TECHNICAL COMPLICATIONS OF IMPLANT RESTORATIONS: COMPONENT DEFORMATION, FRACTURE, SEPARATION

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ABSTRACT

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Aim To review mechanical irreversible implant restoration complications, and discuss prevention and troubleshooting.
Summary A variety of complications, involving different components are discussed, with clinical presentation, possible causes, prevalence data and accompanying circumstances. Recovery procedures and troubleshooting protocols are also presented.
Key learning points a. irreversible complications of implant restorations are less frequent as compared to screw loosening, but more expensive to deal with; b. as in the case of screw loosening, most irreversible complications may be related to the relative overload of the implant-restoration assembly; c. load control, by careful implant placement, restoration design and execution, as well as patient commitment in wearing an occlusal guard are paramount in preventing both reversible and irreversible mechanical implant complications.

KEYWORDS

Technical Complication; Implant; Fracture; Prosthodontics; Deformation.

1. INTRODUCTION

With the global market for implants expected to double in the next decade [1], more general practitioners are placing, restoring, and maintaining dental implants [2]. However, follow-up care and maintenance amounts to almost a third of the total treatment costs [3], which makes servicing implant restorations and understanding failures paramount.
Screw loosening, the primary complication of screw-retained implant restorations, is considered a reversible complication as long as there is no significant deformation to the implant or superstructure connection. Other complications related to component wear, deformation fracture, or separation of different materials in a heterogenous system are irreversible and may or may not be related to screw loosening. This article aims to review these other less common complications and why they might occur.

2. COMPONENT WEAR AND DEFORMATION

Once the intimate fit of the abutment and implant is loosened, unintended movement occurs in the assemblage, with resulting wear of the implant platform and corresponding abutment surface. A loose joint favors non-uniform loads on the components with the likelihood of accelerated wear, deformation, and even fracture. Driving around with a loose ball joint in one's suspension is just looking forward for the vehicle to lose control when the joint fails. On the same reasoning, we reiterate that a loose implant screw is an emergency.
For single unit restorations, the most common type of wear appears as rounding of the angles of the hexagon of the abutment, a result of screw loosening and discrete rotation of the abutment. The concurrent deformation at the receiving end of the implant can also occur. Such changes become more evident with increased lapse of time from screw loosening to retightening.
Screw deformation can occur by bending on the long axis, thread alteration, and head damage. Bending is almost exclusively associated with off-axial overload, before or after screw loosening. Sometimes, a bent screw can become lodged in the implant and simply break at repeated attempts to unscrew, further complicating the retrieval procedure. Thread alteration can be caused by significant over-torqueing, cross-threading, or presence of debris at the time of insertion. When engaging the threads of the implant, the advancing screw should rotate with ease.

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Resistance should only be met when the entire length of the screw has been threaded. Resistance to rotation felt from the beginning indicates un-matched screw, cross-threading, or the presence of debris at the site of insertion. Head damage can be caused by over-torqueing, incorrect access of the driver bit, or using an un-matched driver bit. Sometimes the screw access orifice is not reasonably aligned with the implant/screw axis, and upon torqueing, the shank of the driver binds on the lateral walls of the channel. Such a circumstance not only creates the risk of chipping off restorative material around the orifice, but also may prevent full engagement of the driver in the screw head, risking stripping the screw. The screw head deformation is more frequently encountered for internal hexagon heads (for example Astra Tech / Dentsply Sirona, York, PA, USA; Biohorizons Dental Systems, Birmingham, AL, USA), and less likely for star pattern heads (for example Nobel Biocare USA, Yorba Linda, CA, USA; Straumann USA LLC, Andover, MA, USA).

3. COMPONENT FRACTURE

Component fracture is a more serious, but less frequent complication that may render recall and future appointments more time and expense intensive. Any component of the assembly can undergo fracture under uncontrolled load and/or as a consequence of poor planning/design.
Implant fracture (Fig. 1) is rare - less than 1% at 5 year [4], however, it renders the fixture unusable.
Abutment screw fracture (Figs. 2, 3, 4) is relatively rare, at 0.35% at 5 years [5,6], or 3.5% over 15 years [7].
Abutment fracture can occur as an isolated compli-cation (Fig. 5), or associated with a screw fracture (Figs. 6, 7). Abutments with internal connections fail most frequently where the internal connection and the base of the abutment meet. The fractures compromise both the ability of the joint to keep the abutment properly seated on implant and the anti-rotational feature of the system. The fracture of monolithic structures can be catastrophic in full arch restorations and occurs most of the time through a distal screw access orifice (Fig. 8) if a long distal cantilever is designed, with a frequency of 1.4% [8].

Insufficient material thickness around screw access orifices can be a risk factor for future fracture (Fig. 9).

4. VENEERING FRACTURE AND SEPARATION OF COMPONENTS

Veneering porcelain fracture occurs in up to 10% of the implant supported restorations [9-12] as opposed to the tooth-supported restorations at 2% [13]. The risk increases if the opposing dentition is also an implant supported restoration and the patient is not wearing an occlusal guard [10].
The likelihood of veneering porcelain fracture appears to be associated with the restoration size [9,14], and where there is unsupported material (Fig. 10) at the screw access orifices [15,16]. Fracture/chipping of the veneering porcelain covering zirconia structures is much more frequent – 14.7% than monobloc fractures [8]. Localized chipping can be especially damaging when it involves the incisal margins, and may require full replacement, just as a catastrophic fracture.
In general, when using full contour all ceramic full arch restorations, the best results are to be expected for truly monolithic zirconia and partial cutback zirconia [17-25], as opposed to fully cutback designs that are more prone to porcelain chipping [18,22,25].
Another complication that can occur in extensive zirconia restorations is the separation of compo-nents, when titanium cylinders dis-cement from the monolith (Fig. 11). The fracture of acrylic veneering on extensive restorations is probably the most frequent compli-cation of such structures [26], representing 17% of the mechanical complications [27]. The critical factor incriminated was poor framework design [27], which did not provide proper support for the veneering material.
As it is, implant supported restorations do require maintenance and eventual repairs/replacements. A knowledgeable practitioner and a compliant patient would work together for the best achievable prognosis of such prostheses. As techniques and materials evolve, upgrading existing restorations could produce even better results.

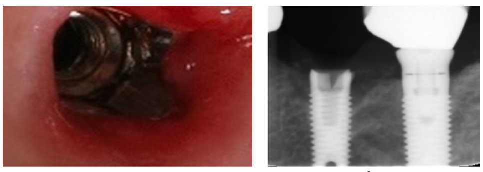
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Figure 1. Implant fracture with platform wall separation: clinical (a) and radiographic (b) view.

Figure 3. Double screw fracture in implant supported fixed partial denture.

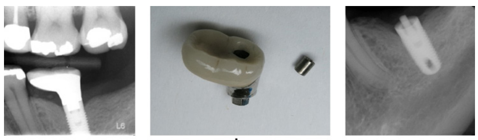
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Figure 2. Abutment screw fracture: a. radiographic view before complication; b. restoration separated from implant with fractured screw head; c. shank and threaded end of screw still inside the implant.

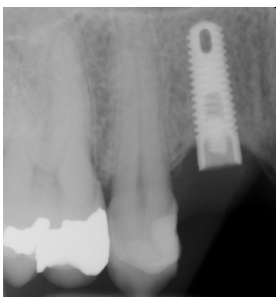

Figure 4. Screw fracture at transition from shank to threaded end.

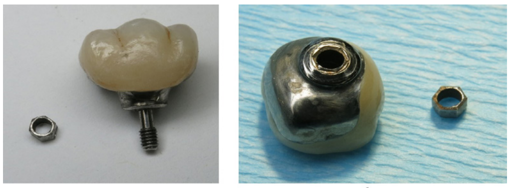

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Figure 5. Abutment fracture. After the fracture of the hex, the joint lost a significant part of preload and anti-rotational resistance. The screw came progressively loose inside the crown until the restoration could be completely removed by the patient: a. fractured abutment hex with screw still inside restoration; b. corresponding fracture surfaces in abutment and hex.

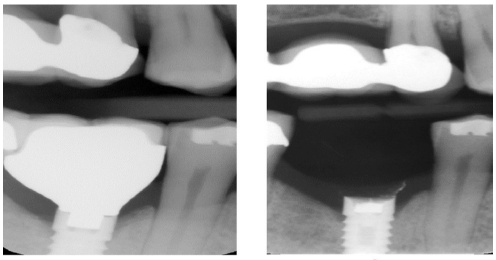

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Figure 7. After repeated screw loosening episodes, the dentist applied adhesive on screw threads as a fix (a). The same patient presented later on with a broken abutment and a broken screw. The fractured screw fragment and the abutment hex remained stuck in the implant (b), worsening the prognosis of fragments' removal from inside the implant.

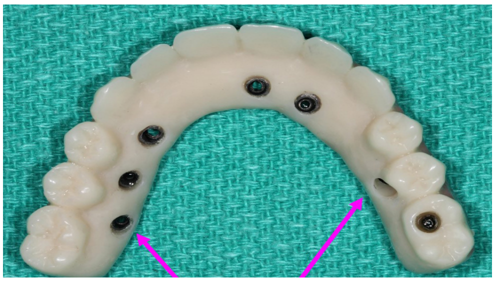

Figure 9. Full arch zirconia implant supported restoration. Please note the reduced material thickness on lingual of screw access orifices corresponding to #16/15 and #23 (arrows). #16/15 area is especially prone to fracture, as it is nearest to the distal cantilever. On the positive side, the distal cantilever is only 9 mm, with moderate leverage.

5. CONCLUSIONS

Screw loosening is the primary implant complication encountered of screw-retained restorations. However, this complication alone is often of very little financial and physical consequence. Component wear and deformation, component fracture, and veneering fracture and separation of materials are more detrimental in terms of repair and/or replacement financially and procedurally for the patient and the restorative dentist. The careful recognition of high-risk cases and diligent treatment planning, including design of the final restoration, is important to limit or avoid these complications completely.

a b

Figure 6. Abutment and screw fracture: a. common screw fracture pattern (junction of shank with head); b. fracture surface of abutment, and screw (screw head remained inside abutment)

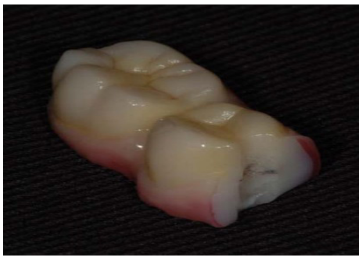

Figure 8. Distal cantilever fracture in full arch zirconia implant supported restoration. Please note that despite the generous amount of material around the screw access orifice, a 17 mm cantilever appeared to produce significant leverage to cause the breakage (Courtesy of Dr. Bryan Limmer, Denver, CO).

Figure 10. Porcelain fracture at screw access orifice.

Figure 11. Titanium cylinders' separation from monolithic zirconia full arch implant supported restoration.

DISCLOSURE

The authors reviewed and approved this manuscript, have no conflicts of interest nor off-label or investigational use in this manuscript. Furthermore, the authors have no financial, economic or professional interests that may have influenced the design, or presentation of the related information.

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None

AUTHOR'S CONTRIBUTION

SU, PW: agree to be accountable for the content of this work.
SU: contributed to the content and data gathering.
PW: contributed to the content and critically revised the manuscript.

REFERENCES

1. Markets and Markets. *Dental implants and prosthesis market by type* (Dental Implants, Bridge, Crown, Abutment, Dentures, Veneers, Inlay & Onlays), *material* (Titanium, Zirconium, Metal, Ceramic, Porcelain Fused to Metal), *type of facility - global forecast to 2023*. Available from: https://www.globenewswire.com/news-release/2019/07/29/1892955/0/en/Dental-Implants-Market-To-Reach-USD-8-06-Billion-By-2026-Reports-And-Data.html
2. iData Research. *US dental implant statistics show a shift to value & discount implants*. Available from: https://idataresearch.com/us-dental-implant-statistics-show-a-shift-to-value-discount-implants/
3. Beikler T, Flemmig TF. EAO consensus conference: economic evaluation of implant-supported prostheses. *Clin Oral Implants Res*. 2015 Sep;26 Suppl 11:57-63. doi: 10.1111/clr.12630. Epub 2015 Jun 15. PMID: 26077930.
Full text links CrossRef PubMed Google Scholar Scopus WoS
4. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. *J Clin Periodontol.* 2002;29 Suppl 3:197-212; discussion 232-233. doi: 10.1034/j.1600-051x.29.s3.12.x. PMID: 12787220.
CrossRef PubMed Google Scholar Scopus WoS
5. Assuncao WG, Delben JA, Tabata LF, et al. Preload evaluation of different screws in external hexagon joint. *Implant Dent.* 2012 Feb;21(1):46-50. doi: 10.1097/ID.0b013e31823fcbce. PMID: 22228458.
Full text links CrossRef PubMed Google Scholar Scopus WoS
6. Feitosa PCP, de Lima APB, Silva-Concílio LR, et al. Stability of external and internal implant connections after a fatigue test. *Eur J Dent*. 2013 Jul;7(3):267-271. doi: 10.4103/1305-7456.115407. PMID: 24926204; PMCID: PMC4053613.
Full text links CrossRef PubMed Google Scholar Scopus
7. Adell R, Lekholm U, Rockler B, et al. A 15-year Study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg*. 1981 Dec;10(6):387-416. doi: 10.1016/s0300-9785(81)80077-4. PMID: 6809663.
CrossRef PubMed Google Scholar Scopus WoS
8. Bidra AS, Rungruanganunt P, Gauthier M. Clinical outcomes of full arch fixed implant-supported zirconia prostheses: a systematic review. *Eur J Oral Implantol*. 2017;10 Suppl 1:35-45. PMID: 28944367.
PubMed Google Scholar Scopus WoS
9. Millen C, Bragger U, Wittneben J-G. Influence of prosthesis type and retention mechanism on complications with fixed implant-supported prostheses: a systematic review applying multivariate analyses. *Int J Oral Maxillofac Implants*. 2015 Jan-Feb;30(1):110-124. doi: 10.11607/jomi.3607. PMID: 25615920.
Full text links CrossRef PubMed Google Scholar Scopus WoS
10. Kinsel RP, Lin D. Retrospective analysis of porcelain failures of metal ceramic crowns and fixed partial dentures supported by 729 implants in 152 patients: patient-specific and implant-specific predictors of ceramic failure. *J Prosthet Dent*. 2009 Jun;101(6):388-394. doi: 10.1016/S0022-3913(09)60083-4. Erratum in: *J Prosthet Dent*. 2009 Aug;102(2):80. PMID: 19463666.
Full text links CrossRef PubMed Google Scholar Scopus WoS
11. Bragger U, Karoussis I, Persson R, et al. Technical and biological complications/failures with single crowns and fixed partial dentures on implants: a 10-year prospective cohort study. *Clin Oral Implants Res*. 2005 Jun;16(3):326-334. doi: 10.1111/j.1600-0501.2005.01105.x. PMID: 15877753.
Full text links CrossRef PubMed Google Scholar Scopus WoS
12. Bragger U, Aeschlimann S, Burgin W, et al. Biological and technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function. *Clin Oral Implants Res*. 2001 Feb;12(1):26-34. doi: 10.1034/j.1600-0501.2001.012001026.x. PMID: 11168268.
Full text links CrossRef PubMed Google Scholar WoS
13. Goodacre CJ, Bernal G, Rungcharassaeng K, et al. Clinical Complications in Fixed Prosthodontics. *J Prosthet Dent*. 2003 Jul;90(1):31-41. doi: 10.1016/s0022-3913(03)00214-2. PMID: 12869972.
Full text links PubMed Google Scholar
14. Sailer I, Muhlemann S, Zwahlen M, et al. Cemented and screw-retained implant reconstructions: a systematic review of the survival and complication rates. *Clin Oral Implants Res*. 2012 Oct;23 Suppl 6:163-201. doi: 10.1111/j.1600-0501.2012.02538.x. PMID: 23062142.
Full text links CrossRef PubMed Google Scholar Scopus WoS
15. Zarone F, Sorrentino R, Traini T, et al. Fracture resistance of implant-supported screw- versus cement-retained porcelain fused to metal single crowns: SEM fractographic analysis. *Dent Mater*. 2007 Mar;23(3):296-301. doi: 10.1016/j.dental.2005.10.013. Epub 2006 Mar 24. PMID: 16564081.
Full text links CrossRef PubMed Google Scholar Scopus WoS
16. Torrado E, Ercoli C, Al Mardini M, et al. A Comparison of the porcelain fracture resistance of screw-retained and cement-retained implant-supported metal-ceramic crowns. *J Prosthet Dent*. 2004 Jun;91(6):532-537. doi: 10.1016/j.prosdent.2004.03.014. PMID: 15211294.
Full text links CrossRef PubMed Google Scholar Scopus WoS
17. Rojas Vizcaya F. Retrospective 2- to 7-year follow-up study of 20 double full-arch implant-supported monolithic zirconia fixed prostheses: measurements and recommendations for optimal design. *J Prosthodont*. 2018 Jul;27(6):501-508. doi: 10.1111/jopr.12528. Epub 2016 Aug 29. PMID: 27570943.
Full text links CrossRef PubMed Google Scholar Scopus WoS
18. Carames J, Suinaga LT, Yu YCP, et al. Clinical advantages and limitations of monolithic zirconia restorations full arch implant supported reconstruction: case series. *Int J Dent*. 2015;2015:392496. doi: 10.1155/2015/392496. Epub 2015 Jun 1. PMID: 26124835; PMCID: PMC4466384.
Full text links CrossRef PubMed Google Scholar Scopus WoS
19. Chang JS, Ji W, Choi, et al. Catastrophic failure of a monolithic zirconia prosthesis. *J Prosthet Dent*. 2015 Feb;113(2):86-90. doi: 10.1016/j.prosdent.2014.07.016. Epub 2014 Oct 25. PMID: 25444283.
Full text links CrossRef PubMed Google Scholar Scopus WoS
20. Altarawneh S, Limmer B, Reside GJ, et al. Dual jaw treatment of edentulism using implant-supported monolithic zirconia fixed prostheses. *J Esthet Restor Dent*. 2015 Mar-Apr;27(2):63-70. doi: 10.1111/jerd.12137. Epub 2015 Jan 30. PMID: 25640984.
Full text links CrossRef PubMed Google Scholar Scopus WoS
21. Moscovitch M. Consecutive case series of monolithic and minimally veneered zirconia restorations on teeth and implants: up to 68 months. *Int J Periodontics Restorative Dent*. 2015 May-Jun;35(3):315-323. doi: 10.11607/prd.2270. PMID: 25909519.
Full text links CrossRef PubMed Google Scholar Scopus WoS
22. Venezia P, Torsello F, Cavalcanti R, et al. Retrospective analysis of 26 complete-arch implant-supported monolithic zirconia prostheses with feldspathic porcelain veneering limited to the facial surface. *J Prosthet Dent*. 2015 Oct;114(4):506-512. doi: 10.1016/j.prosdent.2015.02.010. Epub 2015 Jun 5. PMID: 25979446.
Full text links CrossRef PubMed Google Scholar Scopus WoS
23. Rubinstein S. Surgical and prosthetic management of implants: single and full-arch reconstruction. *Compend Contin Educ Dent*. 2015 Jul-Aug;36(7):504, 507-10, 512 passim. PMID: 26247444.
PubMed Google Scholar Scopus
24. Limmer B, Sanders AE, Reside G, et al. Complications and patient-centered outcomes with an implant-supported monolithic zirconia fixed dental prosthesis: 1 year results. *J Prosthodont*. 2014 Jun;23(4):267-275. doi: 10.1111/jopr.12110. Epub 2014 Jan 6. PMID: 24393461.
Full text links CrossRef PubMed Google Scholar Scopus WoS
25. Oliva J, Oliva X, Oliva JD: All-on-three delayed implant loading concept for the completely edentulous maxilla and mandible: a retrospective 5-year follow-up study. *Int J Oral Maxillofac Implants*. 2012 Nov-Dec;27(6):1584-1592. PMID: 23189314.
PubMed Google Scholar Scopus WoS
26. Ventura J, Jimenez-Castellanos E, Romero J, et al. Tooth fractures in fixed full-arch implant-supported acrylic resin prostheses: a retrospective clinical study. *Int J Prosthodont*. 2016 Mar-Apr;29(2):161-165. doi: 10.11607/ijp.4400. PMID: 26929956.
Full text links CrossRef Google Scholar Scopus WoS
27. Coltro MPL, Ozkomur A, Villarinho EA, et al. Risk factor model of mechanical complications in implant supported fixed complete dentures: a prospective cohort study. *Clin Oral Impl Res.* 2018 Sep;29(9):915-921. doi: 10.1111/clr.13344. Epub 2018 Jul 24. PMID: 30043486.
Full text links CrossRef PubMed Google Scholar Scopus WoS

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Questions

1. Compared to screw loosening, component fracture is:

❑a. More frequent;
❑b. Less frequent;
❑c. About as frequent as screw loosening;
❑d. More frequent in monolithic restorations.

2. The fracture of full-arch monolithic implant restorations occurs most frequently:

❑a. At or near the midline;
❑b. Just behind canine areas;
❑c. Through a distal screw access orifice;
❑d. Where the meso-structure meets the superstructure.

3. Which of the following is not true regarding veneering porcelain fracture in implant restorations?

❑a. Is more frequent that in tooth-supported restorations;
❑b. Is more likely if the opposing arch is also an implant-supported restoration;
❑c. Can be associated with unsupported material;
❑d. Is less frequent than in tooth-supported restorations.

4. The fracture of acrylic veneering in full arch implant restorations is most likely related to:

❑a. Equilibration in group function;
❑b. A restoration in the mandible;
❑c. Poor metal framework design;
❑d. Class III jaw relationship.

Case Reports