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Investigating the Longevity of Implant Protected Occlusion Utilizing the T-Scan III: A Prospective Study

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ABSTRACT

Purpose: To investigate the longevity of Implant Protected Occlusion utilizing the Tekscan III. Materials and Methods: The study was approved at the Washington, D.C. Veteran Affairs Medical Center Dental Service. Patient inclusion criteria consisted of a single tooth endosteal implant bounded by natural teeth and opposed by natural dentition. At initial time of delivery of the prosthesis the occlusal scheme was be verified clinically by the restoring dentist. This result was confirmed using the Tekscan III to measure occlusal force distribution percentage at maximum intercuspation. The analysis included the patient to return and for the evaluation to be reviewed again at 6,9 and 12 months. The force distribution exerted on the implant retained restoration was then compared to the initial delivery appointment. Results: A total data set of 14 subjects with 16 implants was collected. Only 9 subjects fulfilled the entire inclusion criteria. The mean bite force of natural teeth was 10.4% versus the mean bite force in the selected implants was 2.2 %. Conclusions: If Implant protected occlusion remains relatively stable over time is still unclear at this time. Data at this interim analysis does not show a significant difference in implant protected occlusion. Despite the implant protected planned occlusal scheme restoring dentists did not always achieve the desired results. Some statistically insignificant p- values were calculated but found to be irrelevant due to the low power of the study. A better understanding of all implant occlusion would allow clinicians to take a more preventive approach when performing implant treatment planning, as avoidance of implant overloading helps to ensure the long-term stability of implant restorations.

Keywords: dental implants; osseointegration; partially-edentulous; dental implant function; functional loading; implant occlusion.

INTRODUCTION

It has well been debated and discussed in the dental literature that there is no scientific evidence supporting the use of one occlusal scheme over another for natural dentition, removable dental prostheses or implant supported dental prostheses (1). Furthermore occlusion for dental implant supported or retained prostheses had been mostly based on anecdotal theories stemming from natural tooth or complete denture occlusion (1). Most practitioners believe a well-controlled and maintained occlusion could reduce mechanical and biological implant complications, thus increasing the longevity of the prosthesis (2).

Dental implants and natural teeth have different biological and biomechanical characteristics. Biologically, dental implants do not have a periodontal ligament (PDL) and are in direct contact with the bone. Physiological movement of the natural teeth depends on this ligament. The PDL provides the capacity of adaptation to any skeletal deformation/torsion. It also works as a mechanoreceptor through which it is possible to transmit vital information to the central nervous system, it works as a mechanism of negative feedback nerve regulation to control occlusal overload (3). It is possible to infer, in the absence of both periodontal ligaments and periodontal receptors, there is more sensitivity to occlusal overload being that the capacity of loading, support, adaptation to occlusal forces, and proprioception, are significantly reduced. Although the bone has a certain capacity for absorbing occlusal stress (osseoflexion), its ability to do so is dramatically inferior to that of the periodontal ligament (3).

Biomechanically, implants are more susceptible to bending moments and stress concentrations at the crestal bone during loading then a natural tooth which again has a resilient PDL which provides shock absorption. The resiliency of natural teeth can be quantitatively

averages as the mean value for axial mobility of teeth is 25-200 micrometers, whereas axial displacement of an osseointegrated implants is 3 to 5 micrometers (4,5,6).

Dental implants have proven to work quite well without a periodontal ligament. Even though the literature is mixed on the subject of implant dental occlusion it's still prudent for clinicians to take great care to manage occlusal loads whenever possible. One philisophy that was first descibed by Misch and Bidez in the 90's is Implant Protected Occlusion (IPO). It was designed to decrease stress to the implant bone interface and improve clinical longevity by using biomechanics principles. The design of implant protected occlusion is as follows (Table 1): In maximum intercuspation, there should be no contact on the implant restoration when there is light occlusal force. In maximum intercuspaction, there should be light contact on the implant restoration with heavy occlusal force. There should be no contact in excursive movements or presence of premature contacts.

Table 1

Force	In Maximum Intercuspation
Light occlusal force	No contact on the implant restoration
Heavy occlusal force	Light contact on the implant restoration
Excursive movements	No contact

The transfer of forces by remaining natural teeth on the neighboring healing implants may also affect the treatment result in partially edentulous cases. Well performed longitudinal clinical studies on implant occlusion are insufficient at this time. Therefore the aim of this continuing study is to determine if implant protected occlusion remains constant over the course of time.

MATERIALS AND METHODS

All required materials for the human subject research were submitted to the IRB at the Veterans Affairs Medical Center Washington DC and approved under continuing protocol # 01386. Fifty patients are to be enrolled in this study. The inclusion criteria consisted of the following: a single tooth implant restoration, located anywhere in the dentition, bound mesially, distally, and opposing by natural teeth. Restorations included in the study are cement retained restorations, where the custom abutment was placed and torqued to the manufacturer's guidelines with the final restoration cemented. The restorative material of choice for the purpose of this study was not specified. The restorative dentist used an implant protected occlusion protocol. The implant protected occlusion (IPO) protocol includes: no contact on the implant restoration under light occlusal force, light contact on the implant restoration under heavy occlusal force, and no contact on the restoration in excursive movements or premature contacts. This was evaluated clinically by restorative dental providers utilizing a metal foil for occlusion testing (ShimStick, 8u, Almore International, Inc, Portland, OR).

The patient was then sent to the research coordinator the day of delivery where occlusal analysis system utilizing the T-Scan was used (T-Scan III, Tekscan, Inc., Boston, MA). The T-Scan III was calibrated according to manufacturer's instructions. The sensor was placed in the patient's mouth (Figure 1). The patient was instructed to "bite down normally" three times. The position, timing, and percentage of force of the occlusal contacts were recorded with the T-Scan III (Figure 2). The percentage of force data recorded on the implant of interest was determined when the T-Scan algorithm automatically averaged the patient's bite force at maximum intercuspation. The data and video file were saved under a randomly assigned code which was assigned to each patient.

Figure 1 T-Scan III, Tekscan, Inc., Boston, MA

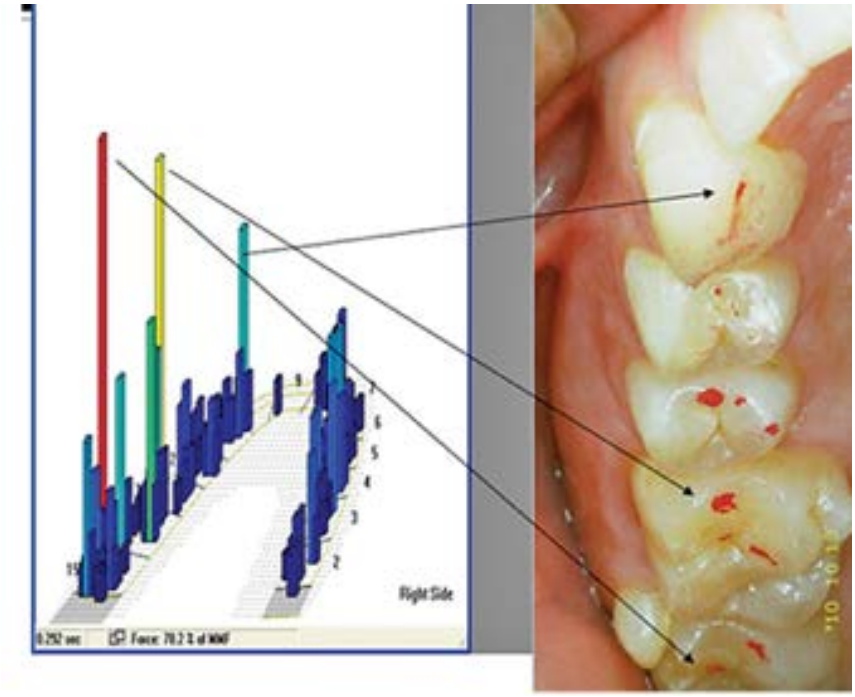

Figure 2 Position, timing, and percentage of force of the occlusal contacts.

The patients involved in the study were asked to return to the dental clinic at 3, 6, 9, 12 months to re-evaluate the constancy of implant protected occlusion. The same protocol for the T-Scan III was followed at each follow-up appointment

RESULTS

A total of fifty patients will be enrolled to complete this research protocol. A data set of 14 subjects with 16 measurable implants was collected. Of the initial 14 subjects 11 of them had a lower baseline implant force than natural tooth force (Table 2). The mean bite force of natural teeth was 10.4% versus the mean bite force in the selected implants was 2.2 % (Figure 3). Nine subjects fulfilled the entire inclusion criteria, including completing the 12 month cycle. Natural teeth show more variation than dental implants (Figure 4)

Table 2 Number of Implants	Follow- up in Months
14	Initial
12	3 month
11	6 month
10	9 month
9	12 month

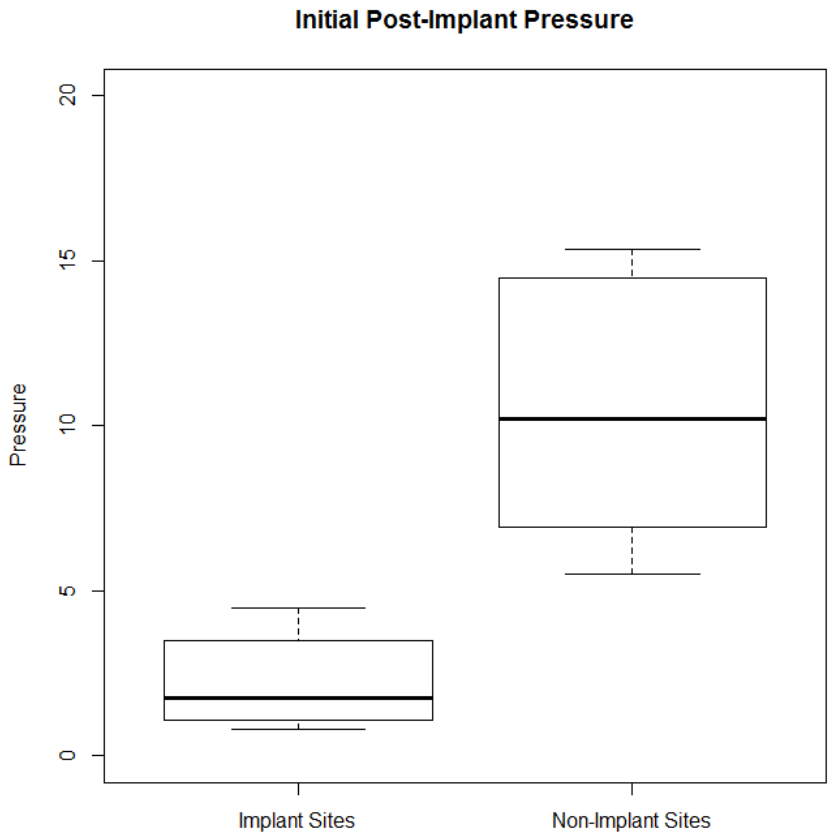

Figure 3: Displays Natural teeth having higher mean bite force than dental implants. This fulfills the inclusion criteria.

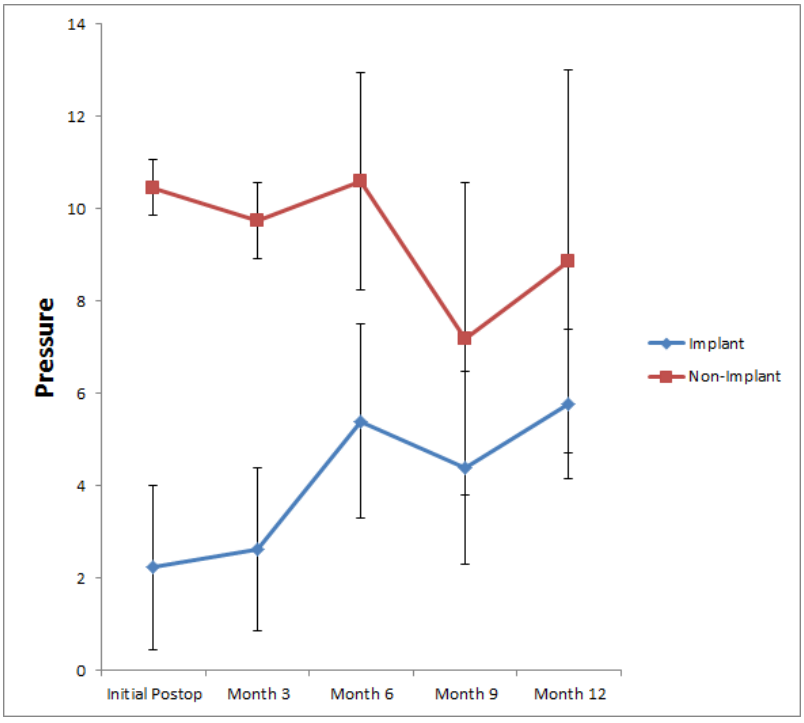

Figure 4: Natural teeth show more variation than dental implants.

Although it appears to have significant changes of bite force between natural teeth and implants further statistical evidence was needed. Due to small sample size and large variability, the non-parametric Wilcoxon Rank Sum test was used for pairwise comparison between initial and 3, 6, 9, and 12 months of bite-force data since a relationship between the bite forces measured from each subject is expected. The p-values were all above 0.05 (Table 3).

Table 3	3 month to initial	**6 month to initial**	9 month to initial	12 month to initial
P-value	0.695	**0.333**	0.176	0.465

DISCUSSION

Implant failures have been attributed to improper occlusal design, which can concentrate stresses in the bone and lead to rapid bone resorption (7). Some anecdotal guidelines are recommended to establish implant occlusal design: (1) cusp designs should be made so that the stress is directed along the long axis of the implant, (2) lateral stresses should be avoided, (3) the width of the occlusal table should be no wider than the width of the implant root, and (4) cusp height should be minimized in order to decrease lateral stress. Sometimes the occlusal table should be flat, providing only centric function (8,9). Implant protected occlusion is at this time just another guide to prevent risk factors suspected in implant failure.

In this study we concluded due to PDL natural teeth show much more variation in force over time than implants and if the IPO protocol is utilized then the implant will be placed in a static and dynamic relationship with less force than the natural teeth. Over time it is suspected that dimensional changes of teeth may intensify the occlusal stress on implants. Due to limited data collection at this time this cannot be stated. In order to prevent the potential overloading on implants from the positional changes, re-evaluation and periodic occlusal adjustments may be necessary.

There are a limited number of subjects enrolled currently in the study, and results could change when more subjects are enrolled in this protocol. Statistically significant differences between the bite forces recorded initially and at 3, 6, 9, and 12 months for natural teeth and for the implants, cannot be concluded. Enrollment is expected to increase in the next year to increasing the N of the study.Some subjects did not fit the inclusion criteria, due to the fact that restoring dentists did not always achieve initial lower implant bite force.

CONCLUSION

Data at this interim analysis does not show a significant difference in implant protected occlusion overtime. If Implant protected occlusion remains relatively stable over time is still unclear at this time. Despite the implant protected planned occlusal scheme restoring dentists did not always achieve the desired results. A better understanding of all implant occlusion would allow clinicians to better facilitate long-term stability of implant restorations.

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REFERENCES

1. Taylor TD, Wiens J, Carr A. Evidence-based considerations for remov- able prosthodontic and dental implant occlusion: A literature review. J Prosthet Dent 2005; 94(6):555–60.

2. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clini- cal complications with implants and implant prostheses. J Prosthet Dent 2003;90:121-32.

3. El “ABC” de la oclusión en la rehabilitación protésica sobre implantes dentarios o prótesis óseointegrada. In: Manns Freese AE, Biotti Picand JL. Manual Práctico de Oclusión Dentaria. 2nd ed. Caracas, Venezuela: Amolca; 2006.

4. Schulte W. Implants and the periodontium. Int Dent J 1995;45:16-26.

5. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. Clin Oral Implants Res 2005;16:26-35.

6. Sekine H, Komiyama Y, Potta H, Yoshida K. Mobility characteristics and tactile sensitivity of osseointegrated fixture-supporting systems. In: van Steenberghe D, Albrekts- son T, Branemark PI, Henry PJ, Holt R, Liden G, editors. Tissue integration in oral and maxillofacial reconstruction. Amsterdam: Excerpta Medica; 1986. p.326-32.

7. Lundgreen, D. , L. Laurell , H. Falk , and T. Bergendal . Occlusal force pattern during mastication in dentitions with mandibular fixed partial dentures supported on osseointegrated implants. J Prosthet Dent 1987. 58:197–202.

8. Fagan, M. , J. Ismail , R. Meffert , and J. Fagan . Implant Prosthodontics Surgical and Prosthetic Techniques for Dental Implants. Chicago, Ill: Yearbook Med; 1990:217–229.

9. Jackson, B. J. Occlusal principles and clinical applications for endosseous implants. J Oral Implantol 2003. 29:230–234.