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ACCURACY OF DIFFERENT TYPES OF WRENCHES FABRICATED BY DIFFERENT IMPLANT MANUFACTURERS

Halil İbrahim Kılınç, DDS, PhD
Assistant Professor, Department of Prosthodontics, Faculty of Dentistry, Erciyes University Kayseri, Turkey

Haydar Albayrak, DDS
Assistant Professor, Department of Prosthodontics, Faculty of Dentistry, Erciyes University, Kayseri, Turkey

Funda Tursun, DDS
Research Asistant, Department of Prosthodontics, Faculty of Dentistry, Erciyes University, Kayseri, Turkey

Hasan Önder Gümüş, DDS, PhD
Associate Professor, Department of Prosthodontics, Faculty of Dentistry, Erciyes University, Kayseri, Turkey

ABSTRACT

Background and Aim: We evaluated the accuracy of wrenches from different domestic implant manufacturers.

Materials and Methods: Five unused wrenches of each three domestic implant manufacturers (Implant KA, Implance, and Nucleoss) were selected. Two of the wrenches were of the spring style and the other was of the friction style. To measure the peak torque value of each wrench, a digital torque device with a chuck to hold each manufacturer's driver was used. Force was applied to the wrench until either the spring style flexed to the target torque value or the friction style released at the target torque value. This procedure was repeated five times for each wrench. A one-sample t-test was used to evaluate achievement of the wrench target torque values. One-way ANOVA and independent t-tests were used to compare the percentage of the torque difference among the different wrench types from the different manufacturers ($\alpha = 0.05$).

Results: The Nucleoss friction-type wrenches applied higher torque values than the target torque value, and the Implant KA and Implance spring-type wrenches applied lower torque values than the target torque value ($p < 0.05$). None of the manufacturers achieved their recommended torque values (Implant KA, $p = 0.003$; Implance, $p = 0.001$; Nucleoss, $p = 0.041$).

Conclusions: The wrenches from Implant KA and Implance applied lower torque, whereas the wrenches from Nucleoss applied higher torque than their recommended torque value.

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Correspondence

Halil İbrahim Kılınç DDS, PhD
Department of Prosthodontics, Faculty of Dentistry
Erciyes University, Kayseri, Turkey
Phone: +90 (352) 207 66 66 - 29075 - 29085
Fax: +90 352 438 06 57
E-mail: hikilinc@erciyes.edu.tr

CLINICAL DENTISTRY AND RESEARCH 2015; 39(3): 95-100 Orjinal Araştırma

FARKLI İMPLANT ÜRETİCİLERİ TARAFINDAN ÜRETİLEN FARKLI TİP TORKLU RAŞETLERİN DOĞRULUĞU

Halil İbrahim Kılınç
Yar. Doç.Dr. Erciyes Üniversitesi, Diş Hekimliği Fakültesi, Protetik Diş Tedavisi Anabilimdalı, Kayseri, Turkey

Haydar Albayrak
Yar.Doç.Dr. Erciyes Üniversitesi, Diş Hekimliği Fakültesi, Protetik Diş Tedavisi Anabilimdalı, Kayseri, Turkey

Funda Tursun,
Araş. Gör. Erciyes Üniversitesi, Diş Hekimliği Fakültesi, Protetik Diş Tedavisi Anabilimdalı, Kayseri, Turkey

Hasan Önder Gümüş
Doç. Dr. Erciyes Üniversitesi, Diş Hekimliği Fakültesi, Protetik Diş Tedavisi Anabilimdalı, Kayseri, Turkey

ÖZ

Amaç: Çalışmamızda farklı yerli implant üreticilerinin torklu raşetlerinin doğruluğu değerlendirilmiştir.

Gereç ve Yöntem: Kullanılmamış beşer adet torklu raşet üç farklı yerli implant üreticisinden (Implant KA, Implance ve Nucleoss) temin edildi. Bu torklu raşetlerden ikisi yaylı tip iken, birisi kırılmalı tip idi. Uç tork değerlerinin kaydında implant üreticisinin anahtarının bağlandığı tutucu uç ve dijital tork-metre kullanılmıştır. Torklu raşetlerden yaylı tipte olanlara, hedef tork değerinin gösterildiği çizgiye ulaşılıncaya kadar, kırılmalı tipte olanlara ise hedef tork değerinde kuvvet boşalması gözleninceye kadar kuvvet uygulanmıştır. Her bir torklu raşet için bu prosedür beş kere tekrar edildi. Torklu raşetlerin hedef tork değerlerine ulaşmalarında tek örneklem t-testi kullanılmıştır. Farklı üreticilerin ve farklı tip torklu raşetlerin hedef torktan sapma yüzdelerinin karşılaştırılmasında tek yönlü varyans analizi ve bağımsız gruplarda t-testi kullanılmıştır (α= 0.05).

Bulgular: Nucleoss kırılmalı tip torklu raşetler hedef tork değerinden yüksek tork kuvvetleri uygularken, ImplantKA ve Implance yaylı tip torklu raşetler hedef tork değerinden düşük tork kuvvetleri uygulamışlardır (p< 0.05). Torklu raşetler üreticilerinin önerdiği hedef tork değerlerinden farklı değerlerde tork uygulamışlardır (Implant KA, p= 0.003; Implance, p= 0.001; Nucleoss, p= 0.041).

Sonuçlar: Implant KA ve Implance torklu raşetlerinde hedef tork değerlerinden daha düşük değerler elde edilirken, Nucleoss torklu raşetlerinde hedef tork değerlerinden yüksek değerler elde edilmiştir.

Sorumlu Yazar

Halil İbrahim Kılınç
Erciyes Üniversitesi, Diş Hekimliği Fakültesi, Protetik Diş Tedavisi Anabilimdalı, Kayseri, Turkey
Telefon: +90 352 207 66 66 - 29075 - 29085
Faks: +90 352 438 06 57
E-mail: hikilinc@erciyes.edu.tr

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INTRODUCTION

Screw loosening is one of the most frequently reported late complications in implant-supported prosthetics, found in 5.8% to 12.7% of implants after 5 years.[1, 2] Many factors may cause screw loosening, such as machining tolerances,[3] component materials,[4] metal fatigue,[5] micromovement during function,[6] applied preload,[7] the elasticity of bone, settling of the screws,[8] mismatch in screw material and design, screw setting, mechanical overload, and inadequate tightening torque.[9] Torque application during tightening the screw keeps the abutment-implant joint under tension (so-called preload).[10-12] The preload is a fundamental factor that can be influenced by the clinician at the delivery stage. Inadequate application of torque results in inadequate preload and may be a major reason for screw loosening.[3,13] Inadequate preload causes microgaps between the abutment and implant.[14] These microgaps not only cause peri-implantitis due to the formation of reservoirs for bacteria[15] but may also cause catastrophic problems with implant-supported restorations because of micromotion of the screw and abutment.[14]

In an optimum preload process, the target torque values of implant systems vary among the implant/screw manufacturers because of screw alloys, screw designs, abutment alloys, and the machining tolerance of the abutment.[16] Thus, clinicians must know the manufacturers' recommended torque values that are applied with recommended mechanical and electronic torque control devices.

Many articles have evaluated the different torque control devices. In a few studies, electronic torque control devices showed large deviations from target torque values.[17] However, most implant manufacturers recommend the use of mechanical torque control devices, also known as wrenches, because of their adequate accuracy.[18] Two types of wrenches, friction (toggle) and spring (beam), are generally used in dentistry. The clinician can apply torque via friction-style wrenches with the handle, which is released at the target precalibrated torque value. In contrast, the clinician can apply torque via spring-style wrenches by flexing the attached bar of the wrench to a premade mark on the surface of the rigid wrench part.[19]

Whichever type of torque control device is recommended by the manufacturer, the reliability must be evaluated because of the importance of screw loosening. Comparisons of these torque control systems with absolute mean differences from target values have been made in several studies, including with devices from different manufacturers imported into Turkey.[18] However, the performance of wrenches fabricated by domestic implant manufacturers is not known. The accuracy and precision of the two different configurations (spring style and peak break) and measured values versus manufacturer-stated values were evaluated in a previous article to understand the performance of these products in the clinic.[19] The study showed that all of the evaluated torque-limiting devices achieved lower torque values than the target values except one manufacturer.[18,19] This could increase the incidence of screw loosening.

Thus, the purpose of the present study was to evaluate the reliability of torque control devices fabricated by domestic manufacturers in achieving their target torque values and compare these manufacturers and torque control device types with respect to absolute differences from target values. The null hypotheses were (1) that there was no significant difference among different types of mechanical torque-limiting devices fabricated by the different manufacturers, and (2) that there was no difference among the wrenches of the manufacturers in achieving their target torque values.

MATERIALS AND METHODS

The accuracies of the wrenches fabricated by three domestic implant manufacturers were evaluated. The wrenches from Implant KA (Mode Medical, Istanbul, Turkey) and Implance (AGS Medical, Trabzon, Turkey) were spring-style devices, whereas the Nucleoss (Şanlilar Medical, Izmir, Turkey) device was of the friction style. Five unused, brand-new wrenches of each type were examined in the present study.

A digital torque device with ±0.3% torque measurement accuracy (Cap Torque Tester Series TT01; Mark 10, NY, USA), with a three-jaw chuck (Precision Quick-Action Drill Chuck; Optimum, Maschinen, Germany) was used to hold each manufacturer's driver. A clockwise driving force was applied to each wrench by the clinician with a torque application rate of approximately 4 s from 0 to the target value, until either the spring-style device flexed to the precalibrated limit or the friction-style device released at the precalibrated torque value. Applicatio of torque to each wrench was repeated five times, and the peak torque values were recorded by another experimenter for blinded torque application.

The five recorded values of each torque control device were averaged, and the mean was used as the single data point to be associated with that specific wrench. The percentage of the difference (PERDIF) between the measured torque value and the target torque value recommended by the manufacturer (Table 1) divided by the target torque was also calculated and recorded.

Table 1. Results of one-sample t tests and descriptors of groups (n= 5)

Group	Recommended Target Torque Value	Mean ± Standard Deviation	t	p	Mean Difference
Implant KA	25	23.15 ± 0.6	-6.596	.003	-1.85
Implance	25	22.95 ± 0.5	-8.271	.001	-2.05
NucleOSS	30	32.07 ± 1.5	2.985	.041	2.07

$$\frac{\text{Recorded Torque Value} - \text{Target Torque Value}}{\text{Target Torque Value}} \times 100$$

The averaged sample torque values and the PERDIF passed the Kolmogorov–Smirnov normality test. The PERDIFs were then subjected to one-way ANOVA and independent t-tests to evaluate manufacturer- and wrench type-related factors. The averaged sample torque values of each group were subjected to a one-sample t-test to evaluate the success of torque-limiting devices of manufacturers at reaching the recommended target torque values. Statistical analyses were performed using SPSS software (ver. 20.0; IBM Corp., Armonk, NY, USA) with 95% confidence intervals.

RESULTS

One-sample t-tests showed that the recorded torque values of all manufacturers of this study differed from their target values ($p < 0.05$) (Table 1). Figure 1 shows the mean torque values and 95% confidence intervals for each torque-limiting device tested with an indication of the target torque value.

One-way ANOVA results revealed that there was a statistically significant difference among the manufacturer groups ($p < 0.001$) (Table 2). According to Tukey's post hoc test, Nucleoss wrenches showed a higher PERDIF than the wrenches of the other manufacturers ($p < 0.05$). Implant KA and Implance wrenches did not show statistically different PERDIFs from each other ($p \geq 0.05$) (Figure 2). According to the results of independent t-tests, friction-style wrenches showed significantly higher PERDIFs than spring-style wrenches ($p = 0.002$) (Figure 2).

DISCUSSION

Because different implant manufacturers have different target torque values for their screws, ranging from 10 to 45 N-cm,[20] any "standard" method for the evaluation of wrench types and manufacturers is controversial. Santos et al.[21] compared the mean measured torque values with the target torque values. Some previous studies preferred to consider the mean absolute torque differences and percentages together,[18,22] while others used only the mean absolute torque difference to compare the accuracy of wrench types and manufacturers.[20] In the present study, the PERDIF of the measured torque value from the target torque value was used to compare different types of wrenches from different manufacturers. Moreover, all positive and negative deviations from the target values of the groups were compared.

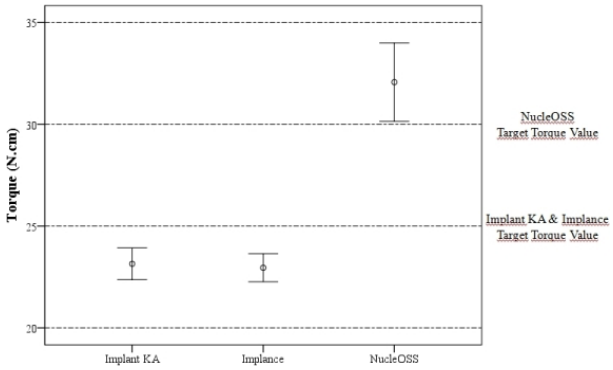


Figure 1. Recommended target torque values (dotted line), applied mean torque values (circles), and 95% confidence intervals for means (vertical bars).

Preload is crucial for implant-abutment assembly and can be influenced by several factors, including torque delivery systems[9] and manufacturing quality.[10] However, there is a lack of torque control device evaluation with most implant manufacturers. Thus, the present study appears to be the first to evaluate preload torque devices of the Implant KA, Implance, and Nucleoss implant systems.

The null hypotheses were rejected according to the results of this study. Nucleoss wrenches applied higher torque values, whereas Implant KA and Implance wrenches applied

Table 2. Results of independent t tests, ANOVA and post-hoc Tukey test

Group	Mean ± Std. Dev. PERDIF	p value of ANOVA	p value of t test
Implant KA	-7.41 ± 2.5[a]	<0.001	
Implance	-8.18 ± 2.2[a]		
NucleOSS	6.91 ± 5.2[b]		
Spring Type	-7.79 ± 2.3[b]		<0.001
Friction Type	6.91 ± 5.2[b]		

Different superscripts shows significant difference of Tukey post-hoc test ($p<0.05$).

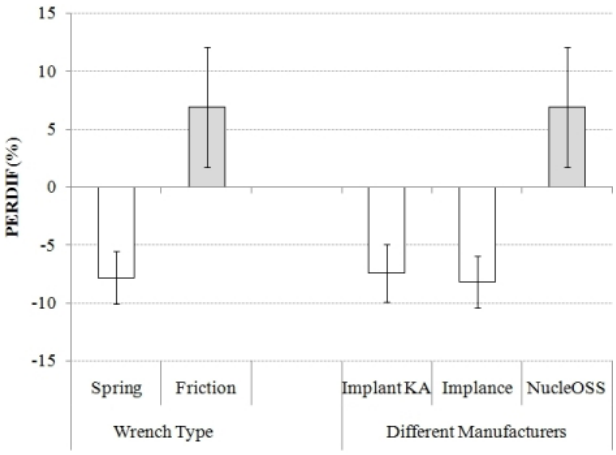


Figure 2. Results of independent t-tests, ANOVA, and post hoc Tukey tests.

lower torque values than the recommended target torque values. This difference was also observed in the comparison of wrench types because Nucleoss was the only friction-style wrench evaluated in this study, whereas the others were spring-style devices. These results are consistent with a previous study in which spring-type wrenches showed less torque preload.[13] However, the friction-type wrenches showed higher torque preload.[23] Given the problem of screw loosening, a higher preload than the target values could decrease screw loosening. Additionally, the fracture resistances of screws to torsional stresses have to be investigated. All of the groups evaluated showed ±10% deviation from their target torque values, which are within reported acceptable inaccuracies for wrenches.[17,21,24,25]

A recent study by Britton-Vidal et al.[1] stated that the difference from the target torque value did not directly address the accuracy of wrench types or manufacturers. For this purpose, means and 95% confidence intervals were suggested for the evaluation of the accuracy of wrenches.[19] In the present study, wrenches were evaluated with the same method, and none of the manufacturers reached their target torque values. Thus, the wrenches evaluated in this study were unsuccessful in achieving the target torque values recommended by the manufacturers. Further studies, including clinical follow-up, could give more evidence about these results and their effects on the incidence of screw loosening.

This study has some limitations. Different types of torque-limiting devices fabricated by different manufacturers were evaluated for their abutment screw preloads. However, screw preload for screw-retained fixed prosthetics was not evaluated. Moreover, the effects of clinical use and sterilization cycles were not considered. Further studies including these considerations should be performed.

CONCLUSIONS

Within the limitations of the present study, the following conclusions were reached for torque-limiting devices in new, unused condition:

1. The torque-limiting devices of three domestic implant manufacturers were unable to achieve the recommended preload values.
2. While the friction-type wrenches of Nucleoss applied higher torque values, the spring-type wrenches of Implant KA and Implance applied lower torque values than the recommended torque values.

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