The Precision of Mechanical Torque Wrenches Used for Implants in Dental Offices

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Purpose: This study aimed to investigate the precision of mechanical torque wrenches used for implants in dental offices. ***Materials and Methods:*** Mechanical torque wrenches (n = 138) with two functional designs and made by three manufacturers were tested by three groups of investigators. Potential influences on accuracy were tested. Relative deviations from targeted torque values and the precision of recorded torque values were analyzed. ***Results:*** Most abutment screws were tightened too tightly rather than too weakly. Differences were apparent in the influence of the functional design of torque wrenches on their precision. No significant correlation between absolute frequency of use and relative deviation or precision was detected. Investigators with different levels of experience exhibited significantly different deviations from targeted torque values. ***Conclusions:*** Average deviation from intended torque values, and levels of imprecision, are evidently not major problems in implant prosthetics; however, high torque values are a cause for concern. *Int J Prosthodont 2015;28:527–530. doi: 10.11607/ijp.4281*

The most common complications of screw-retained two-stage dental systems may be loosening or fracture of the abutment screw.[1] Preloading of the abutment screw by tightening with a specific torque is a major factor related to force-fitting and form closure of the implant-abutment interface. Deceeding this torque can cause screw loosening, and exceeding it can cause screw distension up to screw fracture.[2,3] The aim of this study was to evaluate the accuracy of the torque generated by mechanical torque wrenches used in dentistry. The possible influences of wrench age, frequency of use, and the level of experience of the dentist were also investigated.

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Materials and Methods

Investigators

Dentists from general practice (wrench owners; group X), dentists with advanced skills in implantology (group Y), and dentists with reduced clinical level of experience (group Z) took part in this investigation (Fig 1).

Torque Wrenches

A total of 138 torque wrenches were tested consecutively by one dentist from each investigator group, including 67 wrenches made by CAMLOG Biotechnologies (implant group C), 58 made by Straumann (implant group S), and 13 made by Nobel Biocare (implant group NB) (Fig 2).

Torque Meter

An electronic torque meter (Torque Tester 4-D, Theinert) was fitted into a phantom head (Fig 3) and used for measurement. Before testing, the torque meter was calibrated, and the measurement accuracy was ± 0.5%.

Test Setup

The respective target value was set by the testers and corresponded to the manufacturer's recommended presettings. Activation of the abutment screw was

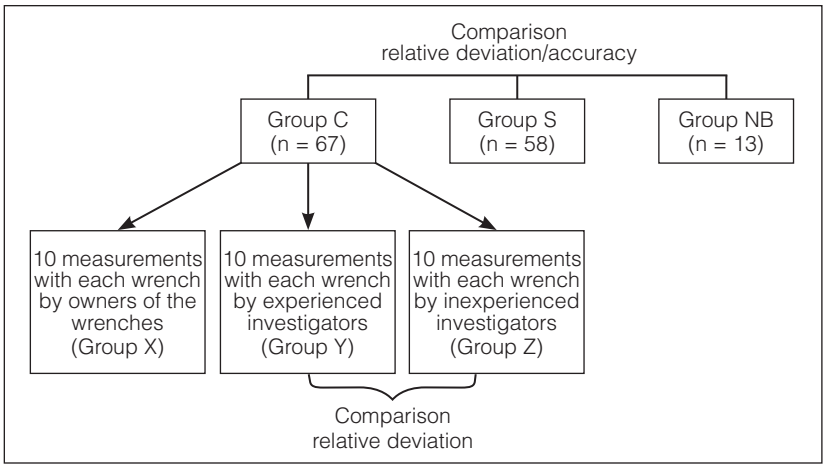

Fig 1 Division of investigators and wrenches into groups. C = Camlog implant system; S = Straumann implant system; NB = Nobel Biocare implant system.

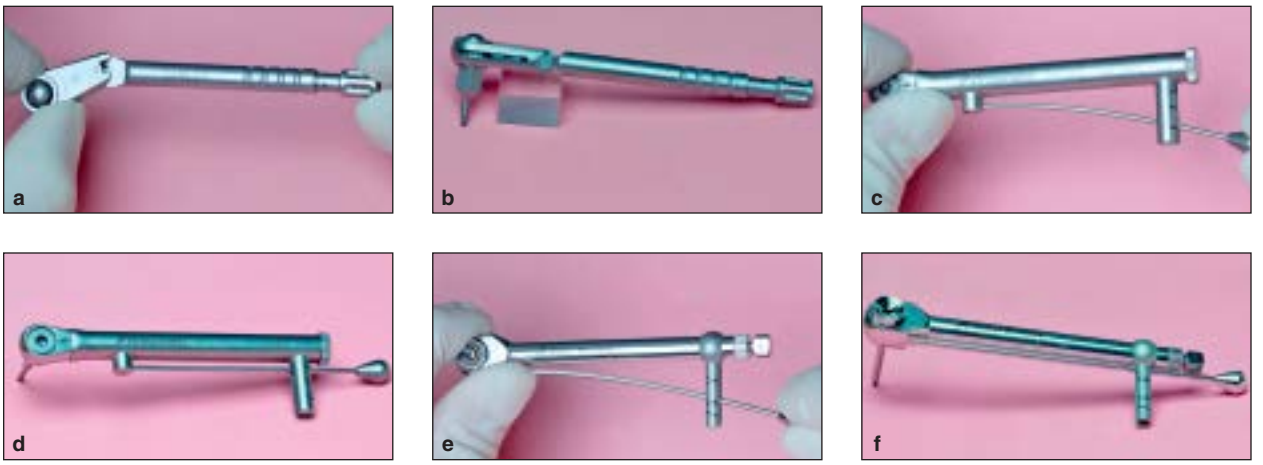

Fig 2 The mechanical torque wrenches tested, with varying functional designs. **(a, b)** Wrench with a spiral-spring release mechanism (implant group C). **(c, d)** Wrench with a spring bar bending mechanism (implant group S). **(e, f)** Wrench with a spring bar bending mechanism (implant group NB).

Fig 3 Test setup. Prepared phantom head with integrated electronically calibrated torque meter (Torque Tester 4-D, Theinert). The abutment screw was located in the area of the mandibular right second premolar (FDI 45).

repeated 10 times. The applied torque values were determined by the torque meter. The same torque wrench was tested by all investigators (groups X, Y, and Z). In group C, 26 test participants opted to set 20 Ncm as the designated maximum torque value, and 41 chose 30 Ncm. In groups S and NB, all test participants chose 35 Ncm. Additionally, wrench age (years of use) and estimated frequency of use per month were recorded.

Indicators of Accuracy

Two indicators were used to evaluate the accuracy of the torque values.

Trueness (relative deviation) indicated compliance between the mean of a data set (torque measurements) and an accepted reference value (targeted torque value). If the mean of a large number of measurements closely matched with the targeted maximum torque value, the trueness was good (Fig 4). Trueness was defined as the mean relative deviation of the 30 repetitions per wrench (10 repetitions per tester) (x1,…,10; y1,…,10; z1,…10), from the targeted standard value N:

$$\sum_{i=1}^{10} \frac{x_i - N}{N} \quad , \sum_{i=1}^{10} \frac{y_i - N}{N} \quad , \sum_{i=1}^{10} \frac{z_i - N}{N}$$

Repeatability indicated the variability among independent measurements taken under fixed conditions. If the measured values are very close to each other, the application method has high precision. However, this does not indicate that the measured values are also true, because they can be repeatable but still wrong (Fig 4). Repeatability is defined as the standard deviation within the values measured for each torque wrench:

$$\sqrt{\sum_{i=1}^{10} (\bar{x} - x_i)^2} \quad , \sqrt{\sum_{i=1}^{10} (\bar{y} - x_i)^2} \quad , \sqrt{\sum_{i=1}^{10} (\bar{z} - x_i)^2}$$

Results

Relative Deviation

The majority of relative deviation values were above the target torque value for all three manufacturers. There were significant differences in deviation between implant groups S and NB ($P < .001$) and groups C and NB ($P = .008$).

Precision

All wrenches showed similar and adequate precision. Statistical comparision of the groups (Kruskal-Wallis test, $P = .014$) showed significant differences between groups C and S ($P = .011$) and groups C and NB ($P = 0.038$).

Frequency of Use

No significant correlation between the absolute frequency of use and relative deviation (Spearman's rho = 0.089) or precision (Spearman's rho = 0.213) was apparent.

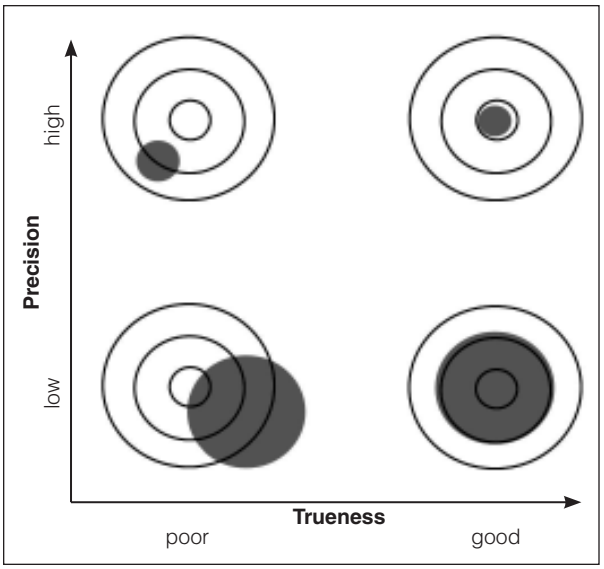

Fig 4 The difference between precision and trueness. The top-right diagram depicts high accuracy.

Level of Experience

Experienced investigators exhibited a lower mean deviation compared to inexperienced investigators. Differences between the groups were statistically significant (*t* test, $P = .006$).

Discussion

The participants in all three implant groups applied forces that were too high. These findings are similar to those of other studies that investigated operators' abilities to generate accurate torque values.[4,5] Corrosion and oxidation of the metal parts might affect the mechanisms, resulting in statistically higher torque values.[6] This could have been the reason torque values were higher than intended in some instances. The extent to which too-high initial torque affects the longevity of abutment screws remains to be determined. A higher initial preload (> 30 Ncm) is reportedly beneficial for abutment-implant stability and to decrease screw loosening.[7]

Conclusions

The excesses in torque detected in this study may not have a critical effect on abutment screw integrity. Calibrated torquing devices are preferable to ensure the desired level of torque.

Acknowledgments

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Literature Abstract

Flawed oral health of a nonsmoking adolescent suggests smoking in adulthood

This study aimed to determine if poor oral health in adolescence could be used to predict onset of smoking in adulthood. The study cohort consisted of self-reported nonsmokers from a pool of adolescents (aged 13 to 15 years) (n = 2582) born in 1979 who participated in annual school oral checkups between 1992 and 1994. The two oral health indicators were decayed teeth (D) and decayed, missing, and filled teeth/surfaces (DMF). Smoking behavior at age 29 was determined with a follow-up questionnaire in 2008. The results showed: *(1)* DMF had no association with higher smoking rates in adulthood. *(2)* Those who were nonsmokers at ages 13 to 15 and had at least 1 decayed tooth (D > 0) at any oral checkup between those ages were almost twice as likely (OR 1.88, 95% CI = 1.2–2.9) to smoke by age 29. *(3)* Odds of smoking by age 29 is high for adolescents with D > 0 at age 13 (OR 1.4, 95% CI = 1.1–1.99), and D > 0 at age 14 (OR 1.8, 95% CI = 1.3–2.4). *(4)* Those with DMF > 0 at age 13 and those with D > 0 at age 15 were more likely to start smoking earlier. The authors concluded that poor oral health (D > 0) in nonsmoking adolescents might predict onset of smoking in adulthood. They suggested early detection of oral health problems in children and emphasized smoking prevention among adolescents with poor oral health.

Saari AJ, Kentala J, Mattila KJ. *Eur J Public Health* 2015;25:491–494. **References:** 17. **Reprints:** Antti J. Saari, JYTA, Tunkkari Health Care Center, Veteli, University of Tampere, Tampere FI-33014, Finland. Email: antti.j.saari@uta.fi—*Simon Ng, Singapore*