DOI: 10.14260/jemds/2015/645

# ORIGINAL ARTICLE

## FREE FIBULA FLOW THROUGH OSTEOCUTANEOUS FLAP IN THE UPPER EXTREMITY SARCOMA RECONSTRUCTION

Balakrishnan T. M[1], Sivarajan N[2]

**HOW TO CITE THIS ARTICLE:**
Balakrishnan T. M, Sivarajan N. "Free Fibula Flow through Osteocutaneous Flap in the Upper Extremity Sarcoma Reconstruction". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 26, March 30; Page: 4464-4472, DOI: 10.14260/jemds/2015/645

**ABSTRACT: INTRODUCTION:** With the evolution of modern reconstructive methods amputations for malignant tumours of the upper limb can be prevented. Of all the methods, the free fibula is most commonly used to bridge bone gaps during limb salvage. **OBJECTIVE:** to study the effectiveness of flow through fibula osteocutaneous flap in the reconstruction of upper extremity following oncological excision of forearm sarcomas, where both axial vessels are excised or dominant vessel is excised. **MATERIALS:** This study was conducted between March 2012 to March 2013 at our institute. A total of 6 cases(4 male and 2 female) aged between 19 and 40 years with Soft tissue sarcoma of the forearm were treated with Wide Local Excision and reconstruction using flow through osteocutaneous fibula flap. Of these, 4 patients had both the ulnar and radial arteries removed and in 2 patients the dominant/ codominant radial aretery was removed. The 4 patients in the first group received post op RT and the other 2 patients received post op chemotherapy. All patients were followed up for a mean period of 9 months. **RESULTS:** Histopathology was varied- Spindle cell sarcoma (2pts), synoviosarcoma (2 pts), osteosarcoma (1pt) and fibrosarcoma (1pt). All the tumours were located in the distal 1/3rd of the forearm. All the flaps survived, and all the patients had good to reasonable hand function at follow up. One patient developed pulmonary metastasis and 1 patient developed CRPS type 2. **CONCLUSION:** Amputation of the upper limb was thought to be the best approach for STS of the forearm. With the flow through flaps the vascularity and function of the hand can be maintained. Thus an irreplaceable vital organ, namely hand, can be saved with these flaps. The missing vascular conduit is reestablished and at the same time, bone and soft tissue is reconstructed.
**KEYWORDS:** Flow through fibula, Osteocutaneous, Sarcoma, Limb preservation surgery.

**INTRODUCTION:** Advances in tumour biology understanding, improved chemotherapy and radiotherapy (neoadjuvant or adjuvant in post op treatment), ability of surgical oncologists to excise the tumour with a good margin(principle of excision without seeing the tumour) and advances in plastic surgical expertise where there is always a technique available to reconstruct any composite defect of the upper extremity have all paved the way for limb salvage surgery.[1] Oncological resections, especially in the forearm sarcomas have resulted in complex composite defects with loss of axial vessels of the hand compromising its vitality.

These defects pose challenging options for any reconstructive surgeon. To envisage vitality and function of the hand, as a part of Limb Preservation Surgery (LPS), it requires a vessel conduit to bridge the defect in the vascular continuity and at the same time it should also provide skeletal stability, muscle and tendon continuity with or without recipient nerve anastomosis and finally the skin cover.

All these requirements are effectively addressed by the flow through fibula osteocutaneous flap,[2] where the peroneal artery restores the vascular deficit by acting as the conduit; the fibula

DOI: 10.14260/jemds/2015/645



provides the skeletal continuity (sometimes as a single bone forearm reconstruction); the peroneus longus harvested on an independent peroneal artery perforator, provides for reconstruction of the muscle tendon deficit, if the vascularised superficial peroneal nerve fascicle is also harvested, it will facilitate functional reconstruction. The skin island is useful for both post op monitoring and reconstruction of skin defect. Thus the flow through fibula osteocutaneous flap provides an avenue for the reconstruction of all the components of complex composite sarcoma resections. The use of neoadjuvant chemotherapy and post-operative radiation adds to the locoregional disease control.[3,4]

**MATERIALS:** In our department, between March 2012 and March 2013 we have done 6 cases of upper extremity Sarcoma reconstruction, all involving the forearm region. Of these in 4 cases both the radial and ulnar artery segments were resected with the tumour. In the other 2 cases the ulnar artery was spared, the resected radial artery was confirmed to be the dominant/codominat vessel, producing on table hypoperfusion of the ulnar border of the hand. So in all the 6 cases we have reconstructed vascular, bony, muscle tendon and skin defect by the flow through osteocutaneous flap. We followed up all these cases for an average of 9 months. All the 6 cases had very good functional recovery of hand with no claudication or ischemic changes.

**SURGICAL TECHNIQUE:** Management of the patient was first discussed with the multispeciality integrated tumour board, comprising the consultants from surgical oncology, Plastic surgery, Medical oncology, Radiation therapy and occupational therapy. A consensus in the management is then arrived in the planning session for the various reconstructive options. Presence of the palmar arch is confirmed (clinical examination inclusive of Allen's test) in all the patients. The handedness of the patient is also taken into consideration.

Preoperative work up includes routine MRI with T2 weighted images are done in all cases. In all patients after explaining the pros and cons of LPS an informed consent was taken. The ability and intelligence quotient to cooperate for post op physiotherapy and neoadjuvant chemotherapy were also assessed for careful patient selection. We do not do preoperative angiogram in the upper or lower limbs.

After the completion of the resection by the surgical oncologist, the tourniquet was removed and 20 minutes of perfusion allowed. The vitality of the hand and the defect were examined. In those patients were the oncologist was certain of resecting the tumour with both the vessels, simultaneous 2 team approach was followed. In those cases were one vessel is resected, simultaneous harvest was done, but the distal peroneal artery is not ligated until the need for a flow through flap was discerned. In the first scenario, were both vessels were resected, starighaway the distal end was prepared for anastomosis and flap is harvested.

We followed the postero lateral approach for flap harvest because it is easy to maintain the perforator to the peroneus longus in this approach. The same technique of fibula flap harvest is used except special attention is paid for harvesting proximal and distal peroneal artery with adequate length to allow tension free anastomosis at the recipient site.

Preplating was done before osteotomy to know the exact dimension of the bone segment, vascular segement, muscle tendon segment and skin paddle dimensions. Compression plated with screws was used for skeletal continuity reconstruction and K wires for wrist arthrodesis. In some cases a combination of both were used.

Peroneus longus muscle tendon unit as required for the deficit is harvested with little extra length. The order of reconstruction was bone, vessels and the musle tendon unit. The long flexor muscle mass with its intact neurovasc bundle were sutured to the proximal part of the Palmaris Longus. Distally PL tendon was weaved into FDP residuam at or proximal to Carpal Tunnel. The defect between the proximal and distal ends were bridged with peroneus tendon using nonabsorbable prolene sutures. When the extensor musle tendon gap was encountered the wrist was arthrodesised in 30 degrees extension, and wrist extensors was transferred to the EDC.

The median and ulnar nerve gaps following resection were reconstructed with vascularised nerve grafts (1 case) as and when required. Less critical nerves such as superficial branch of the radial Nerve, lateral and medial cutaneous nerves of the forearm were ignored.

The skin paddle is sized down to the defect during final closure. During the harvest of peroneus longus the dissection on the lateral side of the fibula is between periosteum and muscle to increase the 3 Dimensional positioning of muscle. The rest of the surface is harvested with little cuff of soleus, peroneus tertius and FHL muscles.

**POST OP COURSE:** Hand elevation, external POP slab (with a window for skin paddle monitoring) splinting the hand in functional position. The POP slab was continued for a period of 4 weeks, after which the patient was educated about care of the insensate hand. After this passive stretching protocol for joints of the hand is started with night splinting for another 4 weeks. Active movements are encouraged in hand joints with proximal joint exercises after 8 weeks.

Of all the 6 patients, 5 flaps had no complications. 1 flap was salvaged by correction of venous thrombosis, with a vein graft. All our patients gained light touch at an average of about 4 months along with large diameter fibre pain and temperature recognition. Functional aspect of recovery was tested by 2 independent observers. All assessments were done at the end of 9 months using the MSTS scoring system.

**DISCUSSION:** The treatment options for upper limb sarcomas include amputations,[5] replantation of the remaining distal forearm/hand,[6,7] prosthesis[8.9] and Limb preservation. In our department we have established, both from the oncological aspect and as well as function/form recovery, LPS is not inferior to amputation.

LPS is a boon for sarcoma forearm patients, wherein both function and form are established. Flow through free fibula osteocutaneous flap when harvested in chimeric form i.e. the skin and muscle paddle harvested on independent perforators, but supplied by the same source vessel; provides all avenues for reconstructing the composite defect.[10] Reconstructing vessel, skeletal, Nerve gaps and the soft tissue defect in one go using flow through fibula osteocutaneous chimeric flap is a technically demanding and raison d'etre to achieve the form and function of the hand. Especially when the supportive medical oncology and radiation therapy readily available limb preservation and salvage can be made a reality.[11,12] The plastic surgeons with this new armamentarium complete the last chip of the limb preservation effort.

There are many studies to support the role of preoperative CTA for the lower limb.[13,14,15] Nasaya et al in their study said that MRA is the investigation of choice for location, position of the peroneal perforators.[16] On the contrary there is enough evidence to suggest that routine preoperative CTA is not requied.[17] Preoperative CTA was not routinely done in our series. Peroneus Longus which

is harvested as a component of chimeric free fibula octeocutaneous flap is a type II muscle.[18] The major pedicle (muscle perforator) from the peroneal to artery was within 2.5cm from the single best perforator the skin paddle in all our cases.

In the first group of 4 patients, where both the forearm axial vessels were sacrificed, the simple extra anastomosis between distal peroneal artery to radial artery in the distal forearm, which takes an extra 30 minutes establishes the vascular conduit continuity and serves to preserve the limb. In the second group of 2 patients, following the extirpation of sarcoma, the presence of ulnar border ischemia in the hand, envisage the need for the flow through free fibula osteocutaneous flap.

The decision on the nerve was taken on table. It has been proved there is no difference in local or distant recurrences with epineurectomy.[19] Gerrand et al technique of preservation of the nerve by planned positive margins was not followed.[20] In those cases where the tumour is obviously invading the nerve, we do not do neurolysis and resection/ nerve grafting is done.

Skillful assessment of the post extirpation defect in terms of skeletal defect, muscle tendon defect, skin defect and nerve gaps paves the way for fabrication of the flap. Simultaneous 2 team approach decreases the operating time. With excellent post-operative monitoring and physiotherapy regimen. All cases had good direct osteosynthesis in the proximal and distal ends with regain of protective sensation in hand, in addition to finger flexion/extension. The skin paddle required was very less. The average skeletal defect was 9.5cm. On follow up there was no evidence of claudiction, ischemic changes. However, one patient developed pulmonary metastasis and one patient CRPS type II. At 9 months follow up there were no signs of any locoregional recurrence and all the flaps had settled well.

Arai et al used the simple fibular osteocutaneous flap for limb preservation. He reported a complication rate of 56%.[21] In comparison our complication rate of 33% was trivial and manageable. However his study was elaborate with a total of 60 cases, and our study had a small sample size of 6 cases.

Gao et al have reported vascularised bone reconstruction as a part of Limb preservation.[22] None of their cases received post op radiotherapy and their complication rates were on par with us.

**CONCLUSION:** Sarcoma reconstruction has undergone a radical change towards preservation of the limb with the usage of the vascularised free fibula flap. The major advantage is that there is no compromise in the extent of resection. We recommend the use of the peroneus longus muscle tendon unit based on an independent perforator from the peroneal artery. The use of the peroneus muscle has improved the functional outcome in these patients.

**REFERENCES:**

1. R.J. Canter, S. Beal, D. Borys, S.R. Martinez, R.J. Bold, A.S. Robbins Interaction of histologic subtype and histologic grade in predicting survival for soft-tissue sarcomas J Am Coll Surg, 210 (2010) 191. e2-198.
2. Mamoon Rashid, Sohail Hafeez, Muhammed Zia. Limb Salvage in Malignant tumours of the upper limb using vascularised fibula. Journal of plastic, reconstructive and aesthetic surgery. Vol 61; 2008; 648-61
3. Kaushal A, Citrin D. The role of radiation therapy in the management of sarcomas. Surg Clin North Am. 2008 Jun; 88(3): 629-46.

4. Curtis KK, Ashman JB et al. Neoadjuvant chemoradiation compared to neoadjuvant radiation alone and surgery alone for Stage II and III soft tissue sarcoma of the extremities. Radiation Oncologyl. 2011 Aug.
5. M.A. Ghert, A. Abudu, N. Driver, A.M. Davis, A.M. Griffin, D. Pearce et al. The indications for and the prognostic significance of amputation as the primary surgical procedure for localized soft tissue sarcoma of the extremity Ann Surg Oncol, 12 (2005), pp. 10–17.
6. M.V. Kuntscher, D. Erdmann, S. Strametz, M. Sauerbier, G. Germann, L.S. Levin [The use of fillet flaps in upper extremity and shoulder reconstruction] Chirurg, 73 (2002), pp. 1019–1024.
7. S.B. Hahn, Y.R. Choi, H.J. Kang, K.H. Shin Segmental resection and replantation have a role for selected advanced sarcomas in the upper limb Clin Orthop Relat Res, 467 (2009), pp. 2918–2924.
8. Horowitz SM (1), Glasser DB, Lane JM, Healey JH. Prosthetic and extremity survivorship after limb salvage for sarcoma. How long do the reconstructions last? Clin Orthop Relat Res. 1993 Aug; (293): 280-6.
9. Mayilvahanan N (1), Bose JC, Paraskumar M, Rajkumar et al. Paget's sarcoma: limb salvage by custom mega prosthesis: four case reports. J Orthop Surg (Hong Kong). 2004 Dec; 12(2): 243-7.
10. Daya M. Peroneal artery perforator chimeric flap: changing the perspective in free fibula flap use in complex oromandibular reconstruction. J Reconstr Microsurg. 2008 Aug; 24(6): 413-8.
11. F.R. Eilber, J. Eckardt Surgical management of soft tissue sarcomas Semin Oncol, 24 (1997), pp. 526–533.
12. P.W. Pisters, R.E. Pollock, V.O. Lewis, A.W. Yasko, J.N. Cormier, P.M. Respondek et al. Long-term results of prospective trial of surgery alone with selective use of radiation for patients with T1 extremity and trunk soft tissue sarcomas Ann Surg, 246 (2007), pp. 675–681 discussion 681–682.
13. Patrick B. Garvey, M.D., Edward I. Chang, M.D., Jesse C. Selber, Matthew M. Hanasono, M.D. Plast Reconstr Surg. Oct 2012; 130(4): 541e–549e.
14. Yvonne L. Karanas M. D. Anuja Antony M.D. Preoperative CT angiography for free fibula transfer Microsurgery Volume 24, Issue 2, pages 125–127, 2004.
15. Diego Ribuffo, Matteo Atzeni, Luca Saba Clinical study of peroneal artery perforators with computed tomographic angiography: implications for fibular flap harvest Surgical and radiological anatomy April 2010.
16. Nasaya Akashi, Tadashu Nomura; Microsurgery. Vol33, Issue 6; 454-459 Sept 2013.
17. Erifukaya, David Saloner, Pablo Leon. Journal of Plastic, Reconstructive and Aesthetic Surgery, Vol. 63, Issue 7, July 2010,Page 1099-1104.
18. Mathes SJ, Nahai F. Reconstructive Surgery: principles, anatomy, and technique. New York: Churchill Livingstone, 1997.
19. M.A. Kemp, D.E. Hinsley, S.E. Gwilym et al Functional and oncological outcome following marginal excision of well-differentiated forearm liposarcoma with nerve involvement J Hand Surg, 36A (2011), pp. 94–100.
20. C.H. Gerrand, J.S. Wunder, R. A. Kandel, B. O'Sullivan, C.N. Catton, R.S. Bell et al. Classification of positive margins after resection of soft-tissue sarcoma of the limb predicts the risk of local recurrence J Bone Joint Surg, 83B (2001), pp. 1149–1155.

DOI: 10.14260/jemds/2015/645



21. K. Arai, S. Toh, K. Tsubo et al. Complications of vascularized fibula graft for reconstruction of long bones. Plast Reconstr Surg, 109 (2002), pp. 2301–2306.
22. Y.H. Gao, L.L. Ketch, F. Eladoumikdachi et al. Upper limb salvage with microvascular bone transfer for major long-bone segmental tumor resections. Ann Plast Surg, 47 (2001), pp. 240–246.

| Serial No. | Patient details | Nerve Involved | Technique of Reconstruction | Skeletal Defect |
|---|---|---|---|---|
| 1. | 20/M | Median | Primary Neurorapphy | 14 cm |
| 2. | 36/F | Ulnar Median | Neurolysis | 8 cm |
| 3. | 40/M | Ulnar Median | Neurolysis | 10.5cm |
| 4. | 22/M | Ulnar Median | Neurolysis | 9.5cm |
| 5. | 19/M | Median | Nerve grafting | 11 cm |
| 6. | 26/M | Ulnar | Neurolysis | 8.5 cm |

Table 1: Nerve Reconstruction

| Serial | Patient Details | Tumour | Functional Score | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pain | Function | Hand Position | Dexterity | Acceptance | Lifting | Total |
| 1 | 20/M | SS | 5 | 4 | 5 | 4 | 4 | 4 | 26 |
| 2 | 36/M | FS | 4 | 3 | 4 | 4 | 4 | 3 | 22 |
| 3 | 40/M | SCS | 4 | 3 | 3 | 3 | 2 | 3 | 18 |
| 4 | 22/M | SCS | 5 | 4 | 5 | 4 | 3 | 4 | 24 |
| 5 | 19/M | OS | 4 | 3 | 3 | 4 | 2 | 2 | 16 |
| 6 | 26/M | ES | 4 | 3 | 4 | 3 | 2 | 4 | 20 |

Table 2: MSTS scoring following tumour resection

SS – Synovial Sarcoma.
FS – Fibro Sarcoma.
SCS – Spindle Cell Sarcoma.
OS – Osteo Sarcoma.
ES – Endothelial Sarcom

DOI: 10.14260/jemds/2015/645



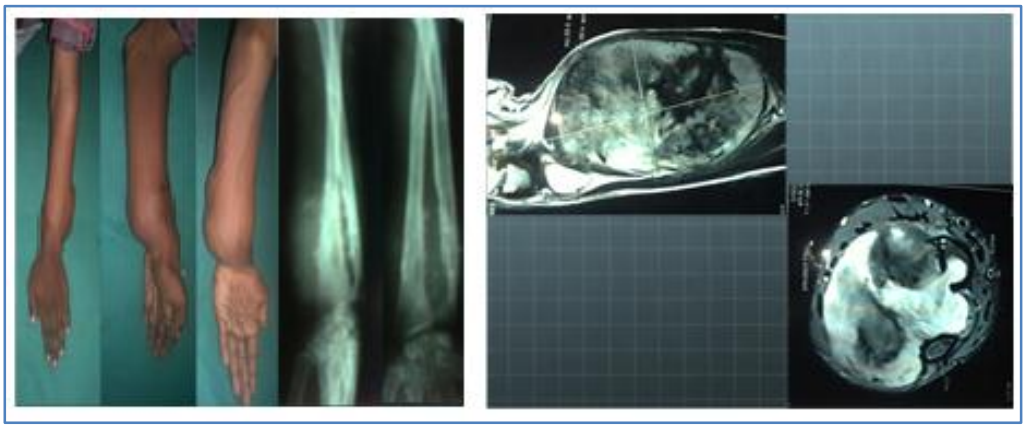

Fig. 1: Pre-operative picture

Fig. 2: CT Picture showing extent of involvement

Fig. 3: Wide local excision involving both forearm blood vessels and neurolysis of ulnar and Radial Nerve done

Fig. 4: Harvesting free fibular flap

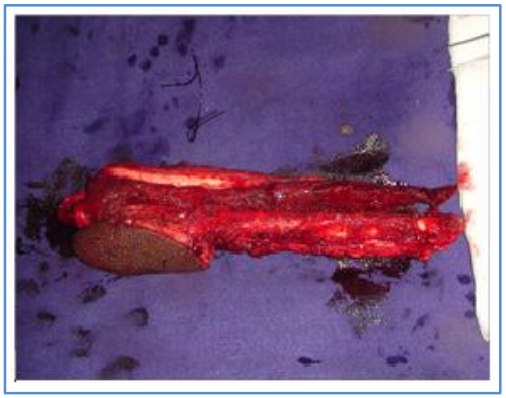

Fig. 5: Chimeric free fibular flap with peroneus longus muscle and tendonand cutaneus paddle

DOI: 10.14260/jemds/2015/645



**Fig. 6:** Peroneus longus musculotendinous unit interposed to the flexor digitorum profundus gap and fibula proximally fixed to the radius and distally arthrodesed to extended wrist and proximal radial artery to peroneal artery anastomosis done and distal peroneal vessel to radial artery anastomosis done and the venae comitantes of the peroneal artery anastomosed to the cephalic vein proximally.

**Fig. 6**


**Fig. 7**

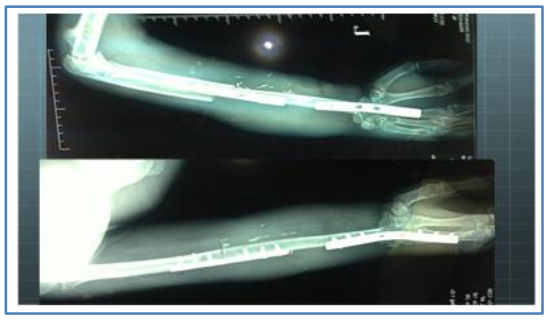

**Fig. 8: Post-operative picture x-ray well settled bone flap**

**Fig. 9: Postoperative follow up with good hand grip function-1 yr**

**Fig. 10: Dexterity obtained for writing - 1 year**

DOI: 10.14260/jemds/2015/645

# ORIGINAL ARTICLE

**AUTHORS:**

1. Balakrishnan T. M.
2. Sivarajan N.

**PARTICULARS OF CONTRIBUTORS:**

1. Assistant Professor, Department of Plastic Surgery, Government General Hospital, Madras Medical College.
2. Associate Professor, Department of General Surgery, Chettinad Hospital & Research Institute.

**FINANCIAL OR OTHER COMPETING INTERESTS:** None

**NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:**
Dr. Sivarajan N,
# 27, Customs Colony,
V. G. P. Salai, Saidapet,
Chennai-600015.
E-mail: sivarajandr@yahoo.com

Date of Submission: 03/03/2015.
Date of Peer Review: 04/03/2015.
Date of Acceptance: 18/03/2015.
Date of Publishing: 27/03/2015.