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## Technical note on the harvest of periosteal forearm composite free flaps in the treatment of early mandibular osteoradionecrotic injury

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1 **Title**

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2 **Technical note on the harvest of periosteal forearm composite free flaps in the**  
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4 **treatment of early mandibular osteoradionecrotic injury**  
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25 **Abstract (150 words)**

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**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**

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2 47 **1. Introduction**  
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8 49 Mandibular osteoradionecrosis (ORN) is a severe complication of radiotherapy  
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10 50 characterized by hypoxic, hypovascular, and hypocellular bone<sup>1</sup> which has lost its  
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13 51 capacity to renew itself. Clinically, ORN presents as spontaneous mandibular bone  
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16 52 exposure or occurs following an endobuccal surgical procedure.<sup>2</sup> Different  
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19 53 complications can occur, in particular cutaneous fistulas and/or pathological  
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22 54 fractures. Therapeutic revascularization surgery (resection of the pathological bone  
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25 55 with immediate reconstruction by microanastomosis of a flap) is the gold standard,  
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28 56 with an efficacy rate of between 86% and 100%.<sup>3,4</sup> By contrast, for treatment  
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31 57 requiring a consensus, such as long-term antibiotic therapy or the Pentoclo protocol,  
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33 58 efficacy assessment requires evaluation by randomized double-blind placebo-  
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36 59 controlled studies.<sup>5</sup> However, due to the difficulties of surgery in irradiated areas, the  
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39 60 scarcity of vessels, and the high risk of failure, most teams consider it preferable to  
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42 61 reserve radical management with free flap reconstruction for cases of ORN with  
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45 62 fractures.<sup>6</sup> Furthermore, malnutrition secondary to reactional trismus is a criterion of  
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48 63 severity, complicating any surgical management. In 2009, D'Hauthuille et al.<sup>7</sup>  
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51 64 proposed the early management of ORN relating to the underlying risk of neoplasia  
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54 65 and the tendency of the lesions to progress. This management is based on marginal  
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57 66 bone resection with reconstruction by a free flap “cover” which preserves the food  
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60 67 masticating function while revascularizing the underlying bone. Thus, periosteal free  
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68 flaps (internal condyle, femoral, or others) are recommended for their osteoinductive  
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69 and osteogenic properties. Indeed, the supply of vascularized living tissues within an  
70 irradiated environment constitutes a physiological response to the treatment of  
71 osteoradionecrosis. The efficacy rate of 100% confirms that it remains essential to  
72 design mandibular ORN curative surgery with a unique and functional approach.

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

80 **2. Technical Note**

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

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

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

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

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

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

### 122 3. Discussion

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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.<sup>10</sup> for the optimization of vascularization of maxillary bone grafts and by Roselli et al.<sup>11</sup> 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,<sup>12</sup> 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<sup>7</sup> 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



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

146 Regarding the technical procedures of revascularization surgery using periosteal  
147 forearm free flaps, the recent controversy on the effectiveness of the main  
148 conservative treatment<sup>5,13-15</sup> requires deep reflection on the part of the entire scientific  
149 community. The limits proposed by Delanian et al.<sup>15</sup> in 2002 are worth remembering:  
150 “cellulite, fracture and bone exposure greater than 1 cm”.

151 **Conclusion**

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

159 **Acknowledgements**

161 **Conflict of Interest Statement: None**

162 **References**

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222 **Captions to illustrations**

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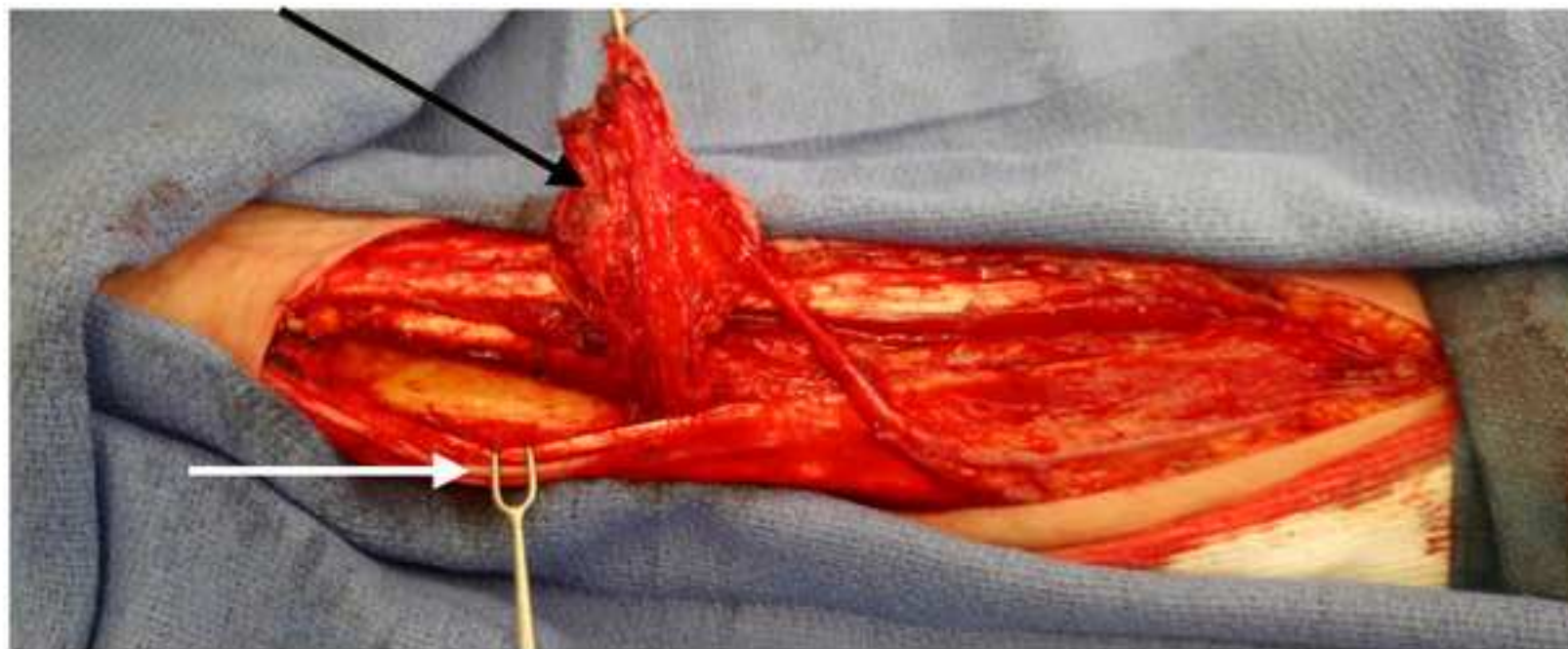
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