Implant Abutment Screw Torque Generated by General Dentists Using a Hand Driver in a Limited Access Space Simulating the Mouth

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For various reasons, dentists may be tempted to definitively tighten implant abutment screws using only handheld screwdrivers. The purpose of this study was to test the ability of general dentists to generate implant abutment screw preload using a simple screwdriver in a limited-access space simulating the mouth. Results indicated that mechanical torque wrenches must be used in posterior areas of the mouth to establish sufficient preload, and dental experience is not a major factor in the ability to tighten an implant abutment screw.

Key Words: implant abutment screw, preload, dental experience

INTRODUCTION

Simplified protocols have made implant-borne restorations a widely used treatment modality for replacing missing teeth. Modern implant-supported fixed restorations are cemented to or are part of abutments attached directly to implant fixtures by internal screws. Compressive forces generated across the implant-abutment interface by tightening the abutment screw to a specific torque help maintain the integrity of the joint and position of the screw, although preload forces slowly decay with time. Preload torque recommendations vary but typically range from 10 to 35 Ncm, depending on screw material and implant/abutment manufacturer. Preload for the abutment screw should ideally be established using a torque wrench and must be sufficient to ensure that lateral forces are distributed to the implant-abutment interface rather than to the screw to reduce the likelihood of loosening or fracture.

Goheen et al evaluated the ability of practitioners, who were experienced in the use of implant components (oral surgeons and prosthodontists), to impart a desired torque (10, 20, or 32 Ncm) to an abutment screw using handheld screwdrivers. It was assumed that, for various reasons, some clinicians might use handheld drivers for definitive tightening of implant-abutment screws rather than obtaining manufacturer’s torque wrenches to establish preload forces. An implant and electronic torque meter sensor assembly was positioned on a dental surveyor allowing unhindered access for screw tightening. The results showed a wide range of variability in force perception among tested subjects and found that some people could generate more torque than the highest desired target value (32 Ncm). The researchers concluded that calibrated torque wrenches should ideally be used to prevent under- or overtightening of abutment screws. The purpose of this study was to determine how much abutment screw preload torque a general dentist (presumed to have less implant component experience than oral surgeons or prosthodontists) could generate using a handheld driver in a limited-access space, simulating the mouth, to see if the use of a mechanical torque wrench is mandatory.

METHODS

A typodont (Kilgore, 500B series, Nissin, Japan) was modified by removing plastic from the socket base at
the site normally occupied by the mandibular left first molar to permit passive positioning for a strain gauge, supported by an elbowed socket wrench extension connected to an electronic sensor (APT 1000, Sensor Developments Inc, Orion, Mich). A 3.75-mm-diameter, 13-mm-long external hex implant fixture with a surgical abutment secured by a gold alloy screw (Osseotite NT Certain, 3i, Palm Beach, Fla) was attached to the strain gauge using acrylic resin (Dura Lay, Reliance Dental Manufacturing Co, Worth, Ill). A custom-fabricated aluminum jig (Magnolia Tool and Manufacturing Co, Inc, Ridgeland, Miss) was used to hold the implant-strain gauge assembly so that the abutment top was just below the level of the occlusal plane (Figure 1). The jig also secured the mandibular member of the typodont to the lower jaw plate of a manikin head that was part of a patient simulator (ADEC, Model 4810, Newberg, Ore) (Figure 2). The strain gauge was checked to confirm a passive, nonbinding fit in function and at rest. Anterior opening for the typodont was fixed at 42 mm, and the manikin head was positioned at a 45° to the floor.

Fifty-six general dentists attending the 2006 Mississippi Dental Association Annual Session volunteered for this study. Before testing, information on sex, year of graduation from dental school, dominant hand, and if implant patients were seen in their practice was obtained. Using a 25-mm mini-hex screw driver (3i), each dentist (seated or standing as preferred) was asked to apply maximum torque to the abutment screw 3 times with a 1-minute rest period between attempts. All dentists wore latex-free synthetic exam gloves (Aloetouch Ultra, Medline Industries, Mundelein, Ill) to better simulate a clinical setting.

Digital readings were recorded in inch pounds (in/lb) by the sensor for each “tightening procedure.” The values collected for each dentist were converted to Newton centimeters (Ncm) using the formula “\(x\) in/lb \times 11.2985 = Ncm.” Using this calculation, 2.66 in/lb equals 30 Ncm.

Autocalibration of the electronic sensor was checked using a factory-calibrated spring-loaded torque gauge (Tonichi model 3.6 BTG, Tokyo, Japan) that was used to tighten the abutment screw with the typodont mandible removed from the manikin to allow unhindered access. Five measurements were made with the Tonichi gauge set at 1.0, 1.5, and 2.0 inch/lb and compared to the digital sensor readings. Each set was averaged and converted to Newton centimeters. Measurements between the Tonichi torque gauge and the digital readings obtained from the electronic sensor showed differences of 0.45 Ncm, 0.56 Ncm, and 0.90 Ncm for 1.0 in/lb, 1.5 in/lb, and 2.0 in/lb, respectively. This gave a linear average of 0.64 Ncm difference between the electronic sensor and the factory-calibrated spring-loaded torque gauge.

**Results**

Of the 56 volunteers participating in the study, 82% were men and 18% were women; 95% were right-hand dominant and 5% left-hand dominant; 89% restored implant patients and 11% did not. Maximum generated torque values for all 56 dentists ranged from 4.0 to 21.7 Ncm (mean = 12.9 Ncm, SD = 3.67 Ncm, and 95% CI = 12.7 to 13.8 Ncm).

Graduation date from dental school ranged from 1956 to 2004; however, half of the group had graduated before 1984, which helped establish two groups: one with more than 20 years of dental experience and one with 20 years or less. The mean
preload torque generated for the pre-1984 group was 13.5 Ncm, and the mean for the post-1984 group was 12.9 Ncm; $t$ test analysis indicated no statistical difference between the 2 groups.

**DISCUSSION**

The literature supports the concept that minimum abutment screw preload torque is critical and that excessive torque can exceed the yield strength of the screw material.\(^7\) The study by Goheen et al\(^6\) permitted unrestricted abutment screw access and tested those assumed to have experience with implant components (oral surgeons and prosthodontists); the overall maximum torque generated with a handheld screwdriver was 36.2 Ncm. The 56 dentists tested in this study were hindered by the limited access to simulate the oral cavity; the mean torque value was 12.9 Ncm, and only 6 could reach a torque value exceeding 20 Ncm, a level well below the 32 Ncm recommended for gold palladium abutment screws.\(^7\) One can assume that other variables that could not be accessed by an in vitro study (such as lack of visibility, saliva, and patient cooperation) would also compromise dexterity or "grip," resulting in a negative effect on a dentist's ability to generate preload torque with a simple screwdriver. Even gloves, which are mandated for intraoral procedures, have been shown to significantly reduce dental dexterity and touch perception.\(^8\)

The year each dentist graduated from dental school was asked to determine if experience using dental tools might influence the ability to generate screw torque with a hand driver. Neiburger\(^9\) examined age and dexterity and found that younger dentists tend to work faster but are less digitally sensitive than older dentists. Results of this study indicate no difference in the ability to generate abutment screw preload torque based on years of practice experience in dentistry. Goheen et al\(^6\) assumed that oral surgeons and prosthodontists have a better working ability with implant system screwdrivers based on experience; however, these conclusions may be questionable in the current environment as an increasing number of implant-supported restorations are being placed by general dentists.

**CONCLUSIONS**

Mechanical torque wrenches must be used in the posterior areas of the mouth to establish sufficient preload forces for implant abutment screws. Limited intraoral access and other dexterity factors affect the amount of torque that can be applied to implant abutment screws using a simple handheld screwdriver. Dental experience (equated to years in practice) does not significantly improve the ability to generate implant abutment screw torque with a hand driver.

**REFERENCES**