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Mandibular rescue: Application of the ALT fascia free flap to arrest osteoradionecrosis of the mandible☆

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A B S T R A C T

Objectives: To evaluate the use of the anterolateral thigh fascia free flap for use in neovascularization of mandibular bone in moderate osteoradionecrosis (ORN). All patients had ORN secondary to prior radiation therapy that was not severe enough to warrant segmental resection and reconstruction.
Study design: Case series.
Setting: Tertiary medical center.
Methods: IRB approval was obtained, and a retrospective chart review performed of all mandibular rescue procedures performed from 2011 to 2014. Patients with a minimum of two years of follow-up were included in the study.
Results: All surgeries were performed by the senior surgeon (MF). Eight patients underwent the mandibular rescue procedure with resolution of pain and return to oral feeding in all patients, and no evidence of ORN progression on follow-up imaging. A total of 9 ALT free flaps were performed (one patient had 2 surgeries). Gender was distributed evenly (4 female/4 male). The average age was 66 (58-78), average length of hospitalization was 2.8 days (1–7), and average follow-up was 46.5 months (25–63).
Conclusions: The mandibular rescue procedure is a novel technique using the ALT fascia lata free flap to provide coverage and nutrient blood flow to mandible devascularized secondary to radiation therapy. The flap provides the advantages of low morbidity, ease of harvest, two-team approach to ablation and reconstruction, and quick recovery resulting in 'short-stay' free flap surgery. Although conclusions must be tempered in this small case series, our early clinical experience shows the ALT fascia lata flap holds promise in halting the destructive progression of ORN that is not yet advanced enough to require a segmental resection and reconstruction.

1. Introduction

Radiation therapy is commonly used as primary or adjuvant therapy in the treatment of head and neck squamous cell carcinoma. Osteoradionecrosis (ORN) is a known complication of radiation therapy, and can occur as a result of external beam radiation, or brachytherapy [1]. The classic presentation is late exposure of bone through skin or mucosa, which does not heal for at least 3 months [2]. The mandible is affected due to a number of factors including bone density, adjacent and often compromised dentition, and proximity to oropharyngeal tumors.

Various theories of ORN pathophysiology include infection, hypocellularity of bone, and radiation induced free radicals as contributing factors. However, there appears to be consensus that hypovascularity/ischemia plays a major role [2–7]. As a result, current accepted management strategies for moderate mandibular ORN involve debridement of necrotic bone, antibiotics and implementation of HBO (Hyperbaric oxygen) therapy to improve oxygen delivery to affected tissues. Despite controversy about effectiveness of HBO in reversing advanced ORN, no routinely employed and effective alternatives have been described.

We present for the first time a series of patients in which a novel 'mandibular rescue' procedure was successfully performed to halt moderate ORN. This, to our knowledge, is the first description of the free anterolateral thigh (ALT) fascia flap used to provide neovascularization to marginalized bone in the setting of ORN.

2. Methods

Institutional review board approval was obtained, and a retrospective chart review was performed of all mandibular rescue procedures performed in our healthcare system from 2011 to 2014. All surgeries were performed by the senior author (MF).

2.1. Patient selection

All patients considered for surgery had radiographic and clinical evidence of mandibular osteoradionecrosis. The majority of patients had undergone previous mandibular debridement and hyperbaric oxygen therapy (6 of 8) with persistent symptoms (pain, recurrent local edema, recurrent locoregional infection) managed with intermittent

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courses of intravenous and oral antibiotics. Patients considered good candidates for intervention with vascularized fascia had sufficient radiographic evidence of unaffected portions of the mandible to presume stability after aggressive debridement of nonviable bone (presumed viable bone equal to at least 50% original mandibular height). Two of the eight candidates were considered marginal for this operation, but due to severe comorbidity precluding more major surgery (1 patient) and patient refusal of segmental reconstruction (1 patient), they also underwent attempted mandibular revascularization.

2.2. Operative technique

Using a trans-oral approach, a limited marginal mandibulectomy is performed with debridement of necrotic bone to healthy, bleeding bone. Teeth are extracted as necessary. Critically, limited periosteal elevation is performed, exposing only mandible necessary to accomplish full removal of devitalized tissue, minimizing the risk to the vascularity of remaining viable bone. Compromised overlying gingiva and mucosa is also removed. No attempt is made to plate or stabilize remaining mandible (disease extensive enough to require such is managed with segmental resection and vascularized bone via standard technique). The fascial ALT free flap is harvested in a two-team fashion simultaneously with the preparation of the recipient site.

2.3. Flap harvest

The free fascia lata is harvested as a perforator flap in the same way a fasciocutaneous ALT flap is harvested. It is our preference to harvest the fascia lata with a small skin paddle to aid in manipulation during harvest, as fascia lata tends to fold on itself without the skin attached and is difficult to grasp and manipulate precisely. Following full flap isolation on the pedicle, a supra-fascial dissection plane (preserving the visible plexus of vessels superficial to the fascia) is followed to separate skin and subcutaneous fat from the fascia lata. This process yields a very thin vascularized sheet of tissue that can be folded into the defect for precise volume replacement and coverage. (Fig. 1).

2.4. Vascular access and inset

A 3 cm minimal access incision is made below the facial notch of the mandible for access to the facial artery and vein. If the geometry is more favorable, or if severe radiation changes are observed in the skin over the facial notch, the angular vessels can be accessed for recipient vessels through a nasolabial sulcus incision [8], or the superficial temporal vessels through a preauricular incision. A subcutaneous tunnel is created from the recipient vessels to the intra-oral defect. The ALT fascia flap is then layered in the defect to fully cover exposed bone and close the mucosal defect. A full thickness skin graft obtained, and aggressively thinned, from the skin paddle that was removed during flap harvest is sutured over the flap (Fig. 2a-b).

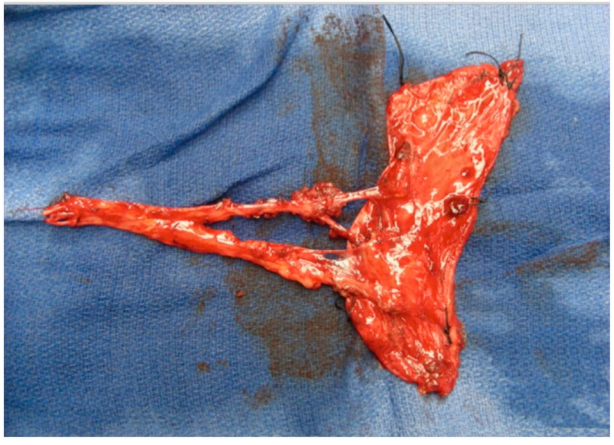

Fig. 1. Photo showing an ALT fascia lata perforator flap after harvest.

Patients are discharged from the hospital once they are ambulating and able to tolerate adequate oral intake. They are given instructions to maintain a liquid diet for 2 weeks, followed by a mechanical soft diet.

At our institution cost data is proprietary and confidential and so cannot be reported directly. The costs of the most recent 5 procedures performed with this technique were compared to the costs of a local treatment course of hyperbaric oxygen therapy for osteoradionecrosis of the mandible. A treatment regimen of 40 dives was chosen as this represents a typical treatment course for osteoradionecrosis of the mandible in our region.

3. Results

Eight patients underwent the mandibular rescue procedure and were observed for over two years of follow-up; all experienced resolution of preoperative pain and recurrent swelling, and returned to normal diets (soft to full depending on remaining dentition). All patients had complete and lasting intraoral coverage of the mandible without any further evidence of bone exposure. There was one delayed flap failure seen at the second post-op visit (2 weeks post-op). This patient was initially managed conservatively with local wound care; however, continued oral bone exposure and compromised healing prompted another fascia lata ALT flap which was successful. Patients undergoing this procedure averaged a 3-day hospital stay (range 1–7), and the mean follow-up was 46.5 months (range 25–63). Additional information regarding each of the cases is summarized in Table 1.

Apart from the single flap failure necessitating revision, one patient was readmitted for aspiration pneumonia (due to baseline severe dysphagia). Otherwise there were no perioperative complications. During the first 8 weeks after surgery all exposed fascia demonstrated robust granulation (indicative of the high regional vascularity). (Fig. 3) All wounds mucosalized completely within 2 months and remained fully covered without change for the remaining follow-up period. (Fig. 2c) Imaging up to 4 years postoperatively has shown no evidence of ORN progression (Fig. 4a-b), with several cases demonstrating an increase in the radiographic bone density.

One patient, who was considered an extremely marginal candidate for the procedure due to a paucity of viable adjacent bone, underwent this ALT fascia lata flap rescue procedure due to severe comorbidities that precluded a more extensive operation (i.e. fibula free flap). Her postoperative course was initially complicated by aspiration pneumonia (mentioned above); despite symptomatic improvement, a routine follow-up panorex at 6 months after surgery demonstrated a fracture of the debrided mandible. This was managed with observation only and after minor in-office bite adjustment with cortical planing of ipsilateral teeth, she has maintained a functional soft diet without significant pain. The mandible remains covered without evidence of infection at more than 3 years postoperatively.

A second patient who had undergone remote contralateral fibula free flap reconstruction successfully, and was also a marginal candidate due to multiple previous ipsilateral debridments and two previous HBO courses, underwent the rescue procedure due to recalcitrance toward a more standard operation (repeat fibular free flap). Although radiographic evidence was equivocal in terms of degree of unaffected mandible, he underwent debridement and ALT fascia lata flap reconstruction. Following an unremarkable postoperative course, he experienced recurrent facial edema and pain at 6 months after surgery, presumably due to residual nonviable bone with infection. This infection was successfully managed with a six week course of intravenous antibiotics and he has remained symptom free without evidence of infection after 63 months of follow-up.

At our institution cost data is proprietary and confidential and so cannot be reported directly. The cost of the most recent 5 procedures

Fig. 2. a) Intraoperative photo showing the defect after a local debridement of the necrotic bone. Note penrose demonstrating vessel tunnel b) Intraoperative photo of inset of the ALT fascia lata flap and coverage with a full thickness skin graft. c) Two month follow-up shows a completely mucosalized and healed wound bed.

amounted to 26.2% of the costs of a 40 dive treatment course of hyperbaric oxygen therapy.

4. Discussion

To date, most treatment approaches for mandibular ORN involve a marriage of conservative measures (debridement, hyperbaric oxygen, ultrasound therapy, antibiotics), reserving segmental resection and reconstruction for advanced, end stage disease. The surgeon's primary goal in initial management is to remove all devitalized bone, which can potentially harbor infection, and then rely on adjunctive measures (i.e. HBO) to increase oxygen delivery to the tissues to prevent further tissue death and promote mucosalization of any remaining exposed bone.

Hyperbaric oxygen has the theoretic effect of decreasing the progression of ORN by increasing the oxygen concentration at the tissue level, as well as a bactericidal effect that it can have on some bacterial species [9]. However, a randomized, placebo-controlled, double blind trial performed by Annane, et al., failed to demonstrate any benefit from HBO in the treatment of advanced ORN [10] (corroborated by 6/8 of our patients having failed HBO therapy). Furthermore, there are drawbacks such as need for frequent sequential sessions (typically 30), high treatment costs, and potential complications to HBO such as retinal detachment. The latter is a rare and devastating complication of HBO and absolute contraindication for further treatment.

The first patient in our series undergoing mandibular rescue developed retinal detachment during HBO, and was hesitant to undergo a segmental resection and fibula free flap. He had evidence of significant apparently viable bone on panoramic mandibular X-ray, prompting consideration of a less morbid “rescue” procedure. (Fig. 4a) There have been few options for treatment of these patients at intermediate risk for ORN, and fewer still for those failing HBO. Neovascularization of adjacent tissues by a vascular pedicle transferred with microvascular techniques is not a new concept, and has been previously demonstrated [11]. The senior author's extensive experience with harvesting perforator ALT flaps and exposing donor vessels via minimal access approaches were the impetus to this application of the fascia lata ALT free flap [12,13]. The abbreviated post-operative course due to low donor site morbidity, resolution of preoperative symptoms, and halted progression of the ORN as seen on post-op imaging led to the case series described herein.

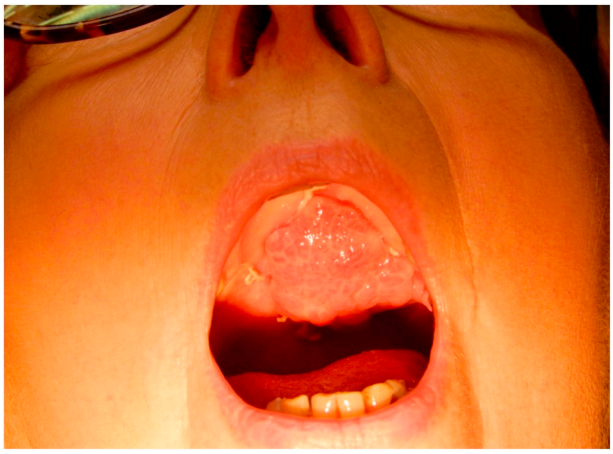

Fig. 3. Fascia lata free flap used in a different procedure but demonstrating the extensive granulation tissue formation indicative of high vascularity and wound healing.

This is our initial experience using vascularized fascia lata harvested as a perforator flap to bring nutrient blood flow to at risk bone; it successfully re-establishes vascular supply, improves tissue oxygenation, increases the clearance of free radicals, and aids in the ability to deliver antibiotics and fight infection. Importantly, this surgery does not preclude or complicate further reconstructive procedures (e.g. fibula flap) should progression of disease mandate a segmental resection.

As evident in the postoperative fracture in one of our patients, paramount to the success of this procedure is the careful selection of patients with sufficient residual viable, stable bone following debridement. Similarly, the additional late postoperative complication of recurrent infection occurred in a patient who was also deemed a marginal candidate for salvage. Six years previously, he had undergone contralateral mandibulectomy and reconstruction with free vascularized fibula. Despite an uncomplicated postoperative course and successful outcome after this procedure, he was adamantly opposed to consideration of a contralateral fibula free flap. With significant exposed nonviable mandible after multiple previous debridements and HBO therapy, an attempt at mandibular rescue was considered to be the most

Table 1
Demographic and surgical information for patients undergoing mandibular salvage. HBO (Hyperbaric oxygen). LOS (Length of stay in the hospital).

Age(yr)	Gender	Defect size	Vessels used	HBO	LOS(day)	Follow-up(mo)
58	M	4 cm(body/angle)	Facial	Yes	1	61
78	F	6 cm(body/angle/ramus)	Angular	No	7	57
68	M	6 cm(body/angle/ramus)	Superficial temporal	Yes	2	63
63	M	14 cm(angle/angle)	Facial	Yes	4	49
76	F	4 cm(post body/angle)	Superficial temporal	Yes	2	43
64	F	14 cm(angle/angle)	Facial	No	4	36
64	M	6 cm(body/angle/ramus)	Facial	Yes	1	38
62	F	8 cm (body/angle)	Superficial temporal	Yes	2	25

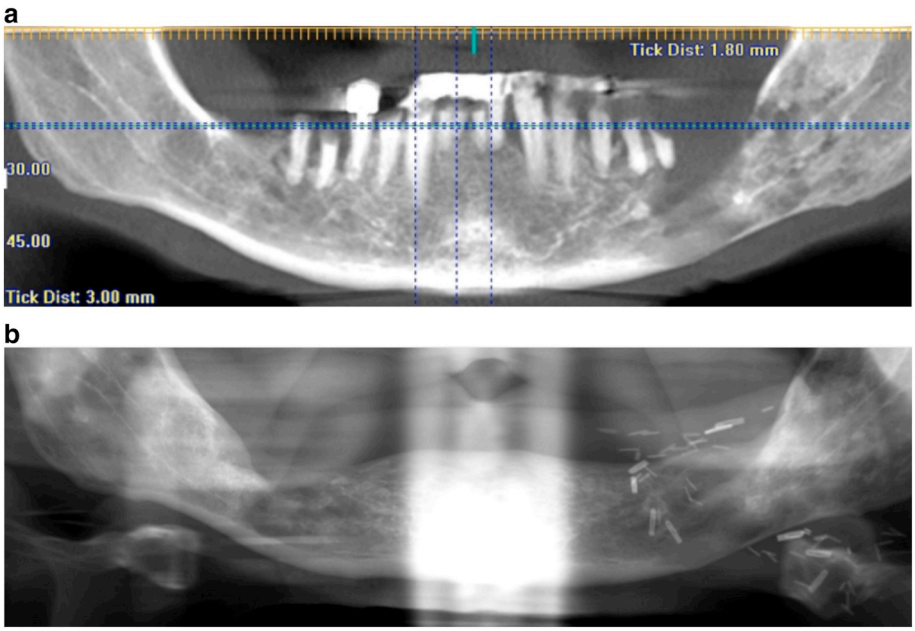

Fig. 4. a) Preoperative panorex imaging showing moderate mandibular osteoradionecrosis with scattered lucencies. b) Postoperative imaging obtained at the 6 month visit shows no evidence of progression of disease. Note the surgical absence of the dentition and the radiopaque surgical clips.

palatable option.

In marginal candidates, there may be value in incorporating cancellous bone grafts or bone progenitors to promote formation of new, healthy mandible. Certainly, the best patient outcome would not only eliminate nonviable bone and infection, but also provide a substrate for future dental rehabilitation through new bone formation. Marx has described such grafting and purported advantages for full segmental resections [14]; however, the mandibular salvage procedure described herein carries the advantage of dramatically less patient morbidity.

A single free flap failure out of the 9 procedures performed demonstrates a significantly lower success rate than that typically experienced at our institution and in the literature for head and neck reconstruction. While the success rates with these small perforator flaps may indeed be lower than those with typical reconstructive flaps, the failure may also reflect the learning curve with this new technique. We theorized that this late failure seen at 2 weeks follow-up was a reflection of the low quality facial vessels selected in this case, which were dissected and isolated directly from the most heavily-radiated tissue bed. Based on this experience, we have avoided vessel selection in severely damaged tissue and instead have opted for superficial temporal, angular or contralateral facial vessels for vascular supply.

The costs of hyperbaric oxygen therapy for the treatment of osteoradionecrosis are high and are a significant drawback [15]. Here we compare the costs of surgical treatment of osteoradionecrosis using our novel surgical technique to the local cost of a course of hyperbaric oxygen therapy. Our surgical technique, given the short hospital stay and short operative time results in a cost that is approximately a quarter of those of a typical course of hyperbaric oxygen therapy. This represents a significant savings and dramatically reduces the health care cost burden among this patient population. Due to the policies of our institution this data is proprietary and cannot be disclosed. This significantly limits the conclusions able to be made. Due to this limitation as well as small sample size, further studies comparing the costs of each method in a larger study population need to be performed.

5. Conclusion

'Mandibular rescue' is a novel technique using the ALT fascia lata free flap to provide coverage and nutrient blood flow to an otherwise devascularized area secondary to radiation therapy. This free flap technique provides the advantages of low morbidity, ease of harvest, low costs and two-team approach to ablation and reconstruction. In contrast to end stage mandibular reconstruction, this can be accomplished through minimal access approaches with short operative times and hospital stays. Critically, treatment with this method does not affect options for further reconstruction (ie vascularized bone) if required in the future. Although conclusions must be tempered in a small case series, our early clinical experience shows the ALT fascia lata flap holds promise in halting the destructive progression of moderately severe ORN that is unresponsive to conservative measures.

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Disclosures

None.

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