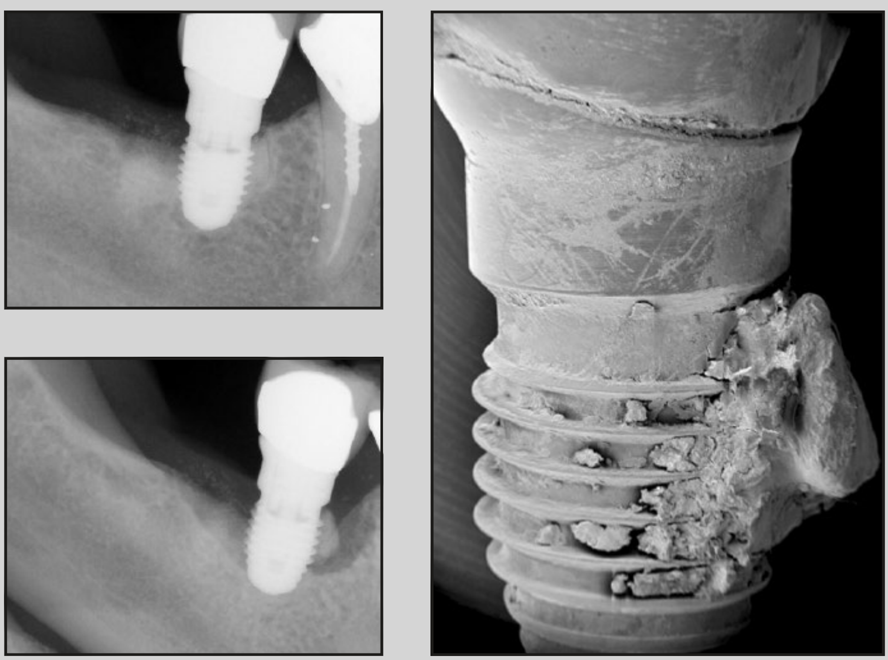
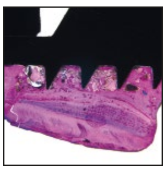


Late Dental Implant Failures Associated with Retained Root Fragments: Case Reports with Histologic and SEM Analysis



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Interest has recently developed in the purposeful retention of root fragments with their periodontal apparatus to support bone and soft tissue at immediate implant sites in the esthetic zone. This methodology is designed to avoid bone grafting, connective tissue grafts, and the use of membranes and may have short-term benefits in terms of tissue preservation. However, it is not completely without long-term risks. At times, implants may be unintentionally placed into edentulous sites where root fragments remain. This report presents two cases of long-term failure postloading associated with unintentionally retained root fragments. Histologic evaluation evidenced retained root fragments in close association with dental implants and the surrounding bone. Scanning electron microscopic evaluation revealed that the failed implant surfaces were infiltrated by bacterial deposits and calculus. Clinicians should exercise caution when placing dental implants in sites with retained root fragments, as long-term risks may be associated with this therapy. Int J Periodontics Restorative Dent 2018;38:9–15. doi: 10.11607/prd.3463

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Osseointegration and subsequent long-term peri-implant health depend on a healthy osseous and soft tissue foundation for the dental implant. Reliable, stable integration has been documented in multiple rigorous long-term studies.[1–3] Due to careful observation, scientific study, and long-term follow-up, osseointegration has become a routine treatment for the failing dentition. The quest to improve implant prosthetics and gingival harmony in the esthetic zone has become the focus in improving implant treatment for patients over the last few decades. However, even atraumatic extraction procedures have been shown to produce soft tissue shrinkage and bony concavities in the alveolar ridge due to physiologic resorption of up to 56% when not aided by bone graft procedures or soft tissue augmentation techniques.[4–9] Recent reports suggest that dental implants immediately placed in esthetic sites combined with the purposeful maintenance of the buccal or proximal aspect of root fragments will result in improved esthetics due to bone and soft tissue volume preservation; however, these reports in humans are limited in duration of follow-up.[10–12] An exception is a report on 46 implants followed for up to 5 years (median: 40 months). This technique was limited to periodontally sound teeth with nonrestorable caries, cervical root resorption, or supracrestal horizontal fractures and excludes teeth with acute inflammation, moderate or severe periodontal disease, and/or facial attachment loss greater than 3 mm.[13]

Recently, evidence has been presented regarding the risk retained root fragments pose to the long-term health of dental implants.[14,15] Two of these reports presented histologic evidence of root-to-implant contact or proximity associated with the adverse complication of late implant failure. Guarnieri et al[14] presented a case report of a sandblasted cylindrical implant that failed with a previously undetected root fragment attached. The histology demonstrated cementum on the implant surface but no periodontal ligament. Langer et al[15] reported a case series of six patients with seven examples of late dental implant complications or failures associated with retained root fragments becoming infected long after implant placement and restoration. This report stressed the need for careful extraction and complete retrieval of fractured root fragments prior to implant placement to maintain a healthy osseous bed for long-term maintenance of osseointegration. The potential complications related to peri-implant infection, bone loss, and implant failure were presented.

The goal of this case report is to present radiographic, scanning electron micrographic (SEM), and histologic findings of two cases of late dental implant failures associated with retained root fragments.

Case Report 1

A 47-year-old woman presented for periodontal and implant maintenance in 2007 with an implant in the mandibular right first molar site. Historical review with the patient's previous dental team revealed that the first molar was initially treated with endodontic therapy in 1991, followed by an apicoectomy procedure 7 years later, in 1998 (Fig 1a), but it subsequently fractured and was extracted in 2003. The site was grafted with anorganic bovine bone graft (ABBG) and allowed to heal for 5 months prior to submerged implant placement. The implant was placed in 2003, then uncovered and restored in 2004. The 2007 periapical radiograph demonstrated healthy bone adjacent to the implant, which was clinically stable with minimal probing depths and no bleeding on probing (Fig 1b). It remained stable for more than 8 years, as evidenced by the 2012 radiograph (Fig 1c), where the bone immediately surrounding the implant appears more dense than that adjacent to the natural tooth. The observed increase in opacity adjacent to the implants is not in itself indicative of any pathology as bone density increases due to osseous condensation.[16,17]

In 2014, the patient presented as an emergency with discomfort at the site of the mandibular right first molar implant, now probing 8 to 9 mm with suppuration. The periapical radiograph revealed advanced peri-implant bone loss and an opacity on the mesial surface of the implant consistent with a retained root fragment (Fig 1d). The root fragment was not clearly discernible in the previous radiographs due to the opaque bone grafting biomaterial and the implant-enveloping osseous condensation. It has been shown that a lesion becomes a radiographic radiolucency only when the bone resorption extends to the cortical bone and reaches a critical size defect of 1 to 3 mm.[18,19]

The implant was surgically removed with the presumptive root fragment attached (Fig 2). The socket was debrided and grafted with freeze-dried bone allograft (FDBA) (RegenerOss Particulate Allograft, Zimmer Biomet) combined with recombinant human platelet-derived growth factor-BB (rhPDGF-BB) (Gem 21S, Osteohealth) for ridge preservation in anticipation of replacing the lost implant. The specimen was fixed in formalin and subsequently evaluated via SEM. Eventually, undecalcified ground sections were prepared according to the Donath technique.[20] The sections were evaluated by light microscopy (LM).

The SEM evaluation of the implant/abutment/crown system revealed hard tissue attached to the mesial surface of the implant (Fig 3). The SEM analysis revealed extensive bacterial infiltration on the surface of the implant and calculus formation consistent with peri-implantitis (Fig 4) and the presence of thick biofilm on the implant.[21,22] The calculus is layered on the implant surface, evidencing the extent and duration of peri-implant attachment loss.

Under LM, the implant was integrated to bone consistent with osseointegration, having bone in direct contact with the implant

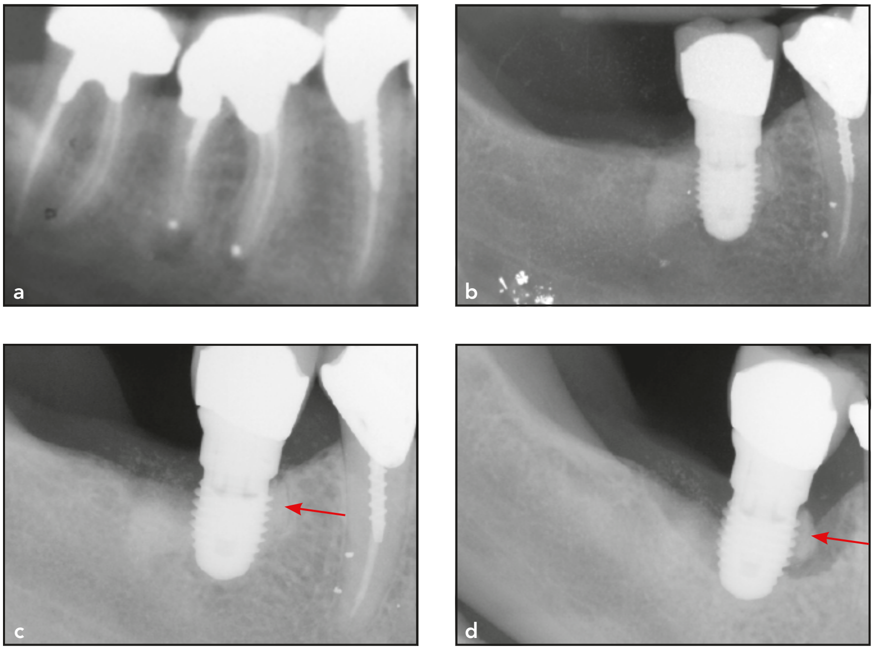


Fig 1 *Mandibular first molar treated in 1991 with endodontic therapy and in 1998 with apical endodontic surgery.* (a) *Section of 1999 panoramic radiograph.* (b) *Dental implant-supported restoration replacing mandibular right first molar with healthy bony profile at 4 years after implant loading in 2007.* (c) *Periapical radiograph at 9-year follow-up. Note the opaque fragment on the mesial side of the implant* (arrow). (d) *Radiograph taken in 2014 reveals failing implant almost 11 years postloading and evidences a retained root fragment attached to the mesial surface of the implant* (arrow).

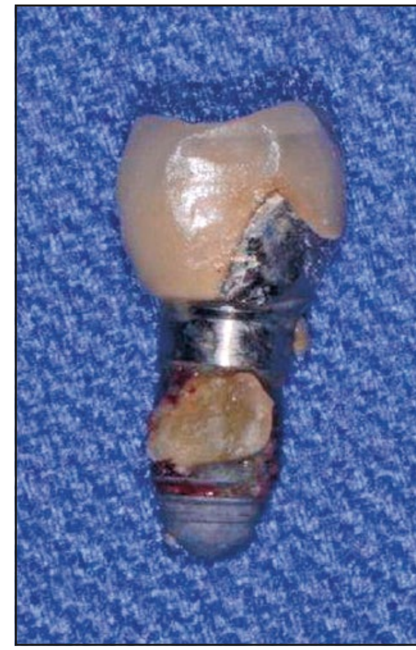
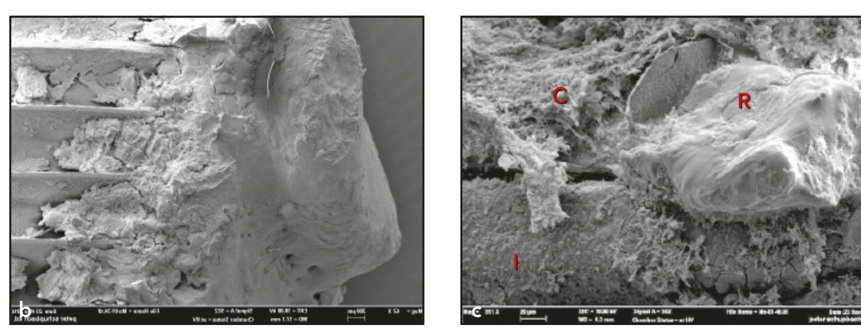


Fig 2 *Clinical view of the retrieved implant.*

Fig 3 *Scanning electron micrograph (SEM) demonstrating hard tissue attached to the mesial surface of the implant.* (a) *×31 magnification.* (b) *×62 magnification.* (c) *×911 magnification. I = implant; R = root fragment; C = calculus.*



(Fig 5a). There was graft biomaterial in close proximity to the fixture; however, new bone formation was evident between the graft material and the implant surface. There was also bone in direct contact with the cementum on the surface of the retained root fragment. The latter was composed of the cementum layer and an adjacent layer of root dentin. Higher magnifications clearly showed the graft material embedded in bone (Fig 5b). Cementum was identified by the presence of cementocytes and dentin by the presence of dentinal tubules. There was no sign of a periodontal ligament.

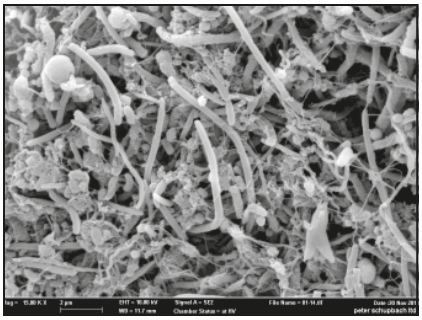


Fig 4 *SEM showing dental calculus and numerous filamentous bacteria.*

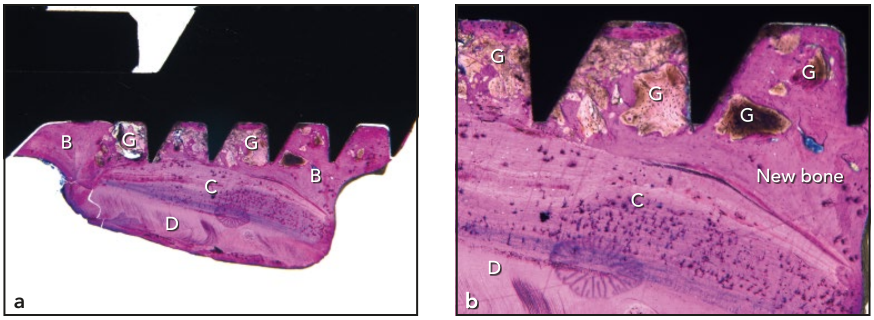


Fig 5 (a) *Ground section showing the presence of cementum (C) and dentin (D) of a root fragment and bone (B) and graft (G) particles interposed between fragment and implant surface.* (b) *Higher magnification revealing the intimate contact between bone (B) and cementum (C).*

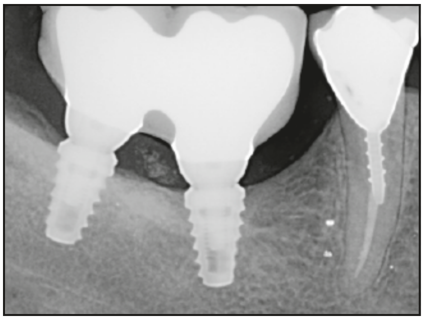
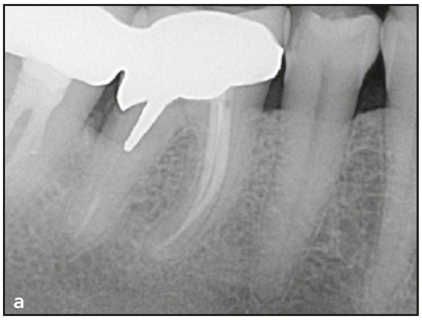
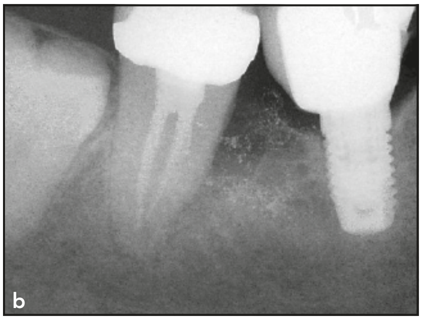


Fig 6 *Radiograph at 1 year postloading of replacement implants.*





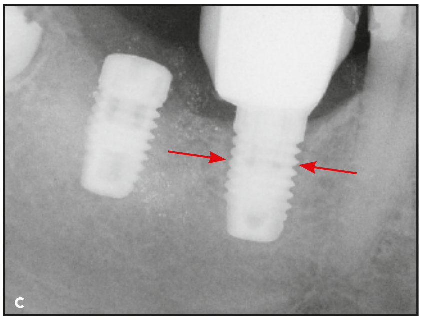


Fig 7 (a) *Mandibular right first molar fractured in 2009.* (b) *Mandibular second molar showing bone loss mesial to the apex. Existing first molar implant at 4 years postloading with no mobility.* (c) *Mandibular right first molar implant with peri-implant radiolucency* (arrows) *and mobility with absence of pain or suppuration.*

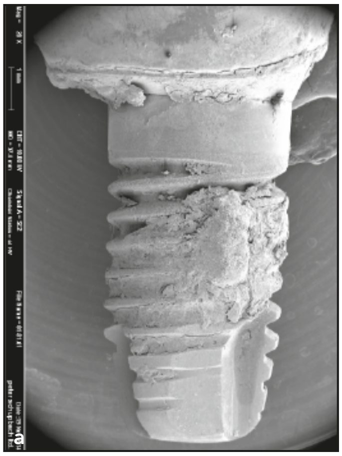
Two new implants were placed in the mandibular right molar region and subsequently successfully restored (Fig 6).

Case Report 2

A 56-year-old woman was referred for a second opinion regarding the Miller Class III mobility of an implant in a mandibular first molar site. The area was not painful nor suppurating. The previous radiographs and consultation with the referring restorative dentist revealed that the mandibular first molar had been treated with endodontic therapy 7 years earlier and had been restoratively splinted to the second molar. When a 10-mm pocket developed, a distal root fracture was suspected (Fig 7a). The first molar was separated from the splint and sectioned, and the roots were extracted separately. The mesial root had been partially ankylosed. A 5 × 10-mm fixture (Replace Select, Nobel Biocare) was immediately placed into the furcal bone with a cancellous demineralized freeze-dried bone allograft (DFDBA) to fill in the remainder of the root sockets. The immediately placed single implant remained in function for 4 years, and the patient was not aware of any problems with it. However, the second molar then developed pocket depth

Fig 8 (left) *Clinical view of retrieved implant* (case 2).

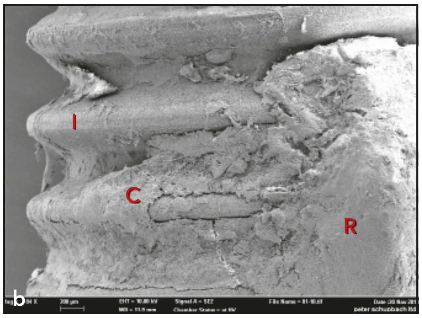
Fig 9 (right and below) (a, b) *SEM images showing hard tissue attached to the surface of the implant.* (c) *SEM image showing extensive biofilm on the implant surface. I = implant; R = root fragment; C = calculus.*



to the apex on the mesial side (Fig 7b). At the time of the patient's initial presentation for diagnosis of the mobility of the first molar implant, a second implant (Replace Select, Nobel Biocare) was placed to replace the second molar. This implant was in the 3-month healing stage. A new digital radiograph revealed a thin peri-implant radiolucency characteristic of a loss of osseointegration without clinical signs of infection (Fig 7c).[23,24] On removal of the implant, 3 mm of shiny material was observed attached to the side of the implant (Fig 8). It was not clinically possible to distinguish the material as bone or root. The implant was placed in formalin and subsequently evaluated via SEM and LM.

As in case 1, the SEM evaluations revealed hard tissue attached between the threads of the implant (Figs 9a and 9b) and extensive infiltration of bacteria forming a thick biofilm on the implant surface (Fig 9c).

The LM evaluation revealed bone between the upper threads of the implant (Fig 10) and cementum, identified by the presence of cementocytes between the lower threads.



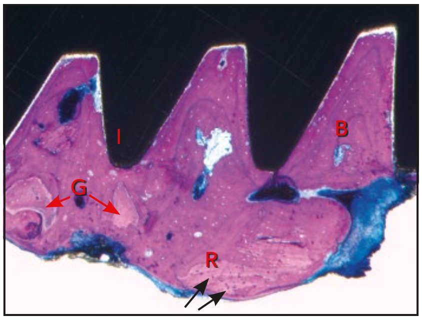


Fig 10 *Ground section showing bone (B) and graft (G) particles attached to the implant (I) surface. Root cementum (R) is identified by the presence of cementocytes* (black arrows) *between the apical threads of the implant.*

Fig 11 *Mandibular first molar replacement implant at 2 years postloading.*

Following implant removal, the socket was thoroughly degranulated with curettes, perforated with a carbide burr to elicit bleeding, and grafted with DFDBA. The area was allowed to heal for 4 months. A 4.8 × 10-mm replacement implant (Straumann Bone Level) was placed and allowed to heal for 3 months before uncovering and loading. At 2 years postloading, the implant is healthy and in good function (Fig 11).

Discussion

The ability of retained roots to maintain the periodontium and associated soft tissue architecture was recently introduced as an approach to solve esthetic implant challenges for immediate implant placement. Unfortunately, the literature lacks long-term studies and case reports demonstrating the viability of the treatment in humans.[10–12] However, there are known associated risks involved with maintaining root fragments proximal to dental implants. Langer et al[15] recently presented a case series documenting multiple cases of late implant complications and failures up to 4 years after loading associated with unintentionally retained root fragments.

This report presents histologic and SEM analysis of two failed implants. One implant failed after 4 years and the other after 10 years of healthy service, with both cases associated with infected retained root fragments and areas of bone loss involving the implant. Initially, the root fragments were not readily visible in the periapical radiographs due to the opaque bone grafting biomaterial, but once the bone loss progressed they were easily discerned.

Given the well-documented long-term predictability of osseointegration and the multiple predictable approaches for managing implant esthetics, it seems advisable to weigh the risks and benefits of purposefully retaining root fragments in immediate proximity to implant placement.[22–27] In addition, the removal of all root fragments should be carefully confirmed clinically and, if necessary, radiographically prior to implant placement. Although implants adjacent to intentionally retained and treated root fragments may function successfully and provide support for buccal bone profiles in the short term, there may be long-term risks for implant failure due to peri-implant infection associated with the retained fragment.

It is currently not possible to quantify the risk associated with root fragments in proximity to implants. There are limited case reports and no current prospective analyses. To determine the cause of an implant failure, it is incumbent on the clinician to investigate the circumstances and conditions prior to and at the time of implant placement. The failed implant surface, the bony site, and the surrounding bone bed need to be carefully examined to determine the cause of the failure. This is especially important for ankylosed roots or when teeth are removed in fragments.

Conclusions

Implants fail for various reasons, such as surgical error in placement, implant fracture, occlusal overload, and peri-implant infection.[28] It is increasingly observed that retained cement[29,30] and unintentionally retained root fragments in proximity to dental implants may also contribute to late implant failures. These failures can occur up to 10 years postloading. Long-term follow-up and careful inspection of failed implants may help in quantifying the frequency of this problem and formulating techniques that will avoid these adverse effects in the future.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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