REVIEW ARTICLE

Osteocutaneous Radial Forearm Free Flap for Maxilla Reconstruction: Surgical Technique

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ABSTRACT

Osteocutaneous Radial Forearm free flap (OCRFF) is a composite flap comprised of a segment of the radial bone with the fasciocutaneous component and is based on Radial artery with Vena comitantes and cephalic vein as pedicle. It is used in midfacial reconstruction especially in the maxillary region involving bony defect. The advantage of this flap is that it is a thin, pliable flap with rich vascularity which provides a soft tissue covering along with a vascularized bone graft. In the recent studies, the flap survival rate is reported to be as high as 96-100% and the donor site complications are relatively low. The key to the success of this flap lies in meticulous pre-operative assessment including Allen's test, proper imaging techniques which includes, USG doppler study of the donor site. Correct technique of flap harvest, radial osteotomy and plating (prophylactic fixation) ensures minimal chances of post-operative complications and flap failure. This article focuses on the pre-operative assessment, relevant anatomy and basic steps of flap harvest technique of OCRFF and aims to encourage the microvascular enthusiasts.

Keywords: Osteocutaneous Radial Forearm free flap, midfacial reconstruction, vascularized bone graft, microvascular surgery.

INTRODUCTION

Radial forearm free flap was first described by Yang et al in 1981as fasciocutaneous flap.[1] The osteocutaneous variant, by incorporating segment of radial bone for reconstruction of mandibular and maxillary defects was first introduced by Soutar et al in 1983.[2] Swartz et al. (1986) noted flap survival as high as 95% with good cosmetic outcome due to its thin and pliable flap and long pedicle.[3] Urken et al (1991) noted risk of radius fracture and concluded that OCRFF is best suited for moderate defects and not ideal for load bearing reconstruction for which fibula and iliac crest flaps are better suited.[4] Richardson et al. (1994) quantified the safe limits of harvest to 40% of the bone circumference with prophylactic plating.[5] Currently OCRFF is unequivocally the best option for mid face reconstruction, orbital floor, and palatal defects although inferior to fibula flap for mandibular reconstruction as noted by Hidalgo et al. (1990s) and Fenton et al.[6,7]

The lower arm and the hand are supplied by Brachial artery which divides into radial and ulnar arteries at the level of the antecubital fossa. OCRFF is based on Radial artery and its venae comitantes along with cephalic vein. The flap harvest requires complete interruption of the radial artery and therefore total reliance on the ulnar system for blood supply of the hand. The radial artery courses between the flexor carpi radialis and brachioradialis muscle and terminates in the deep palmar arch which supplies the thumb and index finger. The ulnar artery in turn terminates as superficial palmar arch and supplies the 3-5th digits. The lateral antebrachial cutaneous nerve runs near the cephalic vein and can be harvested if a sensate flap is desired. The maximum length of bone that can be harvested without risk of post-operative fracture is 9-10cm and should end 2-3 cm proximal to the radial styloid.[8] Maximum harvestable width varies from 40-50% as demonstrated in various studies.[5]

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PRE-OPERATIVE ASSESSMENT

A thorough history should be taken on their occupation or any work restrictions that could cause a post-operative morbidity. Also, it is necessary to ask and examine the hand for any prior surgery or traumatic fracture to the donor forearm. In case of any doubt, it is recommended to get a plain X-ray of the forearm. It is routinely advised to perform an Allen's test to confirm the adequacy of the circulation to the hand through the Ulnar artery.[1-3] In dark skinned patients if the capillary blush is not easily assessed, the perfusion of the hand is confirmed by checking the capillary refill on the nail bed.[9] A clear direction should be taped on the donor forearm to prevent any arterial or venipuncture. Additionally, a USG Doppler of the hand is advised to confirm the patency of the vessels.

SURGICAL STEPS

The patient is placed supine with the donor forearm in an abducted position on an arm board with palm up. A non-sterile tourniquet band is placed and secured in the arm followed by sterile prepping and draping done till the mid humerus. In order to achieve a bloodless field, the arm is exsanguinated and the tourniquet is inflated to 250 mmHg.

Skin incision and dissection: The flap dimensions are marked and skin paddle drawn on the volar aspect of the forearm after careful assessment of the primary defect. Skin incision is given around the flap and skin and subcutaneous tissue are elevated suprafascially to the Brachioradialis (BR) muscle (Fig. 1a, 1b). Incision is given proximally and dissection along the course of the Cephalic vein carried out (Fig. 1c). Identify the lateral antebrachial cutaneous nerve, which is either harvested or preserved.[3] The fascial covering around BR incised and the muscle is retracted laterally. Continue raising the flap with careful retraction and hemostasis until the radial artery and its venae comitantes are encountered. The vessel is controlled using loops or clips. The ulnar aspect of the flap is dissected, down to the lateral edge of Flexor Carpi Radialis (FCR) muscle. The fascia is incised and the muscle is retracted ulnarly, which exposes the septum. The anterolateral septum is preserved which contains the perforators to the skin.[1] Next, the deeper muscles are exposed via retraction and the Flexor policies longus (FPL) and Pronator Quadratus (PQ) is split longitudinally. This exposes the periosteum of the distal radius. The radial artery pedicle is dissected up to the antecubital fossa very carefully not to damage the perforators to the flap and the bone.[2] Throughout the dissection 0.5% xylocaine solution is irrigated over the pedicle concomitantly to avoid vessel spasm.

Radial bone harvest: For bone harvest, the proximal and the distal extent of the bone graft is marked (Fig. 2a). It is advisable to stay distal to the insertion of the pronator teres muscle to avoid injury to the anterior interosseous nerve.[3] Using a powered oscillating saw, make the distal osteotomy first, with a margin of 2-3 cm to the radial styloid.[8,10] It is advisable to give angled cuts to prevent stress, however there are studies which advocate squared (90 degree) cuts.[11] The proximal osteotomy is carried out. It is imperative to limit the width to 40% of the total radial circumference to avoid fracture.[5] After confirming the appropriate length and depth, cuts are given on both the ulnar and radial aspect of the radius (Fig. 2b). The osteotome can be then used to gently free the harvested bone.

Fig. 1: (a) Skin incision given around the marked site of the flap. (b) Skin and subcutaneous tissue elevated suprafascially to the Brachioradialis (BR) muscle. (c) dissection along the course of the Cephalic vein.

Once the hemostasis is completed and the remaining pedicle dissection complete, the radial artery is clamped at the distal end and oxygen saturation is checked on the fingers to confirm the ulnar artery circulation. Once confirmed the radial artery and the associated venae comitantes with cephalic vein are ligated and the flap is placed in a RL solution for preparation for flap inset and plating. The initiation of the ischaemia time of the flap is noted.

Fig. 2: (a) Osteotomy sites marked proximally and distally; (b) Bony cuts given on both the ulnar and radial aspect of the surface of the Radius; (c) Fasciocutaneous and bony component with the pedicle.

Flap transfer and inset: The flap is moved to the maxillary defect (Fig. 3a) and the radial bone graft is contoured with further osteotomies and adjustment to fit the graft into the bony defect. The bone graft is fixed to the native maxilla with mini plate and screws (Fig. 3b). The most commonly utilised recipient vessels for micro vascular anastomosis in our practice are Superior Thyroid artery, External jugular vein, and Superior thyroid vein.[4] The vessel lumen is concomitantly irrigated with heparinised solution to maintain the vessel patency and to reduce the risk of thrombosis.[12]

The donor radius requires prophylactic plating using monocortical or bicortical screws. Additionally, in selected cases bone cement with Tobramycin can be applied to augment the strength and stability of the plates.[11] The muscles are closed in layers and the skin defect closed with split thickness skin graft.

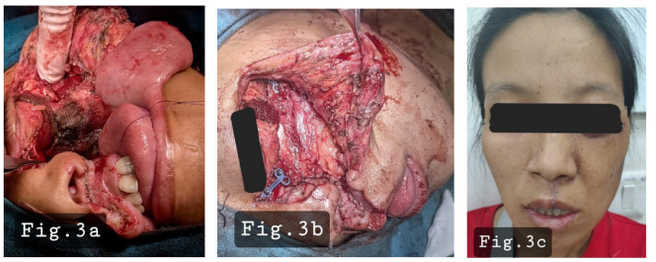

Fig. 3: (a) Maxillary defect after primary tumor clearance; (b) bone graft fixed to the native maxilla with mini plate and screws; (c) Post-operative outcome after 3 weeks.

DISCUSSION

The unique advantages that make OCRFF a superior flap for mid facial defects includes: a reliable skin paddle with long vascular pedicle, and a vascularised bone graft.[1-3] It is particularly suited for moderate maxillectomy defect where a fibula flap might be too bulky and pose cosmetic concerns.[4,6] Connolly et al, in their series involving 68 patients who underwent mid facial reconstruction with ORFF achieved 96% flap survival, with no donor fractures.[13]

Donor site morbidity especially with radial fracture has been a recurring issue reported in many studies.[5] However, Prophylactic plating has been shown to significantly reduce the incidence of donor-site fractures.[8] Sinclair et al noted only 1 fracture in their series of 218 patient.[14] Thus, prophylactic volar plating significantly reduces the incidence of radius fracture.

Although OCRFF demonstrates high flap reliability, several post-operative complications have been described. Early complications include vascular compromise due to arterial insufficiency or venous thrombosis, partial skin paddle necrosis, infection, hematoma, and wound dehiscence.[3,11] Donor-site morbidities remain a concern and include delayed skin graft healing, tendon exposure, sensory disturbances from lateral antebrachial cutaneous nerve injury, reduced grip strength, and pathological radius fracture, particularly when excessive cortical width is harvested without prophylactic fixation.[5,8,12,14] Recipient-site complications such as oroantral fistula, hardware exposure, contour deformity, or inadequate bony support for dental rehabilitation have also been reported in selected cases.[4,13] However, adherence to safe harvest limits (<40% radial circumference), meticulous microvascular technique, and routine prophylactic plating significantly reduce these complications.[5,8,12]

Comparatively, OCRFF has a shorter operative time and hospital stay than fibula or iliac flaps. There are no survival difference and ontological outcomes are similar for OCRFF (96%) when compared with other flaps like fibula (94%), DCIA (93%), scapula (97%) as observed by a network meta-analysis.[15]

CONCLUSION

The Osteocutaneous Radial Forearm Free Flap is unequivocally the most reliable and versatile flap for reconstructing moderate maxillary and mid facial defects. With a thorough understanding of the relevant anatomy, careful pre operative assessment and following the surgical steps of flap harvest, osteotomies, and anastomosis meticulously, we can achieve high flap survival rate and low post-operative complications and morbidities.

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