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Evaluation of Manual Insertion Torque of Dental Healing Abutments by Multiple Providers

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ABSTRACT

The aim of this study was to compare clinician's ability to hand tighten dental healing abutments of different types and sizes. In addition, this in vitro study examined if the clinician's experience in dentistry, gender and dental Area of Concentration (AOC) had any effect on the reverse torque values (RTV). Four ZimVie Certain internal connection dental implants (4.1mm x 11.5mm) were placed in a printed jig and secured to a table using a vice. Four ZimVie dental healing abutments were chosen: 3mm One-Piece (OP-ZimVie), 3mm Two-Piece (TP-ZimVie), 8mm One-Piece (OP-ZimVie), 8mm Two-Piece (TP-ZimVie). Thirty clinicians wore powder-free exam gloves and were asked to hand tighten each healing abutment to 20 Ncm. The healing abutments were randomized in order and replaced every 5 providers to minimize thread fatigue. The investigator used a digital torque gauge to record the RTV. The data was analyzed using two-way ANOVA and a Shapiro Wilk test. The 3mm OP had the highest mean RTV of 15.67 Ncm and the 3mm TP had the lowest mean RTV of 13.62 Ncm. The average RTV was 14.78 Ncm which was below the manufacturer's recommended insertion torque value. The two-way ANOVA revealed a significant difference between different abutment types with OP having significantly higher RTV values than TP ($p = 0.031$). The clinician's experience in dentistry, gender and AOC were not statistically significant. This in vitro study found: 1) OP abutments had higher RTV than TP abutments, 2) average RTV was below the manufacturer's recommended insertion torque value for each abutment type and 3) clinician's experience in dentistry, gender and AOC had no effect on RTV.

Key Words*: dental implants, dental healing abutments, torque, abutment loosening, abutment height*

INTRODUCTION

Endosseous implants have become a popular treatment method for tooth replacement in recent years[1]. Once an implant has been surgically placed in the mouth, a healing abutment is attached to aid in soft and hard tissue healing around the implant[2]. The final prosthesis is delivered after osseointegration of the implant and achievement of an ideal emergence profile. However, there are a few complications that jeopardize the success of the implant. One of these complications is loosening of the healing abutment[3]. According to one study by Silva-Neto et al, in which different tightening torques were applied to implant-abutment interfaces, it was demonstrated that implant-abutments with lower torque values had microleakage and higher torque values showed no bacterial contamination[4]. The bacteria introduced to the interface can cause inflammation which disrupts osseointegration of the implant[5]. This can result in additional surgeries, cost, time and ultimately implant failure.

It has been a common practice to hand tighten healing abutments despite documented variations in clinician's ability to hand tighten healing abutments[6]. One study by Kanawati et al, examined dental student's hand torquing ability on dental implant healing abutments and found that maximum torque values ranged from 11Ncm to 38Ncm[6]. The average for male and female were 28Ncm and 19Ncm respectfully[6]. Another study by Parnia et al evaluated maximum torque of male and female dentists and discovered that mean value of maximum torques in male and female were 20.8Ncm and 14.3Ncm respectfully[7].

There are limited studies examining the difference between hand tightening different dental healing abutment types and sizes and no studies are available examining hand tightening of different types of healing abutments by multiple providers. Therefore, the primary purpose of this study was to compare RTV of different healing abutment types and sizes by multiple

clinicians. Our secondary objective was to evaluate various clinician's ability to achieve the manufacturer's recommended torque values for dental healing abutments. Our third objective was to examine if a clinician's experience in dentistry, their gender, or area of concentration (AOC – general dentist or specialist) had any effect on RTV. Our null hypothesis was that there will be no difference in RTV on different healing abutment types and sizes, there will be no difference in clinician's and manufacturer's recommended RTV and no difference in RTV based on clinician's experience, gender and AOC.

MATERIALS AND METHODS

Four 4.1mm x 11.5mm internal connection butt-joint dental implants (Certain T3 Non-Platform Switched Tapered Implant, ZimVie Dental, Palm Beach Gardens, FL) were chosen. Four dental healing abutments (HEA) of different types and heights were selected: 3mm One Piece (OP - ZimVie), 8mm One Piece (OP - ZimVie), 3mm Two Piece (TP - ZimVie) and 8mm Two Piece (TP - ZimVie) (BellaTek Healing Abutments, ZimVie Dental, Palm Beach Gardens, FL) (Figure 1). A 17mm narrow posterior large hexed driver (ZimVie Driver, ZimVie Dental, Palm Beach Gardens, FL) was used for the study (Figure 2). A 3D software application (Meshmixer, Autodesk Inc., San Rafael, CA) was used to design and a 3D printer (FormLabs 3, FormLabs Inc., Somerville, MA) was used to create a custom jig. The custom jig was printed using Dental LT V1 Clear Resin (FormLabs Inc., Somerville, MA). Four dental implants were fixed into 4 slots of the custom jig with ultra-violet light curable resin material (Triad Gel Clear Colorless, DENTSPLY International Inc., York, PA). The custom jig was then secured to tabletop vice (Figure 3). Thirty Army dental providers at Fort Cavazos, Texas were chosen to participate in the study. The participants wore exam gloves (Sterling SG Nitrile Powder-Free exam gloves, Halyard Health, Alpharetta, GA) that were appropriate to their hand size. The

participants then sat on a chair and were given instruction to hand tighten the healing abutment to what they perceived to be 20N cm torque using the hand driver. The implant HEA were randomized in order per each participant. The investigator secured the universal screwdriver into a 3-jaw chunk of the digital torque gauge (BTGE50CN, Tohnichi America Corporation, Buffalo Grove, IL) to record the reverse torque values (RTV) of each dental HEA (Figure 4). The RTVs were then recorded in computer software (Excel, Microsoft, Redmond, WA) for analysis. The RTV were compared using two-way analysis of variance (ANOVA) and a Shapiro Wilk test ($P > 0.05$). All statistical analyses were performed using statistical software (IMB SPSS for Windows, version 28, Armonk, NY).

RESULTS

All data is presented in Figure 5-8. In this study, 3mm OP had the highest mean RTV (15.67 ± 3.967 Ncm) and 3mm TP had the lowest mean RTV (13.62 ± 3.882 Ncm). The two-way ANOVA revealed a significant difference between different abutment types with OP having significantly higher RTV values than TP ($p = 0.031$). The RVT values did not differ significantly by height ($p = 0.478$). The average RTV was below the manufacturer's recommended insertion torque value of 20 Ncm. The Shapiro Wilk comparisons found that the experience, gender and AOC did not have any significant effect on RTV.

DISCUSSION

The mean RVT of all 4 dental abutment groups were significantly different from each other, therefore the first null hypothesis was rejected. The mean RTV were significantly influenced by the abutment type. The OP abutments showed higher RTV than the TP abutments. The reason for this could be due to the blue coating on the OP abutments. The blue color surface

of the OP abutment screws could have attributed to a tighter fit between the abutment and the implant. In addition, OP had the longest screw length compared to TP abutments. The longer screw length could have increased the surface area and had higher engaging forces on the implants, resulting in higher RTV.

The second hypothesis was rejected since the mean RTVs were below the manufacturer's recommended insertion torque value. The lower mean RTV could be due to using the powder-free exam gloves instead of surgical gloves. That may have contributed to less gripping forces and hindered these clinician's ability to tighten abutments to the recommended torque value.

The third hypothesis was accepted since the clinician's experience in dentistry, gender and dental AOC did not have any effect on the RTV, although experience was close to a statistically significant correlation. This result differed from a study done by Alikhasi et al, where male providers achieved higher torque value than female providers[8].

The present study had a few limitations. The participant sample size was small. Only thirty clinicians participated in the study limiting the power of the result. Also, the healing abutment was used 5 times instead of using it once. Using healing abutment multiple times could have worn the threads and led to lower RTV. Lastly, the study was a bench top study and did not perfectly mimic the clinical setting. The participants were likely able to apply higher torque on the bench top than they would be able to in an actual patient's mouth. Further studies are needed to evaluate different healing abutment types and sizes in actual clinical settings.

CONCLUSION

Based on the findings of the bench top study, the following conclusions were drawn: 1) clinicians were able to generate more RTV on OP abutments compared to TP abutments, 2)

clinicians were unable to generate manufacturer's recommended torque values, 3) clinician's experience in dentistry, gender and AOC had no effect on RTV. Based on the findings of this study, it is recommended that the use of torque wrenches to tighten dental healing abutments should be a standard practice rather than hang tightening dental healing abutments.

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Figure 1. Dental Healing Abutments (from left to right 3mm OP, 3mm TP, 8mm OP, 8mm TP)

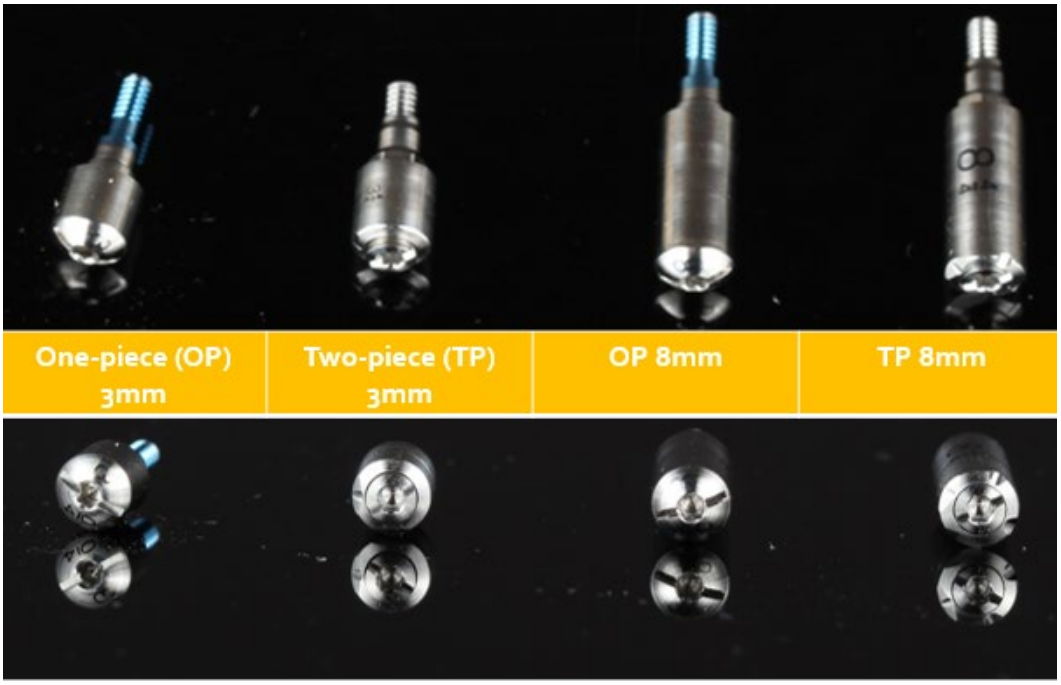

Figure 2. A narrow posterior large hexed driver 17mm

Figure 3. Reverse torque value recorded with digital torque gauge for 8mm OP healing abutment secured to table top vice.

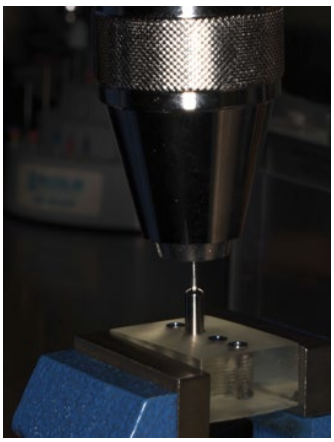

Figure 4. Tohnichi digital torque gauge

Figure 5. Mean reverse torque values of 4 different healing abutments

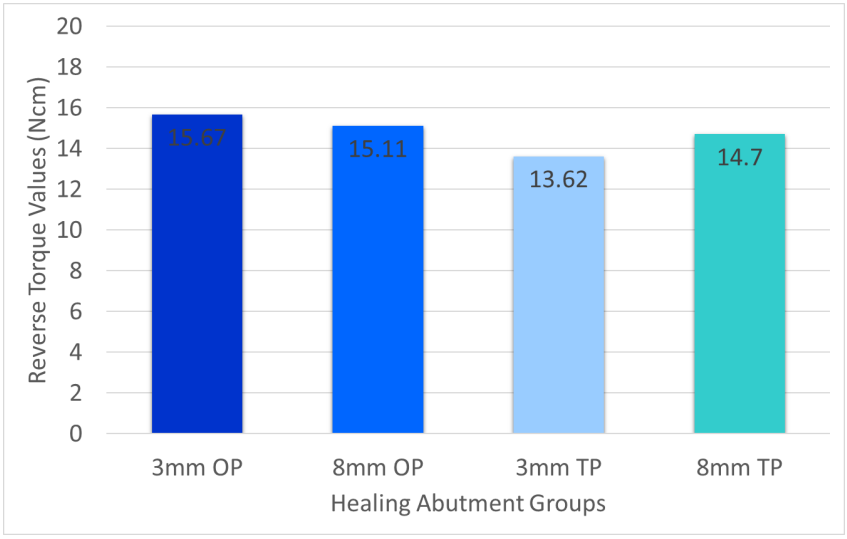

Figure 6. Clinician's years of experience and reverse torque values

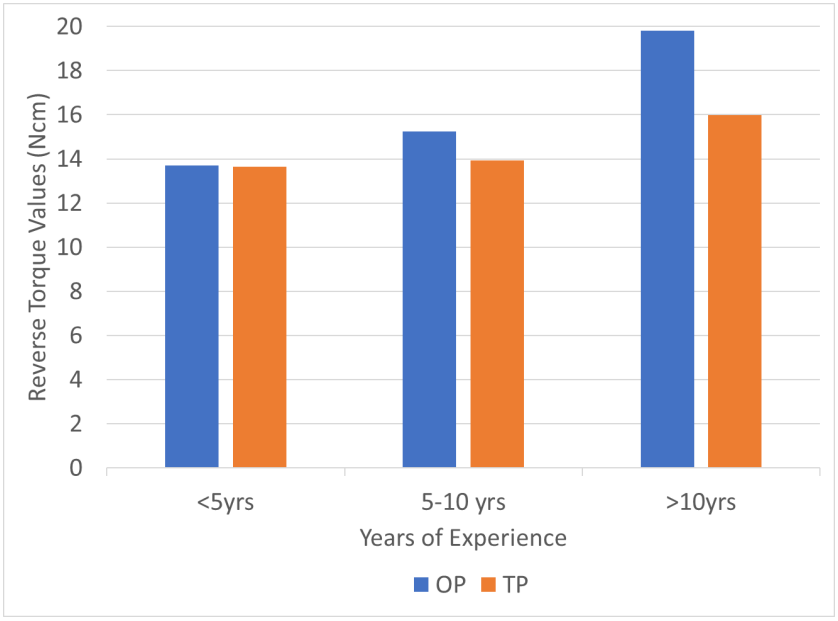

Figure 7. Gender and reverse torque values

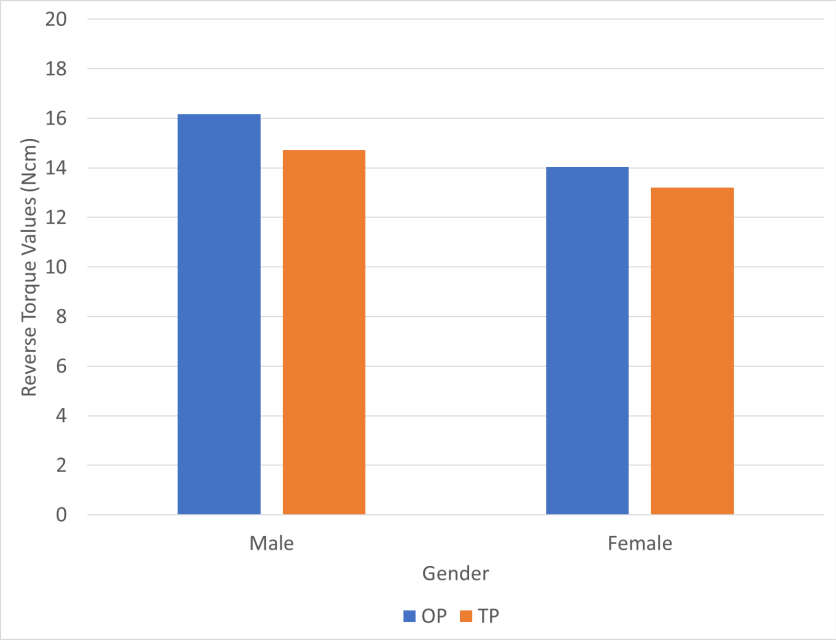

Figure 8. Dental AOC and reverse torque values