



# Perforator based flap coverage from the anterior and lateral compartment of the leg for medium sized traumatic pretibial soft tissue defects— a simple solution for a complex problem

B. Jagannath Kamath\*, Thangam Verghese Joshua, S. Pramod

*Department of Orthopaedics, Kasturba Medical College, Mangalore, India*

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## KEYWORDS

Perforator based flaps;  
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**Summary** Compound fractures involving the leg, exposing the tibia or other poorly vascularised tissues such as tendons still pose a big problem for a reconstructive surgeon and they need early plastic surgical intervention. A prospective study of 10 cases of moderate sized defects in the leg exposing the tibia due to trauma was undertaken between January 2003 and August 2004 with an average follow up of 12 months. Pre-operative identification of the perforator around the wound was meticulously performed using hand held Doppler equipment. Most of the wounds were covered within the first 3-5 days of the injury. All the flaps were raised from the anterior or the lateral compartment of the leg to cover the adjacent tibial bone. Five flaps were raised as proximally based and five flaps were raised as distally based flaps. No flap was raised and advanced in a V-Y fashion. Split skin grafting was required in all cases to cover the secondary raw area created following the flap elevation. All flaps survived and served the purpose. In one case we encountered a deep seated infection resulting in sinus formation needing further debridement in the form of sequestrectomy. In conclusion, the authors believe that the perforator based flap cover described here is simple, safe and a versatile procedure for a trauma surgeon to cover the moderate sized traumatic pre-tibial wounds exposing the bone and the tendons.

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\* Corresponding author. Address: Jyoti Mansions, Opposite Prabhath Talkies, K.S.R Road, Mangalore 575001, India. Tel.: +91 824 2440233/2497650; fax: +91 824 2428379.

E-mail address: [bjkamath@satyam.net.in](mailto:bjkamath@satyam.net.in) (B.J. Kamath).

Compound fracture of the leg with loss of skin and soft tissue over the pretibial region exposing the bare bone or the fracture site are an extremely common occurrence. Many flaps, have been described to cover these raw areas such as,

proximally or distally based fascio-cutaneous flaps,<sup>1-6</sup> sural artery flaps,<sup>7</sup> proximally or distally based arterial flaps,<sup>8-12</sup> distally based adipo-fascial flaps,<sup>13,14</sup> gastrocnemius myocutaneous flaps<sup>15</sup> or muscle flaps with overlying split skin grafting.<sup>16-18</sup> In order to minimise the loss of function of muscle, a part of the muscle such as hemisoleus<sup>16,17</sup> or a split muscle such as anterior tibial muscle flaps<sup>18</sup> have been used. Most of these flaps are from postero-medial calf region or postero-lateral sural region. The donor areas are quite away from the recipient region needing extensive dissection and difficult arc of rotation to reach the defect. Bipedicle fasciocutaneous<sup>19</sup> or myocutaneous<sup>15</sup> are suitable for narrow longitudinal raw areas. Some surgeons have used fascial release<sup>20</sup> and gradual coverage using skin traction<sup>21</sup> as a method to cover pretibial traumatic wounds.

Perforator based flaps from the leg have been used to cover raw areas in nontraumatic conditions like post-excision of skin lesions, Basal Cell Carcinoma, etc.<sup>22-24</sup> The regional anatomy of the antero-lateral compartment has provided several septocutaneous perforators all along the intermuscular septum and intercompartmental septum.<sup>25,26</sup> They are quite significant in size and number and are constant both in diaphyseal and metaphyseal regions of the leg, This favourable regional anatomy can be used to raise and rotate or transpose perforator based flaps to cover small to medium sized adjacent pretibial defects either as proximally or distally based flaps. The skin on the anterolateral compartment had never been a favourite choice of reconstructive surgeons before the advent of perforator based flaps. Some of the flaps like distally based anterior tibial artery flaps, described by Wee et al and Morrison et al.<sup>11,12</sup> are technically demanding, time consuming and

involve sacrificing a major artery of the leg. In low energy trauma where the raw area is only pretibial with preserved and undamaged skin and soft tissue of anterior and lateral compartment, anterior and lateral compartmental perforator based flaps are closest, safest and simplest of all the locoregional flaps. The donor raw area will be small because the flaps are raised with the pivot point close to the raw area, hence the morbidity is low, unlike the posterior faciocutaneous flaps in the calf, sural artery flaps. The intra-operative position of the patient for these flaps is supine making the technique of raising the flap simple and less time consuming without the need of a qualified assistant.

## Patients and methods

Between January 2003 and August 2004, 10 patients with moderate sized soft tissue defects ranging from 3×3 to 8×4 cm with an average of 6×4 cm were treated and followed for an average period of 12 months in Government Wenlock Hospital, Mangalore with perforator based flaps raised either from anterior compartment {seven cases} or lateral compartment {three cases} [Table 1]. Five flaps were based proximally and five flaps were raised distally. All the flaps were rotated or transposed to cover the defect. No flap was used as a V-Y advancement flap. Out of 10 patients nine were males and one female. The average age of the patient was 35 years ranging from 23 to 48 years.

All 10 patients had concomitant bony injury, which were treated by open reduction and internal fixation in three patients, external

**Table 1** Patient details

| Sl no | Age (years) | Sex | Site | Size (cm) | Feeder | Base | Complications | Time since injury (days) |
|-------|-------------|-----|------|-----------|--------|------|---------------|--------------------------|
| 1     | 48          | F   | M/3  | 4×5       | One    | Dist | Nil           | 4                        |
| 2     | 40          | M   | M/3  | 7×3       | One    | Dist | Nil           | 2                        |
| 3     | 35          | M   | M/3  | 4×5       | One    | Prox | Nil           | 4                        |
| 4     | 42          | M   | L/3  | 8×4       | One    | Dist | Nil           | 3                        |
| 5     | 30          | M   | L/3  | 5×4       | One    | Dist | Sinus         | 3                        |
| 6     | 40          | M   | P/3  | 3×3       | One    | Prox | Nil           | 7                        |
| 7     | 23          | M   | P/3  | 5×6       | One    | Prox | Nil           | 6                        |
| 8     | 40          | M   | M/3  | 7×5       | One    | Prox | Nil           | 3                        |
| 9     | 38          | M   | P/3  | 7×5       | One    | Dist | Nil           | 4                        |
| 10    | 48          | M   | P/3  | 7×2       | One    | Prox | Nil           | 3                        |

P/3, proximal third; M/3, middle third; L/3, lower third; M, male; F, female; Y, years; Prox, proximally based; Dist, distally based.

fixation in five patients and intra-medullary nailing in two patients. In six patients the raw area exposed the fracture site (Figs. 1(A), 2(A) and 3(A)) and in another four patients it was the bare tibial bone without periosteal covering that was exposed.

## Methods

All 10 procedures were done under spinal or epidural anesthesia with the patient in the supine position. Pre-operatively, the perforators were identified and marked using hand held Doppler



**Figure 1** (Case 3) (A) Post-traumatic pretibial wound measuring 4×5 cm exposing the fracture site in middle 1/3 of the tibia. (B) Pre-operative three perforators were identified using a hand; held Doppler [P1, P2, P3]. (C) The proximal perforator [P1] was more suitable in this case, hence was chosen. (D) Flap raised till the perforator visualised [white arrow]. (E) Well settled flap after 6 weeks.

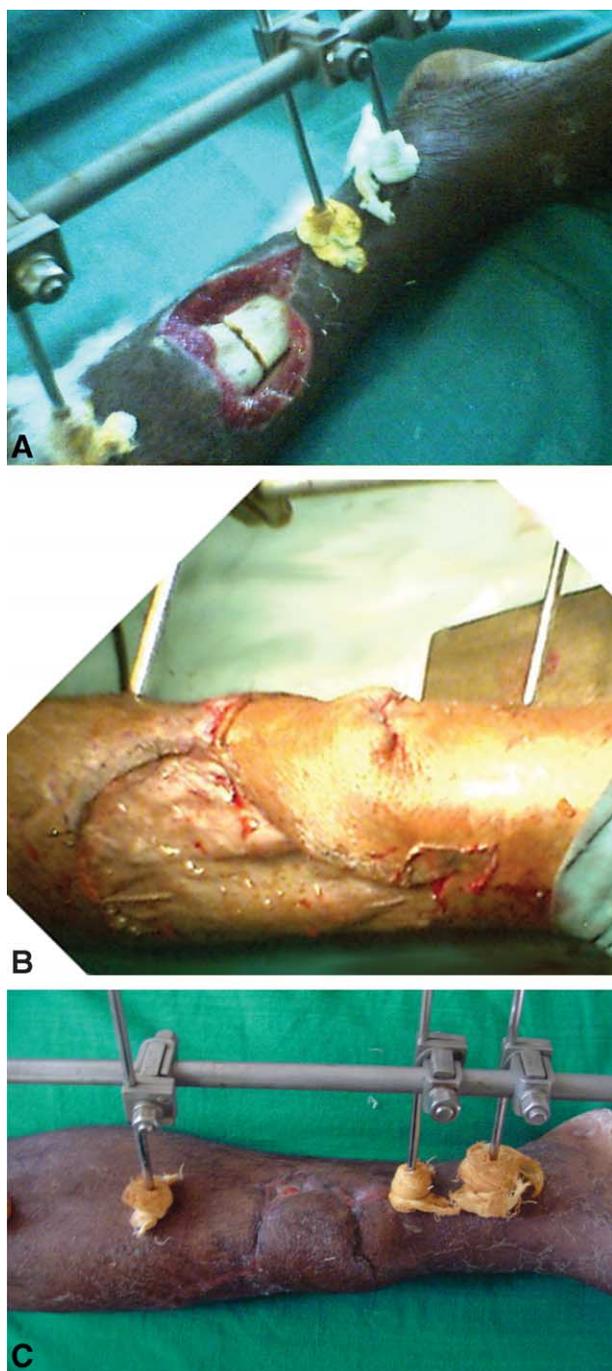


**Figure 2** (Case 4) (A) Post-traumatic two pretibial wounds measuring  $8 \times 4$  cm and  $2 \times 3$  cm in the distal 1/3 of the leg. (B) The distally based perforator flap [P1] [white arrow] was raised and rotated up to  $160^\circ$ . (C) Flap inset without any tension. (D) Well settled flap after 6 weeks.

equipment [EMCO-HUNTLEIGH D500 Mini Doppler. The pocket Doppler, 8 MHz] around the raw area. The perforator most prominent and closest to the raw area was chosen. Most of the flaps were raised in delayed primary situations after 3-5 days following the injury. Pneumatic tourniquet without exsanguination was used. Starting from the tip, the flap was raised towards the pedicle as a fasciocutaneous flap including the aponeurosis and the epimysium of the anterior or lateral group of muscles with the help of operating loupes leaving only the fleshy muscle fibres behind for adequate graft take. No attempt was made to dissect between the deep fascia and the aponeurosis of the muscles. The flap was dissected till the perforator was seen at the pivot point with a small intact bridge of skin less than 1 cm around the pedicle. No attempt was made to skeletonise the pedicle or the perforator. V-Y advancement of the flap commonly done in nontraumatic conditions was considered risky in anterolateral compartment in delayed primary

flap coverage in traumatic conditions. Following the rotation or transposition, the flap was used to cover the defect using 3-0 or 4-0 nylon (ETHILON) tension free sutures with 2 or 3 penrose drains in situ. In all 10 cases, a secondary raw area created following the elevation of the flap was covered with split skin grafting. Post-operatively a bulky dressing was applied with strict instruction for leg elevation. Since the raw area, flap and the pedicle are all situated in the anterolateral compartment, there was no fear of any compression of any of these structures, compromising the results. Flap was left open for repeated inspection and split skin grafting was inspected on 5, 8 and 11th days.

All 10 flaps were fed by only one perforator closest to the defect. The superficial peroneal nerve in all 10 cases has been spared and the flap being in the anterolateral compartment did not violate the long or short saphenous venous system. No special attention was paid to preserve any superficial vein in the anterolateral compartment.



**Figure 3** (Case 5) (A) Post-traumatic pretibial wound measuring  $5 \times 4$  cm exposing the fracture site. (B) Distally based perforator flap-intra-operative picture. (C) Well settled flap after 6 weeks with a complication of sinus because of the underlying infection.

## Results

In all the 10 patients, the flaps served the purpose with nine patients ending up with complete primary healing of flaps and split skin grafting. Only one patient suffered a deep infection which resulted in

chronic sinus formation [Fig. 3(C)] which we attributed to improper primary debridement. However, there was no need for any secondary plastic surgical procedure required in that patient though he underwent sequestrectomy as a separate procedure. The purpose of the flap coverage was served in that patient.

No patient had any loss of function of anterior or lateral compartmental muscles.

## Discussion

Local and regional flaps from the calf either as proximal or distally based fascio cutaneous,<sup>1-6</sup> adipofascial<sup>13,14</sup> or neurocutaneous flaps<sup>27</sup> are versatile but involve greater dissection with increased morbidity because of difficult arc of rotation and farther pivotal point from the defect. Pedicles may have to be tunnelled and larger raw areas resulting from the flap elevation may have to be covered with split skin grafting in posterior and dependant positions in the calf, needing careful graft protection in the early post-operative period. Muscle and musculocutaneous flaps not only have the above mentioned disadvantages but also involve sacrifice of important muscle. Split skin grafting over muscle flap though results in a stable coverage may preclude secondary skeletal procedures.

Anterolateral compartment of the leg has never been considered as a favorite choice of skin coverage for small to moderate sized pretibial traumatic defects of the leg. The previously described reversed anterior tibial artery flap is time consuming and technically demanding. Superficial peroneal neurocutaneous flap<sup>27</sup> has been described but involves tedious dissection sacrificing the superficial branch of peroneal nerve. Previous studies<sup>25,26</sup> have shown that there are plenty of septo-cutaneous perforators arising from the anterior tibial or peroneal arteries. These perforators are easily amenable for pre-operative identification by hand held Doppler machine. In this study we have used septocutaneous perforators present in the intermuscular septum number one, two and three arising from anterior tibial artery and septum number four arising from the peroneal artery as described by Thomas P. Whetzel et al.<sup>25</sup> Fairly large areas of skin can be raised based on these robust perforators with narrow or skeletonised pedicles close to the defects to be covered. The graft take over the anterior tibial muscle has not been a problem and does not affect planning and placement of the incisions for any future secondary bony procedures. Though we have used anterior and

lateral compartmental perforator based flaps as V-Y advancement flap in nontraumatic lesions in the leg, we do not recommend the same in moderate sized traumatic wounds especially in delayed primary situations. Niranjana et al.<sup>24</sup> reported 40 cases of perforator based flaps in the leg, out of which eight cases were traumatic in nature. Six out of these eight traumatic cases in that study were in the posterior compartment and the two cases in the lateral compartment were small in size. In our series the average size of the defect was greater and was found clinically not suitable for primary closure by V-Y advancement. We fully agree with Niranjana et al. in that these flaps will not be suitable in avulsive and degloving traumatic wounds caused by high velocity injury. This report has proved that moderate sized pretibial traumatic defects can be covered easily and safely with least donor site morbidity, using locally available versatile perforator based flaps. Uncomplicated intra-operative positioning of the patient in supine position, will also work in favour of surgeons and anaesthetists thereby minimising the cost and effort from the theatre personnel. In conclusion, a simple and user-friendly local flap has been described with good clinical results.

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