-year implant survival rate is 98%, and the success rate of the prosthesis is 100%. Only a few small prosthetic complications have been reported.²² These results suggest that the technique and clinicians have developed over time.

In a similar study in the edentulous mandible, the incidence of temporary prosthesis fracture was 6.3% of total cases, while in some other studies this rate was 11% to 16%.^{4, 42}

The most common prosthetic complication in our study was fractures, especially in temporary prostheses (33.3% in Maxilla, 10% in Mandible). However, they did not cause major problems at implant level. In addition,

16.6% prosthetic screw loosening was seen. We believe this could be related to the calibration of the prosthetic torque kit.

In our study, the rate of hygienic problems was relatively high (44.4%). This issue is very important because preserving the surrounding soft tissue health is very necessary for success.⁴¹ Therefore, strict control of hygienic problems is mandatory in long-term care.

The results of our study show that all implants survive despite hygienic or prosthetic complications. This shows that the control and follow-up program is effective, and that complications can be solved at baseline and without growth.

Implantation success criteria for marginal bone loss and other parameters were first proposed in 1986 and are still known as the gold standard for implant success.⁴³

One aim of this study was to evaluate the success of marginal bone loss (MBL) by performing immediate measurement and analysis of marginal bone loss (MBL).

The success of dental implants is defined by implant survival. However, ongoing marginal bone loss (MBL) may compromise long-term survival of implants. The success criteria for MBL were proposed by Albrektsson et al. 1 mm MBL was seen as normal in the first year after abutment connection and it was accepted to be 0.2 mm / year after each.

Traditionally, the 1 year peri-implant MBL is assumed to be between 1.6 and 2.0mm^{31, 44} but a reduction of the implant is reported in MBL.⁴⁵⁻⁴⁶ Laurell and Lundgren have been shown lower MBL used in some implant types over a 5-year period.⁴⁷ The MBL value, which was measured in another study with fifteen years of follow-up, was reported to be 1.5 mm in the first year following prosthesis construction. It is reported that the prognosis of an implant may be reliable after the first year.^{20, 48}

Aparicio et al. used tilted and axial implants as an alternative to sinus lifting in patients with posterior maxillary atrophy. Twenty-five patients were rehabilitated with 29 fixed prostheses supported by 101 implants. Fifty-nine implants were implanted axially and 42 implants were tilted. The mean follow-up was 37 months. After 5 years, the cumulative success rate of implant was 95.2% (survival: 100%) for tilted implants and 91.3% for axial implants (survival rate: 96.5%), and the prosthetic survival rate was 100%. In the fifth year, mean marginal bone loss was 1.21 mm for tilted implants and 0.92 mm for axial ones. The results show that the use of tilted implants is an effective and safe alternative to sinus lifting procedures.⁴⁹

In the study of Agliardi et al, immediate full-arc fixed prostheses supported by the axial and tilted implants were applied to the atrophic maxillary and 3-year clinical and radiographic results were evaluated. All final prostheses were stable and the cumulative survival rate was 100%. In the 3-year follow-up, MBL was 1.55 ± 0.31 mm in axial implants and 1.46 ± 0.19 mm in tilted implants and there was no statistically significant difference between them ($p = 0.05$). As a result, placement of implants with this configuration has been considered as a predictable approach for immediate restoration of edentulous maxilla.⁵⁰

Krennmair et al. 44 patients had 4 implants immediately and 3 years following the implant. MBL changes were evaluated radiologically at 12, 24 and 36 months follow-up. It was seen that MBL increased significantly compared to years ($p < 0.001$).⁵¹

In a retrospective review including thirteen studies, implant survival rate and MBL changes were evaluated. Survival rate for 1 MB4 years was found to be 97.2% and the mean MBL was 1.45 mm.⁵²

In a study, MBL values were 1.53 mm in the first year after prosthesis making in standard and conical implant restorations.¹⁸ Factors leading to the high rate of MBL in this first year were not fully understood. However, there is evidence that, the micrograph at the implant-abutment junction and the occurrence of biological width are responsible.³⁷ In the results of long-term follow-up studies such as Pablo et al. 20 years, the mean MBL values were in a wide range ranging from 0.2 mm to 1.2 mm.³²

In the results of our study, the MBL value increased with time but no significant difference was observed between the angles of the implants. At the same time, this increase was similar between maxilla and mandible. Although the results in the mandible were better in terms of numerical values, but this difference was not statistically significant.

An implant that causes clinical symptoms is defective. However, MBL is rarely symptomatic but may compromise implant survival over the long term. In addition, the long-term prognosis of an implant cannot be based solely on MBL calculations in the first year. However, it is important to follow up patients to predict future problems.⁴³

In conclusion, this study showed that the use of tilted implants to rehabilitate atrophic jaws may be a good alternative to bone augmentation procedures in the posterior area, providing good function and aesthetics and providing high patient satisfaction. However, the possible complications should be determined by the controls and corrected by early intervention.

Declarations

Competing interests: The author declares that he has no conflicts of interest related to the publication of this manuscript.

Funding: No funding was received for this research.

REFERENCES

- 1- R. Adell, B. Eriksson, U. Lekholm, P. I. Branemark, and T. Jemt. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *The International Journal of Oral & Maxillofacial Implants* 1990; 5, 347– 359.
- 2- T. Jemt and J. Johansson. Implant treatment in the edentulous maxillae: a 15-year follow-up study on 76 consecutive patients provided with fixed prostheses. *Clinical Implant Dentistry and Related Research* 2006; 8, 61-69.
- 3- Randow K, Ericsson I, Nilner K, Petersson A, Glantz PO. Immediate functional loading of Brånemark dental implants. An 18-month clinical follow-up study. *Clin Oral Implants Res* 1999;10:8-15.
- 4- Francetti L, Agliardi E, Testori T, Romeo D, Taschieri S, Del Fabbro M. Immediate rehabilitation of the mandible with full prosthesis supported by axial and tilted implants: interim results of a single cohort prospective study. *Clin Implant Dent Relat Res* 2008;10:255-263.
- 5- P. Malo, B. Rangert, M. Nobre. “All-on-Four” immediate- function concept with Brånemark system implants for completely edentulous mandibles: a retrospective clinical study. *Clin Implant Dent Relat Res* 2003;5(Suppl 1):2-9.
- 6- P. Malo, M. Nobre, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. *J Am Dent Assoc* 2011;142:310-320.
- 7- Ganeles J, Rosenberg MM, Holt RL, Reichman LH. Immediate loading of implants with fixed restorations in the completely edentulous mandible: report of 27 patients from a private practice. *Int J Oral Maxillofac Implants* 2001;16: 418-426.

- 8- D. Morton, J. Jaffin, H.P. Weber. Immediate restoration and loading of dental implants: Clinical considerations and protocols. *Int J Oral Maxillofac Implants* 2004;19:103-108.
- 9- Esposito M, Grusovin MG, Coulthard P, Worthington HV. Different loading strategies of dental implants: a Cochrane systematic review of randomised controlled clinical trials. *Eur J Oral Implantol* 2008;1:259-276.
- 10- S. S. Wallace and S. J. Froum. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Annals of Periodontology* 2003; 8: 328-343.
- 11- M. Del Fabbro, G. Rosano, and S. Taschieri. Implant survival rates after maxillary sinus augmentation. *European Journal of Oral Sciences* 2008; 116: 497-506.
- 12- A. Katranji, P. Fotek, and H. L. Wang. Sinus augmentation complications: etiology and treatment. *Implant Dentistry* 2008; 17: 339-349.
- 13- L. Krekmanov, M. Kahn, B. Rangert, and H. Lindström. Tilting of posterior mandibular and maxillary implants for improved prosthesis support. *International Journal of Oral and Maxillofacial Implants* 2000; 15: 405-414.
- 14- C. M. Bellini, D. Romeo, F. Galbusera et al. A finite element analysis of tilted versus nontilted implant configurations in the edentulous Maxilla. *International Journal of Prosthodontics* 2009; 22: 155-157.
- 15- L. Francetti, D. Romeo, S. Corbella, S. Taschieri, and M. Del Fabbro. Bone level changes around axial and tilted implants in full-arch fixed immediate restorations. Interim results of a prospective study. *Clinical Implant Dentistry and Related Research* 2012; 14: 646-654.
- 16- Peñarrocha M, Boronat A, Garcia B. Immediate loading of immediate mandibular implants with a full-arch fixed prosthesis: a preliminary study. *J Oral Maxillofac Surg* 2009;67:1286-1293.
- 17- Mozzati M, Arata V, Gallesio G, Mussano F, Carossa S. Immediate postextractive dental implant placement with immediate loading on four implants for mandibular-full-arch rehabilitation: a retrospective analysis. *Clin Implant Dent Relat Res* 2012 Jan 11.
- 18- Duyck J, Van Oosterwyck H, Vander Sloten J, De Cooman M, Puers R, Naert I. Magnitude and distribution of occlusal forces on oral implants supporting fixed prostheses: an *in vivo* study. *Clin Oral Implants Res* 2000;11:465-475.
- 19- Cannizzaro G, Felice P, Soardi E, Ferri V, Leone M, Esposito M. Immediate loading of 2 (all-on-2) versus 4 (all-on-4) implants placed with flapless technique supporting mandibular cross-arch prostheses: preliminary results from a pilot randomised controlled trial. *Eur J Oral Implantol* 2011;4:205-217.
- 20- Cannizzaro G, Torchio C, Leone M, Esposito M. Immediate versus early loading of flapless-placed implants supporting maxillary full-arch prostheses: a randomised controlled clinical trial. *Eur J Oral Implantol* 2008;1:127-139.
- 21- P. Malo, B. Rangert, and M. Nobre. All-on-4 immediate-function concept with Branemark system implants for completely edentulous maxillae: a 1-year retrospective clinical study. *Clinical Implant Dentistry and Related Research* 2005; 7 supp: 88-94.
- 22- P. Malo, M. de Araujo Nobre, A. Lopes, C. Francischone, and M. Rigolizzo. "All-on-4" immediate-function concept for completely edentulous maxillae: a clinical report on the medium (3 years) and long-term (5 years) outcomes. *Clinical Implant Dentistry and Related Research* 2012; 14: 139-150.
- 23- O. T. Jensen, M. W. Adams, J. R. Cottam, S. M. Parel, and W. R. Phillips. The all-on-4 shelf: maxilla. *Journal of Oral and Maxillofacial Surgery* 2010; 68: 2520-2527.
- 24- L. Francetti, E. Agliardi, T. Testori, D. Romeo, S. Taschieri, and M. D. Fabbro. Immediate rehabilitation of the mandible with fixed full prosthesis supported by axial and tilted implants: interim results of a single cohort prospective study. *Clinical Implant Dentistry and Related Research* 2008; 10: 255-263.
- 25- C. A. Babbush, G. T. Kutsko, and J. Brokloff. The all-on- four immediate function treatment concept with NobelActive implants: a retrospective study. *The Journal of Oral Implantology* 2011; 37: 431-445.

- 26- D.S.Penalosa, R.Z.Alonso, M.P.Diago, M.P.Diago. The all-on-four treatment concept: Systematic review. *J Clin Exp Dent*. 2017;9(3): 474-488.
- 27- Albrektsson, T., Buser, D. & Sennerby, L. On crestal/marginal bone loss around dental implants. *The International Journal of Oral & Maxillofacial Implants*: 2012; 27: 736–738.
- 28- Misch, C.E., Perel, M.L., Wang, H.L., Sammartino, G., Galindo-Moreno, P., Trisi, P., Steigmann, M., Rebaudi, A., Palti, A., Pikos, M.A., Schwartz- Arad, D., Choukroun, J., Gutierrez-Perez, J.L., Marenzi, G. & Valavanis, D.K. Implant success, survival, and failure: the international congress of oral implantologists (icoi) pisa consensus conference. *Implant Dentistry*. 2008; 17: 5–15.
- 29- Roos-Jansaker, A.M., Lindahl, C., Renvert, H. & Renvert, S. Nine- to fourteen-year follow- up of implant treatment. Part ii: presence of peri- implant lesions. *Journal of clinical periodontology*. 2006; 33: 290–295.
- 30- Papaspyridakos, P., Chen, C.J., Singh, M., Weber, H.P. & Gallucci, G.O. Success criteria in implant dentistry: a systematic review. *Journal of dental research*. 2012; 91: 242–248.
- 31- Tarnow, D.P., Cho, S.C. & Wallace, S.S. The effect of inter-implant distance on the height of inter-implant bone crest. *Journal of periodontology*. 2000; 71: 546–549.
- 32- Pablo G.M., Ana L.C., Inmaculada O.O., Alberto M.F., O'Valle A.C. Marginal bone loss as success criterion in implant dentistry: beyond 2 mm. *Clin Oral Impl. Res*. 2015;26: 28-34.
- 33- T. Albrektsson, G. Zarb, P. Worthington, and A. R. Eriksson. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *The International Journal of Oral & Maxillofacial Implants* 1986; 1: 11-25.
- 34- C. E. Misch, M. L. Perel, H. L. Wang et al. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) pisa consensus conference. *Implant Dentistry* 2008; 17: 5-15.
- 35- I. Kürkçüoğlu, A. Köroğlu, S.E. Özkır. Dental implantlarda başarı kriterleri ve başarı değerlendirme yöntemleri. *Atatürk Üniv. Diş Hek. Fak. Derg*. 2010; 20:3:221-229.
- 36- T. Testori, F.Galli, L.Fumagalli, M.Capelli, F.Zufetti, M.Deflorian, A.Parenti, M.DelFabbro. Assessment of long-term survival of immediately loaded tilted implants supporting a maxillary full-arch fixed prosthesis. *Int J Oral Maxillofac Implants*. 2017; 32(4): 904-911.
- 37- Z.Gümrukçü, Y.T. Korkmaz, F.M.Korkmaz. Biomechanical evaluation of implant-supported prosthesis with various tilting implant angles and bone types in atrophic maxilla: A finite element study. *Comput Biol Med*. 2017; 1(86):47-54.
- 38- K.A.A.Alcayhuaman, D.S.Penalosa, Y.Nakajima, S.N.Papagergiou, D.Boticelli, N.P.Lang. Biological and technical complications of tilted implants in comparison with straight implants supporting fixed dental prosthesis. A systematic review and meta-analysis. *Clin Oral Implants Res*. 2018;29 Suppl118: 295-308.
- 39- R. Crespi, R. Vinci, P. Cappare', G. E. Romanos, and E. Gherlone. A clinical study of edentulous patients rehabilitated according to the "all on four" immediate function protocol. *The International Journal of Oral & Maxillofacial Implants* 2012; 27: 428-434.
- 40- S.Graves,B.A.Mahler,B.Javid,D.Armellini and O.T.Jensen. Maxillary all-on-four therapy using angled implants: a 16- month clinical study of 1110 implants in 276 jaws. *Dental Clinics of North America* 2011; 55: 779-794.
- 41- J.C.C.Epinosa, R.C.Oyagüe, M.A.S.Figallo, R.G.Serrano, C.D.Lynch, M.M.Collar, D.T.Lagares, J.L.G.Perez. Combination of straight and tilted implants for supporting screw-retained dental prostheses in atrophic posterior maxillae: A 2-year prospective study. *J Dent* 2017;63:85-93.
- 42- Agliardi E, Panigatti S, Clerico M, Villa C, Maló P. Immediate rehabilitation of the edentulous jaws with full fixed prostheses supported by four implants: interim results of a single cohort prospective study. *Clin Oral Implants Res* 2010;21:459-465.

- 43- D. Schwartz-Arad, R.Herzberg,L. Levin. Evaluation of Long-Term Implant Success. J Periodontol 2005; 76(10): 1623-1628.
- 44- Cardaropoli, G., Lekholm, U. & Wennstrom, J.L. Tissue alterations at implant-supported single-tooth replacements: a 1-year prospective clinical study. Clinical Oral Implants Research.2006; 17: 165–171.
- 45- Norton, M.R. Multiple single-tooth implant restorations in the posterior jaws: maintenance of marginal bone levels with reference to the implant- abutment microgap. The International Journal of Oral & Maxillofacial Implants. 2006; 21: 777–784.
- 46- Novaes, A.B. Jr, de Oliveira, R.R., Muglia, V.A., Papalexiou, V. & Taba, M. (2006) The effects of interimplant distances on papilla formation and crestal resorption in implants with a morse cone connection and a platform switch: a histomorphometric study in dogs. Journal of periodontology. 2006; 77: 1839–1849.
- 47- Laurell, L. & Lundgren, D. Marginal bone level changes at dental implants after 5 years in function: a meta-analysis. Clin Implant Dentistry & Related Research. 2011;13: 19–28.
- 48- Canullo, L., Iannello, G., Penarocha, M. & Garcia, B. Impact of implant diameter on bone level changes around platform switched implants: preli- minary results of 18 months follow-up a prospec- tive randomized match-paired controlled trial. Clinical Oral Implants Research. 2012; 23: 1142–1146.
- 49- C. Aparicio, P. Perales, B. R.M. Eng. Tilted Implants as an Alternative to Maxillary Sinus Grafting: A Clinical, Radiologic, and Periotest Study. Clinical Implant Dentistry and Related Research. 2001; (3);1: 39-49.
- 50- E. Agliardi, A. Pozzi, C.F.J. Stappert, R. Benzi, D. Romeo, E. Gherlone. Immediate Fixed Rehabilitation of the Edentulous Maxilla: A Prospective Clinical and Radiological Study after 3 Years of Loading. Clin Implant Dentistry. 2014; 16 (2): 292-302.
- 51- S. Krennmair, M. Weinlander, T. Forstner, G. Krennmair, M. Stimmelmayer. Factors affecting peri-implant bone resorption in four Implant supported mandibular full-arch restorations: a 3-year prospective study. J Clin Periodon- tology. 2016; 43 (1): 92-101.
- 52- V. Moraschini, G. Velloso, D. Luz, E. P. Barboza. Implant survival rates, marginal bone level changes, and compli- cations in full-mouth rehabilitation with flapless computer-guided surgery: a systematic review and meta- analysis. Int J Oral Maxillofac Surg. 2015; 44 (7): 892-901.

Figure Legends



Figure 1. OPG before treatment.

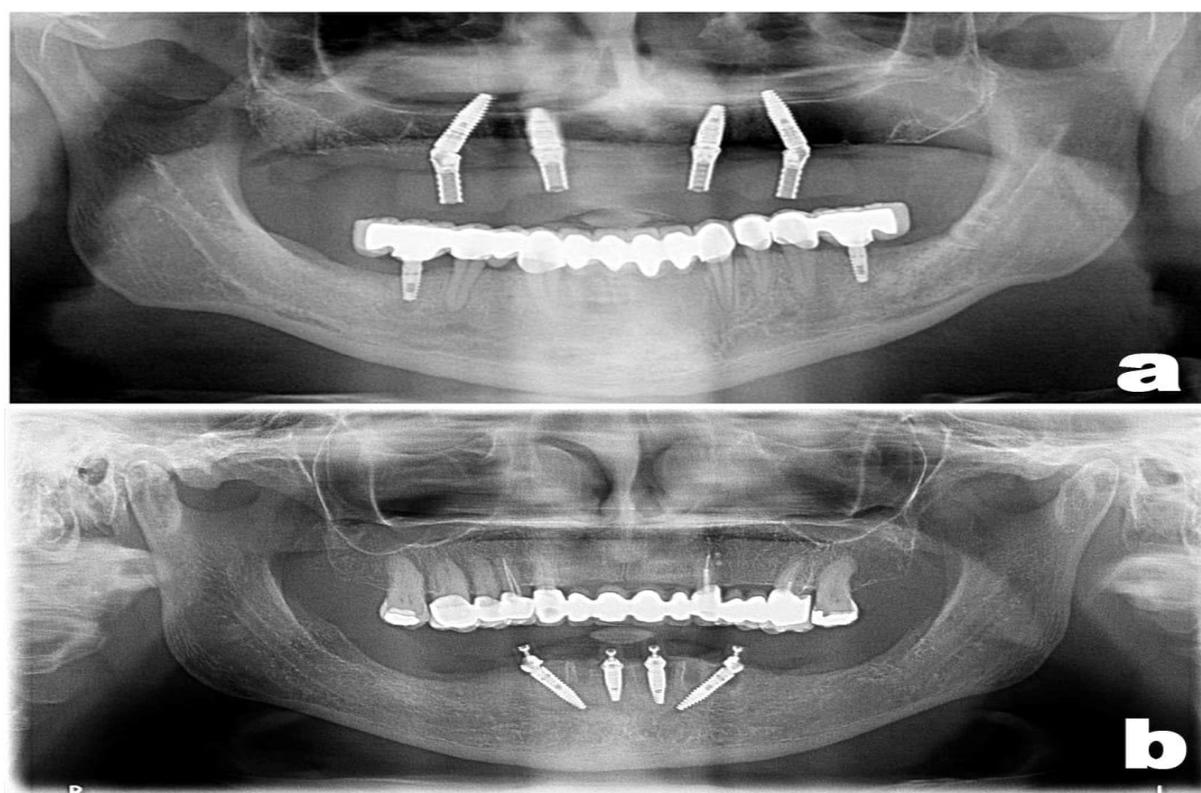


Figure 2. Postoperative OPG.

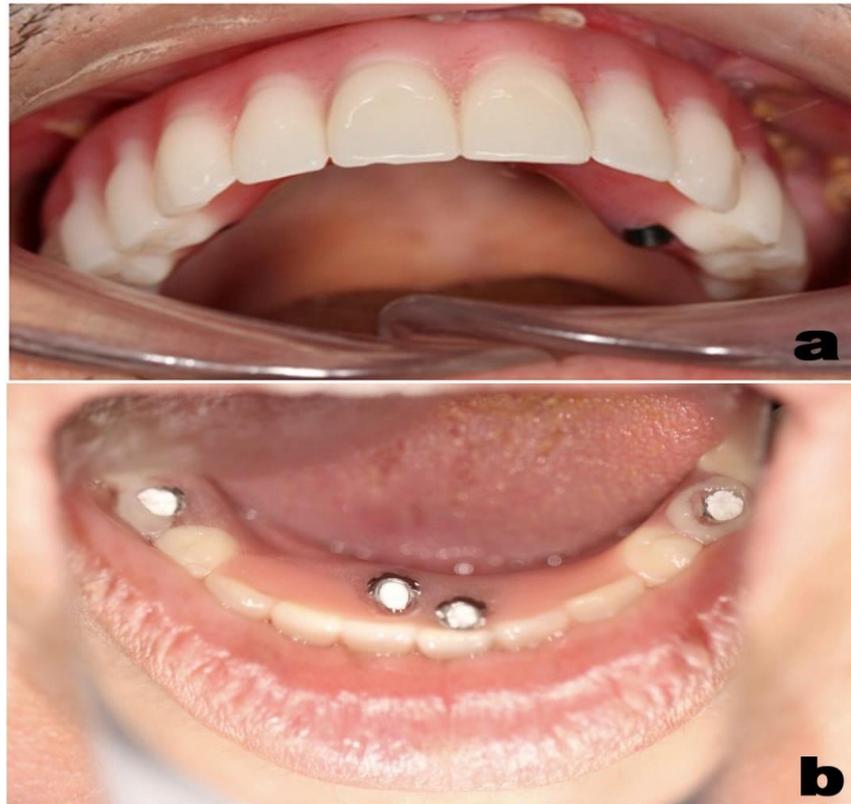


Figure 3. Insertion of temporary prosthesis.

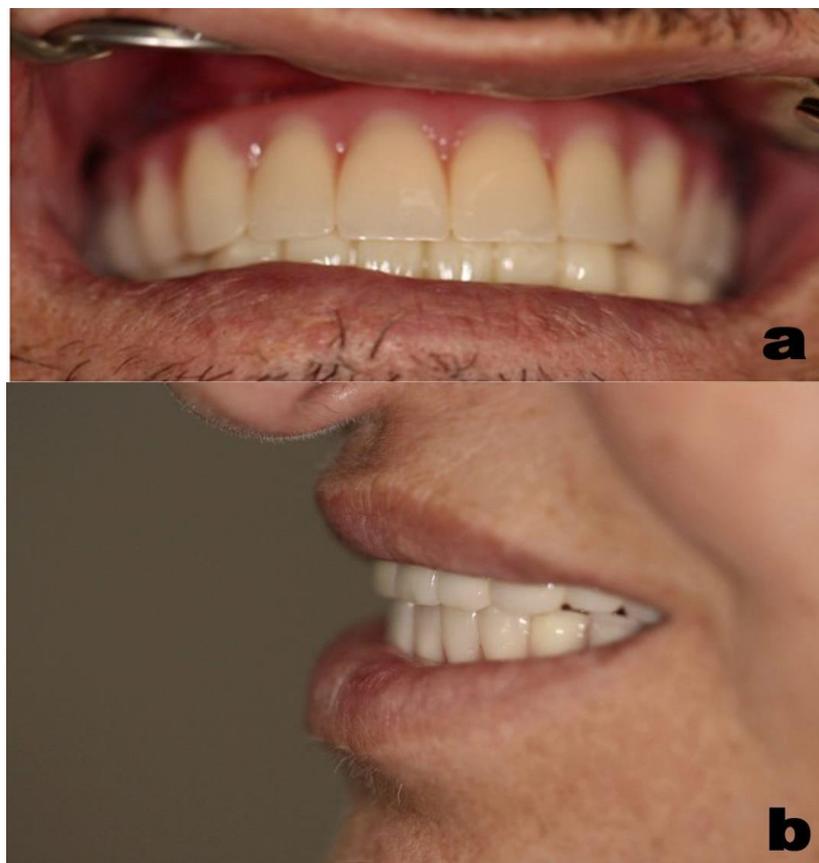


Figure 4. Occlusion control of temporary prosthesis.

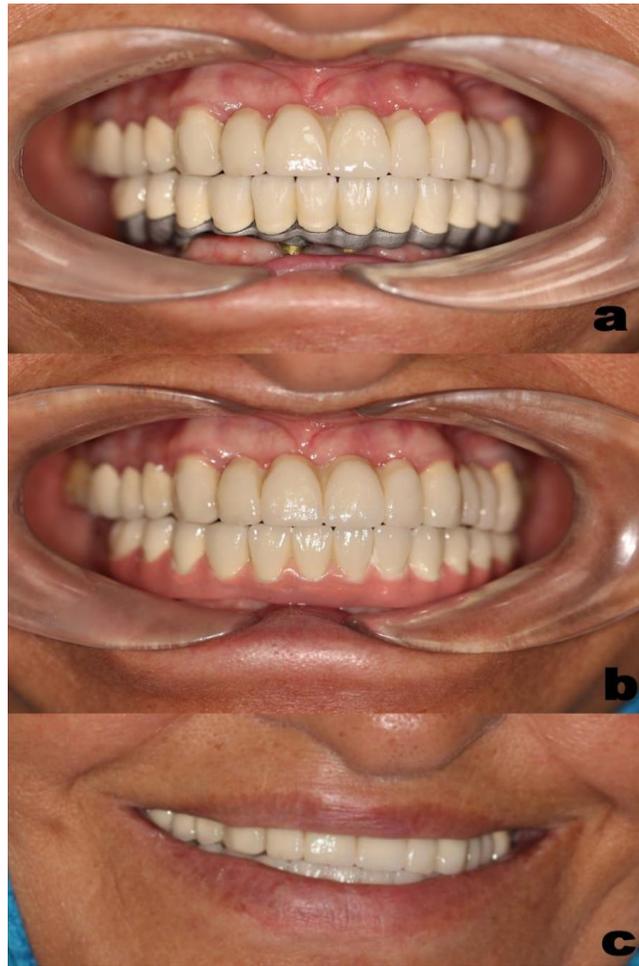


Figure 5. Insertion of permanent hybrid prosthesis.

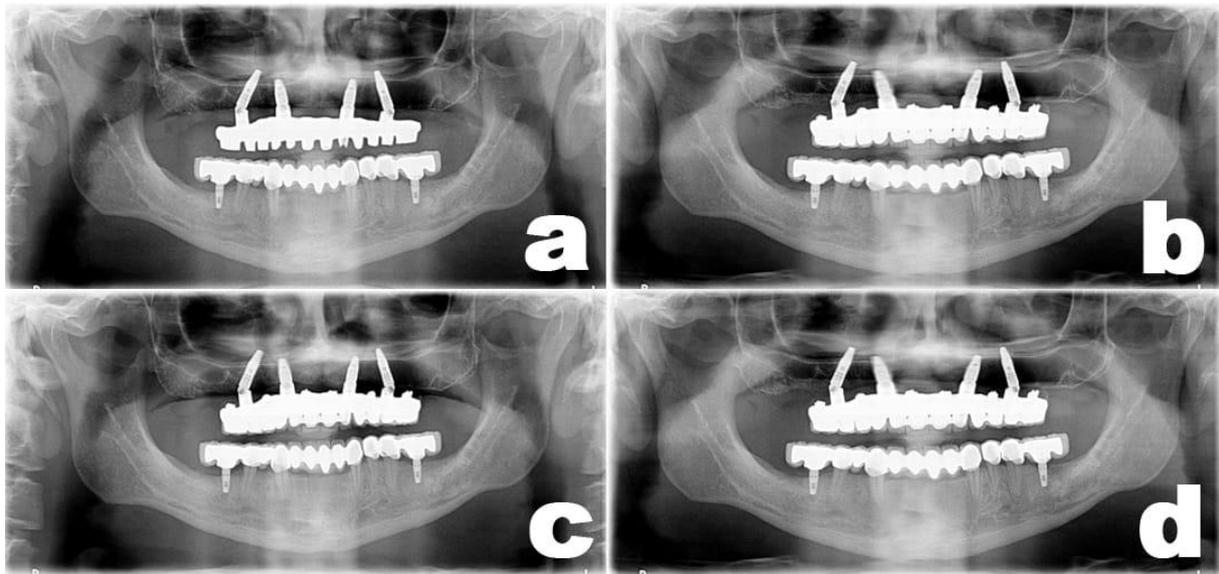


Figure 6. Control of maxilla.

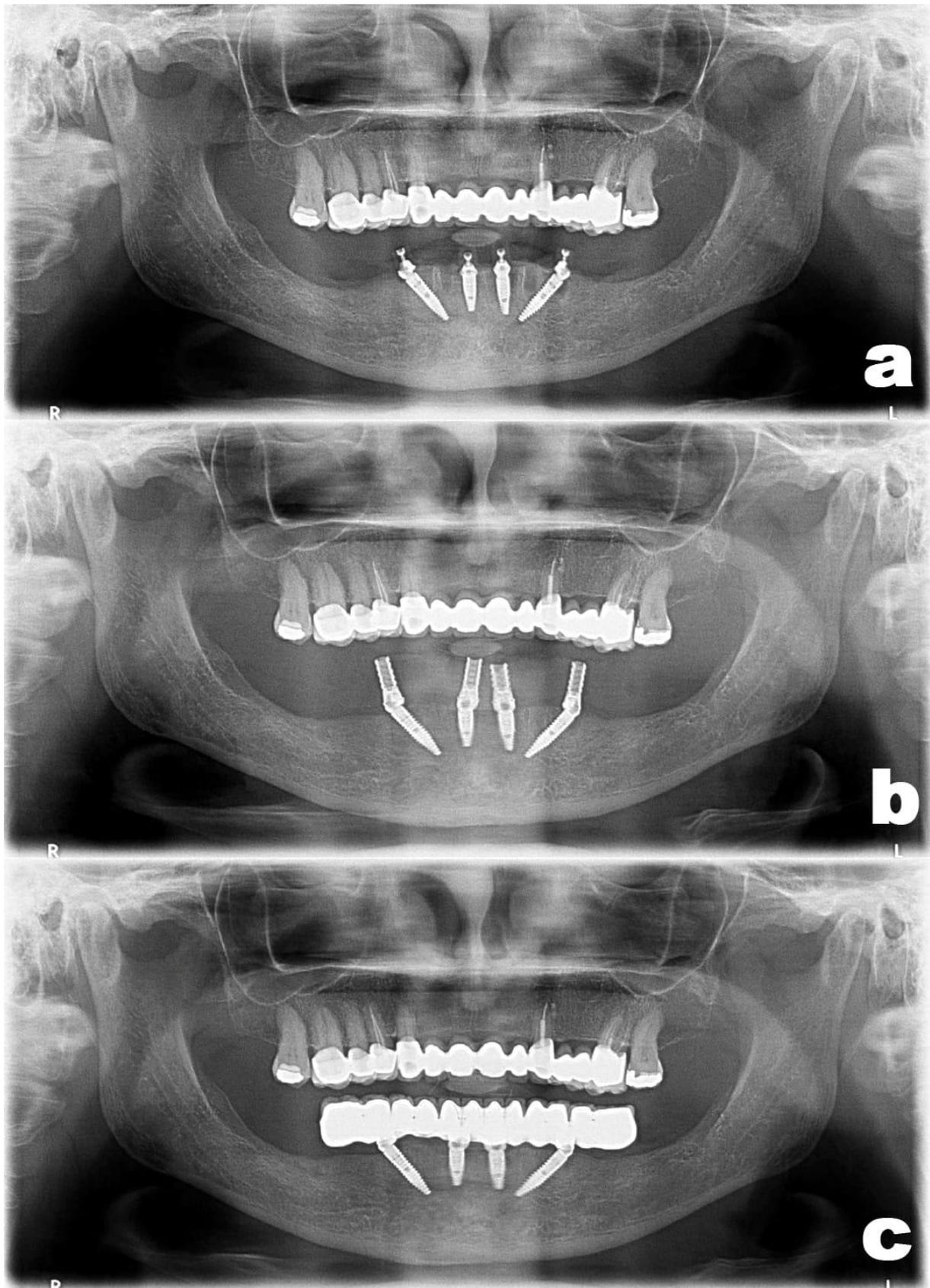


Figure 7. Control of mandible.

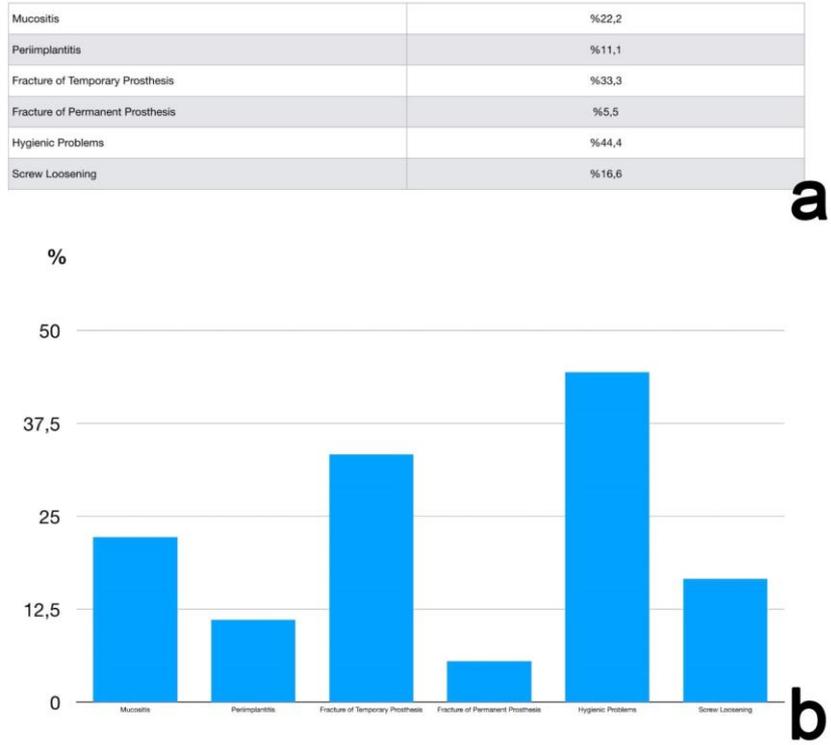


Figure 8. Clinical complications seen in maxilla cases.

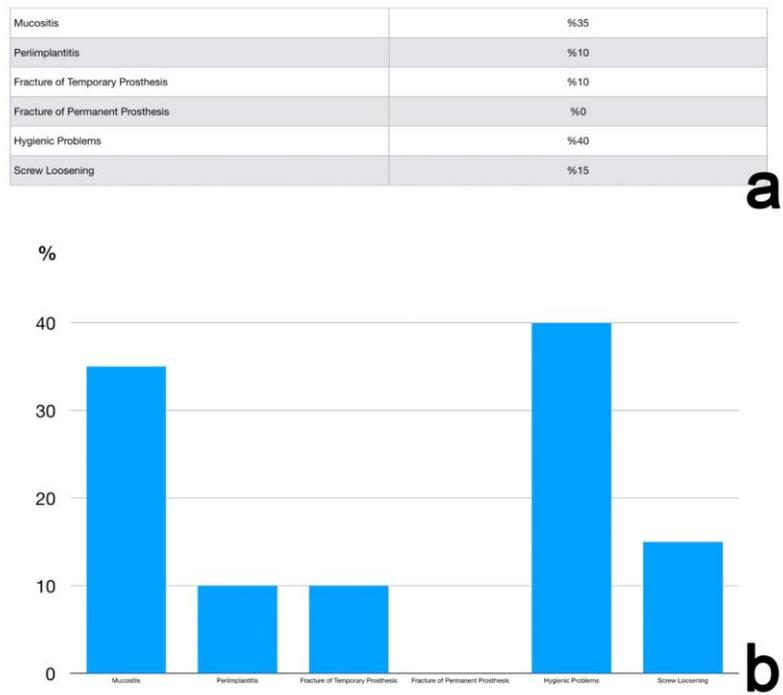


Figure 9. Clinical complications in mandible.

		6thMonth MBL (mm)		12thMonth MBL (mm)		18thMonth MBL (mm)		24thMonth MBL (mm)	
		Aver	SD	Aver.	SD	Aver.	SD	Aver.	SD
MAND.	Axial	0,36	0,13	1,03	0,27	1,30	0,31	1,52	0,30
	Tilted	0,48	0,18	1,23	0,28	1,45	0,23	1,62	0,22
MAX.	Axial	0,32	0,15	1,09	0,16	1,45	0,27	1,54	0,25
	Tilted	0,54	0,14	1,41	0,27	1,56	0,24	1,75	0,24

Figure 10. Average (Aver.) and Standard Deviation (SD) Values of MBL Measurements.

	Total	sd	Average	F	p	Eta ²
MBL	123,944	3	41,315	752,399	0,000*	0,836
MBL * JAW	0,356	3	0,119	2,164	0,092	0,014
MBL * APPLICATION	0,353	3	0,118	2,144	0,094	0,014
MBL * JAW * APPLICATION	0,146	3	0,049	0,885	0,449	0,006

***p<0,05**

Figure 11. Repeated measures ANOVA Analysis Results.

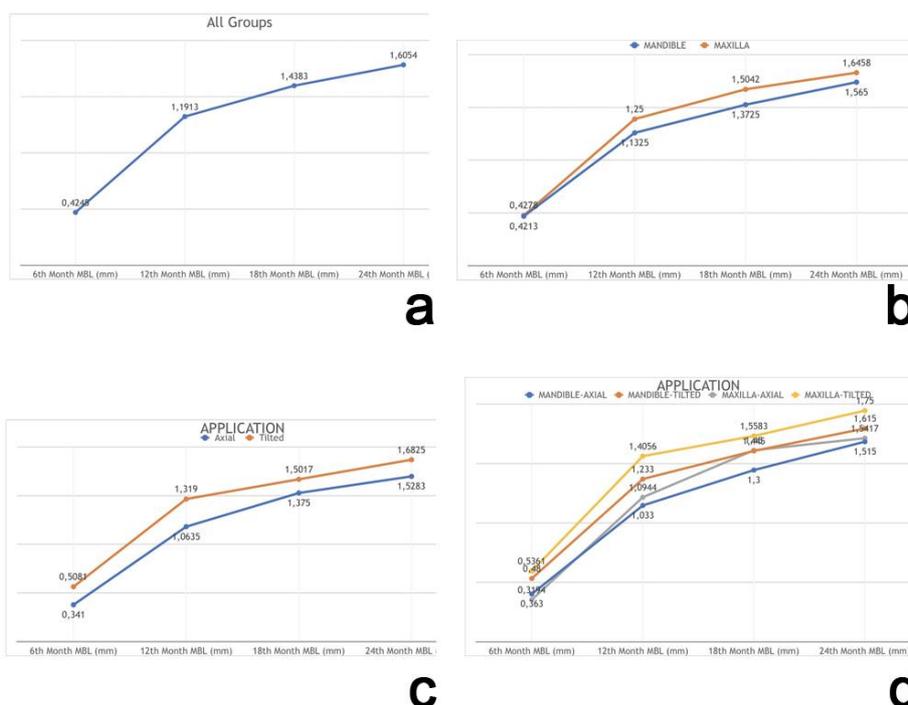


Figure 12. Graphic of time-dependent change in all MBL measurements.