Fracture of Dental Implants: Literature Review and Report of a Case

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The introduction of osseointegrated dental implants has given the patient a functional and esthetic solution to partial and total edentulism. This modality, with a reported 90 to 95% initial success rate, is considered to be a viable alternative for many patients.[1–6] Nevertheless, a variety of complications have been observed throughout the years.[7] These complications can be sorted into three groups according to their origins: biological processes, mechanical inadequacies, and patient adaptation.[8] A temporal classification was also described: during surgery, early complications, and late complications.[1,2]

Fractured implants rarely occur, yet, this complication merits consideration as it presents a major problem for the patient and the clinician alike. Most authors reported very low fracture incidence. Balshi et al[5] reported eight fractured implants among 4045 implants. Similarly, Mericske-Stern et al[9] found only one case in 66 implants. The Mayo Clinic study observed three occurrences of fractures in 1778 implants.[4] Jemt and Lekholm[10] reported a single case in a series of 259 implants, whereas Zarb and Schmitt[11] could not find any fracture in a series of 274 implants. To the contrary, Takeshita et al[12] reported a much higher incidence—five fractures out of 68 implants. Ragnar et al,[6] in a multicenter study with a 5- to 15-year follow-up, reported that the fracture rate was 0 to

Fracture of dental implants is a rare phenomenon with severe clinical results. In this article, the literature is reviewed and various causative factors that may lead to fracture are presented. Galvanic activity has not been mentioned before as a possible cause for implant fracture, yet, it can occur at the level of contact with the superstructure. This is illustrated by the case of a titanium implant restored with a nonprecious porcelain-fused-to-metal cemented crown that fractured 4 years after loading. The radiographs show alveolar bone resorption around the fixture. Metallurgical analysis of the implant indicated that the fracture was caused by metal fatigue and that the crown metal, a nickel-chromium-molybdenum alloy, exhibited corrosion. These findings suggest a new explanation for implant fractures; cytotoxic nickel ions, leaching from the base metal alloy may cause bone resorption. This in turn leads to increased mobility, facilitating washout of the luting cement. Contact of the base metal with titanium in the presence of oral fluids produces galvanic currents that hasten corrosion and leaching out of nickel ions, thus leading to further bone resorption. Loss of bone support allows lateral bending moments that cause metal fatigue, eventually leading to fracture. Therefore, good treatment planning and appropriate case selection might have prevented this fracture. Furthermore, the use of nonprecious metal alloy for the crown's infrastructure had further contribution to the chain of events that led to the implant's fracture. (Implant Dent 2002;11:137–143)

Key Words: dental implants, fracture, galvanic corrosion, nickel, metal fatigue

6% in the maxilla, whereas in the mandible it was 0 to 3%.

Several factors have been suggested as possible causes for dental implant fractures. These include:

1. **Design or production flaws.** In different analyses of fractured implants, Balshi[5] and Piattelli et al[13] found that defects in the manufacturer's design and production are the least likely reasons for implant fracture.
2. **Inadequate fit of the superstructure.** The superstructure should be seated passively, otherwise it creates undesirable forces.[14] A nonpassive fit of the superstructure may produce tension between the implant and the superstructure, thus impairing stability of the implant.[15] It might also cause fracture of anchoring implants that carry most of the masticatory load.[15–17] Furthermore, if sufficient rigidity is not achieved, the anchoring unit closest to the load will bear the major part of the load.
3. **Load factors.** These factors are related to occlusal forces (magnitude and direction) and the implant's bearing forces.
   a. In-line implants—two implants, or a combination of a natural tooth and an implant, are ar-

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ranged in a straight line. This geometry allows for bending to occur as a result of lateral occlusal components, which might lead to an implant's fracture.[18]

b. Leverage—the forces generated at the occlusal contact position may be magnified to a considerable degree at the implant cross section with the alveolar crest. This phenomenon may occur if there is a lever arm between the position of forced contact and the position of support.[18–20]

4. **Bruxism or heavy occlusal forces.** A parafunctional occlusal habit can contribute to the potential overload, as load magnitude, duration, frequency, and direction are increased by such activity. Excessive wear and a history of fracturing natural teeth or veneering material are considered signs of excessive functional load.[13,18]
5. **Design of the superstructure.** The type of restoration may influence the load and stress that are transmitted to the implant. An implant supporting a bridge, for example, has a smaller tendency to fracture than an implant supporting a removable prosthesis.[6] Cantilever type bridges tend to break more often than "conventionally" designed bridges.[21,22]
6. **Implant location.** Piattelli et al[23] have claimed that implants at the posterior mandible are most prone to fracture. In a different study,[13] he found that maxillary implants have a higher predisposition to fracture. Rangert et al[18] showed that implants located in posterior regions were at an increased risk of overload. A multicenter analysis of ITI implants (ITI; Straumann AG, Waldenburg, Switzerland) used for single tooth replacements[1] also revealed fractures only in the molar region, predominantly in the mandibular first molar area. In this area, load level is high, and the buccolingual jaw movement and cusp orientation generate excessive laterally-directed forces. In their study, all single tooth fractures occurred in the posterior mandible. In all, 90% of the fractures involved the first premolar region or further posteriorly. In a study of 353 patients,[4] all restored with fixed restorations, only three patients experienced implant fracture, all of them in the mandible.
7. **Implant size (diameter).** Small-diameter implants tend to fracture more easily than large ones, especially when placed in a posterior location. According to Siddiqui and Caudill,[14] an implant 5 mm in diameter is three times stronger than a 3.75-mm implant, and an implant 6 mm in diameter is six times stronger than a 3.75-mm implant. Another advantage of the wider implant is that they are more biomechanically appropriate for replacing larger posterior teeth.
8. **Metal fatigue.** According to Morgan et al[25] and Linkow et al,[27] most fractures during loading were due to metal fatigue and not overload. The high local stresses required for crack initiation and propagation are thought to be the result of three conditions:

   - Periimplant bone resorption—this leads to higher bending stresses (see below).
   - Cross-sectional changes in the implant—when bone loss reaches a level corresponding to the end of the abutment screw, the implant is converted from a solid composite cylinder to a tube (without the central screw). Consequently the resistance to bending is reduced in this region and bending and axial stresses become much greater.
   - Stress concentration—the sharp corner of the root of a thread creates an area of significant stress concentration, providing an ideal site for crack initiation. The cracks that propagate from the site of maximum stress may result in sudden failure.[13]

9. **Bone resorption around the implant.** In many cases, such resorption was found preceding implant fracture, particularly when single molar implants were involved. Corono-apical bone resorption produces a higher bending stress on the implant, because of the loss of supporting bone. Furthermore, this periimplant bone resorption usually extends to the level corresponding to the end of the abutment screw where the resistance to bending is diminished.[18,25] The behavior of periimplant bone is tightly related to the magnitude and direction of stresses that are transmitted to the implant. These forces are affected by the nature of the opposite dentition, bite force, number of implants available to carry the load, position of the implant within the prosthesis, and implant geometry.[26]

Report of a Case

Clinical Data

A 78-year-old female, with a partially edentulous mandible, was referred for implant treatment. Her medical history was of no consequence.

A 12-mm hollow-cylindrical transgingival implant (ITI) was inserted in the lower left second premolar area. Implants were not inserted in the molar area, due to the lack of vertical bone height. After a three-month preloading healing period with no complications noted, clinical osseointegration was achieved, and the patient was sent back to the referring dentist for restoration. A ceramic fused-to-metal crown was fabricated and permanently cemented (Fig. 1). The patient received maintenance therapy on an irregular basis—approximately once per year. Radiograph follow-up revealed mild resorption around the implant. No clinical symptoms were evident at that time (Fig. 2).

Four years after implant placement, the patient presented at the office complaining of discomfort on the left side of her lower jaw with loosening of the crown. Clinical examination revealed excessive horizontal movement of the crown and swelling in the adjacent mucosa. The crown was removed using a very light force and came off together with the upper third of the implant (Fig. 3). Radiographs taken at that time revealed the apical part of the osseointegrated implant with broken edges and noticeable bone loss, coronal to the implant's broken edge. The patient elected not to remove the apical portion of the implant, which was left to heal subgingivally. A year later, new bone was evident around the apical portion of the implant (Fig. 4). The soft tissue had healed and the edentulous ridge was restored with a removable prosthesis.

Metallurgic Analysis

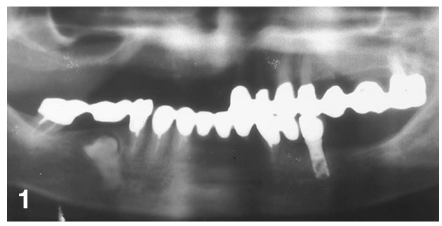
The broken implant and the crown were sent for metallurgic analysis. The following analyses were performed: energy dispersive spectroscopy of the implant and the crown, fractography, and prosthetic analysis.

Energy dispersive spectroscopy revealed that the implant was made of pure titanium, and the crown of nickel-chromium-molybdenum alloy. Fractography, at low magnification, showed that the implant was hollow at this level (Fig. 5A); and at high magnification, striations indicated brittle fractures (Fig. 5B). The latter occurs following metal fatigue caused by cyclic loading, such as chewing.[16] The prosthetic analysis revealed corrosion on the surface of the crown. The laboratory analysis suggested that toxic nickel ions from the crown's infrastructure might have diffused into the periimplant tissue, contributing to bone resorption.

Discussion

In the case report presented here, a previously osseointegrated implant fractured 4 years after placement. This kind of fracture can be defined as a late failure,[2] the etiology of which may be multifactorial. From a biological point of view, periimplantitis that develops around the implant may result in bone resorption, which may lead to a consequent fracture. The mechanism of such bone resorption is well documented.[28–31] Periimplantitis may range from localized mucositis to a more advanced lesion, where bone loss around a previously osseointegrated oral implant results in "disintegration."[29] This lesion is the result of an inflammatory response to plaque accumulation and may show progression similar to that observed around natural teeth. Mucositis is a prerequisite for the development of periimplantitis, but the factors involved in the transition from an initial to an advanced lesion are not fully understood.[30] The microbial flora in periimplantitis is characterized by a large number of gram-negative pathogens and spirochetes.[32] The bacteria in the partially edentulous implant case may be more pathogenic than in the fully edentulous case, indicating a possible seeding mechanism from tooth pocket to implant crevice.[33]

Leakage of cytotoxic metal ions into the periimplant tissue may be another factor to facilitate bone resorption. Different types of nonprecious alloys may discharge toxic ions, usually nickel or chromium that diffuse



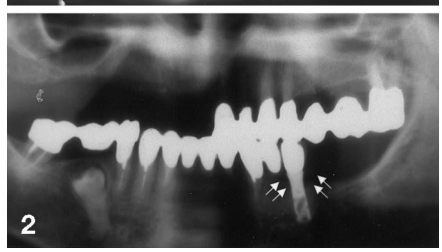


Fig. 1. Panoramic radiograph of the osseointegrated implant with the prosthetic restoration.

Fig. 2. Panoramic radiograph 1 year after loading. Note initial bone resorption around the implant's neck (arrows).

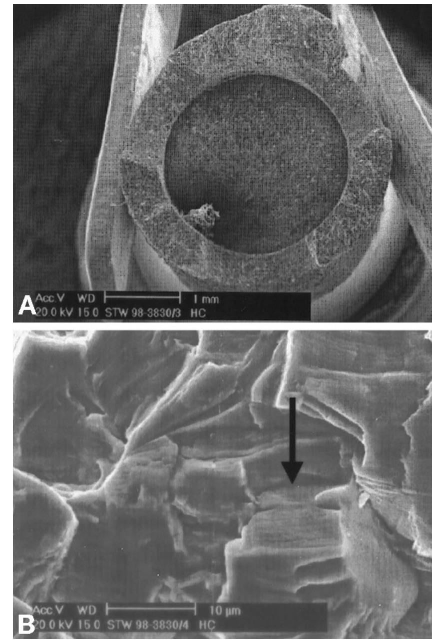
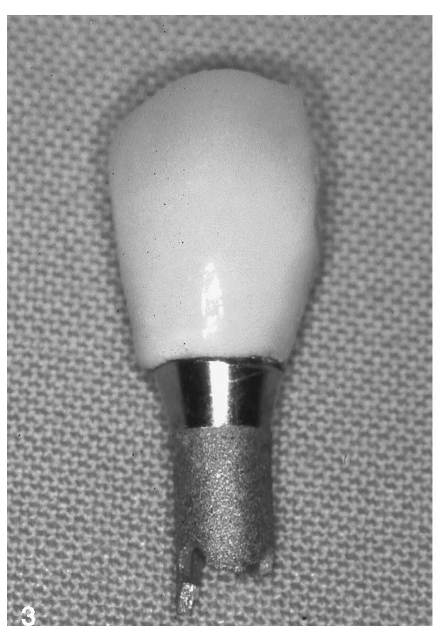


Fig. 5. Scanning electron microscopy views of the fracture. **A,** Low power view of the fractured surface of the HC-Titanium implant: magnification ×20, bar = 1 mm. The fractured surface exhibits a dimpled aspect, characteristic of tensile fracture. Note that at the site of the fracture, the implant appears as a ring, because it is hollow at this level. **B,** Higher magnification of the surface of the fracture: magnification ×2200, bar = 10 mm. The symmetrical parallel striations (arrow) are indicative of brittle fractures.



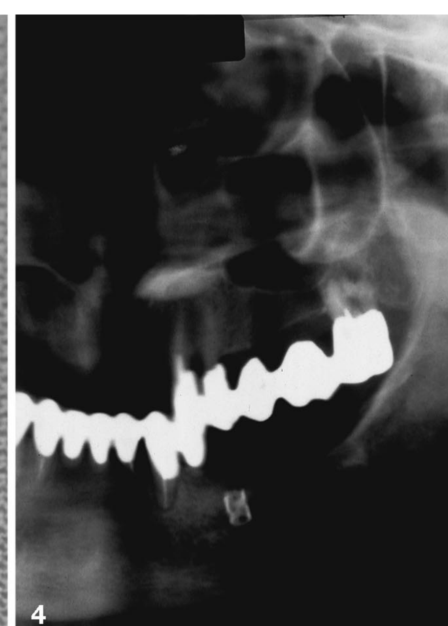


Fig. 3. Coronal fragment of the implant with the crown.

Fig. 4. Panoramic radiograph 1 year after extraction of the fractured coronal portion. Complete bone healing.

into the periimplant tissue and cause tissue reaction and bone resorption.[24] Most implant systems are made of commercially pure titanium. Therefore, only the superstructure (crown or bridge) may be the source of these ions, especially when made of nonprecious or semi-precious alloys, such as nickel-chromium-molybdenum. Corrosion may set in and result in the leaking of ions into the surrounding tissues. Clinical signs and symptoms of this local toxic reaction include discoloration, swelling, bleeding, and infection.[34]

Corrosion of the metal crown may be caused or accelerated by differences in the electric potential between the implant (made of pure titanium) and the crown (made of nickel-chromium-molybdenum alloy). Titanium is a highly reactive metal, contrary to common belief. It is cathodic to most metals and when coupled together, may accelerate galvanic attack on the less noble ones. The parameters that affect the magnitude of this galvanic corrosion are the difference in the electrolytic potential between the metals and the contact area between the metals. The electrolytic potential of a given metal is a constant. The difference can be minimized by fabricating the restoration from a metal alloy that possesses a similar, or close, electrolytic potential to that of titanium. Alternatively, the contact area between the implant and the restoration may be isolated by the use of cement (such as zinc phosphate cement).[35] Reducing the relative contact area between the two metals is not recommended, as it will reduce the retention of the restoration.[36] Therefore, the possibility of galvanic corrosion must always be kept in mind when choosing a metallic alloy for the crown.

In a series of 22 failed implants, which were analyzed by scanning electron microscope and Auger electron spectroscope, Esposito et al[37,38] found only one case of clinical infection. The surface of the implant retrieved from the infected site consisted of titanium oxide and varying amounts of additional elements, predominantly carbon. Nitrogen, sodium, calcium, phosphorus, chlorine, sulfur, and silicon were detected. The effect of these materials on the implant-bone interface is unknown, but they may be involved in the failure of the implant. Additionally, it is known that nickel ions, corroded from nonprecious metals, may cause tissue necrosis, bone loss, impaired bone mineralization, and even loosening of orthopedic implants.[39] Nickel ions are toxic to osteogenic cells and they affect their proliferation and differentiation. Finally, it was recently recommended to limit the use of nickel in the oral cavity.[40]

We would like to suggest taking the following factors into consideration—the possible mechanisms that led to the fracture represented here. High cyclic load caused breakdown and washout of the cement, and possibly some bone resorption around the implant. Exposure of the different metals to saliva caused galvanic corrosion of the crown, followed by release and diffusion of nickel ions into the surrounding bone. At that stage, bone resorption, related to plaque-induced periimplantitis and nickel ions' toxic effect, was accelerated, and the torque produced on the implant increased concurrently, fueling the resorptive process. This, in turn, contributed to increased mobility of the implant that accelerated and eventually led to fracture of the implant.

Conclusions

This case report illustrates a possible adverse affect of nonprecious metal alloy used for prosthetic restorations in conjunction with titanium implant bodies. Ions that leach out of nonprecious alloys may cause bone resorption, ultimately leading to failure and even fracture of an implant. Further investigation will be needed to confirm these findings.

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Disclosure

The authors claim to have no financial interest in any company or any of the products mentioned in this article.

References

1. Levine RA, Clem DS, Wilson TG, et al. Multicenter retrospective analysis of the ITI implant system used for single-tooth replacements: Results of loading for two or more years. *Int J Oral Maxillofac Implants.* 1999;14:516–520.
2. Lekholm U, Van Steenberghe D, Herrmann I, et al. Osseointegrated implants in the treatment of partially edentulous jaws: A prospective 5-year multicenter study. *Int J Oral Maxillofac Implants.* 1994;9:627–635.
3. Buser D, Mericske Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. *Clin Oral Implants Res.* 1997;8:161–172.
4. Tolman DE, Laney WR. Tissue-integrated prosthesis complications. *Int J Oral Maxillofac Implants.* 1992;7:477–484.
5. Balshi TJ. An analysis and management of fractured implants: A clinical report. *Int J Oral Maxillofac Implants.* 1996;11:660–666.
6. Ragnar A, Eriksson B, Lekholm U, et al. A long-term follow up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants.* 1990;5:347–359.
7. Grunder U, Polizzi G, Goene R, et al. A 3-year prospective multicenter follow-up report on the immediate and delayed-immediate placement of implants. *Int J Oral Maxillofac Implants.* 1999;14:210–216.
8. Tonetti MS, Schmid J. Pathogenesis of implant failure. *Periodontology 2000.* 1994;4:127–138.
9. Mericske-Stern R, Steinlin Schaffner T, Marti P, et al. Peri-implant mucosal aspects of ITI implants supporting overdentures. A five-year longitudinal study. *Clin Oral Implants Res.* 1994;5:9–18.
10. Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: A 5-year follow up report. *Int J Oral Maxillofac Implants.* 1993;8:635–640.
11. Zarb G, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: The Toronto study. Part III: Problems and complications encountered. *J Prosthet Dent.* 1990;64:185–194.
12. Takeshita F, Sutsugu T, Higuchi Y, et al. Histologic study of failed hollow implants. *Int J Oral Maxillofac Implants.* 1996;11:245–250.
13. Piattelli A, Piattelli M, Scarano M, et al. Light and scanning electron microscopic report of four fractured implants. *Int J Oral Maxillofac Implants.* 1998;13:561–564.

14. Siddiqui AA, Caudill R. Proceedings of the 4th international symposium on implant dentistry. Focus on esthetics. San Diego, California, January 27–29, 1994. *J Prosthet Dent.* 1994;72:623–634.

15. Piattelli A, Scarano A, Vaia E, et al. Histological evaluation of the peri-implant bone around plasma-sprayed non-submerged titanium implants retrieved from man: A report of two cases. *Biomaterials.* 1996;17:2219–2224.

16. Rangert B, Jemt T. Forces and moments on Branemark implants. *Int J Oral Maxillofac Implants.* 1989;4:241–247.

17. Garg AK, Morales M, Navarro I. Repair of a transmandibular impar: Clinical report. *Implant Dent.* 1997;6:11–13.

18. Rangert B, Krogh PHJ, Langer B, et al. Bending overload and implant fracture: A retrospective clinical analysis. *Int J Oral Maxillofac Implants.* 1995;10:326–334.

19. Jaarda MJ, Razzogg ME, Gratton DG. Effect of preload torque on the ultimate tensile strength of implant prosthetic retaining screws. *Implant Dent.* 1994;3:17–21.

20. Jaarda MJ, Razzogg ME, Gratton DG. Providing optimum torque to implant prostheses: A pilot study. *Implant Dent.* 1993;2:50–52.

21. Luterbacher S, Fourmousis I, Lang NP, et al. Fractured prosthetic abutments in osseointegrated implants: A technical complication to cope with. *Clin Oral Implants Res.* 1999;11:163–170.

22. Steflik DE, Parr GR, Singh BB, et al. Light microscopic and SEM analyses of dental implants retrieved from humans. *J Oral Implants.* 1994;20:8–24.

23. Piattelli A, Scarano A, Paolantonio M. Clinical and histologic features of a non-axial load on the osseointegration of a posterior mandibular implant: Report of a case. *Int J Oral Maxillofac Implants.* 1998;13:273–275.

24. Charton-Picard F, Eloy R. L'allergie aux alliages utilises en art dentaire et a leurs composants. *Le Chirurgien Dentiste de France.* 2000;970:17–24.

25. Morgan MJ, James DF, Pilliar RM. Fractures of the fixture component of an osseointegrated implant. *Int J Oral Maxillofac Implants.* 1993;4:409–414.

26. Piattelli A, Corigliano M, Scarano A. Microscopical observations of the osseous responses in early loaded human titanium implants: A report of two cases. *Biomaterials.* 1996;17:1333–1337.

27. Linkow LI, Donath K, Lemons JE. Retrieval analyses of a blade implant after 231 months of clinical function. *Implant Dent.* 1992;1:37–43.

28. Hass R, Haimbock W, Mailath G, et al. The relationship of smoking on peri-implant tissue. *J Prosthet Dent.* 1996;76:592–596.

29. Lang NP, Mombelli A, Tonetti MS, et al. Clinical trials on therapies for peri-implant infections. *Ann Periodontol.* 1997;2:343–356.

30. Hurzeler MB, Quinones CR, Kohal RJ, et al. Changes in peri-implant tissues subjected to orthodontic forces. *J Periodontol.* 1998;69:396–404.

31. Piattelli A, Scarano A, Piattelli A. Histologic observations on 230 retrieved dental implants: 8 years experience (1989–1996). *J Periodontol.* 1998;69:178–184.

32. Eke PI, Braswell LD, Fritz ME. Microbiota associated with experimental peri-implantitis and periodontitis in adult Macaca mulatta monkeys. *J Periodontol.* 1998;69:190–194.

33. Meffert RM. Periodontitis vs. peri-implantitis: The same disease? The same treatment? *Crit Rev Oral Biol Med.* 1996;3:278–291.

34. Rosentiel SF, Land MF, Fujimoto J. *Contemporary Fixed Prosthodontics.* 2nd ed. St. Louis: Mosby-Year Book; 1995:416–419.

35. Turpin YL, Tardivel RD, Tallec A, et al. Corrosion susceptibility of titanium covered by dental cements. *Dent Mater.* 2000;16:57–61.

36. Lowenheim FA. *Modern Electroplating.* 2nd ed. New York: John Wiley & Sons; 1963:5–8, 737.

37. Esposito M, Lausmaa J, Hirsch JM, et al. Surface analysis of failed oral titanium implants. *J Biomed Mater Res.* 1999;48:559–568.

38. Esposito M, Hirsch JM, Lekholm U, et al. Biological factors contributing to failures of osseointegrated oral implants. (I). Success criteria and epidemiology. *Eur J Oral Sci.* 1998;106:527–551.

39. Morais S, Sousa JP, Fernandes MH, et al. Decreased consumption of Ca and P during in-vitro biomineralization and biologically induced deposition of Ni and Cr in the presence of stainless steel corrosion products. *J Biomed Mater Res.* 1998;42:199–212.

40. Charton-Picard F, Eloy R. L'allergie aux alliages utilises en art dentaire et a leurs composants. *Le Chirurgien Dentiste de France.* 2000;970:17–24.

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Abstract Translations [German, Spanish, Portuguese, Japanese]

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ZUSSAMENFASSUNG: Zahnimplantatsbrüche kommen zwar selten vor, ziehen dann aber schwerwiegende klinische Konsequenzen nach sich. Im vorliegenden Bericht erfolgt ein Überblick über die Literatur, außerdem werden ursächliche Gründe für eine Implantatsfraktur vorgestellt. Galvanische Aktivität, die bei Kontakt zum Oberbau auftreten kann, wurde bislang noch nie mit der Entstehung von Implantatsbrüchen in Verbindung gebracht. Dieses Phänomen kann durch den Fall eines Titanimplantats näher beleuchtet werden, das nach Wiederherstellung mittels unedler PFM-zementierter Krone 4 Jahre nach Belastung eine Fraktur aufwies. Bei Röntgenuntersuchungen wurde alveolare Knochenresorption rund um die Anlagerungsstelle festgestellt. Metallurgische Analysen ergaben, dass die Implantatsfraktur durch Ermüdungserscheinungen im Metall hervorgerufen wurde. Auch wurde innerhalb dieser Untersuchungen festgestellt, dass das Metall der Krone, eine Nickel-Chrom-Molybdän-Legierung, korrodierte. Aufgrund dieser Ergebnisse kann der neuartige Rückschluss bezüglich der Entstehung von Implantatsfrakturen erfolgen, dass aus der Basismetalllegierung austretende zytotoxische Nickelionen zu Knochenresorption führen können. Dies resultiert in einer erhöhten Implantatbeweglichkeit, die wiederum eine Auswaschung des verbindenden Zements wahrscheinlicher macht. Durch den Kontakt des Basismetalls zum Titan bei Vorliegen von Mundflüssigkeit werden galvanische Ströme erzeugt, die eine Korrosion und ein Auswaschen von Nickelionen begünstigen. Als Resultat tritt weitere Knochenresorption auf, die aufgrund des dann fehlenden Haltes durch die Knochensubstanz zu lateralen Flexionen im Metall und somit zu Ermüdungserscheinungen und eventuell Frakturen führen kann. Daher ist eine sorgfältige Behandlungsplanung und verantwortungsbewusste Fallauswahl für eine Vermeidung solcher Brüche unabdingbar. Auch sollte berücksichtigt werden, dass die Verwendung unedler Metalllegierungen für die Krone ebenfalls zum letztendlichen Bruch des Implantats beiträgt.

SCHLÜSSELWÖRTER: Zahnimplantate, Fraktur, galvanische Korrosion, Nickel, Ermüdungserscheinungen im Metall

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ABSTRACTO: La fractura de implantes dentales es un fenómeno raro con severos resultados clínicos. Se hace una revisión de la literatura sobre el tema y los distintos factores causales que pueden llevar a la presentación de la fractura. La actividad galvánica no se ha mencionado antes como una posible causa de la fractura del implante, sin embargo, puede ocurrir al nivel del contacto con la superestructura. Esto lo ilustra el caso de un implante de titanio restaurado con una corona de porcelana fusionada a metal no precioso que se fracturó cuatro años después de la carga. Las radiografías muestran la reabsorción del hueso alveolar alrededor del aparato. El análisis metalúrgico del implante indicó que la fractura fue causada por la fatiga del metal y que el metal de la corona, una aleación de níquel, cromo y molibdeno exhibieron corrosión. Estas conclusiones de la fatiga sugieren una nueva explicación de la fractura de los implantes: iones de níquel citológicos, que salen de la aleación del metal de la base podría causar la reabsorción del hueso. Esto a su vez lleva a una mayor movilidad que facilita la eliminación del cemento para moldes. El contacto del metal de la base con el titanio en la presencia de líquidos orales produce corrientes galvánicas que aceleran la corrosión y eliminación de iones de níquel, llevando a una reabsorción adicional del hueso. La pérdida del soporte del hueso permite momentos de movimientos laterales que causan fatiga del metal eventualmente llevando a la fractura. Por lo tanto, una buena planificación del tratamiento y selección apropiada del caso podría haber prevenido esta fractura. Además, el uso de una aleación de metal no precioso para la infraestructura de la corona podría haber contribuido adicionalmente a la cadena de eventos que llevó a la fractura del implante.

PALABRAS CLAVES: implantes dentales, fractura, corrosión galvánica, níquel, fatiga del metal

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SINOPSE: a fratura de implantes odontológicos é um fenômeno raro com resultados clínicos severos. A literatura foi revisada e vários fatores causadores que podem levar à fratura são apresentados. Atividade galvânica não foi mencionada anteriormente como uma causa possível de fratura de implante. Entretanto, a mesma pode ocorrer no ponto de contato com a superestrutura. Isto pode ser observado no caso de um implante de titânio restaurado com uma coroa cimentada PFM não preciosa fraturada 4 anos após a colocação. As radiografias mostram reabsorção do osso alveolar ao redor do suporte de fixação. Uma análise metalúrgica do implante indicou que a fratura foi causada por fadiga do material e que o metal da coroa, uma liga de níquel-cromo-molibdênio, apresentou corrosão. Estas observações sugerem uma nova explicação para fraturas de implantes: íons de níquel citotóxicos e lixiviação vinda da liga de metal da base podem causar reabsorção do osso. Isto, por sua vez, leva a uma maior mobilidade, facilitando a lavagem do cimento de obturação. O contato da base de metal com o titânio na presença dos fluídos bucais produz correntes galvânicas que aceleram a corrosão e a lixiviação dos íons de níquel, causando assim ainda mais reabsorção. A perda do suporte ósseo permite momentos de movimentação lateral que causam fatiga do material, eventualmente levando à fratura. Portanto, um bom planejamento de tratamento e uma seleção apropriada de caso poderiam ter evitado tal fratura. Ademais, a utilização de uma liga de metal não precioso para a infra-estrutura da coroa contribui com a cadeia de eventos que levou à fratura do implante.

PALAVRAS-CHAVES: implantes odontológicos, fratura, corrosão galvânica, níquel, fadiga de material

デンタルインプラントの破損：文献調査と症例報告

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概要：デンタルインプラントの破損は稀に起こるが、その臨床的影響は大きい。本論文ではそれについての過去の文献が調査され、起こしうる各種の要因が論じられる。superstructureとの接触面で発生しうる電気的活動は、これまでインプラント破損の原因として論じられたことがなかった。それが起こりうることが、設置4年後に破損を来たした非貴金属PFMセメントクラウンで修復されたチタンインプラントの症例で示される。固定部位周辺の歯槽骨吸収がX線写真で観察され、クラウンのニッケル・クローム・モリブデン合金が腐蝕を起こしており破損が金属疲労によるものであったことがインプラントの冶金学的分析で示される。これらの発見によって、細胞毒性のニッケル・イオンのベースメタルアロイからの滲出が骨吸収の原因となるという、インプラント破損の新しい説明が可能になる。これがさらに易動性を高めルーティングセメントの溶出を起こす。唾液の存在下のベースメタルとチタンの接触でガルヴァーニ電気が起こり、腐食とニッケル・イオン溶出を促し、骨吸収がさらに悪化する。骨サポートの損失によって側方曲げモーメントが起こり、これによる金属疲労が最終的に破損を起こす。この発見は、慎重な治療計画と処置選択でこのような破損を予防でき、クラウンのinfrastructureとしての非貴金属性メタルアロイがインプラント破損に帰結する一連の現象の要因となることを示している。

キーワード：デンタルインプラント、破損、電蝕、ニッケル、金属疲労

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