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Management of an Imminent Pathological Fracture of a Fibular Neomandible Via a Minimally Invasive Approach—A Case Report

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Abstract

Fibular free flap reconstruction remains the workhorse of postmandibulectomy reconstruction. Dental implantation to support a dental prosthesis is a sought-after outcome when the area of resection involves tooth-bearing zones.
Chronic perisoft tissue pedicle hyperplasia with secondary infection leading to gradual bone loss is a simple complication to manage in the general population, but it becomes a serious issue in the fibula mandibular reconstruction patient in that it can lead to pathological fracture of the fibula.
A case of a patient with a near fracture of his fibula mandibular reconstruction, and its management via a minimally invasive approach is presented.

The aim of mandibular reconstruction is to recreate the form of the lower third of the face, re-establish the patient's ability to eat and speak, and maintain a patent airway.[1] Allowing a continuity defect to persist unaddressed results in the two separate single-joint residual segments retracting lingually from muscle pull, resulting in what's known as an "Andy Gump" defect of profound mandibular retrognathia with impairment of speech, mastication, swallowing and facial esthetics. Hidalgo was the first to use fibular bone to reconstruct a mandibular defect in 1989.[2] As the process of microvascular transfer has been refined, the fibular free flap has become a staple donor site for mandibular reconstruction.[3–5]

Due to its length, the fibular free flap is the only donor site from which total mandibular defects can be reconstructed. It is readily osteotomized allowing shaping of a reconstructed mandible, is well vascularized and has a bicortical structure facilitating dental implantation.[6–8] In partial reconstructions, the fibula is often positioned near the inferior border of the mandible to maintain facial contour leaving a significant space between its upper surface and the occlusal plane. This increase in suprastructure/implant ratio has been associated with increased difficulty and rate of complications in dental rehabilitation.[6–9]

Bone height of 7 to 10 mm is the quoted minimum in which implants can be placed, and ≥10 mm in bone height is sufficient thickness in reconstructed mandibles for safe implant placement.[8]

The prevalence of peri-implantitis in the general population ranges widely in the literature. Older studies report a range of 0.8% to 14%.[10,11] However, a recent 2019 retrospective analysis by Kordbacheh et al reported a 34% prevalence on the patient level and 21% prevalence on the implant level. This corresponded to incidence rates of 0.16 per patient-year and 0.10 per implant-year respectively.[12] Another 2019 study reported the prevalence to be 16.7%.[13]

The data on peri-implantitis in the fibular free flap reconstructed population is limited; however, one study showed only 4 of 105 implants failed due to peri-implantitis.[14] Another identified peri-implantitis in 14.8% of surviving implants at the 5- and 10-year follow-ups. As well, the risk of

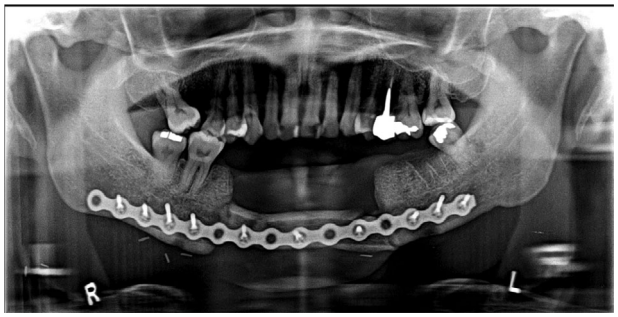

Figure 1 PAN with reconstruction plate in situ.

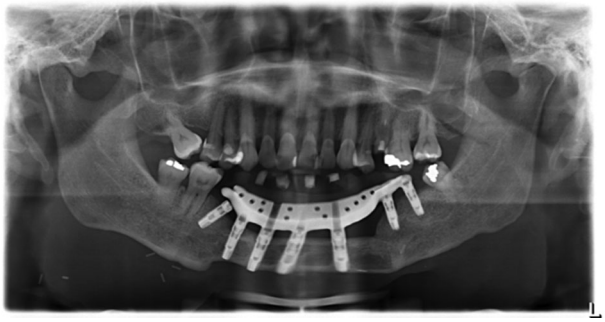

Figure 2 PAN of delivered completed screw-retained implant supported segmental prosthesis.

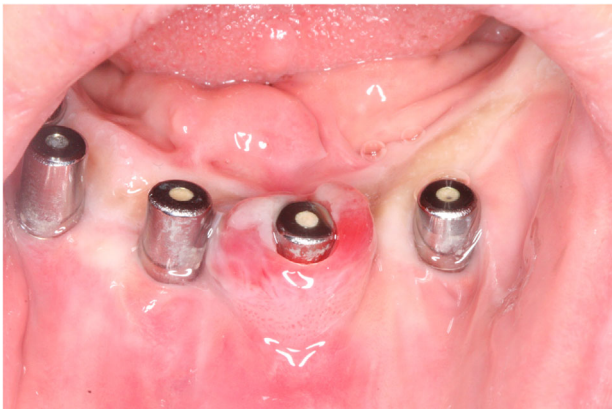

Figure 3 Clinical photo of inflamed peri-implant tissue.

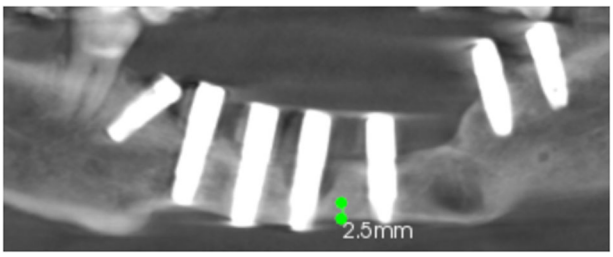

Figure 4 Radiograph showing extensive bone loss.

developing peri-implantitis was estimated to be higher (odds ratio = 1.5) for patients without connective tissue or skin grafts versus patients with them (18.2% vs. 9.5%).[15] A retrospective analysis of forty-three patients with a combined total of 216 implants placed after reconstruction reported that the rate of peri-implantitis varied depending on the type of reconstruction. Revascularized fibula exhibited peri-implantitis in 9% (5/55) of cases versus 38% (19/50) in free fibula. Amongst several flap types, the revascularized fibula seemed most resistant to inflammatory processes, followed by revascularized iliac crest, free iliac crest, and free fibula.[16] However, implants placed in the fibula typically emerge through a soft tissue layer made up of skin, muscle, fatty tissue, scar tissue and at times remnants of oral tissue. Thus, these implants may behave differently from implants placed in native jaw bone, and whether the term peri-implantitis should be used to describe progressive bone loss and tissue inflammation around implants within fibular remains under discussion.

There is limited literature on the management of near pathological fractures of fibula reconstructed mandibles due to peri-implantitis. It is the goal of this case report to present a novel, minimally invasive management technique to address this problem.

Case

A 59-year-old male was diagnosed with an ameloblastoma in 2007 and underwent an anterior segmental mandibulectomy with immediate fibular free flap reconstruction (Fig 1). Following union of segments, multiple dental implants were placed in both his native mandible and the fibula mandibular reconstruction in August 2009. The original reconstruction plate was removed in March 2009. Following integration of the implants, a long-span implant retained fixed partial denture was delivered (Fig 2).

The patient reports that almost immediately, sporadic peri-implant infections started to appear around multiple of his implants. This would be managed with improved oral hygiene practices including flossing and mechanical irrigation under the non-removable prosthesis, and short courses of systemic and topical antibiotic therapy.

He was referred for further treatment in the summer of 2019 for an infected implant in the area of the lower right central incisor. Clinically there was marked inflammation around the midline implant in question. (Fig 3) The prosthesis was removed, and healing abutments were placed on each implant in anticipation of the upcoming explantation surgery.

Imaging of this lower right central incisor implant showed peri-implant bone loss involving the crestal 70% of the total fibular height (Fig 4). At the time of the original surgery, the implant was bicortically placed such that the apex of the implant extended beyond the inferior border of the fibula. This is a common and appropriate approach to maximize both initial primary stability and also to maximize bone-implant interface for subsequent integration. Now that implant removal is planned, this bicortical implant position is now a detriment as it creates a high risk of pathological fracture at time of explantation.

It was anticipated that if the implant was just removed, intraoperative fracture where the bone was the weakest could very

likely occur. While showing extensive bone loss, the most inferior portion of the implant remained integrated with the surrounding bone, and removal would require reverse torqueing at significant force, or trephining, both of which would further weaken the bone.

Classical management in removal of a deeply impacted tooth or implant where pathological fracture is anticipated, would be to pre-emptively apply rigid fixation to the two anticipated segments.[17] In this case, this would have involved placement of a new reconstruction plate to the facial aspect of the fibula. The bone immediately adjacent to the anticipated fracture line contains multiple dental implants, and they might have blocked the usage of most screw holes of the reconstruction plate in these key regions. It would also have required another surgery under general anesthesia via a submandibular cutaneous incision which the patient preferred to avoid.

A conservative approach could be to disconnect the long-span prosthesis from the ailing implant. This can be achieved via removing the prosthesis, placing a cover screw on the implant, and reshaping the pontic immediately over the removed implant. The hope would be that the implant would resubmerge and become dormant, or eventually self-exfoliate. An important component to this approach working would be allowing patient access to clean the area around this failing implant, such that either successful soft tissue coverage, or a slow exfoliation of the implant by the body could take place in the cleanest conditions possible. The original framework was fabricated at implant level without a transmucosal component to allow for soft tissue adaptation, and access for oral hygiene. Thus, the original framework would not allow this patient access for proper hygiene.

An approach was chosen whereby the implants themselves can become part of a rigid fixation scheme, by way of fabrication of a custom milled bar. As the mandible was already considered at risk of fracture, prosthodontics opted to not remake a full arch implant level analog impression so as to not add extra flexural stress on the weakened mandible. The original implant level mandibular stone cast from 2009 was obtained. Healing abutments were retrieved from the patient's mouth, and the original implants retained fixed partial denture was seated back both on the cast and in the mouth for a one-screw test with radiographs. By confirming the prosthesis seats passively both in patient and on original cast, it was felt that it was appropriate to use the original 10-year-old cast to fabricate the new bar without needing to make a new impression or scan.

Occlusal registration was made and a maxillary new irreversible hydrocolloid impression was made to evaluate the amount of space available for the fixation bar. The maxillary impression, mandibular implant level cast and long-span fixed partial dentures were sent to the laboratory while healing abutments were placed on the mandibular implants during fabrication of the fixation bar.

The mandibular cast was scanned using a desktop scanner, and a fixation bar was digitally designed by the laboratory (Panthera Dental, Quebec). A wide diameter bar with smooth contours was chosen in anticipation of this being a load-bearing unit. A custom lingual deflection was created in the arch form in the area of the failed implant. This was done by asking the lab to project an 8-mm-diameter cylinder above the failed implant and design the bar to avoid this (Fig 5). This created an unobstructed working path above the implant to allow for instrumentation. After verification of the digital design by both prosthodontics and oral surgery, the fixation bar was milled from titanium alloy.

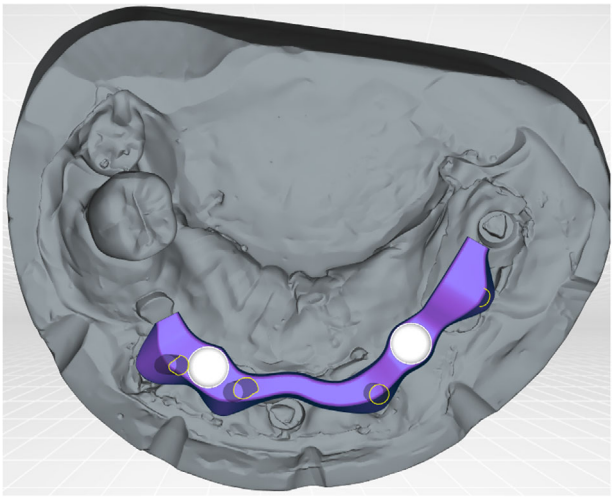

Figure 5 Screenshot of bar design.

The patient presented back with prosthodontics to retrieve the healing abutments, except for the abutment on the to-be-removed implant and seat the fixation bar. Passive fit was confirmed via a one-screw test. The custom bar was secured to two implants on each side of the failed implant, and all screws were torqued to 35 Ncm.

The patient was then anesthetized with 2% lidocaine 1:100,000 epinephrine. The healing abutment of the failing non-mobile implant was removed, and reverse torque was first attempted with a standard restorative torque wrench. Reverse torque value of 70 Ncm was reached without movement of the implant. The restorative torque-wrench was then removed, and replaced with a Hand Driver (Nobel Biocare).

Gradual application of a reverse torque was done manually until the implant-bone-interface was compromised. The implant was then removed via reverse rotation. On inspection, some vital bone was attached to the surface of the implant. The wound was inspected. The facial wall of the defect was comprised of only soft tissue. The lingual wall of the defect was bone. Particulate cortical allograft (Raptos, Citagenix, Laval) was packed into the defect. A collagen barrier (Heliplug, Citagenix, Laval) was placed over the graft and secured with 4-0 vicryl rapide sutures. Imaging of the fixation bar in situ was taken (Fig 6) and the patient was discharged with po amoxicillin 500 mg TID and Chlorhexidine 0.12% rinse for a week. The fixation bar was left on for a duration of four months post-op. The patient did not wear any other mandibular restoration. Short-term healing checks were unremarkable.

At the four-month mark, de novo bone formation was seen in the site of previous grafting (Fig. 7A, 7B, 7C). The bony diameter of the surgical site measured 14 × 10 mm. This was comparable to the remainder of his mandibular reconstruction and was felt to be of sufficient structural strength to return to normal function.

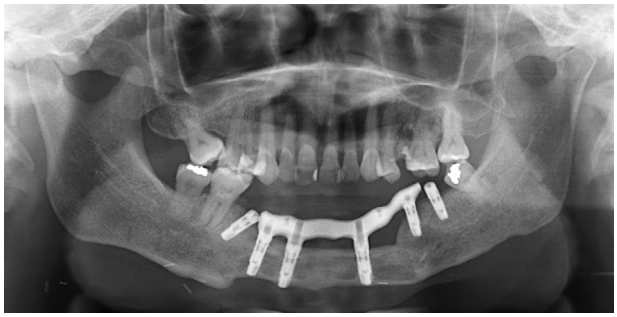

Figure 6 Immediate post-op PAN.

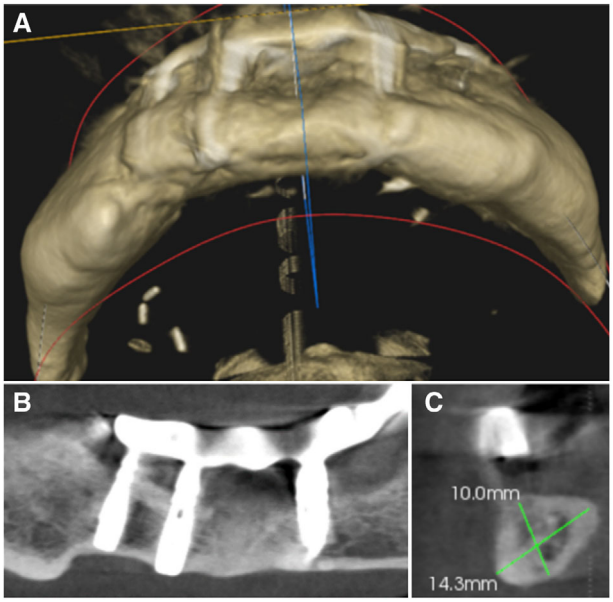

Figure 7 (A) 3D reconstructed view of regenerated bone at surgical site, (B) panoramic view, and (C) cross-sectional view.

The patient was referred to maxillofacial prosthodontics to fabricate a new implant retained overdenture on remaining implants that will allow more simple hygiene practices.

The management of peri-implantitis in a fibular reconstruction is particularly challenging due to the thin nature of the fibula, and the tendency for implants to be placed through-and-through in a bicortical fashion. Explantation of these implants put the patient at high risk of intra-operative or postoperative fracture.

This case was fortunate to have the right factors to manage conservatively: existence of multiple implants on either side of the failed implant to serve as rigid fixation screws, acute issue confined to only one of the implants, and patient resources to fabricate a custom bar at high cost, were all critical elements to make this approach possible.

In a different patient where multiple implants are failing simultaneously, and treatment costs are a concern, this approach would not have been viable. Prevention of peri-implantitis will continue to be the best way to manage these late complications. Removal of multiple implants, rigid fixation of multiple fracture segments, or sacrifice of the fibula and repeat reconstruction with a free flap would be some of the possible endpoints of peri-implantitis.

Drawing from the knowledge of peri-implantitis in the general population, uncleansable restoration design, and absence of appropriate attached tissue adjacent to the implant continue to be two of the biggest clinician-mediated contributors to peri-implantitis. Immobility of the tongue is a common comorbidity in this population. Whether it stems from denervation of the muscles or from scar-induced tethering, the resultant inability of the tongue to clear food from around the implant further compounds the hygiene challenges.

Hygiene-mediated issues can be managed by designing the fixed prosthesis in a cleansable fashion, or choosing removable prostheses for select patients. Although fixed prostheses are often preferred by patients, as they provide similar chewing to their natural dentition, this patient had been struggling with hygiene and peri-implantitis issues for years with his long-span fixed implant prosthesis and opted for a mandibular removable prosthesis. Inappropriate tissue type around implants can be managed via adjunctive soft-tissue procedures such as vestibuloplasties and gingival grafting as part of the overall surgical treatment plan. It is notable that this is a midline implant, and thus mandibular flexure and its tensile stress on the symphyseal area could have played a role in the bone loss as well.

The current momentum in the literature is towards virtual surgical planning of the procedure, and concurrent delivery of the fibula, implant and reconstruction in one procedure. This has revolutionized treatment outcomes for patients. However, this approach will also add complexity to the ability to optimize the peri-implant soft tissue biotype and architecture after the fact. The authors look forward to this new frontier in postresection jaw reconstruction.

Conclusion

Fibular free flap reconstruction remains the workhorse of the postmandibulectomy reconstruction but chronic perisoft tissue pedicle hyperplasia with secondary infection leading to gradual bone loss can lead to pathological fracture of the fibula. This case report presents successful management of a near fracture of fibula mandibular reconstruction via a minimally invasive approach.

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