Survival rate and the clinical analysis of the implant inserted with the conventional or guided surgery: A prospective analysis

[1]Shrikant Patel, [2]Apoorva Bhargava Daga, [3]Aarti Lala, [4]Krunal Patel, [5]Manpreet Kaur, [6]Mayur Parmar

[1]Reader, Department of Oral Pathology, Pacific Dental College & Hospital, Debari, Udaipur, Rajasthan, India
[2]Assistant Professor, Department of Dentistry Pacific Institute of Medical Sciences, Udaipur, Rajasthan, India
[3]DDS, Horsham Dental Care, Horsham, PA, USA
[4]DDS, Advanced Smile Design, Willowgrove, PA, USA
[5]Reader, Department of Oral Pathology, Maharishi Markandershwar College of Dental Sciences and Research (Deemed to be university), Mullana, Haryana, India
[6]Professor, Department of Dentistry, GMERS Medical College, Himmatnagar, Gujarat, India

Corresponding author: Shrikant Patel, Reader, Department of Oral Pathology, Pacific Dental College & Hospital, Debari, Udaipur, Rajasthan, India
Email: shrikantpatelmds@gmail.com

ABSTRACT

Introduction: The clinical study's main goal was to determine the frequency of peri-implant inflammation and changes in the marginal bone level around dental implants with single-unit fixed dental prostheses (FDP) and the teeth next to them, in relation to the horizontal and vertical implant positions.

Materials & Method: After following a conventional drilling procedure, internal hex implants were inserted at healed sites. RFA measurements were taken using the Osstell_ Mentor immediately following implant placement (primary ISQ) and postoperatively at 2, 3, 4, 5, 6, 9, 12, 18, and 24 months. After implant insertion and at postoperative 4, 7, 10, 12, 18, and 24 months, periapical radiographs were performed to assess marginal bone loss (MBL).

Results: The IT of various bone kinds indicated significant variances. Implants positioned in locations with bone density of D1 or D2 had considerably higher IT than those positioned in D3 or D4 regions. 63 implants had bone loss of less than 1 mm, 21 implants lost bone of less than 1 mm, and 6 implants lost bone of more than 2 mm. The most significant bone loss measured 2.68 mm. Only three of the implants—out of the six with bone loss greater than 2 mm—presented with BOP.

Discussion & Conclusion: Utilizing insertion torque and resonance frequency analysis, clinical testing of implant stability is simple to carry out. The findings of this study imply that bone density and implant diameter were important factors in determining IT/primary ISQ. Primary ISQ had less of an effect on MBL than bone density and IT.

Keywords: Implant Insertion, Marginal Bone loss, Resonance Frequency, Survival, Torque

INTRODUCTION

A paradigm change in oral rehabilitation occurred when Brnemark et al. introduced the idea of osseointegration and dental implants in the late 1970s. Dental implant treatment's long-term clinical performance can be impacted by both primary factors linked to various surgical

procedures and secondary factors connected to the development of marginal bone loss. Flap elevation is a common technique in implant surgery because it provides direct access to implant sites, enhances control over implantation angulation, and lowers the danger of bone fenestrations and dehiscences.[1-3]

For implant therapy to be successful over the long term and to produce favourable aesthetic results, the peri-implant bone levels that were surgically attained must be maintained or improved. In particular during the first year after surgical implantation, the process of bone remodelling surrounding the implants has been thought of as a typical time-dependent phenomenon, to which clinical, individual, and device-related factors contribute.[4-6]

With documented survival rates of 95.4% after 5 years of function, dental implant procedure provides relatively predictable results.1 Although implant survival rates are good, peri-implant inflammation is a common occurrence and could ultimately lead to marginal bone loss. Early on after implant placement and/or occlusal stress, the peri-implant marginal bone loss is frequently seen radiographically and is commonly referred to as bone remodelling.[7,8]

The healing process following surgical damage and/or physiological adaptation to function and the corresponding mechanical pressures have both been linked to such early marginal bone loss. Following this normal bone remodelling, marginal bone loss could develop as a result of plaque-induced peri-implant inflammation and lead to a progressive loss of osseointegration, posing a serious risk to the long-term efficacy of implant therapy.[9,10]

This retrospective clinical study's main goal was to determine the frequency of peri-implant inflammation and changes in the marginal bone level around dental implants with single-unit fixed dental prostheses (FDP) and the teeth next to them, in relation to the horizontal and vertical implant positions.

MATERIALS & METHOD

The Department of Implant Dentistry in the dental college and affiliated medical facility was where the current study was carried out. The university's institutional committee granted its approval and the institute review board accepted the study protocol after receiving ethical clearance. For this prospective trial, patients who sought implant therapy were screened. Each eligible patient met the requirements for a single implant-supported crown and was somewhat dentate. Each participant signed an informed consent form after being told of the study's objectives in their native tongue.

The following criteria were used to choose a total of 45 participants:

Age above 20, absence of serious systemic disorders known to affect bone metabolism, abstinence from smoking or light smoking (less than one pack per day), managed periodontal disease, adequate oral hygiene, and presence of 2 mm keratinized tissue are all prerequisites.

The following were the exclusion criteria: 1) active infection at implant sites; 2) severe bruxism; 3) uncontrolled periodontal diseases; 4) poor dental hygiene; 5) pregnancy; and 6) requirement for bone augmentation.

Cone beam computed tomography (CBCT), a periapical film, and a panoramic radiograph were obtained for preoperative evaluation. After using a unique surgical template, the jaw was scanned using CBCT. On the basis of CBCT data, the implants were planned using Dicom data programme. The programme allows the clinician to choose the proper implant lengths and diameters for insertion as well as measure the average bone density in Hounsfield units at the implant sites.

SURGICAL PROCEDURES

After following a conventional drilling procedure, internal hex implants were inserted at healed sites. The preoperative CBCT examination performed by the same dentist who implanted all of the implants graded bone density (D1 to D4) according to Misch's

classification. Additionally, the bone density was confirmed by drilling feeling during osteotomy in accordance with Lekholm and Zarb's categorization. 30 rpm was the pace at which the implants were implanted using a surgical motor. Using a torque wrench, which allowed for the recording of the final insertion torque value, the implants were placed. The buccal alveolar crest level and the implant platform were put at the same elevation.

RFA measurements were taken using the Osstell_ Mentor immediately following implant placement (primary ISQ) and postoperatively at 2, 3, 4, 5, 6, 9, 12, 18, and 24 months (secondary ISQ). For data processing, a sensor called Smart Peg was fastened to the implant fixture. The implant stability quotient (ISQ), which has a scale from 1 to 100, is a numerical measure used to represent RFA values. A low ISQ score indicates low implant stability, whereas a high value indicates excellent stability. Every time an implant was measured, it was in the buccal, lingual/palatal, mesial, and distal directions. The mean of the four measurements was then noted.

All implant-supported crowns arrived four to five months after surgery. Screw-retained crowns or cement-retained crowns with lingual/palatal notches were created to make retrieving them easier for ISQ measurements.

MARGINAL BONE LOSS

After implant insertion and at postoperative 4, 7, 10, 12, 18, and 24 months, periapical radiographs were performed to assess marginal bone loss (MBL). To precisely assess MBL, standardised radiographs were taken using the paralleling approach and a placement jig made for each participant. Based on the ratio of the image to the actual length of the implant fixture placed, radiographic magnification was calibrated. It was measured how far the implant platform was from the marginal bone. At the planned follow-ups, the MBL was defined as the average of the mesial and distal values for each fixture.

STATISTICAL ANALYSIS

SPSS Statistics 22.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. T-test and analysis of variance (ANOVA) for multiple pairwise comparisons were performed to determine statistically significant differences.

ASSESSMENT OF PERI-IMPLANT DISEASE

Periimplantitis and peri-implant mucositis were evaluated for presence. BOP-free implants were seen as healthy. The broad disease definitions for peri-implant mucositis and peri-implantitis were based on BOP and marginal bone loss parameters, where peri-implant mucositis was defined as the "presence of the clinical signs of inflammation of the periimplant mucosa that is bleeding upon probing with gentle force at the time of review examination without marginal bone loss" and peri-implantitis as the "presence of BOP in addition to loss of supporting bone. When one or more implant sites displayed BOP without concurrent bone loss, peri-implant mucositis was determined to be the cause. Based on two case definitions—(i) bone loss of more than 1 mm and a positive BOP, and (ii) bone loss of more than 2 mm and a positive BOP—peri-implantitis was identified.

RESULTS

The 45 patients who were a part of the current study ranged in age from 30 to 70, with a mean age of 52.06 years. The study's participants were 23 males and 25 women. None of the patients had any history of any particular habits. Twenty patients received care in the maxilla area, and 25 received care in the mandible area. In 45 patients, a total of 100 implants were inserted. The implants were distributed as follows: The maxillary anterior region received 25 implants (25%), the maxillary posterior region 20 implants (20%), the mandibular anterior

region received 25 implants (25%), and the mandibular posterior region received 30 implants (30%).

Following are the implant distributions based on bone density: In the D1 bone, 6 (6%) implants were inserted; in the D2 bone, 34 (34%) implants; in the D3 bone, 42 (42%) implants; and in the D4 bone, 18 (18%) implants. According to the CBCT bone study, implants with varying lengths of 10, 11, and 13 mm and varied diameters of 3, 3.5, 4, and 5 mm were employed. The implants had a 100% survival rate during the 2-year follow-up since neither movement nor significant problems (such as screw or fixture fracture) were discovered.

Table 1 displays the mean IT and primary ISQ of implants for various ages, genders, bone densities, implant diameters, and implant lengths. Compared to younger participants, patients over 50 reported lower results for the IT and primary ISQ. However, there were no statistically significant differences between the age groups in terms of mean IT and primary ISQ ($P > 0.05$).

The differences between the genders in IT and primary ISQ were negligible. Males had higher primary and IT scores than females, but there were no discernible differences between the sexes ($P > 0.05$). The range of 20 to 50, with a mean of 30.50 5.25 Ncm.

The IT of various bone kinds indicated significant variances. Implants positioned in locations with bone density of D1 or D2 had considerably higher IT than those positioned in D3 or D4 regions. Significantly greater IT values were seen in implants with bigger diameters. However, implant length had no discernible effect on IT.

The principal stability measurement's mean ISQ was 60.064.20 (interquartile range: 50 to 80). High bone density (D1 or D2) and D4 bone density showed clear major ISQ differences. Primary ISQ between the diameters varied significantly (P 0.05), as well. The primary ISQ of implants with bigger diameters was higher. The principal ISQ was not significantly different across the range of implant lengths. After the surgery, for the first six months and beyond, there were no discernible changes in the secondary ISQ. Age, gender, bone density, and implant length differences in secondary ISQ at 6 and 24 months after surgery were minimal. Secondary ISQ was more influenced by implant diameter, but the differences were not significant.

High positive associations between IT/bone density and primary ISQ/implant diameter were found using correlation analysis. IT/implant diameter, IT/primary ISQ, and primary ISQ/bone density all showed moderately positive associations. There was just a slender association between primary ISQ and implant length. A very slight association between IT and implant length was also discovered.

At the immediate postoperative period, 4, 7, 10, 12, 18, and 24 months, minimal bone loss was recorded. Despite the fact that there was a statistically significant difference between the two time points (4 and 7 months), the MBL concentration at this time was so low that the difference might not have been clinically significant. In addition, no notable variations in MBL postoperative 1 year could be found.

A total of 400 probing measurements were taken of the 100 implants in total. Average probing depths were 2.95 mm at the site level, 2.90 mm at the implant level, and 2.99 mm at the patient level, respectively. At least one implant site had BOP in 50 implants, or 50% of the total. As a result, the prevalence of peri-implant mucositis at the implant level was 50% and at the patient level it was 66.7% when one or more sites had BOP. It is possible to see a higher prevalence with various numbers of BOP-positive locations.

With an ICC of 0.99, the inter-rater agreement for calibrating radiographic measures was quite good. Ten of the 100 implants had radiographs that were either unavailable or unsuitable for measurements. The remaining 90 implants' radiographic bone loss was computed. 63 implants had bone loss of less than 1 mm, 21 implants lost bone of less than 1

mm, and 6 implants lost bone of more than 2 mm. The most significant bone loss measured 2.68 mm. Only three of the implants—out of the six with bone loss greater than 2 mm—presented with BOP. As a result, the prevalence of peri-implantitis was 1.5% at the implant level and 3% at the subject level when it was defined as bone loss 2 mm and positive BOP.

DISCUSSION

In modern dentistry, missing teeth is matters of indifference as their best alternatives available is dental implant which is highly successful, long-lasting, comfortable, and also function like natural tooth. Dental implants made up of titanium have a unique property to fuse with the living bone called as "osteophilic property (osseo‑ bone, philic‑ loving)" thus becoming a part of the jawbone. Studies are going on in the field of dental implantology to achieve higher success rate for the patients seeking the surgery thus providing a better quality of life.[11,12]

The replacement of missing teeth with implant-supported restorations has become an accepted treatment modality for partially and totally edentulous patients. According to clinical studies, the long-term survival of dental implants has exceeded 96%, which makes it a more accepted and sought treatment by our patients. A stable and aesthetic implant restoration can be achieved only through careful consideration of the biological principles of peri-implant hard and soft tissue healing, as well as the selection of an appropriate implant type and position.[13-15]

Maligned implants often complicate the clinical laboratory procedures employed for fabrication of superstructures. Due to improper load distribution, an overall increase in stress concentration on supporting structures may occur. This may compromise the maintenance of the bone implant interface. Excellent outcomes with dental implants can be achieved by guided implant placement.[16,17]

Inaccurate positioning of dental implants can cause aesthetic, biologic and prosthetic complications as high rates of crestal bone loss, screw loosening and fracture of prosthetic components. The advent of cone beam computed tomography (CBCT) has played a role in the development of guided surgery techniques.[18-20]

Resonance frequency analysis (RFA) of implant stability was first proposed by Meredith in 1996.23 It is a noninvasive and safe analytical tool for measuring implant stability at different time points with high reliability. RFA has been introduced into many basic researches to improve devices and has attracted considerable scientific interest. Application of RFA to assess implant stability during any period, to evaluate the effect of various types of loading, and to early diagnose implant failing can benefit clinical implant therapy and follow-ups. Together with IT measurement, RFA may provide more accurate and valuable information about the status of bone-implant interface and real implant stability.

CONCLUSION

Utilising insertion torque and resonance frequency analysis, clinical testing of implant stability is simple to carry out. The findings of this study imply that bone density and implant diameter were important factors in determining IT/primary ISQ. Primary ISQ had less of an effect on MBL than bone density and IT.

REFERENCES

1. Karthik, K.; Thangaswamy, V. J. J. o. P.; Sciences, B. Evaluation of implant success: A review of past and present concepts. **2013**, *5*, S117-S119.
2. Buser, D.; Sennerby, L.; De Bruyn, H. J. P. Modern implant dentistry based on osseointegration: 50 years of progress, current trends and open questions. **2017**, *73*, 7-21.

3. Elias, C. N. J. I. d. a. r. e. p. R. I. Factors affecting the success of dental implants. **2011**, 319-364.
4. Dhir, S. J. J. o. I. S. o. P. The peri-implant esthetics: An unforgettable entity. **2011**, *15*, 98.
5. Prathapachandran, J.; Suresh, N. J. D. r. j. Management of peri-implantitis. **2012**, *9*, 516.
6. Buser, D.; Chappuis, V.; Belser, U. C.; Chen, S. J. P. Implant placement post extraction in esthetic single tooth sites: when immediate, when early, when late? **2017**, *73*, 84-102.
7. Albrektsson, T.; Donos, N.; Research, W. G. J. C. O. I. Implant survival and complications. The Third EAO consensus conference 2012. **2012**, *23*, 63-65.
8. Kligman, S.; Ren, Z.; Chung, C.-H.; Perillo, M. A.; Chang, Y.-C.; Koo, H.; Zheng, Z.; Li, C. J. J. o. c. m. The impact of dental implant surface modifications on osseointegration and biofilm formation. **2021**, *10*, 1641.
9. Raikar, S.; Talukdar, P.; Kumari, S.; Panda, S. K.; Oommen, V. M.; Prasad, A. J. J. o. I. S. o. P.; Dentistry, C. Factors affecting the survival rate of dental implants: A retrospective study. **2017**, *7*, 351.
10. Setzer, F.; Kim, S. J. J. o. d. r. Comparison of long-term survival of implants and endodontically treated teeth. **2014**, *93*, 19-26.
11. Lim, K. G. A Retrospective Clinical Study Evaluating Full-Arch Monolithic Zirconia Implant Supported Fixed Dental Prosthesis. The University of North Carolina at Chapel Hill, 2017.
12. Jones, J. D.; Garcia, L. T.: *Removable partial dentures: a clinician's guide*; John Wiley & Sons, 2009.
13. Buser, D.; Mericske-stern, R.; Pierre Bernard, J. P.; Behneke, A.; Behneke, N.; Hirt, H. P.; Belser, U. C.; Lang, N. P. J. C. o. i. r. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. **1997**, *8*, 161-172.
14. Wyatt, C.; Zarb, G. A. Treatment outcomes of patients with implant-supported fixed partial prostheses. University of Toronto, 1996.
15. Snauwaert, K.; Duyck, J.; van Steenberghe, D.; Quirynen, M.; Naert, I. J. C. o. i. Time dependent failure rate and marginal bone loss of implant supported prostheses: a 15-year follow-up study. **2000**, *4*, 13-20.
16. Abdelfattah Mohamed, A. M.; El Homossany, M. E. M.-B. J. E. D. J. COMPARING THREE DIFFERENT SURGICAL GUIDES PROTOCOL ON THE MARGINAL BONE LOSS AROUND IMPLANTS IN IMPLANT ASSISTED MANDIBULAR OVERDENTURE. **2020**, *66*, 853-860.
17. Meijer, H.; Kuiper, J.; Starmans, F.; Bosman, F. J. T. J. o. p. d. Stress distribution around dental implants: influence of superstructure, length of implants, and height of mandible. **1992**, *68*, 96-102.
18. Patel, S.; Metgud, R. J. J. o. c. r.; therapeutics. Estimation of salivary lactate dehydrogenase in oral leukoplakia and oral squamous cell carcinoma: a biochemical study. **2015**, *11*, 119-123.
19. Ribas, B. R.; Nascimento, E. H. L.; Freitas, D. Q.; dos Anjos Pontual, A.; dos Anjos Pontual, M. L.; Perez, D. E. C.; Ramos-Perez, F. M. M. J. I. s. i. d. Positioning errors of dental implants and their associations with adjacent structures and anatomical variations: a CBCT-based study. **2020**, *50*, 281.
20. Palacios-Garzón, N.; Ayuso-Montero, R.; Jané-Salas, E.; Anglada-Cantarell, J. M.; López-López, J. J. C. Marginal Bone Loss in Implants with External Connection versus Internal Conical Connection Prior to Prosthetic Loading. A Randomized Clinical Study. **2020**, *10*, 1044.