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Title

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Abstract (150 words)

Periosteal radial forearm free flaps allow functional and curative treatment of osteoradionecrotic jaw lesions. The flap responds physiologically to hypoxia, hypocellularity, and hypovascularity, which are characteristic results of osteoradionecrotic injury. Here, we propose a reproducible, simple, and safe method for harvesting a forearm free flap, allowing us to obtain a periosteal composite free flap. Our technique offers potential early management of osteoradionecrotic lesions resistant to medical treatment. Furthermore, the forearm periosteal composite free flap offers the advantage of a long vascular pedicle which is ideally suited for necks which have been submitted to irradiation or multiple operations. Thusly, vascular anastomosis can be performed at a distance from the irradiated areas. Compared to other periosteal free flaps, such as those harvested from the iliac crest or the internal femoral condyle, the presence of a skin paddle facilitates clinical flap monitoring, optimizes the restoration of bone sealing, and facilitates the treatment of scarring.

Keywords:

Osteoradionecrosis, periosteal free flap, management, revascularization surgery, forearm periosteal free flap

Text

1. Introduction

Mandibular osteoradionecrosis (ORN) is a severe complication of radiotherapy characterized by hypoxic, hypovascular, and hypocellular bone[1] which has lost its capacity to renew itself. Clinically, ORN presents as spontaneous mandibular bone exposure or occurs following an endobuccal surgical procedure.[2] Different complications can occur, in particular cutaneous fistulas and/or pathological fractures. Therapeutic revascularization surgery (resection of the pathological bone with immediate reconstruction by microanastomosis of a flap) is the gold standard, with an efficacy rate of between 86% and 100%.[3,4] By contrast, for treatment requiring a consensus, such as long-term antibiotic therapy or the Pentoclo protocol, efficacy assessment requires evaluation by randomized double-blind placebo-controlled studies.[5] However, due to the difficulties of surgery in irradiated areas, the scarcity of vessels, and the high risk of failure, most teams consider it preferable to reserve radical management with free flap reconstruction for cases of ORN with fractures.[6] Furthermore, malnutrition secondary to reactional trismus is a criterion of severity, complicating any surgical management. In 2009, D'Hauthuille et al.[7] proposed the early management of ORN relating to the underlying risk of neoplasia and the tendency of the lesions to progress. This management is based on marginal bone resection with reconstruction by a free flap "cover" which preserves the food masticating function while revascularizing the underlying bone. Thus, periosteal free

flaps (internal condyle, femoral, or others) are recommended for their osteoinductive and osteogenic properties. Indeed, the supply of vascularized living tissues within an irradiated environment constitutes a physiological response to the treatment of osteoradionecrosis. The efficacy rate of 100% confirms that it remains essential to design mandibular ORN curative surgery with a unique and functional approach.

From this perspective, and taking into account the scarring fibrosis of the post-radial endobuccal mucosa, the forearm free flap with a radial periosteal component offers several advantages responding to the constraints of early osteoradionecrotic lesion revascularization surgery: i) it provides a periosteal membrane, and ii) its fasciocutaneous flap facilitates clinical flap monitoring and optimizes buccal tightness with tension-free sutures. Here, we describe our harvesting technique, ensuring fast and safe dissection.

2.Technical Note

After verifying the ulnar vascularization of the palmar arch using Allen's test, the dimensions of a fasciocutaneous paddle is defined, centered on the radial vascular pedicle. It is important to overestimate the volume of the cutaneous paddle needed relative to the bone exposure area to allow tension-free suturing during endobuccal insertion.

Using a pneumatic tourniquet, a curvilinear incision starting from the fold of the elbow to the upper point of the skin paddle is performed. Then, the ulnar and radial sides of the skin paddle should be carefully incised to include the cephalic vein. It is important to begin the dissection of the fasciocutaneous paddle by the radial side of the flap to protect the cutaneous branches of the radial nerve. Once dissected and reclined by placing a Gillies hook or a Faraboeuf spreader on the brachioradial muscle tendon (Figure 1), the radial periosteum is incised with the length corresponding to the slice of mandibular bone section to be “resurfaced”. The periosteum is then gently roughened to avoid it dissociating from the radial vascular pedicle.

The ulnar surface of the flap is secondarily dissected up to the tendon of the long flexor muscle of the carpus, which is then retracted with a Gillies hook, allowing exposure of the lower end of the radius. This facilitates the access to the radial periosteum, which should be incised and scraped until it reaches the contralateral detachment zone. Once the entire periosteum is released, the distal end of the radial

vascular pedicle is dissected, then ligated to counter-incise the radial periosteum and release it over its entire length. The limit of the proximal portion of the radial periosteum is defined according to the required length.

The remaining steps of harvesting are the same as the conventional procedures described by Yang, in 1981.[8] The careful dissection of the radial vascular pedicle is carried out with ligatures of all collaterals until a sufficient vascular pedicle length is obtained to allow for anastomosis (Figure 2). Finally, after releasing the pneumatic tourniquet, the radial accompanying veins (*vena comitans*) are ligated to check for the presence of cephalic venous return. If there is no cephalic venous drainage, the cephalic vein is sacrificed and a accompanying vein is used. Once weaned, the flap is washed with a heparinized saline solution to prevent the risk of distal microthromboses.

When setting the flap in its position, the radial periosteum is sutured prior to the mandibular periosteum to isolate the section of bone. Then, the skin paddle is sutured without tension to the adjacent mucosa by separate stitches of absorbable braided sutures. In principle, microsurgical anastomoses should be performed using separate stitches of non-absorbable non-braided sutures (9/0 or 10/0) always starting with the vessels of the flap to avoid any disassociation of the intima from the media of the irradiated vessels during the passage of the needle, which would increase the thrombogenic risk.[9]

3. Discussion

By reporting our harvesting technique for periosteal forearm free flaps, we provide a safe and accessible alternative management option for early ORN or ORN refractory to medical treatment. Initially proposed by Kelley et al.[10] for the optimization of vascularization of maxillary bone grafts and by Roselli et al.[11] as a cancer surgery option for marginal mandibulectomy, the periosteal forearm free flap has many advantages for surgery performed in the irradiated area.

First, known for its reliability,[12] the forearm free flap offers the advantage of having a long vascular pedicle to respond to the difficulties of avascular necks encountered subsequent to radiotherapy or multiple surgeries. Indeed, this characteristic makes it possible to perform microsurgical anastomosis on vessels located outside the irradiation area, such as the temporal or transverse vessels.

In addition, the skin paddle of the periosteal forearm composite free flap facilitates the good inset of the flap as well as treatment of scar ridges responsible for ankyloglossia or a reduced buccal opening. This is not possible with other periosteal free flaps[7] such as those from the iliac crest or internal femoral condyle that tend to retract.

Finally, the presence of a skin paddle makes it easier to monitor the vitality of the free flap due to the recoloring time which can help to signal the the need for vascular anastomosis revision. Nevertheless, unlike the external brachial free flap with humeral periosteum, the adipose volume of the fasciocutaneous component of the

forearm composite free flap can require a second surgical procedure to reduce or eliminate excess tissue.

Regarding the technical procedures of revascularization surgery using periosteal forearm free flaps, the recent controversy on the effectiveness of the main conservative treatment[5,13-15] requires deep reflection on the part of the entire scientific community. The limits proposed by Delanian et al.[15] in 2002 are worth remembering: "cellulite, fracture and bone exposure greater than 1 cm".

Conclusion

The reliability of the forearm free flap and its vascular pedicle length makes it a flap of choice in irradiated neck surgery. The periosteal vascularized transfer provides a physiological response to the physiopathogenesis of ORN while restoring the oral seal essential to oral nutrition. However, this revascularization surgery using the periosteal flap is only possible if an early diagnosis is made before the strength of the mandibular arch is weakened.

Acknowledgements

Conflict of Interest Statement: None

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Captions to illustrations

Figure 1: Intraoperative photograph of the harvesting of the radial periosteal paddle (black arrow) achieved by dissecting the sensitive branches of the radial nerve (white arrow) which are retracted and protected by a Gillies hook on the tendon of the brachio-radial muscle. It is important to detach the subperiosteum carefully to avoid devascularization of the periosteal membrane secondary to decoupling from the radial vascular pedicle.

Figure 2: Intraoperative photographs before weaning of the periosteal forearm free flap and after releasing the touniquet to confirm (a) the viability of the skin paddle, and (b) the integrity and vascularization of the periosteal membrane.

Figure 1

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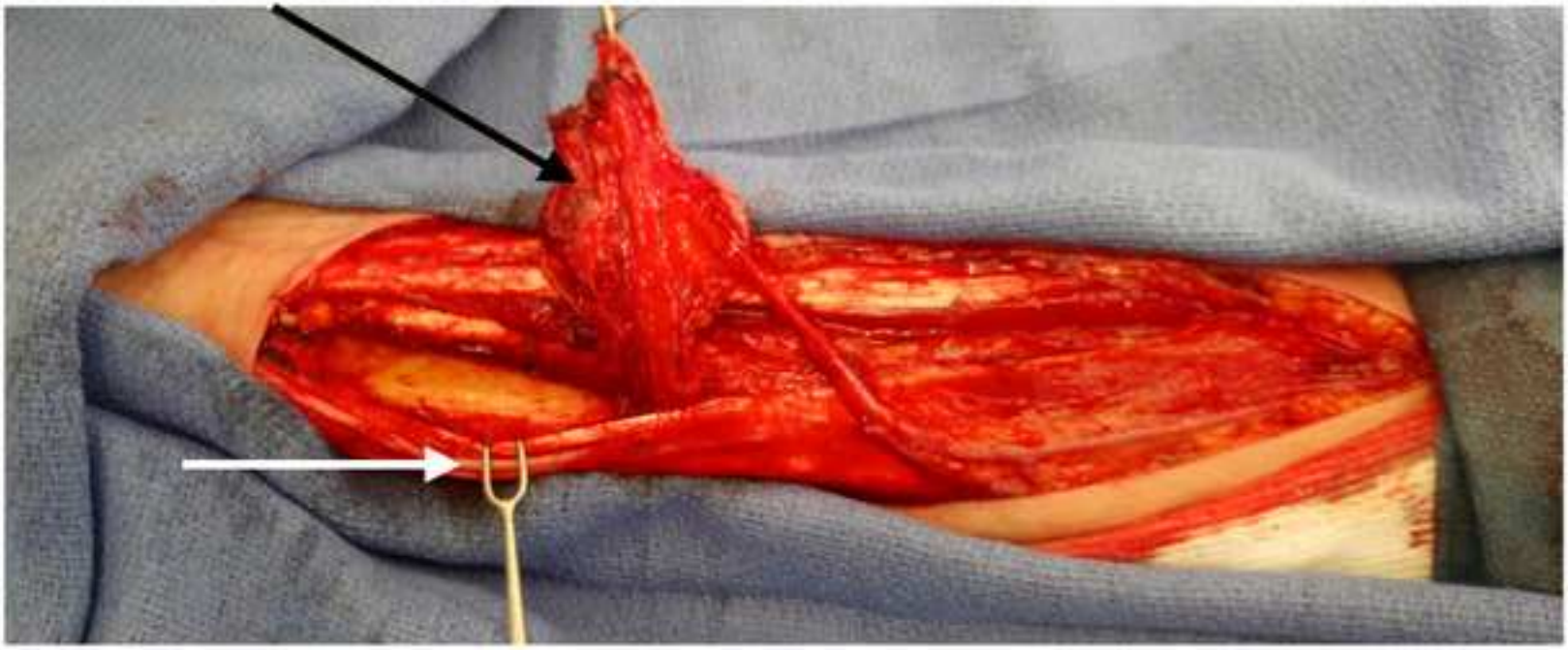

Figure 2

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