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PROSTHETIC COMPLICATIONS ASSOCIATED WITH IMPLANT-RETAINED SINGLE CROWNS: A NARRATIVE REVIEW

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Abstract

Over the past decade, dental implant therapy has become the gold standard for the restoration of a single missing tooth. The current literature shows evidence of excellent long-term performances and high survival rates. Despite this, prosthetic complications remain a significant clinical challenge. The clinician needs to have a proper understanding of the risk factors that lead to these complications and probable failure. This narrative review was performed through scientific articles published between 2000 and 2022, indexed in MEDLINE and PubMed databases. This review aims to evaluate the prosthetic complications that may occur after single implant-retained crown insertion.

Keywords: Implant complications, prosthetic complications, prosthetic failures, technical complications, mechanical complications

Introduction

Dental implants have revolutionized restorative dentistry by providing a durable and effective solution for missing teeth. They offer significant advantages over conventional fixed and removable partial dentures, especially for single missing tooth. However, despite their widespread success, they are not immune to complications. Prosthetic complications, in particular, pose challenges that can affect their longevity and functionality.[1] Prosthetic complications are related to the exoprosthesis of the implant.[2] They can be either technical - related to lab-fabricated parts like fracture of chipping of veneering/covering material or mechanical - related to pre-fabricated parts like implant or abutment fracture.[3] Based on a meta-analysis by Jung et al, the 10-year survival rate of single implants was 95.2% but for the implant-supported single crowns was 89.4%.[4] The commonly seen prosthetic complications in this regard are categorized as screw loosening/fracture, loss of retention, veneer chipping, component fracture, and interproximal contact loss.[5,6]

Screw Loosening

According to Jung et al, screw loosening was and still is the most frequently occurring complication with single crowns. The 5-year cumulative

incidence of abutment screw loosening was reported to be 12.7%.[7] Any loose screw can lead to crestal bone loss due to bacteria colonization in the exposed interface.[8] The main causative factor seems to be inadequate application of tightening torque to generate the necessary "preload".[9] Preload is defined as the clamping or stretching force that occurs across the interface of implant components being attached together via screw tightening. It is the residual stretch or elongation that remains within the body of the screw after the tightening procedure is completed (in bolted joint mechanics).[1] One phenomenon that exacerbates this issue is the "settling effect" which is a phenomenon involving loss of preload after initial tightening of the screw. Siamos et al suggested that the screw should be retightened at an interval of 10 minutes after the initial tightening to avoid this settling effect.[10] Various risk factors need to be considered in the etiology. The external hex connection has been associated with a higher incidence of screw loosening than the internal hex.[11] Similarly, angulated and multiunit abutments exhibit a higher incidence than straight abutments.[12] Cement-retained crowns reported lower incidence than screw-retained crowns, but clinicians still prefer the latter due to lesser biological complications.[13] Evolution of screw designs and materials has reduced the incidence of screw loosening by nearly 50% after the year 2000,[14] however, bruxism can severely contribute to the biomechanical stresses on the implant due to repeated dynamic and static loading, causing screw loosening and eventual fracture.[15] Centering the occlusal contact, flattening cuspal inclination, proper tightening and retightening of the abutment screw (30-35 N-cm is ideal preload), narrowing the buccolingual width of the restoration, and reducing cantilevers are some of the guidelines to be considered in the management and prevention of screw loosening.[16]

Screw Fracture

Screw fracture is a rare complication that is almost always preceded by undetected or mismanaged screw loosening. The probable etiology is bruxism, an unfavorable superstructure, overloading, or malfunction.[17] Biomechanical stresses incident on the abutment screw can first lead to loosening and eventually fracture if the overload is not properly managed.[8] The junction between the threads and the neck of the abutment screw is particularly susceptible to fracture.[18] To mitigate this, Piermatti et al suggested using a thicker screw with an apical indexer.[19] The risk factors for screw fracture are the same as those for screw loosening, as it is clear that screw fracture will generally be preceded by loosening, serving as a warning sign unless some kind of trauma is involved. In the event of a screw fracture, the clinician must remove the broken screw without causing damage to the fixture. Proper management and timely intervention can help prevent the escalation from screw loosening to screw fracture.[8]

Loss of Crown Retention

Loss of retention is the 2nd most frequently occurring prosthetic complication reported in around 4.1% of single-crowns in 5-year review studies.4 Crown retention is categorized as screw-retained and cement-retained types, each with its own advantages and disadvantages.[20] According to a systematic review by Wittneben et al, there were no significant differences in terms of survival for either type of retention, but technical complications were seen more with screw-retained crowns, especially veneer chipping around the area of the screw access hole. On the other hand, cement-retained crowns were associated with more biological complications.[21]

Metal ceramic crowns are mainly cemented with conventional cemented like zinc phosphate or

glass ionomer as their retention does not depend on adhesion to the abutment for clinical function. In contrast, full ceramic crowns are cemented with adhesive resin cement to improve retention and subsequent clinical function.[22] Loss of retention rates has been reported to be 1.1% in ceramic crowns whereas it is 5.5% for metal-ceramic crowns, after 5 years of function.[23,24] Clinicians nowadays mostly prefer screw-retained due to its predictable retrievability for removal, but if the implant placement is not prosthetically driven, especially in the anterior region, then it is not esthetic due to buccal placement of screw access hole and hence avoided.[2]

Veneer Chipping/Fracture

Veneer chipping is the 3rd most frequent prosthetic complication with a 5-year complication rate of 3.5%.[4,26] Spazzin et al demonstrated that veneered alumina and lithium disilicate crowns experienced chipping in 1.8% and 3.5% of cases, respectively, after five years of function. In contrast, veneered zirconia crowns showed significantly higher chipping rates of 11.8% over the same period. For comparison, metal-ceramic crowns exhibited a chipping incidence of 3.5%.[4,24] Achieving long-term survival of materials such as ceramics in the oral cavity is a significant challenge. The aging of ceramics is accelerated by chemical attacks from acidic foods and drinks, as well as by temperature fluctuations. As these materials age, their susceptibility to fractures and chipping increases.[25] Possible causes for "ceramic chipping" include non-anatomic substructure designs, unsupported ceramic veneering, weaker porcelain, mismatches in thermal expansion and contraction, poor porcelain bonding, patient-specific factors such as occlusion after cementation and also parafunctional activity.[26] To mitigate these risks, implant-protected occlusion is recommended for single crowns.[27] Sailer et al reported that avoiding veneering ceramics and using monolithic ceramics for restoration can significantly reduce the incidence of chipping.[6]

Abutment/Fixture Fracture

Fracture of implant components, such as implants, abutments, and abutment screws, is a rare complication that can occur in the long term and severely affect the integrity of the fixture. The fracture rate of these components has been reported to be 5.6%.[28] Misch et al reported that internal stress from factors like bruxism and the crown-implant ratio (C/I) can lead to mechanical complications.[29] Other possible risk factors are dental implant manufacturing and design failure, superstructure design, implant positioning, implant diameter, metal fatigue, and bone resorption around the implant, but none of these can be considered as clear causative factors.[7] In a study conducted by Murakami et al, the abutment fracture rate was 1.6% and the implant fracture rate was 0.7%. This study also identified trends related to gender, showing that men were at a higher risk of abutment or implant fracture due to higher bite force.[30] Huang et al reported that ceramic abutments exhibited more fractures than metallic abutments – leading to implant fracture.[31] One promising solution for use in esthetic regions is the use of internally connected titanium-base abutments with zirconia abutments. A study by Murakami et al indicated that the fracture strength of this hybrid solution is similar to that of titanium abutments, although clinical research on this alternative remains scarce.[32]

Proximal Contact Loss

An open contact between a normal tooth and an implant-retained crown can develop where there was previously a firm contact. This may further lead to food lodgment, caries, and periodontal issues. One theory that explains this occurrence is that the anterior component of occlusal forces is directed mesially causing friction near the

contact points that leads to the wearing away of the teeth, causing mesial migration of the natural tooth.[33] An alternate hypothesis is that occlusal changes could result from craniofacial growth past adulthood.[34] According to a review by Greenstein et al, an interproximal gap appeared 34–66% of the time following the placement of an implant crown. This could occur as soon as three months following prosthetic rehabilitation, typically at the mesial point of the restoration.[35]

Discussion

Prosthetic complications in single implants are influenced by a variety of factors, including mechanical stress, material properties, and patient-specific characteristics. This narrative review described the following six categories of prosthetic complications that were associated with single implant-retained crowns: (1) Screw Loosening (2) Screw Fracture, (3) Loss of Retention (4) Veneer Chipping (5) Abutment/Fixture Fracture (6) Proximal Contact Loss. Multiple studies have shown that screw loosening is the most common prosthetic complication in this regard. Fracture of the screw is a consequence of untreated or mismanaged screw loosening. The 2nd most common complication is veneer chipping seen in the restorative material. This can compromise esthetics and may also alter the existing occlusion.[6] Despite these complications, the 5-year survival rates of single implants (fixtures) are reported to be 96.8% and the implant-retained single crowns have a 5-year survival rate of 94.5% indicating results superior to those of fixed partial dentures in the same time period.[4]

Conclusion

Issues such as ceramic chipping, fractures of implant components, and other mechanical failures highlight the importance of careful design, material selection, occlusion, and most importantly patient assessment to enhance the longevity and success of single-implant prosthetics. The clinician must be well equipped to prevent risk factors, identify initial stages of such complications after loading of the prosthesis, as well as be able to manage them in case of occurrence.

References

1. Laney WR. Glossary of Oral and Maxillofacial Implants. The International journal of oral & maxillofacial implants. 2017 Jul 1;32(4):Gi-200.
2. Montero J. A review of the major prosthetic factors influencing the prognosis of implant prosthodontics. Journal of Clinical Medicine. 2021 Feb 17;10(4):816.
3. Salvi GE, Bragger U. Mechanical and technical risks in implant therapy. The International journal of oral & maxillofacial implants. 2009 Apr;24(Suppl):69-85.
4. E. Jung R, Zembic A, Pjetursson BE, Zwahlen M, S. Thoma D. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clinical oral implants research. 2012 Oct;23:2-1.
5. Goodacre BJ, Goodacre SE, Goodacre CJ. Prosthetic complications with implant prostheses. EJOI. 2018;11:27.
6. Sailer I, Karasan D, Todorovic A, Ligoutsikou M, Pjetursson BE. Prosthetic failures in dental implant therapy. Periodontology 2000. 2022 Feb;88(1):130-44.
7. Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clinical oral implants research. 2008 Feb;19(2):119-30.
8. Resnik R. Misch's Contemporary Implant Dentistry E-Book: Misch's Contemporary Implant Dentistry E-Book. Elsevier Health Sciences; 2020 Jan 25.
9. Stüker RA, Teixeira ER, Beck JC, Costa NP. Preload and torque removal evaluation of three different abutment screws for single standing implant restorations. Journal of Applied Oral Science. 2008;16:55-8.
10. Siamos G, Winkler S, Boberick KG. The relationship between implant preload and screw loosening on implant-supported prostheses. Journal of Oral Implantology. 2002 Apr 1;28(2):67-73.
11. Gracis S, Michalakis K, Vigolo P, Vult von Steyern P, Zwahlen M, Sailer I. Internal vs. external connections for abutments/reconstructions: a systematic review. Clinical oral implants research. 2012 Oct;23:202-16.
12. Hotinski E, Dudley J. Abutment screw loosening in angulation-correcting implants: An in vitro study. The Journal of Prosthetic Dentistry. 2019 Jan 1;121(1):151-5.
13. Sailer I, Mühlemann S, Zwahlen M, Hämmerle CH, Schneider D. Cemented and screw-retained implant reconstructions: a systematic review of the survival and complication rates. Clinical oral implants research. 2012 Oct;23:163-201.
14. Pjetursson BE, Asgeirsson AG, Zwahlen M, Sailer I. Improvements in implant dentistry over the last decade: comparison of survival

and complication rates in older and newer publications. International journal of oral & maxillofacial implants. 2014 Jan 2;29.

15. Mishra S, Chowdhary R. Bruxism and Abutment-screw Loosening in Dental Implants. 2018 Jul 1;8:69–70.
16. Krishnan V, Tony Thomas C, Sabu I. Management of abutment screw loosening: Review of literature and report of a case. The Journal of Indian Prosthodontic Society. 2014 Sep;14(3):208-14.
17. Brunski JB, Puleo DA, Nanci A. Biomaterials and biomechanics of oral and maxillofacial implants: current status and future developments. International Journal of Oral & Maxillofacial Implants. 2000 Jan 1;15(1).
18. Khraisat A, Stegaroiu R, Nomura S, Miyakawa O. Fatigue resistance of two implant/abutment joint designs. The Journal of prosthetic dentistry. 2002 Dec 1;88(6):604-10.
19. 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 Dentistry. 2006 Dec 1;15(4):427-35.
20. Camatta HP, Ferreira RM, Ferrairo BM, Strelhow SS, Rubo JH, Mori AA, Ferruzzi F. Mechanical Behavior and Fracture Loads of Screw-Retained and Cement-Retained Lithium Disilicate Implant-Supported Crowns. Journal of Prosthodontics. 2021 Oct;30(8):690-7.
21. Wittneben JG, Millen C, Brägger U. Clinical Performance of Screw-Versus Cement-Retained Fixed Implant-Supported Reconstructions-A Systematic Review. International journal of oral & maxillofacial implants. 2014 Jan 2;29.
22. Spazzin AO, Guarda GB, Oliveira-Ogliari A, Leal FB, Correr-Sobrinho L, Moraes RD. Strengthening of porcelain provided by resin cements and flowable composites. Operative dentistry. 2016 Mar 1;41(2):179-88.
23. Pjetursson BE, Tan WC, Tan K, Brägger U, Zwahlen M, Lang NP. A systematic review of the survival and complication rates of resin-bonded bridges after an observation period of at least 5 years. Clinical Oral Implants Research. 2008 Feb;19(2):131-41.
24. Rabel K, Spies BC, Pieralli S, Vach K, Kohal RJ. The clinical performance of all-ceramic implant-supported single crowns: A systematic review and meta-analysis. Clinical oral implants research. 2018 Oct;29:196-223.
25. Scherrer SS, Denry IL, Wiskott HA, Belser UC. Effect of water exposure on the fracture toughness and flexure strength of a dental glass. Dent Mater. 2001;17(4):367–71.
26. Wittneben JG, Buser D, Salvi GE, Bürgin W, Hicklin S, Brägger U. Complication and Failure Rates with Implant-Supported Fixed Dental Prostheses and Single Crowns: A 10-Year Retrospective Study. Clin Implant Dent Relat Res. 2014;16(3):356–64.
27. Misch CE, Bides MW. Implant-protected occlusion. Int J Dent Symp. 1994;2(1):32–7.
28. Yi Y, Koak JY, Kim SK, Lee SJ, Heo SJ. Comparison of implant component fractures in external and internal type: A 12-year retrospective study. J Adv Prosthodont. 2018;10(2):155.
29. Huang HM, Tsai CM, Chang CC, Lin CT, Lee SY. Evaluation of loading conditions on fatigue-failed implants by fracture surface analysis. International Journal of Oral & Maxillofacial Implants. 2005 Nov 1;20(6).
30. Murakami H, Igarashi K, Fuse M, Kitagawa T, Igarashi M, Uchibori S, et al. Risk factors for abutment and implant fracture after loading. J Oral Sci. 2021;63(1):92–7.
31. Pjetursson BE, Zarauz C, Strasding M, Sailer I, Zwahlen M, Zembic A. A systematic review of the influence of the implant-abutment connection on the clinical outcomes of ceramic and metal implant abutments supporting fixed implant reconstructions. Clinical oral implants research. 2018 Oct;29:160-83.
32. Sailer I, Asgeirsson AG, Thoma DS, Fehmer V, Aspelund T, Özcan M, et al. Fracture strength of zirconia implant abutments on narrow diameter implants with internal and external implant abutment connections: A study on the titanium resin base concept. Clin Oral Implants Res. 2018;29(4):411–23.
33. Pang N, Suh C, Kim K, Park W, Jung B. Prevalence of proximal contact loss between implant-supported fixed prostheses and adjacent natural teeth and its associated factors: a 7-year prospective study. Clin Oral Implants Res. 2017 Dec;28(12):1501–8.
34. Byun S, Heo S, Ahn S, Chang M. Analysis of proximal contact loss between implant-supported fixed dental prostheses and adjacent teeth in relation to influential factors and effects. A cross-sectional study. Clin Oral Implants Res. 2015 Jun;26(6):709–14.
35. Greenstein G, Carpentieri J, Cavallaro J. Open contacts adjacent to dental implant restorations: etiology, incidence, consequences, and correction. J Am Dent Assoc. 2016;147(1):28–34.