Review Article

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Dental Implant Fractures – Aetiology, Treatment and Case Report

Dentistry Section

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ABSTRACT

Purpose: This study aimed to investigate the etiology, clinical manifestations, and treatment options of dental implants fractures through a literature review and to relate a clinical report.

Methods: A literature review was performed using the Medline database and this paper describes a case demonstrating the management of implant fracture. Twenty two articles were selected in the present literature review.

Results: Nowadays the use of dental implants to rehabilitate completely and partially edentulous patients became the best treatment option; however, this treatment is suitable to failure. The fracture of implant body is a possible complication. The fracture of implant body is a late complication and is related to the failure in implant design or material, non-passive fitting of the prosthetic crown and overloading. Clinically, prosthesis instability and spontaneous bleeding are observed. Three options of treatment have been indicated: complete removal of implant fragment, maintenance of implant fragment, and surface preparation of the fragment with insertion of a new abutment.

Conclusion: The literature indicates the complete removal of the fragment as the best treatment option.

Keywords: Dental Implantation, Bone reabsorption, Treatment failure

INTRODUCTION

The use of implant-supported dentures for rehabilitating partial and total edentulous patients has promoted the function recovery of the stomatognathic system, in addition to preserving the dental structures, and providing longevity of the treatment. Due to the high success rates, the insertion of dental implants has become a knowable treatment solution for several patients [1].

A total 95.3% cumulative success rate of implants inserted in partial edentulous areas has been shown by previous studies after 3-7 years of loading [2]. Nevertheless and not surprisingly, several complications which involve dental implants are still prone to occur and dental surgeons must be attentive to this situation, to prevent further biomechanical problems and implant failures [3]. These complications can involve loosening or fractures of the prosthetic and abutment screws, as well as implant fractures [1].

Implant fractures are a frustrating problem not only for patients, but also for clinicians, since they usually involve loss of both the implants and the prostheses [4].

A fracture is an infrequent complication which affects two out of every 1,000 implants [3,5-8]. Those studies that make no mention of this complication usually involve a limited number of patients and implants, and the follow-up is typically short [9,10].

Implant fractures constitutes clear implant failures and in most of the cases, they require implant removal [8].

The objective behind doing the present literature review was to analyze the causes of dental implant fractures and to describe the treatment options for these failures, aiming to help the clinicians to properly plan the implant-supported prosthesis treatment by considering important biomechanical aspects of this type of rehabilitation.

MATERIALS AND METHODS

Medline database was used to conduct the present literature study. The keywords, “dental implant fracture” and “implant failures” were used during the search. The search was restricted to articles published in the years, 1995 to 2013. Only English language clinical reports, literature reviews and in vitro studies were included. Animal and in vitro studies that were not related to implant body fractures were excluded. Therefore, a total of twenty two articles were selected in the present literature review.

This research was approved by our local institutional review board.

RESULTS

The results of this literature review have been presented in [Table/Fig-1].

DISCUSSION

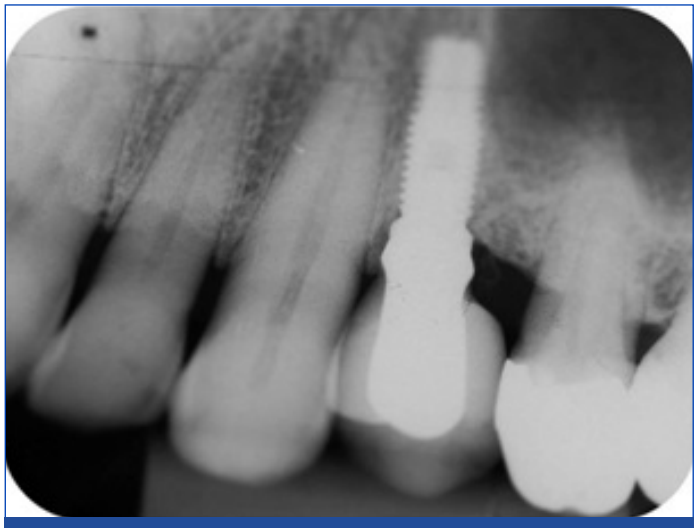
Aetiology

The time that the failure occurs is used to classify the type of failure. When it happens before or at abutment insertions, it is considered as an early failure, and it may be attributed to drawbacks which occur during osseointegration healing phase. On the other hand, after occlusal loading [Table/Fig-2], any problem which occurs with the implant-prosthesis set is considered as a late failure, and it is related to any process that may affect the maintenance of previously established osseointegration [11].

Authors	Purpose	Conclusions
Mendonça et al., [1]	To report on a clinical situation involving a patient restored with a mandibular overdenture that presented a fractured implant 2 years after placement.	The probable cause of the implant fracture was due to biomechanical overload caused by parafunctional habits. The implant head was flattened to make it smooth, retapping the internal screw, installing a new abutment (longer), and fabricating part of the overdenture bar.
Al Quran et al., [2]	To report on a case of implant fracture, its possible causes, and how the case was managed.	The combined effect of the heavy occlusal loading and the type of opposing tooth contacts may have resulted in load concentration over the implant-supported fixed partial denture in both centric and excentric occlusion.
Eckert et al., [3]	To determine the incidence of implant fracture in completely edentulous and partially edentulous arches and to determine what factors may predispose an implant to a higher fracture risk.	Implants fracture at similar rates in the maxilla as in the mandible, implant fractures occur more frequently in partially edentulous restorations, all observed fractures occurred with commercially pure 3.75-mm-diameter threaded implants, and prosthetic or abutment screw loosening preceded implant fracture for the majority of the implants.
Gealh et al., [4]	To investigate the literature to identify causative factors that may lead to fracture of dental implants and to discuss available procedures.	The fracture of osseointegrated dental implants is a late complication that, despite presenting low incidence, is highly frustrating. The causes attributed to the fracture of dental implants are multifactorial. The treatment consists of the removal of the fractured fragment, the installation of another implant and the manufacturing of another prosthesis.
Brägger et al., [5]	To compare the frequency of biological and technical complications with fixedpartialdentures (FPDs) on implants, teeth and as mixed tooth-implant supported FPDs over 4 to 5 years of function.	Favourable clinical conditions were found at tooth and implant abutments after 4-5 years of function. Loss of FPD over 4-5 years occurred at a similar rate with mixed, implant or tooth supported reconstructions. Significantly more porcelain fractures were found in FPDs on implants. Impaired general health status was not significantly associated with more biologicalfailures but bruxism as well as extensions were associated with more technicalfailures.
Berglundh et al., [6]	To systematically review the incidence of biological and technicalcomplications in implant therapy reported in prospectivelongitudinalstudies of at least 5 years.	Implant loss was most frequently described (reported in about 100% of studies), while biologicalcomplications were considered in only 40-60% and technicalcomplications in only 60-80% of the studies. This observation indicates that data on the incidence of biological and technicalcomplications may be underestimated and should be interpreted with caution.
GargalloAlbiol et al., [7]	To evaluate 21 fractured implants, with an analysis of patient age and sex, the type, length and diameter of the implant, positioning in the dental arch, the type of prosthetic rehabilitation involved, the number of abutments and pontics, the presence or absence of distal extensions or cantilevers, and loading time to fracture.	Implant fracture was more common in males than in females, and the mean patient age was 56.9 years. Nineteen cases corresponded to implant-supported fixed prostheses. The great majority of fractured implants were located in the molar and premolar regions, and most fractured within 3-4 years after loading. It is important to know and apply the measures required to prevent implant fracture, and to seek the best individualized solution for each case - though complete implant removal is usually the treatment of choice.
Sánchez-Pérez et al., [8]	To describe the management options and discusses the possible causal mechanisms underlying such failures, as well as the factors believed to contribute to implant fracture.	Implant fracture is often preceded by other mechanical problems that can be interpreted as indicators of implant overload. It is important to avoid mechanical problems and excessive bone reabsorption. Attention should focus on the number, diameter and distribution of the implants, as well as on the design of the prosthesis supported by them. When implant fracture occurs, the best management option is to remove the fragment remaining in the maxilla or mandible. The new implant replacing it should be as wide as possible, with due checking and adjustment of the occlusal forces in order to avoid overload.
Jemt & Lekholm [9]	To report on almplanttreatment in edentulousmaxillae.	Five-year cumulative implant failure rates varied from 7.9% for patients considered to have enough bone to be provided with fixed prostheses immediately after second-stage surgery to 28.8% for those with severely resorbed jaws receiving an overdenture. Failure of implanttreatment correlated significantly with bone quality and ratio of 7-mm implants.
Gotfredsen & Karlsson [10]	To evaluate whether there was a difference between machined and TiO(2)-blasted implants regarding survival rate and marginal bone loss during a 5-year observation period.	Good 5-year results with small ISFPP in the mandible, as well as in the maxilla were showed. No significant differences were found in failure rate and marginal bone loss around implants with a machined rather than a TiO(2)-blasted surface.
Alssadi et al., [11]	To assess the influence of systemic and local bone and intra-oralfactors on the occurrence of early implant failures, i.e. up to the abutmentconnection.	The indication for the use of oral implants should sometimes be reconsidered when alternative prosthetic treatments are available in the presence of possibly interfering systemic or localfactors.
Romeo et al., [12]	A systematic review was carried out to evaluate the success and survival rate of implants supporting cantilever prosthesis, as well as the incidence of technical and biological complications.	ICFDPS can be considered a r eliable treatment: the systematic review assessed that there is no increase in complication rate due to the presence of the cantilever.

Manor et al., [13]	To characterize and compare early and late implant failures.	Late failures were associated with moderate to severe bone loss, a larger number of failed implants per patient, a higher incidence in men, and mostly in posterior areas. Early failures were associated with minimal bone loss, occurred more in women, at a younger age, and in most cases the implants were intended to support single crowns.
Balshi [14]	To analyze fractured implants.	All fractures had associated marginal bone loss. The majority were supporting posterior prostheses. Parafunctional habits were diagnosed in all patients. Most patients presented with loosening or fracture of prosthetic gold screws or abutment screws prior to fracture. This study reports on the treatment of fractured implants accomplished by refacing the fractured titanium and adapting new abutments or replacing the entire implant with subsequent prosthesis refabrication.
Velásquez-Plata et al., [15]	To report on the fracture of a standard endosseous dental implant 11 years after placement.	Scanning electron microscopy revealed striations on the fracture surface, suggesting a fatigue-associated failure.
Piattelli et al., [16]	To present a light and scanningelectronmicroscopic study of fourfracturedimplants.	The scanningelectronmicroscopic study of the fractured surfaces of all fourimplants showed the presence of fatigue striations. Bending overload was probably created by a combination of parafunctional forces, boneresorption, posterior location of the implants, and implant diameter.
Gargallo-Albiol et al., [17]	To evaluate 21 fractured implants and their characteristics.	Implant fracture was more common in males, the mean patient age was 56.9 years, corresponded to implant-supported fixed prostheses, located in the molar and premolar regions, and most fractured within 3-4 years after loading.
DiPede et al., [18]	To evaluate the effect on the failure load of preparing a 0.5-mm chamfer finish line on an implant collar at apical depths.	The mean load required to fracture the abutment/implant assembly decreased significantly after various amounts of implant collar preparation.
Mangano et al., [19]	Evaluation of the peri-implantbone responses in implantsretrieved for fractureaftermore than 20 yearsloading.	Histology and histomorphometry showed that, even after many years of function, all implants presented more than adequate bone to implant contact and they appeared to be very well integrated in the peri-implantbone.
Mc Dermott et al., [20]	To identify the types, frequencies, and riskfactorsassociated with complications following placement of dentalimplants.	The overall frequency of implant complications was 13.9% (10.2% inflammatory, 2.7% prosthetic, 1.0% operative), of which 53% were minor Of the 3 factorsassociated with an increased risk for complications, tobacco use and implant staging may be modified by the clinician to enhance outcome.
Goodacre et al., [21]	To determine the types of complicationsthat have been reported in clinical dental implant studies and to provide data regarding their frequency.	Mechanical complications were screw loosening/fracture, implant ractures, framework, resin base and veneering material fractures, opposing prosthesis fractures, and overdenture mechanical retention problems. Some studies also presented phonetic and esthetic complications.
Flanagan [22]	To report on a case of external and occlusaltrauma to dentalimplants.	A traumatic force damaged the implant prosthetic crown, but not the bone encasing the implant or the integration of the implant.

[Table/Fig-1]: Reviewed papers purpose and final considerations



[Table/Fig-2]: Oclusal loading: Implant and prosthetic crown

It has been shown that late failures are mainly related to peri-implantitis (32%) [12], overloading (46.4%), and implant fractures [13] [Table/Fig-3].

[Table/Fig-3]: Implant fracture

The causes of implant fractures may be grouped into three categories: 1) failures which are related to the material and design of the implant; 2) absence of fit between implant and crown and, 3) parafunctional habits (e.g. bruxism) [14].

Both the overload and the no passive fit can cause fractures or frequent loosening of the prosthetic screws before occurrence of implant fractures [12]. These small complications are warning signs that cannot be ignored and they should be addressed, to prevent more invasive, costly, and time-consuming procedures [1,3,15].

For diagnostic purposes, Sánchez-Pérez et al., grouped the fracture risk factors into three main categories: patient related factors, implant related factors and prosthesis related factors. "Patient factors" include pocket depth of 5 or more millimetres; bone loss; and overload (bruxism). "Implant factors" include a diameter which is smaller than 4 millimetres 12, a crown/implant rate which is greater than 1 and implant design. "Prosthetic factors" include loosening or torsion of the prosthetic screws, cantilevers and ceramic fractures. In the presence of more than three factors which pertaini to one or more of these categories, the risk of fractures is high [16-19].

1. Bone tissue resorption is caused by infection or peri-implantitis. Among the implants that are still under function, a total of 4-15 present with any sign of peri-implantitis [16,17].

2. Mechanical problems which occur include fractures. Metal fatigue caused by biomechanical overloading appears to be the most frequent cause [16-19].

According to McDermott et al., [20], some of the factors which alert us about a fracture risk are an excessive occlusal load, the location of the implant (posterior versus anterior, maxilla versus mandible), an insufficient number of implants which support the prosthesis as a result of incorrect biomechanical planning, the material from which the prosthetic screws are made, and an implant diameter of under 3.5 mm.

Overload can also be a consequence of patient physiological alterations (e.g., parafunctional activity). In fact, both centric and eccentric bruxism can lead to implant overload and metal fatigue. For this reason, patients with any sign of parafunction should be treated with an increased number of dental implants and they should use acrylic resin occlusal splints [12,16,17,21,22]. Several prosthetic crown factors such as non-balanced occlusions, the presence of distal cantilevers, and the presence of misfits between implants and prosthetic crowns have been attributed to the presence of overloading [12,16,17,21,22].

When vertical bone loss coincides with the apical limit of the screw which joins trans epithelial abutment to implant, the risk of an implant fracture increases considerably [21].

Clinical manifestations

Patients may often report spontaneous bleeding and mobility. Implant fractures are often associated with inflammatory responses on the part of the mucosa which surrounds the fracture site. In this context, bleeding in response to probing is frequent, and high gingival index scores are observed [8].

An X-ray study is very useful. Bone loss surrounding the implant appears to be a constant finding. Before implant fracture occurrence, signs of bone loss can be visualized through X-ray examinations. Several studies have attributed peri-implant bone resorption as an essential factor of implant fracture risk, and this resorption can far the fracture line [1,4,5,7,8,13,15].

Histological data

Mangano et al., evaluated histological and histomorphometrical characteristics of the peri-implant bone responses in implants which were retrieved for fractures after more than 20 years loading. A total of 5 implants which were retrieved after a loading period of more than 20 years, were found: 2 had been retrieved after 20 years, 1 had been retrieved after 22 years, 1 had been retrieved after 25 years, and 1 had been retrieved after 27 years. All these implants were histologically processed. Compact, mature bone which lay in close contact with the implant surface was observed in all specimens, with no gaps or connective tissues at the interface. Around some implants, bone was found, which was in different maturation stages. Mainly, in proximity of the implant surface, the presence of newly formed bone was observed, while in areas which were distant from the implant, mature, compact bone with many remodeling areas and cement lines was detected. Many primary and secondary osteons were present. Bone to implant contact percentage varied from 37.2% to 76%.

Treatment

While facing an implant fracture, three options of treatment are available [1,8,14,17].

1- Remove the fractured implant by means of trephines. The current implant which is marked, provides different designs of trephines according to the dimensions of the fractured implants (i.e. diameter and length). After fractured implant removal, a new implant can be installed at the same surgical bed or at another place. While placing the new implant into the same bed, the dental surgeon should pay attention to the diameter of trephine, because it can affect the primary stability of the new implant [17].

A recent study described "apicoectomy" as a suitable technique for removing fractured implants and inserting new implants at the same clinical session. This technique was based on opening a hole in the bone, in order to improve the visualization of the apical fragments of the fractured implants and to remove those fragments through this hole. Afterwards, a new implant is placed in a conventional manner, and the hole is closed by using the same bone which is removed from the patient [4].

2) Removal of the coronal portion of the fractured implant with the purpose of placing a new prosthetic post1: Some brands of implants offer a kit for this purpose, including a rotary instrument to smoothen the fracture edges, and an instrument for working new internal threading for the implant [17].

3) Removal of the coronal portion of the fractured implant, leaving the remaining apical part integrated in the bone: In case there is no need of new implant insertion, the actual crown may be changed to fit to this situation. Otherwise, if a new implant is necessary to support the prosthesis, it may be implanted in another place, but the anatomical limitations should be considered [17].

Complete implant extraction can be the treatment of choice [1,8,14,17]. However, when percentage of contact with bone is high, and when fracture is not located too far apically, restoration of the connection between post and implant may be a valid option. To this effect, it is essential to radiologically confirm the absence of radiotransparency, and to determine mobility of the fragment electronically. This option should only be contemplated if there are still enough remaining internal threads to guarantee adequate prosthetic post retention [14].

Recently, a study was conducted on load which was required for occurrence of fractures of the abutments / implants after various amounts of implant collar preparations (0.5-mm chamfer margin placed 1 or 2 mm apical to the implant / abutment interface). This preparation implant collar reduced a significant fracture load.

Clinical Report

Clinical examination of a 58-year-old female who presented without maxillary left 1st bicuspid: The existing mandibular restorations were a tooth-supported, metal-ceramic, fixed partial denture which extended from the left 1st bicuspid to 2nd molar and a removable partial denture which restored the right 2nd bicuspid to 2nd molar in a Kennedy class II partially edentulous jaw.

After completing clinical and diagnostic evaluations, an optimal treatment plan was formulated to place 1 implant in the area of the maxillary left 1st bicuspid, to support a fixed partial denture.

One dental implant which was 4.1mm in diameter and 11.5mm in length (SIN Sistema de Implante, São Paulo, Brazil) was placed in the area of the maxillary left 1st bicuspid. After a healing period of 6 months, the implant was restored with the proposed fixed partial denture, with a 1st bicuspid [Table/ Fig-1].

One year later, the patient presented on an emergency visit, complaining of pain and mobility in the implant-supported, fixed partial denture area.

Clinical examination revealed that the fixed partial denture exhibited some mobility. On removing the prosthesis, a part of the implant came out with the crown. The implant was fractured in the crown third [Table/ Fig-1]. The fractured implant was removed with trephine at the same clinical session. We waited for three months to insert new implant. A treatment plan was made for the patient to retrieve the fractured implant and to receive new a dental implant with modifications in the implant and prosthetic designs.

CONCLUSION

The most important concern is fracture prevention. For this reason, it is very important to provide an adequate rehabilitation plan taking into consideration, the use of a greater number of implants with wider diameters, mainly in the posterior regions. For prosthetic crowns, optimized and distributed occlusions should be provided. In presence of implant fractures. Complete removal of the fractured implants and the placement of new implants is the best option of treatment. In summary, dental surgeons should be aware about the factors that prevent implant fractures. In case of implant fractures, their complete removal is considered as the best solution of treatment.

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