Systematic analysis of factors that cause loss of preload in dental implants

S. Nithyapriya, A. S. Ramesh, A. Kirubakaran, Jeevitha Mani, J. Raghunathan

Department of Prosthodontics, Adhiparasakthi Dental College, Melmaruvathur, Tamil Nadu, India

Abstract

Screw loosening is the most common factor associated with dental implant failure. One of the major cause for screw loosening is the "loss of preload". Several factors including screw geometry, material properties particularly stiffness, surface texture and condition of mating surfaces, degree of lubrication, rate of tightening, integrity of joint etc.

Objective: This review analyses the factors that are responsible for the loss of preload.

Material and Methods: Screw geometry, Implant- Abutment Connection type (external hexagon platform, morse taper), Material properties viz Stiffness, Resilience, Materials viz gold, titanium, titanium alloy, Surface texture of the abutment screw, Condition of mating surfaces, Lubrication, Torque value, Rate of tightening (10, 20, 35N and retorque after 10mins) are taken into consideration in this study. The MEDLINE-PubMed database was searched from September 2016 to 10 years previously. Several journals were hand searched and from cross references. The outcome analysed are the factors that are responsible for loss of preload.

Results: The search yielded 84 articles. After excluding duplicated abstracts and applying the inclusion and exclusion criteria, 36 studies were eligible for analysis. The result shows that loss of preload can occurs depending upon the type of material used, torque method, torque sequences, abutment connection type, influence of lubrication, abutment collar length. However we detected some potential limitations in the studies selected, mainly a minimum number of samples used for the study. Hence we suggest further studies to guarantee an excellence in methodological quality.

Conclusion: Based on the available data it can be summarized that the knowledge of preload loss must be known for the clinicians to avoid such screw loosening and subsequent implant failure.

Keywords: Abutment screw, dental implant, preload

Address for correspondence: Dr. S. Nithyapriya, Department of Prosthodontics, Adhiparasakthi Dental College, Melmaruvathur, Tamil Nadu, India.
E-mail: nithul219@gmail.com

Received: 16th October, 2017, **Accepted:** 28th March, 2018

INTRODUCTION

The most common failure associated with dental implant is screw loosening and fracture of implant.[1] One of the major causes for screw loosening is the "loss of preload." Preload is the axial force in the neck of the screw, which is between the first mating thread and head of the abutment screw.[2] The tensile force clamps the abutment

Access this article online	
Quick Response Code:	Website: www.j-ips.org
	DOI: 10.4103/jips.jips_294_17

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Nithyapriya S, Ramesh AS, Kirubakaran A, Mani J, Raghunathan J. Systematic analysis of factors that cause loss of preload in dental implants. J Indian Prosthodont Soc 2018;18:189-95.

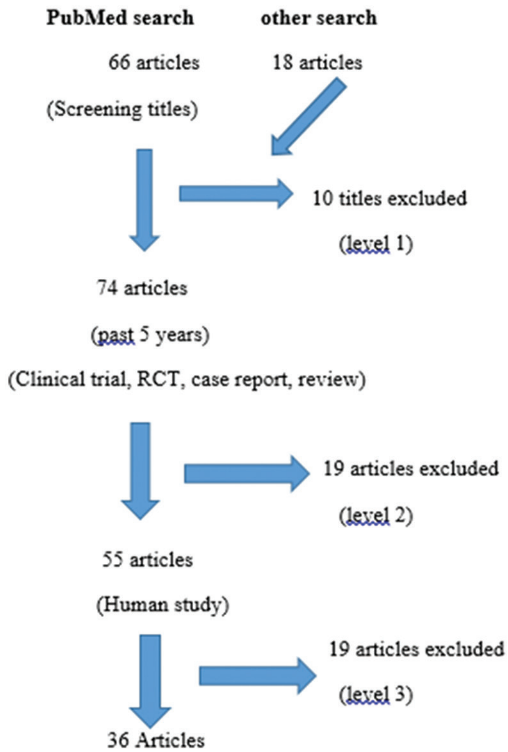

Figure 1: Flowchart of the search process

to the implant.[3] The relationship between applied torque and preload depends on several factors including screw geometry, material properties, surface texture, degree of lubrication, rate of tightening, and integrity of joint.[2] This study aim at determining the factors which causes loss of preload in dental implants. This systematic review is focused on the factors which cause loss of preload that leads to dental implant failure.[4-6]

METHODOLOGY

Search strategies

The following analysis was performed according to the guidelines and the principles of the PRISMA statement for a systematic review.

Focused question (Patients, Intervention, Comparison, and Outcomes)

The review is focused on: "what are the factors causing loss of preload which eventually leads to dental implant failure?"

The following medical subjects headings terms: "abutment screw," "preload," "dental implants," and their related entry terms were used in different combinations using the Boolean Operators "AND" and "OR" for the research. In addition, manual search was made [Figure 2].

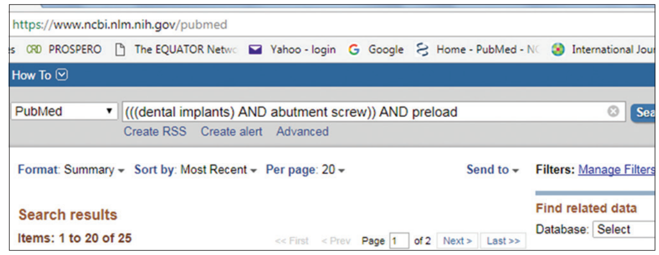

Figure 2: Pudmed search

([[dental implants] AND abutment screw]) AND preload.

Inclusion criteria

Loss of preload, screw loosening, screw fracture, screw geometry, implant-abutment connection type (external hexagon platform, Morse taper), material properties, namely, stiffness, resilience, and materials, namely, gold, titanium (Ti), Ti alloy, surface texture of the abutment screw, condition of mating surfaces, lubrication, torque value, rate of tightening (10, 20, 35N, and retorque after 10 min), and integrity of joint.

Exclusion criteria

Functional habits such as bruxism, clinical syndromes (such as epilepsy, psychological disorders, and osteoporosis) implant fracture.

Filters

Other inclusion criteria are as follows (a) articles published in English language; (b) human studies; (c) studies which have the relationship between dental implants and loss of preload; (d) animal studies; (e) systematic reviews; (f) cohort studies; and (g) randomized controlled trial (RCT).

Other exclusion criteria are as follows (a) articles published in another language other than English; (b) studies that does not have the relation between dental implants and loss of preload; (c) full text articles that were not available on the database searched; (d) duplicated articles; (e) letters to editor; and (f) commentaries. Studies other than RCT, systematic reviews and cohort studies were eliminated to reduce bias.

Data extraction

All studies which met the inclusion and exclusion criteria for review were obtained and screened independently and were analyzed using PRISMA guidelines [Figure 1]. The following data were extracted from the studies included for review reference, study design, number of implants, group specification of the study, initial torque, preload, and loss of preload. The quality of the various studies was not considered in the final analysis; therefore, no quality assessment has been done.

Table 1: Torque sequence

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Georgios Siamos	RCT	40	I. Torqued, stand for 3 h and then loosened II. Retorqued after 10 min with same torque values and allowed to stand for 3 h III. Torqued, retorqued after 10 min, load applied for 3 hours before loosening	25,30,35,40 Ncm		26%-29% 17%-19% 23%-32%	To overcome the settling effect, investigators recommended to retorque the abutment screw 10 min after the first torque application
Hanen Nejer Al-Otaibi	RCT	4	A. torquing screws to 35 Ncm B. Torquing screws to 35 Ncm and retorquing to the same value C. Torquing the same screws to 35 Ncm for three times	35 Ncm	A. 27.9±0.7 Ncm B. 29.5±1.5 Ncm C. 27.2±1.6 Ncm		Retorquing once has highest preload value than torqued group and retorqued twice group
Dandan Xia	RCT	30	A. 24 Ncm B. 30 Ncm C. 36 Ncm			A. 9.42% torque loss B. 8.40% torque loss C. 29.73% torque loss	Group C exhibited 11.44% torque loss without loading and 22.94% after loading
Keith L.Guzaitis		41	Primary screw cycles / Reference screw cycle 1-9 / 10 1-19 / 20 1-29 / 30 1-39 / 40 After 10 min retorqued to the same torque value. After 5 min the preload reverse torque value was measured	25 Ncm		PS9>PS19>PS29 or 39	Significant differences in mean reverse torque were observed with greater number of screw insertion cycles. After 10 screw insertion cycles, a new prosthetic screw should be used
Haddad Arabi Bulaqi			15 rpm 30rpm		15 rpm / 30 rpm 574 / 593 489 / 504 377 / 393 312 / 320		By increasing the tightening speed, the length of required time for junction deformation was reduced. As tightening speed increases, the preload also increases
Maha M.Al-Sahan	RCT	4	One step (0 Ncm–15 Ncm) Three step (0-5-10-15) 6 sequences, 2 methods, 5 replications		181.3 / 285.5 311.5 / 127.5 245.9 / 176.4 309.8 / 189.6 73 / 763.4 100.1 / 349.7		Preload was achieved when the tightening sequence began with the implant tat exhibit largest misfit
Atais Bacchi		40	I. Torque with 32 Ncm II- Torque with 32 Ncm holding it for 20 s III. Torque with 32 Ncm and retorque after 10 min IV. torque (32 Ncm) and holding it for 20 s and retorque after 10 min			Conventional / DLC 25.3 / 22.7 25.2 / 23.3 28 / 23 26.3 / 20.8	The use of conventional Ti screws for fixation provides higher loosening torque values than DLC screws after cyclic loading

DLC: Diamond like carbon coated screw, RCT: Randomized controlled trial

DISCUSSION

Preload is the initial load when a torque is applied to the screw. The preload is a contributing factor for the stability of screw connection parts, is affected by various mechanical factors.[5] One of which is the settling effect or embedment relaxation. The settling effect occurs due to microroughness on the two contact surfaces so that

Table 2: Type of material

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Rafael Augusto STUKER	RCT	30	A. Gold screws B. Ti screws C–surface treated Ti	30.07±0.28 Ncm	A. 117.71 N-140.48 N B. 25.30 N-4.68 N C. 90.28 N-104.09 N		Gold has the highest preload value than Ti and surface treated Ti
R Doolabh	RCT	2	1–10Ti 2–10Au 2. 10Au	20Ncm, 32Ncm, 40Ncm	1-43.686 2-29.313		Au screws generate higher preload values than Ti
Jae-Kyoung Park	RCT	6	Ti and Ti with tungsten carbide carbon coating	30 Ncm+30Ncm			Tungsten carbide coating alloy provides higher preload than noncoating alloy screws.
Burak Yilmaz		9	Ti Zr	30Ncm		p<0.0144	Atlantis Ti abtment displaced more than custom Zr
Jae-Young Jo		15	T3-Grade 3 Ti T4-Grade 4Ti TA-Ti-6Al-4V	T3-823.1N T4-865.4N TA-912.3N			TA exhibited higher preload values than T3 and T4.
Atais Bacchi		40	Conventional Ti screw, diamond like coated screw			Conventional DLC 25.3 22.7 25.2 23.3 28 23 26.3 20.8	The use of conventional Ti screws for fixation provides higher loosening torque values than DLC screws after cyclic loading

DLC: Diamond like carbon coated screw, RCT: Randomized controlled trial

when initial torquing of the screw is applied, the rough areas collapse and leads to screw loosening. Hence, preload must be maintained to prevent joints from separating.[1,5,6,10]

The present review is investigated to determine the factors that are responsible for loss of preload and screw loosening.

TYPE OF MATERIAL

Six articles, which includes 102 implants the preload values of different types of materials were evaluated. In comparison between gold, Ti, Ti alloys and surface treated Ti, gold exhibits higher preload value than other elements. It is then followed by Ti alloys, surface-treated Ti, and pure Ti type of material [Table 2].[14,16,28,31,37,38,40-42,44]

TORQUE METHOD

Two articles, compared the efficacy of manual torque with that of the digital torque meter, out of which one article is a systematic review. By the result, researchers found that calibrated torquing devices are mandatory as the abutment should not be over tightened or under tightened to avoid misfiting of the implant abutment complex [Table 4].[2,3,21,25,34,45]

TORQUE SEQUENCE

Seven articles evaluated the torquing sequence for the maintenance of preload values and found that retorquing after 10 min of initial torque is efficient to maintain the preload value [Table 1].[1,6,12,18,23,27,30,32,33,37,43]

ABUTMENT CONNECTION TYPE

Of the seven articles, two articles were concluded by doing a study in about 56 implants and found the result that design of joint was not significant in affecting the preload values. And also, other articles which includes 51 implants, showed that internal hexagon type exhibits greater preload than external hexagonal type [Table 3].[8,11,15-17,19,20,22,24,26]

INFLUENCE OF LUBRICATION

Dry lubricant coatings such as 60–80 nm Ti nanoparticles, Vaseline, and human saliva were used as a lubricating agent in about three studies. Eighty-five implants were evaluated for this influence of lubrication on preload values. Results found that lubricants decreases the friction and thereby helps in maintenance of preload by regulating the settling effect [Table 5].[7,9,13,29,39]

ABUTMENT COLLAR LENGTH

One article evaluated the significance of abutment collar length in a total of 15 implants and found that increase in the height of abutment collar length has a significant influence on the torque loss of abutment-implant screw after cyclic loading [Table 6].[35,36]

SUMMARY

As per the results of the studies include we can summarizes the following.

Table 3: Abutment connection type

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Jack Piermatti	RCT	40	Internal connection External hex	32 Ncm			Findings suggest that the design of the joint was not significant in torque loss. But screw design appears to be important factor
Hyon-Mo Shin		35	External hex butt joint Morse taper	1. 26±0.8 2. 28.3±1.4 3. 26.5±1.4 4. 25.1±1.1 5. 26.8±0.4		1. 5.4±3.4% 2. 9.3±7.8% 3. 8.3±4.0% 4. 17.2±4.8% 5. 27.0±10.5%	External butt joint was more advantageous than the internal connection in terms of postload removal torque loss
Jae-Kyoung Park	RCT	6	1. External hex butt joint 2. Internal conical connection with 8° taper 3. Internal conical connection with 11° taper	30 Ncm+30 Ncm			Internal conical connections were more effective than external-hex butt joint connections
Sergio Rocha Bernardes		10	External hexagon (5) Morse taper (5)	32 Ncm 32 Ncm 20 Ncm 20 Ncm 32 Ncm	*P*=0.947 *P*=0.996 *P*=0.999 *P*=0.999 *P*=0.984		External hexagon showed the lowest preload values then the internal hexagonal type
Giovanna Murmura	RCT	70	35. Internal hexagon connection 35. Internal octagon connection	I. 25 Ncm II. 35 Ncm			
Takuma TSUGE	RCT	16	Internal and external hexagonal type	20 Ncm		Initial preload RTV / Postloading RTV 10.4 / 11 18.3 / 20.1 12.8 / 13.8 18.9 / 20.4	Implant abutment connection did not have an effect
Ki-Seong Kim		50	Taper internal hexagon Morse taper internal octagon	5 Ncm 10 Ncm 30 Ncm 30 Ncm 30 Ncm 30 Ncm 30 Ncm			Internal hexagon type showed markedly higher settling for all instances of tightening than the external group

DLC: Diamond like carbon coated screw, RVT: Reverse torque value, RCT: Randomized controlled trial

Table 4: Torque method

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Kelvin L.Goheen			Manual torque devices Electronic torque controller	10 Ncm 20 Ncm 32 Ncm	0.7 Ncm-18.1 Ncm 1.4 Ncm-33.7 Ncm 8.2 Ncm-36.2 Ncm		Calibrated torquing devices are mandatory
Richard L.Burguete	Review		A. Hand torque wrench, power nut runner B. Torque wrench, power nutrunner			A. 23%-28% error B. 17%-23% error	There are significant potential advantages in the use of torque/angle control to tighten the screws both in terms of tightening operation and sensing misfits in the implant system

- Gold fixation screws provides higher preload values than Ti and Ti alloy screws
- Calibrated torquing device is mandatory to get adequate preload
- Retorquing of abutment screws after 10 min of the initial torque should be performed during implant abutment connection
- Abutments with more extensive contact areas with

Table 5: Influence of lubricant

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Georgr K. Tzenkis		15	Human saliva	11, 33.809 g	168-200 187-218 204-236	1. −18.267 2. −17.667 3. −35.933	Higher preload was achieved after repeated use of a saliva-Lubricated gold prosthetic retaining screw
Hung Wen Lee		30	I. Without contamination II. 60 nm–80 nm Ti nano particles			I. 5.08% II. 0.07%	Abutment screw contamination decreased preload values because of settling effect
Mariana de Almeida Basilio		40	Vaseline	20 Ncm		P=0.820	Dry lubricant coatings decrease the friction and allow a greater amount of applied torque to be converted into preload

Table 6: Abutment collar size

References	Study design	Number of implants	Groups	Initial torque	Preload	Preload loss	Interpretation
Marzia Alikhasi		15	I. 1.5 mm gingival height II. 3.5 mm gingival height III. 5.5 mm gingival height	35Ncm		I. 10.20 Ncm II. 14.40 Ncm III. 16.20 Ncm	Increase in the height of abutment collar length has significant influence on the torque loss of abutment-implant screw after cyclic loading

implant have been associated with a lower incidence of toque loss
- Internal connection type has higher preload value than external hexagon type
- Results found that lubricants decreases the friction and thereby helps in maintenance of preload by regulating the settling effect.

CONCLUSION

Ideally, the use of lubricated gold screws with internal connection type should be placed with calibrated torquing device and retorquing it after 10 min of the initial torque gives the maximum preload. Since screw loosening is the major reason for implant failure due to embedment relaxation, one should know the reason behind it. The knowledge of preload loss must be known for the clinicians to avoid such screw loosening and subsequent implant failure.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Breeding LC, Dixon DL, Nelson EW, Tietge JD. Torque required to loosen single-tooth implant abutment screws before and after simulated function. Int J Prosthodont 1993;6:435-9.
2. Goheen KL, Vermilyea SG, Vossoughi J, Agar JR. Torque generated by handheld screwdrivers and mechanical torquing devices for osseointegrated implants. Int J Oral Maxillofac Implants 1994;9:149-55.
3. Burguete RL, Johns RB, King T, Patterson EA. Tightening characteristics for screwed joints in osseointegrated dental implants. J Prosthet Dent 1994;71:592-9.
4. Sakaguchi RL, Borgersen SE. Nonlinear contact analysis of preload in dental implant screws. Int J Oral Maxillofac Implants 1995;10:295-302.
5. Weiss EI, Kozak D, Gross MD. Effect of repeated closures on opening torque values in seven abutment-implant systems. J Prosthet Dent 2000;84:194-9.
6. Siamos G, Winkler S, Boberick KG. Relationship between implant preload and screw loosening on implant-supported prostheses. J Oral Implantol 2002;28:67-73.
7. Tzenakis GK, Nagy WW, Fournelle RA, Dhuru VB. The effect of repeated torque and salivary contamination on the preload of slotted gold implant prosthetic screws. J Prosthet Dent 2002;88:183-91.
8. Khraisat A, Hashimoto A, Nomura S, Miyakawa O. Effect of lateral cyclic loading on abutment screw loosening of an external hexagon implant system. J Prosthet Dent 2004;91:326-34.
9. Kitagawa T, Tanimoto Y, Odaki M, Nemoto K, Aida M. Influence of implant/abutment joint designs on abutment screw loosening in a dental implant system. J Biomed Mater Res B Appl Biomater 2005;75:457-63.
10. Byrne D, Jacobs S, O'Connell B, Houston F, Claffey N. Preloads generated with repeated tightening in three types of screws used in dental implant assemblies. J Prosthodont 2006;15:164-71.
11. Piermatti J, Yousef H, Luke A, Mahevich R, Weiner S. An *in vitro* analysis of implant screw torque loss with external hex and internal connection implant systems. Implant Dent 2006;15:427-35.
12. Al Jabbari YS, Fournelle R, Ziebert G, Toth J, Iacopino AM. Mechanical behavior and failure analysis of prosthetic retaining screws after long-term use *in vivo*. Part 3: Preload and tensile fracture load testing. J Prosthodont 2008;17:192-200.
13. Guda T, Ross TA, Lang LA, Millwater HR. Probabilistic analysis of preload in the abutment screw of a dental implant complex. J Prosthet Dent 2008;100:183-93.
14. Stüker RA, Teixeira ER, Beck JC, da Costa NP. Preload and torque removal evaluation of three different abutment screws for single standing implant restorations. J Appl Oral Sci 2008;16:55-8.
15. Tsuge T, Hagiwara Y. Influence of lateral-oblique cyclic loading on abutment screw loosening of internal and external hexagon implants. Dent Mater J 2009;28:373-81.
16. Park JK, Choi JU, Jeon YC, Choi KS, Jeong CM. Effects of abutment screw coating on implant preload. J Prosthodont 2010;19:458-64.
17. Kim KS, Lim YJ, Kim MJ, Kwon HB, Yang JH, Lee JB, *et al*. Variation

in the total lengths of abutment/implant assemblies generated with a function of applied tightening torque in external and internal implant-abutment connection. Clin Oral Implants Res 2011;22:834-9.

18. Guzaitis KL, Knoernschild KL, Viana MA. Effect of repeated screw joint closing and opening cycles on implant prosthetic screw reverse torque and implant and screw thread morphology. J Prosthet Dent 2011;106:159-69.
19. Gracis S, Michalakis K, Vigolo P, Vult von Steyern P, Zwahlen M, Sailer I, *et al*. Internal vs. external connections for abutments/reconstructions: A systematic review. Clin Oral Implants Res 2012;23 Suppl 6:202-16.
20. Ferreira MB, Delben JA, Barão VA, Faverani LP, Dos Santos PH, Assunção WG, *et al*. Evaluation of torque maintenance of abutment and cylinder screws with Morse taper implants. J Craniofac Surg 2012;23:e631-4.
21. Butignon LE, Basilio Mde A, Pereira Rde P, Arioli Filho JN. Influence of three types of abutments on preload values before and after cyclic loading with structural analysis by scanning electron microscopy. Int J Oral Maxillofac Implants 2013;28:e161-70.
22. Murmura G, Di Iorio D, Cicchetti AR, Sinjari B, Caputi S. *In vitro* analysis of resistance to cyclic load and preload distribution of two implant/abutment screwed connections. J Oral Implantol 2013;39:293-301.
23. Al-Sahan MM, Al Maflehi NS, Akeel RF. The influence of tightening sequence and method on screw preload in implant superstructures. Int J Prosthodont 2014;27:76-9.
24. Bernardes SR, da Gloria Chiarello de Mattos M, Hobkirk J, Ribeiro RF. Loss of preload in screwed implant joints as a function of time and tightening/untightening sequences. Int J Oral Maxillofac Implants 2014;29:89-96.
25. Jörn D, Kohorst P, Besdo S, Rücker M, Stiesch M, Borchers L, *et al*. Influence of lubricant on screw preload and stresses in a finite element model for a dental implant. J Prosthet Dent 2014;112:340-8.
26. Shin HM, Huh JB, Yun MJ, Jeon YC, Chang BM, Jeong CM, *et al*. Influence of the implant-abutment connection design and diameter on the screw joint stability. J Adv Prosthodont 2014;6:126-32.
27. Delben JA, Barão VA, Dos Santos PH, Assunção WG. Influence of abutment type and esthetic veneering on preload maintenance of abutment screw of implant-supported crowns. J Prosthodont 2014;23:134-9.
28. Doolabh R, Dullabh HD, Sykes LM. A comparison of preload values in gold and titanium dental implant retaining screws. SADJ 2014;69:316-20.
29. Krishnan V, Tony Thomas C, Sabu I. Management of abutment screw loosening: Review of literature and report of a case. J Indian Prosthodont Soc 2014;14:208-14.
30. Xia D, Lin H, Yuan S, Bai W, Zheng G. Dynamic fatigue performance of implant-abutment assemblies with different tightening torque values. Biomed Mater Eng 2014;24:2143-9.
31. Jo JY, Yang DS, Huh JB, Heo JC, Yun MJ, Jeong CM, *et al*. Influence of abutment materials on the implant-abutment joint stability in internal conical connection type implant systems. J Adv Prosthodont 2014;6:491-7.
32. Villarinho EA, Cervieri A, Shinkai RS, Grossi ML, Teixeira ER. The effect of a positioning index on the biomechanical stability of tapered implant-abutment connections. J Oral Implantol 2015;41:139-43.
33. Bulaqi HA, Mousavi Mashhadi M, Geramipanah F, Safari H, Paknejad M. Effect of the coefficient of friction and tightening speed on the preload induced at the dental implant complex with the finite element method. J Prosthet Dent 2015;113:405-11.
34. Bulaqi HA, Mousavi Mashhadi M, Safari H, Samandari MM, Geramipanah F. Effect of increased crown height on stress distribution in short dental implant components and their surrounding bone: A finite element analysis. J Prosthet Dent 2015;113:548-57.
35. Sarfaraz H, Paulose A, Shenoy KK, Hussain A. A three-dimensional finite element analysis of a passive and friction fit implant abutment interface and the influence of occlusal table dimension on the stress distribution pattern on the implant and surrounding bone. J Indian Prosthodont Soc 2015;15:229-36.
36. Siadat H, Pirmoazen S, Beyabanaki E, Alikhasi M. Does abutment collar length affect abutment screw loosening after cyclic loading? J Oral Implantol 2015;41:346-51.
37. Bacchi A, Regalin A, Bhering CL, Alessandretti R, Spazzin AO. Loosening torque of universal abutment screws after cyclic loading: Influence of tightening technique and screw coating. J Adv Prosthodont 2015;7:375-9.
38. Yilmaz B, Gilbert AB, Seidt JD, McGlumphy EA, Clelland NL. Displacement of implant abutments following initial and repeated torqueing. Int J Oral Maxillofac Implants 2015;30:1011-8.
39. Lee HW, Alkumru H, Ganss B, Lai JY, Ramp LC, Liu PR, *et al*. The effect of contamination of implant screws on reverse torque. Int J Oral Maxillofac Implants 2015;30:1054-60.
40. Rezende CE, Griggs JA, Duan Y, Mushashe AM, Nolasco GM, Borges AF, *et al*. An indirect method to measure abutment screw preload: A pilot study based on micro-CT scanning. Braz Dent J 2015;26:596-601.
41. Peixoto HE, Bordin D, Del Bel Cury AA, da Silva WJ, Faot F. The role of prosthetic abutment material on the stress distribution in a maxillary single implant-supported fixed prosthesis. Mater Sci Eng C Mater Biol Appl 2016;65:90-6.
42. Mattheos N, Li X, Zampelis A, Ma L, Janda M. Investigating the micromorphological differences of the implant-abutment junction and their clinical implications: A pilot study. Clin Oral Implants Res 2016;27:e134-43.
43. Al-Otaibi HN, Almutairi A, Alfarraj J, Algesadi W. The effect of torque application technique on screw preload of implant-supported prostheses. Int J Oral Maxillofac Implants 2017;32:259-63.
44. Dincer Kose O, Karataslı B, Demircan S, Kose TE, Cene E, Aya SA, *et al*. *In vitro* evaluation of manual torque values applied to implant-abutment complex by different clinicians and abutment screw loosening. Biomed Res Int 2017;2017:7376261.
45. Basílio MA, Abi-Rached FO, Butignon LE, Arioli Filho JN. Influence of liquid lubrication on the screw-joint stability of Y-TZP implant abutment systems. J Prosthodont 2017;26:656-8.

“Quick Response Code” link for full text articles

The journal issue has a unique new feature for reaching to the journal’s website without typing a single letter. Each article on its first page has a “Quick Response Code”. Using any mobile or other hand-held device with camera and GPRS/other internet source, one can reach to the full text of that particular article on the journal’s website. Start a QR-code reading software (see list of free applications from http://tinyurl.com/yzlh2tc) and point the camera to the QR-code printed in the journal. It will automatically take you to the HTML full text of that article. One can also use a desktop or laptop with web camera for similar functionality. See http://tinyurl.com/2bw7fn3 or http://tinyurl.com/3ysr3me for the free applications.