the accuracy of prosthetic rehabilitation, the index reduces the internal conical area in contact with the abutment.

Hein et al from Faculdade São Leopoldo Mandic, Brazil, compared the detorque values of universal abutment screws placed at different angles with both indexed and nonindexed systems for implants with internal tapered connections. A group of 18 indexed and 18 nonindexed implants were subdivided into 3 groups with different angulations: 0°, 17° and 30°. Prosthetic abutments were coupled to the implants using manufacturer-specified torque. Then each unit underwent mechanical cycling simulating approximately 6 months of masticatory function, after which they were inspected for permanent deformation, and detorque values were measured.

All abutment screws became loose under mechanical cycling. In the nonindexed group, 59.9% of torque was maintained, compared with only 44.8% in the indexed group. The difference held true for all 3 angulations. The indexed group showed a mean torque loss of 1.4% for every increased degree of angulation; no significant differences were seen among the 3 angulations in the nonindexed group.

Comment

Loosening of the fixation screw under masticatory loads is the most frequently reported complication in implant-supported restorations, especially for single-unit crowns. Tapered connection implants have a lower rate of loosening complications, but the use of angled prosthetic abutments caused greater screw loosening in indexed abutments.

Hein D, Joly JC, Napimoga MH, et al. Influence of abutment angulation on loss of prosthetic abutment torque under mechanical cycling. J Prosthet Dent *2021;125:349.e1-e6.*

Retorquing Abutment Screws

Prosthetic abutment screw loosening in implant-based restorations for single missing posterior teeth occurs frequently, especially during the first year of loading. When a 2-piece abutment is used, loosening of the abutment screw and axial displacement of the abutment may occur under long-term loading. Left unaddressed, this screw loosening can result in loosening of the abutment and prosthesis.

Xu et al from Peking University Shenzhen Hospital, China, hypothesized that waiting to retorque the abutment screw until the prosthesis had been in use for 1 month would result in better outcomes. They studied 77 maxillary and 81 mandibular implants (40 premolars, 118 molars) that had been restored with 3 different implant systems. All implants received screw–cement-retained prostheses, zirconia crowns cemented to titanium abutments before placement that were then screwed together to the implant. After the abutment screws were tightened to the manufacturers' recommended torque, the abutment screws of 1 group of restorations were retightened 10 minutes later; in the other group, the screws were not retightened.

At baseline, none of the retightened screws showed any preload loss. At the 1-month recall, all restorations were checked for possible screw loosening. Of the 16 cases with a preload loss, 7 had been retightened after 10 minutes, while the remaining 9 had not, a nonsignificant difference. Nor was there a significant difference between the rate of preload loss between molars and premolars. Retightening the abutment screws 10 minutes after the initial torquing appeared to have no effect on preload loss after 1 month.

Comment

The authors stressed the need to retorque abutment screws 1 month after the initial torque, along with the importance of long-term follow-up. They recommended a schedule of visits at 1, 3, 6 and 12 months after placement, then annually.

Xu Y, Li W, Su M. Clinical assessment of preload maintenance in the abutment screws of single posterior implants after 1 month of use. Int J Oral Maxillofac Implants *2021; 36:177-181.*

In the Next Issue

Critical consideration for implant restoration fit

Our next report features a discussion of this issue and the studies that analyze them, as well as other articles exploring topics of vital interest to you as a practitioner.

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Focusing on Dental Implants

Screw Performance: An Important Factor in Implant Success

Central to reliable dental implant restoration is the dentist's capacity to understand and appropriately manage prosthesis retention screws. In this respect, dentists have truly become modern-day oral engineers. Predictable therapeutic success requires an appreciation of screw-joint preload, screw-torque maintenance during function, and screw lubrication and its impact on preload, along with factors influencing the anticipated loss of preload over time and reliable mechanical generation of preload using the appropriate tools. In this issue of Prosthodontics Newsletter*, we review some of the current literature detailing the application of prosthesis retention screws in successful implant dentistry.*

Fluids' Influence on Abutment Screw Preload

The term "preload" refers to the force with which an abutment is loaded onto the implant with an abutment screw. The recommended tightening torque and resulting preload are designed by abutment screw manufacturers to achieve a maximum of 80% of the screw's elastic limit. Exceeding the elastic limit leads to plastic deformation of the screw, resulting in a decrease of preload and, ultimately, screw fracture. What remains unknown is whether various fluids in the oral cavity during the placement of implant-supported restorations might affect the preload.

Rathe et al from Danube Private University, Austria, conducted an in vitro investigation of the effect of blood, saliva, chlorhexidine (CHX) gel and a sealing silicone on the preload of abutment screws. They created 50 test specimens, each with an abutment screw, an abutment analog and a thread sleeve resembling the corresponding implant; the test specimens were then divided into 5 groups. One group was left dry and served as the control. In the other groups, either whole human blood, artificial saliva, 1% CHX digluconate gel or a sealing silicone was applied to the lumen of the thread sleeve until the lumen was completely filled. Each specimen was then tightened with a torque wrench to 5 different tightening torques: 15 Ncm, 20 Ncm, 25 Ncm, 30 Ncm and 35 Ncm. Abutment screw preload forces were recorded for each specimen at each tightening torque.

In all groups, including the control group, preload forces increased linearly with increased tightening torque. No significant differences were found at

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Fluids' Influence on Abutment Screw Preload

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any level of tightening torque between the control group and the saliva group or the blood group. A significant difference was seen between the control group and the CHX group only at the highest torque level (35 Ncm), while significant differences were seen between the control group and the silicone sealant group only at 15 Ncm and 25 Ncm. None of the substances tested showed any lubricant action on the threads of the implant abutments.

Comment

Ideally, the restoration should be performed under dry conditions; however, the presence of blood or saliva in the implant lumen appears to have no negative impact on the preload force, while CHX gel had a negative effect only at the highest level of tightening torque.

Rathe F, Ratka C, Kaesmacher C, et al. Influence of different agents on the preload force of implant abutment screws. J Prosthet Dent *2021;126:581-585.*

Screw Loosening In Angled Abutments

While the use of cement-retained implant-supported prostheses provides an esthetically pleasing and mechanically sound result, removal of excess cement can pose a challenge, with failure to remove it a major contributor to the development of peri-implant diseases. Screw retention avoids this problem, while allowing for better control of oral hygiene and retrievability if the need for repairs arises. Unfortunately, screws may loosen over time, which can lead to disturbances in transfer and distribution of applied occlusal forces, screw or implant fractures, and the formation of microgaps at the implant–abutment interface, allowing bacterial leakage.

Al-Zordk et al from Mansoura University, Egypt, investigated the impact of abutment angulation on torque maintenance of prosthetic and abutment screws. Fifty epoxy casts missing maxillary central, lateral and canine teeth were created and then divided into 5 groups of 10 casts each:

- **0–0 group:** both central and canine implants received straight abutments
- **0–17.5 group:** the central implant received a straight abutment, and the canine abutment received a 17.5° angled abutment
- **17.5–17.5 group:** both central and canine implants received 17.5° angled abutments
- **0–35 group:** the central implant received a straight abutment, and the canine abutment received a 35° angled abutment
- **35–35 group:** both central and canine implants received 35° angled abutments

The abutment screw (25 Ncm) and the prosthesis screw (18 Ncm) were tightened for 5 seconds, then retightened after 10 minutes. After a further 10 minutes, the reverse torque value for each screw was recorded, after which the screw was retightened to the prescribed torque. All restorations were thermally aged to represent 1 year in service and cyclically loaded to simulate 1 year of masticatory forces. At the end of loading, torque loss and percentage of torque loss were computed.

Central and canine prosthesis screws showed significant torque loosening, torque loss and percentage of torque loss in all groups, with the canine screws demonstrating significantly greater losses than the central screws. Torque loss for prosthesis screws ranged from 13.6% in the 0–0 group to 24.9% in the 35–35 group. Similar results were found for the abutment screws, with torque loss ranging from 11.4% in the 0–0 group to 19.1% in the 35–35 group (Table 1).

Comment

These results suggested that screw loosening in both prosthesis and abutment screws increases as abutment angulation increases, with torque loss greater in the canine screws than in the central screws. Practitioners need to bring patients back on a regular follow-up schedule to monitor screw loosening in screw-retained implant-supported anterior dental prostheses.

Al-Zordk W, Al-Dobaisi T, Ghazy M. Torque maintenance of screw-retained implant-supported anterior fixed dental prosthesis with different abutment angulations after aging. Int J Oral Maxillofac Implants *2021;36:723-729.*

Table 1. Percentage of torque loss in prosthesis and abutment screws after aging.

Group	0–0	0–17.5	17.5–17.5	0–35	35–35
Prosthesis screw					
Central	12.8%	12.3%	16.7%	15.0%	24.9%
Canine	14.3%	15.2%	17.8%	27.1%	26.1%
Average	13.6%	13.7%	17.2%	21.0%	24.9%
Abutment screw					
Central	11.1%	11.8%	14.8%	12.5%	18.9%
Canine	11.6%	15.1%	13.1%	19.5%	19.3%
Average	11.4%	13.4%	13.9%	16.0%	19.1%

Real-life Use of Torque Wrenches

Screw loosening remains the most frequently reported prosthetic complication with screw-retained implant prostheses. An often-overlooked question is whether clinicians use or follow industry standard guidelines when using tools designed to optimize screw tightening. Wadhwani et al from the Oregon Health Sciences University surveyed practicing dental practitioners to study their use of torque wrenches and tightening protocols, and to gauge their understanding of these relative to current best-practices standards.

A group of 10 academic dental specialists from 8 universities on 3 continents designed a 9-question survey (Table 2) that they administered to various groups of dentists attending (either in person or on the internet) lectures given by several of the academics between August 2019 and April 2020. Respondents were informed that participation was both voluntary and anonymous. All questions were formatted as multiple choice, with 2 to 4 possible answers. The survey was filled out by 428 participants, a 68% return rate.

More than half the respondents reported using the beam-type torque wrench, while almost half said their torque wrench had been in use for >3 years. Nearly half the respondents reported that they had observed <1 screw loosening of an implant restoration per year. Just 6% had calibrated their torque wrenches, while 86% failed to understand the term "preload" and what it referred to. More than half the respondents did not know if the speed of activation affected torque delivery. Exactly half the respondents reported employing a protocol of tightening to the required torque value, waiting a few minutes, then retightening; nearly a quarter only tightened the abutment screw once with the torque wrench.

Table 2. Survey questions.

1. Which type(s) of torque wrench do you have?
2. How long have you had your torque wrench?
3. When do you use it most often?
4. How often have you seen screw loosening of an implant restoration?
5. Have you ever calibrated the torque wrench?
6. For a "Beam Type" wrench, 20 Ncm is most accurately represented by… [three pictures were provided]
7. What is "Preload" of a screw?
8. Does the speed of tightening when using either a bar or toggle type torque wrench have an effect?
9. What is your tightening protocol when using a torque wrench on Final Abutments/Restoration?

Comment

Perhaps the most important takeaway from this survey involves how few practitioners calibrate their torque wrenches. ISO standards call for torque-limiting devices to be calibrated every 12 months or 5000 cycles, with more frequent calibration for tools that are overloaded or if ambient conditions during use and storage are exceeded. That describes most torque wrenches used in dentistry, given the negative effects of cleaning and heat sterilization. A torque wrench out of calibration may overdeliver or underdeliver the recommended torque, increasing the likelihood of a negative outcome.

Wadhwani CPK, Rosen PS, Yang G, et al. Survey of dental clinicians for attitude and use of torque-limiting devices. Int J Oral Maxillofac Implants *2021;36:538-545.*

Abutment Angulation and Screw Loosening

High rates of clinical complications involving the fixation screw occur, especially in single-unit restorations. The use of internal conical connections decreases the rate of abutment screw loosening while improving adaptation among the prosthetic components and decreasing micromovement between abutment and implant. Ideally, dental implants should align with mastication forces, but clinical conditions may require the placement of an implant in a non-optimal position, creating the need for an angulated prosthetic abutment. Although components with a tapered connection may be provided with an internal hexagonal index to improve