The widespread use of endosseous osseointegrated implants to replace missing natural teeth increases the chances of implant complications and failures, despite the high initial success rate reported in the literature. Implant fracture is one possible complication that results in ultimate failure of the dental implant. Such a complication poses a management crisis even for the most experienced clinician. This article reports on a case of implant fracture, its possible causes, and how the case was managed.

Key Words: fracture, implant, partial denture

INTRODUCTION

The restoration of partially and completely edentulous patients with dental implants has become a first-choice treatment modality in modern dentistry for certain clinical situations. Prospective and longitudinal studies related to partial edentulism have indicated cumulative implant success rates ranging from 89 to 95.3% and cumulative survival rates ranging from 93.6 to 96.7% 3–7 years after loading.

This treatment modality is not problem-free however, and is associated with multiple complications that can lead to failure. One unfortunate complication immediately results in implant fracture. Such a complication poses a management crisis even for the most experienced clinician.

This article reports on the fracture of a dental implant, and how the case was managed.

CASE REPORT

A 67-year old female presented with a complaint that her existing maxillary removable partial denture had poor fit and retention (Figure 1). Clinical examination revealed 2 metal-ceramic crowns on the maxillary right 2nd bicuspid and 1st molar (Figure 1), and a class I Kennedy classification provisional acrylic removable partial denture restoring the maxillary right 2nd molar and all dentition spanning from the maxillary right 1st bicuspid to the maxillary left 2nd molar. The existing mandibular restorations were a tooth-supported, metal-ceramic, fixed partial denture extending from the left 2nd bicuspid to 2nd molar, a metal-ceramic crown on the right 1st bicuspid and a removable partial denture restoring the right 2nd bicuspid to 2nd molar in a Kennedy class II partially edentulous jaw (Figure 2).

After completing clinical and diagnostic evaluations, an optimal treatment plan was formulated to place 2 implants in the areas of the maxillary left 1st bicuspid and 1st molar to support a three-unit fixed partial denture, and a Kennedy class IV removable partial denture to restore the ridge from the maxillary right 1st bicuspid to the left cuspid.

Two dental implants (Bicon Dental Implants, Bicon, Boston, Mass) were placed in the areas of the maxillary left 1st bicuspid and 1st molar in March 1999 (Figure 3). The implants were 3.5 mm in diameter and 11 mm in length. After a healing period of 4 months, the implants were restored in July 1999 with the proposed 3-unit, metal-ceramic, fixed partial denture with a 2nd bicuspid bound pontic. A Kennedy...
FIGURES 1–6. FIGURE 1. The maxillary arch of a 67 year old female with existing restorations were 2 metal-ceramic crowns on the right 2nd bicuspid and 1st molar teeth. FIGURE 2. The existing mandibular restorations were a tooth-supported metal-ceramic fixed partial denture extending from the left 2nd bicuspid to 2nd molar, a metal-ceramic crown on the right 1st bicuspid and a removable partial denture restoring the right 2nd bicuspid to 2nd molar. FIGURE 3. Periapical radiograph of the 2 dental implants placed in the area of the maxillary left 1st bicuspid and 1st molar. FIGURE 4. Abutments placed on implants. FIGURE 5. A 3-unit metal-ceramic fixed partial denture that had a bound pontic in the 2nd bicuspid area and a Kennedy class IV removable partial denture with acrylic teeth was fabricated to restore the partially edentulous ridge from the right 1st bicuspid to the left cuspid restoring definitive protheses inserted in position. FIGURE 6. Periapical radiograph showing fractured distal implant.
class IV removable partial denture with acrylic teeth was fabricated to restore the partially edentulous ridge from the right 1st bicuspid to the left cuspid. The treatment was finished by August 1999 (Figures 4 and 5).

Five years 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 part of the distal implant came out with the denture. The distal implant was fractured in the middle third (Figures 6 and 7). The fixed partial denture, along with the coronal portion of the fractured implant, was retrieved under local anesthesia. The plan was to remove the abutment on the mesial implant and replace it with an O-ring abutment, then fabricate a Kennedy Class II maxillary overdenture to restore the ridge from the 1st bicuspid to the left 2nd molar.

According to the manufacturer (Bicon) abutments are retrievable and could be removed utilizing an extracting forceps and applying a pull and rotation force. Attempts to retrieve the abutment using this technique failed, however, and the abutment could not be removed from the remaining mesial dental implant. As a result, the treatment plan was modified. The fixed partial denture was sectioned and the crown on the mesial implant was retained and cemented back in place (Figure 8). The removable partial denture was modified by adding 2 teeth and delivered back to the patient.

In March 2005 the patient presented with part of the remaining dental implant in her hand. The implant in the first premolar region was fractured (Figures 9 and 10). A treatment plan was made for the patient to receive new a dental implant with modifications in the implant and prosthetic designs.

**Discussion**

Dental implant fracture generally occurs as a rare late complication of dental implant treatment. The report-
ed incidence of this complication varies in the literature. Dental implants are government regulated devices in the United States. All failed, retrieved, including fractured, implants that are returned to companies are reported to the Food and Drug Administration (FDA) by law. This information is available from the FDA for every implant system.

Regarding the Branemark dental implant system, in a long long-term multicenter study Adell et al.\(^1\) reported a cumulative implant fracture rate of less than 5% in both the maxilla and the mandible over a period of 10 to 15 years, with the exception of one study group where the fracture rate reached 16% in the maxilla. Eckert et al.\(^2\) reported an implant fracture rate of 0.6% in both the maxilla and the mandible.\(^2\) More implant fractures occur in partially edentulous arches (1.5%) compared to completely edentulous arches (0.2%).\(^2\) Jemt and Lekholm\(^3\) reported the fracture of 1 implant out of 259 implants loaded.

Dental implant fracture is primarily attributable to fatigue stress that results from repeated loading of the dental implant. Absence of the periodontal ligament present within natural teeth and the direct apposition to bone would not allow the dental implant to move under loading to accommodate for occlusal forces. This may result in excessive overloading leading to mechanical failures. With most dental implant systems, the screws are the usual weak link resulting in screw loosening and/or fracture. This does not apply to dental implants (Bicon) in this report, which do not have connecting screws. The connection between the abutment and the implant is obtained through a 1.5\(^\text{u}\) locking taper mechanism, which eliminates the need for screws.

Adverse loads generated by occlusal forces induce wide varieties of mechanical failures in the dental implant components ranging from screw loosening to fractures of both screws and implants. This mechanical rupture and failure is higher in the posterior region compared to the anterior region and is magnified in the event of single- or two-implant configurations, the presence of a cantilevered prosthesis, nonaxial loading, or with bruxism and heavy occlusal forces. Another probable risk factor involved is crestal bone resorption which can occur over time.\(^4\) This risk factor is aggravated by the increased occlusal loading resulting in crater-like crestal bone loss as seen in animal studies.\(^5\) This results in increasing the crown-root ratio as well as the torque forces and flexure on the dental implants leading to fatigue stress fracture.

In this clinical case, the patient occlusal loads were excessive, as revealed by the wear facets and attrition of the incisal edges of the mandibular anterior teeth (Figure 11).

The narrow diameter of the implants that replaced the 1st molar and the 1st premolar could also have contributed to the fracture. One other dynamic factor in this patient is the opposing occlusion. The maxillary right 2nd bicuspid and 1st molar are metal-ceramic crowns and are opposed by the acrylic teeth of the definitive mandibular removable partial denture (ceramic vs. acrylic) (Figure 12). The implant-supported metal-ceramic fixed partial denture opposed the metal-ceramic partial denture (ceramic vs. ceramic).

\(1^\text{st molar, 1st premolar, maxillary right 2nd bicuspid, and 1st molar are metal-ceramic crowns. The opposing occlusion is comprised of acrylic teeth.} \)
metal-ceramic fixed partial denture restoring maxillary left 2nd bicuspid and 2nd molar and the natural 1st premolar (ceramic vs. ceramic) (Figure 13). The acrylic teeth of the maxillary removable partial denture opposed the natural mandibular teeth ranging from the left 1st bicuspid teeth to the right canine and the metal-ceramic crown on the right 2nd bicuspid (acrylic vs. natural teeth and ceramic) (Figures 12 and 13).

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 eccentric occlusion. This load could have increased gradually with time as the acrylic tooth contacts wore out by the opposing dentition in areas other than the implant-supported fixed partial denture. This extra loading probably resulted in the fracture of both implants with time.

It is suggested that careful, periodic occlusal evaluation and analysis before and after implant restorations should be carried out. A sound adoption of biomechanical principles must also be considered in the planning of combined tooth and implant supported partial dentures.

REFERENCES

3. Jemt and Leckholm