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Mechanical Complications of Dental Implants: A Review

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Abstract

Although dental implants show high survival and success rates, some complications that describe by biomechanical failures may occur. Among these, implant fractures are rare but consequence irreversible outcomes. The objective of the present review was to inspect the causes of mechanical complications especially dental implant fractures, to help clinicians properly plan implant-supported prosthesis treatment by considering important biomechanical aspects.

Keywords: Dental Implants; Implant-Supported Dentures

Introduction

The use of implant-supported dentures has the advantage of improving function and preserving tooth structures, so ensuring the longevity of the dental treatment [1]. A total 95.3% cumulative success rate has been shown after 3-7 years of loading dental implants. Due to the high success rates, dental implants have become a preferred treatment option [2,3]. Nevertheless, several complications are reported to involve implant components and prostheses at higher rates compared with implant loss. The cause of these complications is multifactorial and can be biological or mechanical. These biomechanical complications and implant failures occur such as loosening or fractures of the prosthetic and abutment screws, as well as implant fractures [4,5].

Implant fracture is an infrequent complication that affects two out of every 1,000 implants [3]. However, it was concluded that implant fracture prevention is the most important consideration. Implant fractures are apparent implant failures and critical issues for patients and clinicians. They usually involve the loss of both the implants and the prostheses and require implant removal or being put to sleep [1,6].

The objective of the present literature review was to inspect the causes of mechanical complications especially dental implant fractures, to help clinicians properly plan implant-supported prosthesis treatment by considering important biomechanical aspects.

Methods

An extensive literature search was completed using the electronic databases of PubMed, Science Direct, and Web of Science. The used keywords strings were: Implant AND failures or Implant AND Complications. The following filters were applied: (1) time interval from 2010, (2) Additional refined search within the results: biomechanical failures, implant fractures, language: English.

Abstracts were analyzed, and were excluded if they were more about implant-supported prosthetic complications, biological complications, management of complications, or clinical studies that have less than 1 year of follow-up. Accordingly, to complement this review, the involving mostly mechanical complications in-vitro studies, long-term clinical studies, and systematic reviews were selected.

Classifications of Implant Failures

Failures in dental implants include biological complications such as failure to achieve osseointegration or the presence of periimplantitis, as well as some mechanical complications [6]. The time the failure occurs is used to classify the failure type. If it occurs before or at abutment insertions, is considered an early failure, and may be based on a lack of osseointegration. If it occurs after occlusal loading, is considered a late failure, and related to any situation that may negatively affect the maintenance of previously achieved osseointegration [7].

For diagnostic purposes according to the implant failure risk factors are into three main categories: patient-related factors, implant-related factors, and prosthesis-related factors. Patient-related factors; bone loss and overload (bruxism). Implant-related factors; a crown/implant rate that is greater than 1 and implant design. Prosthetic factors; loose or fracture of the prosthetic screws, and restoration fractures [8,9].

Another classification divides implant failures into those caused by "Biomechanical Overload," those caused by "Infection or Inflammation," and those from "Other Causes". Biomechanical overload is manifested by the loss or fracture of an implant component, of these, implant fracture is the most important consideration [6,10].

Classification of Causes of Implant Fractures

There are two main causes of implant fractures which constitute 1% of biomechanical complications. These are the reduction of bone support of the implant after overloading and loss of vertical tissue [11,12]. The causes of implant fractures have been defined as shown in the Figure 1.

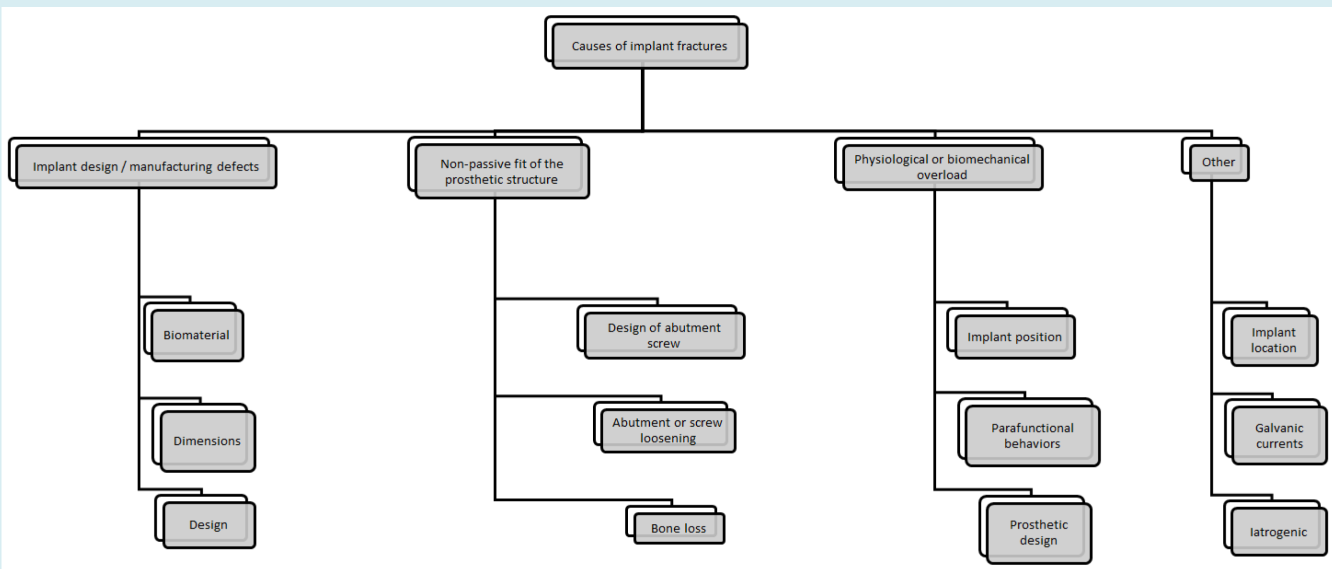

Figure 1: Classification of causes of implant fractures [13].

Accordingly, the main factors that may cause implant fractures, include implant design, implant dimensions, biomaterial from which the implant is produced, implant manufacturing defects, implant position and location, parafunctional behaviors, biomechanical or physiological overload, and prosthetic design [13,14].

Implant Design: The chewing forces are transmitted to the bone through the implants, causing stress at the implant-bone interface. Implant design is important in terms of tolerating the stresses occurring at the interface and preventing an adverse tissue response, increasing the surface area, and ensuring implant stability and osseointegration [15]. It is known that the geometry of the implant should be such that it reduces the stress concentration in the cervical region and increases the bone-implant contact area. Implant designs and surfaces differ according to the manufacturers, and there is no definite constant consensus about design or surface treatment [16,17]. To exhibit the appropriate biomechanical behavior, to increase the implant surface area, to minimize the stress formation in the neck region by converting the shear-type tensions between the implant and the bone into compression-type tensions, the threads are positioned as micro threads near the neck and macro threads in the middle, and they are modified with different thread areas [17,18]. In addition to the implant body, the abutment design also has an impact on the fracture strength. It has been shown that angled abutments create higher stress values in the cervical region and have lower fracture strength than straight abutments [19-21].

Implant Dimensions: Narrow-diameter implants are less resistant to fatigue failures and fractures than regular or large-diameter implants and are more prone to material defects that can occur during manufacturing [22,23]. Since the fracture strength of implants is directly proportional to the third degree (cube) of the implant diameter, a 0.2 mm reduction in diameter can result in an approximately 15% reduction in fracture resistance [24]. Long implants exhibit better prognoses and higher success rates compared to short implants. The reason for this; shorter implants have a lower bone-implant contact area. Optimum criteria and clinical principles for implant-supported fixed restoration treatments are based on the requirement that the implant length is≥10 mm. However, in cases where there are some anatomical limitations, the surgical operation cannot be performed for various reasons and short implants are required to be used, biomechanical risks can be reduced by preferring larger diameter implants, avoiding cantilevers in prosthetic restoration, preventing angled forces and splinting the implants together [25,26]. In cases where narrow diameter implants are required, the surface area can be increased by choosing long implants, but it has been shown that the implant length does not have as much effect on the stress distribution as the implant diameter [25,27,28].

Implant Biomaterial: Structural properties of the biomaterial used in implant production, such as elastic modulus, hardness, compression strength, and fatigue resistance, are effective in the resistance of dental implants to chewing forces and the absence of adverse tissue response to the forces transmitted to the bone [15]. Most biocompatible materials do not have the sufficient structural strength to withstand the forces to which dental implants are subjected. Among all available biomaterials used in dental implant manufacturing today, pure titanium and titanium alloys represent the ideal in terms of biomechanical durability, biocompatibility, and behavior at the bone-implant interface [29,30]. Recently, zirconia in dental implant production is popular, especially with one-piece designs required by the material's structure, showing high success and survival rates [31,32].

Implant Manufacturing Defects: Manufacturing defects are considered a very low reason for mechanical complications that may occur in implants. In the microscopic evaluation of implant fractures, no porosity or defects were observed on the titanium surface, indicating a manufacturing defect. The main factors that can cause implant body fracture are; implant biomaterial, size, and design. Also, it has been noted that implant body fractures are associated with most fatigue failures [23,29].

Implant Position and Location: Implant fractures are more common in premolar and molar regions where chewing forces are higher and lateral movements are more affected. The fact that the implants are positioned as angled or placed outside the required position is also a risk factor for implant fractures [23].

Parafunctional Behaviors, Biomechanical or Physiological Overload: Biomechanical and physiological overloads may result from inappropriate implant angulation or position, insufficient occlusal support, insufficient bone contact, or parafunctional behaviors [10,33]. Overloading frequently causes the loosening or fracture of an implant component. Loosening can involve cement failure, the screw of the prosthesis or abutment loosening, or osseointegration failure. Implant fractures mean fractures occurred at the implant body, abutment screw, or prosthesis screw [10]. Biomechanical and physiological overloads are the most common causes of dental implant fractures. Such complications may occur after static loads exceed the fracture resistance of the material, as well as dynamical loads of lower values, may occur due to fatigue in the material. Overloads are mainly dependent on parafunctional habits and prosthesis design. In individuals with parafunction habits, the time when teeth are in contact with each other is much higher compared to normal individuals. These contacts may be in the form of excessive occlusal loads or continuous repetitions of slight occlusal loads in a way that increases the risk of implant fracture [11,23,31].

Prosthetic Design: Prosthetic restorations should have a design that will not increase biomechanical risks. To minimize biomechanical risks, the passive fit of the restoration to the implants should be ensured, the crown/implant ratio should be <1:1, and a cantilever-free restoration should be made, with a flat occlusal morphology with a narrow occlusal table. Physiologic loads should be parallel to the long axis of the implant, there should be no premature contacts, and the lower jaw should be free during lateral and protrusive movements. Occlusal force distribution should be homogeneous on the implants, in some cases, it should be adjusted in favor of the implants or infraocclusion should be created when necessary. In addition, the application of a protective full arc occlusal splint is important [34,35].

Conclusion

Although implant fractures are very rare among implant failures, care should be taken to prevent them from occurring as it is a complications that cannot be repaired or treated. Due to overloads being the most common cause of dental implant fractures, dental surgeons and prosthodontics should be knowledgeable and attentive to the factors that may cause overloading. Accordingly, providing an acceptable treatment plan mainly in the posterior region, the use of numerous implants and wider diameters, and appropriate prosthetic restorations design provided distributed occlusions, are very important.

References

1. Gealh W, Mazzo V, Barbi F, Camarini ET (2010) Osseointegrated implants fracture: causes and treatment. J Oral Implantol 37(4): 499-503.

2. Sánchez Pérez A, Moya Villaescusa MJ, Jornet Garcia A, Gomez S (2010) Etiology, risk factors and management of implant fractures. Med Oral Patol Oral Cir Bucal 15(3): 504-508.

3. Goiato MC, Haddad MF, Filho HG, Villa LMR, Dos Santos DM, et al. (2014) Dental Implant Fractures- Aetiology, Treatment and Case Report. J Clin Diagnos Res 8(3): 300-304.

4. Bozini T, Petridis H, Garefis K, Garefis P (2011) A meta-analysis of prosthodontic complication rates of implant-supported fixed dental prostheses in edentulous patients after an observation period of at least 5 years. Int J Oral Maxillofac Implants 26(2): 304-318.

5. De Kok IJ, Duqum IS, Katz LH, Cooper LF (2019) Management of Implant/Prosthodontic Complications. Dent Clin North Am 63(2): 217-231.

6. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY (2003) Clinical complications with implants and implant prostheses. J Prosthet Dent 90(2): 121-132.

7. Alssadi G, Quiryen M, Komerek A, van Steemberghe D (2007) Impact of local and systemic factors on the incidence of oral implant failure, up to abutment connection. J Clin Periodontol 34(7): 610.

8. DiPede L, Alhashim A, Vaidyanathan TK, Flinton R (2013) Fracture resistance of soft tissue level implants after cyclic loading and external modification. J Prosthet Dent 109(1): 30-36.

9. Mangano C, Piattelli A, Mortellaro C, Mangano F, Perrotti V, et al. (2013) Evaluation of peri-implant bone response in implants retrieved for fracture after more than 20 years of loading: A case series. J Oral Implantol 41(4): 414-418.

10. Liaw K, Delfini RH, Abrahams JJ (2015) Dental Implant Complications. Semin Ultrasound CT MR 36(5): 427-433.

11. Gupta S, Gupta H, Tandan A (2015) Technical complications of implant-causes and management: A comprehensive review. Natl J Maxillofac Surg 6(1): 3-8.

12. Salvi GE, Brägger U (2009) Mechanical and technical risks in implant therapy. Int J Oral Maxillofac Implants 24: 69-85.

13. Balshi TJ, Hernandez RE, Pryszlak MC, Rangert B (1996) A comparative study of one implant versus two replacing a single molar. The International journal of oral & maxillofacial implants 11(3): 372-378.

14. Virdee P, Bishop K (2007) A review of the aetiology and management of fractured dental implants and a case report. Br Dent J 203(8): 461-466.

15. Brunski JB (1988) Biomaterials and biomechanics in dental implant design. The Int J Oral Maxillofac Implants 3(2): 85-97.

16. Elias CN (2011) Factors Affecting the Success of Dental Implants. Implant Dentistry-A Rapidly Evolving Practice. IntechOpen

17. Gaviria L, Salcido JP, Guda T, Ong JL (2014) Current trends in dental implants. J Korean Assoc Oral Maxillofac Surg 40(2): 50-60.

18. Delgado Ruiz RA, Marković A, Calvo Guirado JL, Lazić Z, Piattelli A, et al. (2014) Implant stability and marginal bone level of microgrooved zirconia dental implants: A 3-month experimental study on dogs. Vojnosanitetski pregled 71(5): 451-461.

19. Brosh T, Pilo R, Sudai D (1998) The influence of abutment angulation on strains and stresses along the implant/bone interface: Comparison between two experimental techniques. J Prosthet Dent 79(3): 328-334.

20. Canay S, Hersek N, Akpınar I, Asık Z (1996) Comparison of stress distribution around vertical and angled implants with finite-element analysis. Quintessence Int 27(9): 591-598.

21. Han J, Zhao J, Shen Z (2017) Zirconia ceramics in metal-free implant dentistry. Adv Appl Ceram 116(3): 138-150.

22. Preis V, Kammermeier A, Handel G, Rosentritt M (2016) *In vitro* performance of two-piece zirconia implant systems for anterior application. Dent Mater 32(6): 765-774.

23. Sanivarapu S, Moogla S, Kuntcham RS, Kolaparthy LK (2016) Implant fractures: Rare but not exceptional. J Indian Soc Periodontol 20(1): 6-11.

24. Osman RB, Ma S, Duncan W, De Silva RK, Siddiqi A, et al. (2013) Fractured zirconia implants and related implant designs: scanning electron microscopy analysis. Clin Oral Implants Res 24(5): 592–597.

25. Himmlová L, Dostálová T, Kácovský A, Konvicková S

(2004) Influence of implant length and diameter on stress distribution: a finite element analysis. J Prosthet Dent 91(1): 20-25.

26. Misch CE, Steignga J, Barboza E, Misch Dietsh F, Cianciola LJ, et al. (2006) Short dental implants in posterior partial edentulism: a multicenter retrospective 6-year case series study. J Periodontol 77(8): 1340-1347.
27. Klein MO, Schiegnitz E, Al Nawas B (2014) Systematic review on success of narrow-diameter dental implants. Int J Oral Maxillofac Implants 29: 43-54.
28. Sierra Sánchez JL, Martínez González A, García Sala Bonmatí F, Mañes Ferrer JF, Brotons Oliver A (2014) Narrow-diameter implants: are they a predictable treatment option? A literature review. Med Oral Patol Oral Cir Bucal 19(1): 74-81.
29. Misch CE (2008) Contemporary Implant Dentistry. 3rd (Edn.), Mosby Elsevier.
30. Saini M, Singh Y, Arora P, Arora V, Jain K (2015) Implant biomaterials: A comprehensive review. World J Clin Cases 3(1): 52-57.
31. Atalay P, Öztaş DD (2022) Fatigue resistance and fracture strength of narrow-diameter one-piece zirconia implants with angled abutments. J Esth Restor Dent 34(7): 1060-1067.
32. Sadowsky SJ (2020) Has zirconia made a material difference in implant prosthodontics? A review. Dent Mater 36(1): 1-8.
33. Abrahams JJ (2001) Dental CT imaging: A look at the jaw. Radiology 219(2): 334-345.
34. Gross MD (2008) Occlusion in implant dentistry. A review of the literature of prosthetic determinants and current concepts. Aust Dent J 53(1): 60-68.
35. Sahin S, Cehreli MC, Yalçin E (2002) The influence of functional forces on the biomechanics of implant-supported prostheses--a review. J Dent 30(7-8): 271-282.