

The Flaps That Orthopaedic Surgeons Need to Know: Practical Flaps/Pedicle Reconstruction in Compound Limb Injuries

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Abstract

Background: Compound limb injuries frequently involve extensive soft tissue loss with exposed bone, joints, or implants. Timely vascularized soft tissue coverage is critical for preventing infection, non-union, and amputation. Although microsurgical free tissue transfer has significantly improved limb salvage rates (1,5,6), such facilities are not universally available. ORTHOPLASTIC integration allows orthopaedic surgeons to perform reliable soft tissue reconstruction in resource-limited settings.

Objectives: To evaluate the effectiveness, safety, limb salvage rate, and functional outcomes of fasciocutaneous and pedicled flap reconstruction performed by an orthopaedic surgeon.

Methods: A retrospective observational study was conducted on 134 patients treated over 38 years (1986–2024). Seventeen cases treated with isolated skin grafting were excluded, leaving 117 patients requiring advanced reconstructive procedures. Techniques included fasciocutaneous flaps, cross-leg flaps, abdominal and thigh pedicled flaps, reverse sural flaps (4), and local rotational flaps. Outcomes were assessed using flap survival, complication rates, fracture union, limb salvage, and Lower Extremity Functional Scale (LEFS).

Results: Patients ranged from 15–78 years (mean 35.5 years). Trauma was the predominant etiology. Overall flap survival exceeded 95%. Minor complications occurred in three cases (4.5%) and were successfully managed. Limb salvage was achieved in all major reconstructive cases. In selected tibial fractures with residual gaps of 1.5–2 cm, spontaneous bone formation (neo-osteogenesis) was observed following flap coverage, likely due to improved local vascularity.

Conclusion: Fasciocutaneous and pedicled flaps performed by trained orthopaedic surgeons provide reliable, cost-effective, and reproducible soft tissue coverage. In appropriately selected cases, these techniques offer outcomes comparable to more complex reconstructions (2,7,8).

Keywords: Orthoplastic Surgery, Fasciocutaneous Flap, Cross-leg Flap, Pedicled Flap, Compound Fracture, Limb Salvage, Soft Tissue Reconstruction, Orthopaedic Trauma

1. Introduction - Aim of the Study

Soft tissue defects in compound limb injuries present major reconstructive challenges. While fracture stabilization is essential, durable soft tissue coverage is equally critical for infection control and fracture union. Microsurgical free flap reconstruction has advanced limb salvage significantly (1,5,6). However, such procedures require specialized infrastructure, prolonged operative time, and substantial financial resources. In many governments, rural, and emergency trauma centres, these resources are limited. Fasciocutaneous flaps, originally popularized by Pontén (8,11) and anatomically classified by Cormack and Lamberty (9) and Nakajima et al. (10), provide reliable vascularized coverage while preserving muscle function. Contemporary literature supports the effectiveness of pedicled perforator flaps and regional flaps in lower limb reconstruction (2,7). This study presents a 38-year personal clinical experience of orthopaedic procedures performed by an orthopaedic surgeon in resource-variable settings.

The aim of this study was to evaluate clinical outcomes, complications, and limb salvage following fasciocutaneous and pedicled flap reconstruction performed by an orthopaedic surgeon. Orthopaedic surgery integrates plastic surgical principles into orthopaedic trauma care. This study highlights the practical, safe, and effective role of orthopaedic surgeons in performing soft tissue reconstruction using fasciocutaneous and pedicled flaps, based on long-term real-world experience. Soft tissue defects associated with compound limb injuries pose a significant reconstructive challenge. Although the primary pathology is orthopaedic, successful outcomes depend equally on timely and durable soft tissue coverage. Traditionally, such reconstruction has been the domain of plastic surgeons. However, limited availability, high cost, and delayed referrals often compromise outcomes, especially in government, rural, and industrial trauma centres. Orthopaedic surgery has emerged as a collaborative subspecialty combining orthopaedic stabilization with plastic reconstructive techniques. Fasciocutaneous flaps, in particular, have gained popularity due to their reliability, ease of execution, preservation of muscle function, and favourable aesthetic outcomes.

This study presents a long-term experience of an orthopaedic surgeon performing orthopaedic procedures for limb salvage and functional restoration. This study presents a comprehensive 38-year personal clinical experience of orthopaedic surgery performed by an orthopaedic surgeon, focusing on soft-tissue coverage in compound injuries of upper and lower limbs. The work emphasizes the evolving role of orthopaedic surgeons in managing soft-tissue defects traditionally addressed by plastic surgeons, especially in resource-limited, rural, government, and emergency settings. The study covers a wide spectrum of soft-tissue reconstruction techniques, including split-thickness and full-thickness skin grafts, local rotation flaps, cross-leg flaps, abdominal and thigh pedicled flaps, sural flaps, perforator-based fasciocutaneous flaps, and fillet flaps. Indications included traumatic compound injuries, exposed bone and joints, chronic infected wounds, post-TKR wound breakdown, neuropathic ulcers, paraplegic sacral sores, and rare conditions such as painful pigmented neuropathic nevi. The

content highlights limb salvage, functional restoration, infection control, and in addition, provide durable soft tissue coverage, improved local vascularity following flap reconstruction which may contribute to an enhanced biological environment or fracture healing.

2. Materials and Methods

- Study Design
- Retrospective observational study (1986–2024)
- Study Population
- 134 patients treated; 17 skin graft-only cases excluded
- Final cohort: 117 males, 17 females
- Age: 15–78 years (mean 35.5 years)
- Indications
- Compound fractures with exposed bone/joint/implant
- Chronic infected wounds
- Postoperative wound breakdown
- Neuropathic ulcers

2.1. Study Design and Population

A retrospective observational study was conducted on 134 patients treated over 38 years (1986–2024). All patients had significant soft-tissue defects requiring reconstructive surgery. Simple skin graft 17 cases were excluded to maintain methodological rigor.

2.2. Study Parameters Include

Final cohort: Population: 117 males and 17 females, Age range: 15–78 years (mean 35.5 years)

- **Anatomical Sites**
Upper limb, lower limb (leg, ankle, foot, knee), chest, sacrum, coccyx
- **Etiology**
Trauma (majority), chronic wounds, postoperative complications, neuropathic lesions
- **Surgical Procedures performed**
54 fasciocutaneous flaps (8,9,10), Cross-leg flaps, Abdominal and thigh pedicled flaps
Reverse sural flaps (4), Local muscle flaps where indicated (3), Fillet flaps,

2.3. Preoperative Protocol

- Radical debridement in all cases
- Infection control
- Selective NPWT (12 cases)
- Clinical vascular assessment

2.4. Inclusion Criteria -- Indications

- Compound fractures with exposed bone/joint/implant
- Chronic infected wounds
- Postoperative wound breakdown
- Neuropathic ulcers

2.5. Exclusion Criteria

Isolated split-thickness skin graft procedures
Preoperative preparation of the defect was undertaken in all patients. An excision and debridement was performed for all

cases. Twelve wounds received therapy with a negative pressure (NPWT) of 125 mm Hg. As a standard, a silver sponge was applied for a period of 7 day at a constant mode of operation of the system.

Sr no	Area of surgery	No of cases	Male	Female	Surgeries performed	Complications
1	Upper limb – hand & forearm	19	17	2	17 abdominal/chest flaps 2 local flaps	0%
2	Upper limb – elbow & arm	05	4	1	3 chest flaps arm 1 local flap, 1 fillet graft	0%
3	Upper limb chest	12	9	3	Chest to hand fingers	0%
4	Hand fingers	28	26	2	Cross finger thumb flaps	0%
5.	Chest	01	1	0	1 Local rotation flap	1 Minor gap – healed
6.	Lower limb knee	01	1 *	0	1 Local rotation failed - Cross leg to knee worked	Healed (post TKR)
7.	Lower limb leg tibia	52	45**	7	50 cross leg 2 leg to ankle flap	2 marginal necrosis 1 flap necrosed (Revised) 4.5%
8.	Lower limb foot	05	5*	0	2 local flap – sural N. Flap 3 thighs to heel flap	1 big ulcer pressure sore on lower thigh healed gradually 20%
9	Non ortho ear lip Coccyx	11	09	02	Local rotation flaps	0%
10	TOTAL	134	117	17		

The above list included 4 cases marked as * where plastic surgeries performed by specialized did not succeed, one patient operated TKR with ischemia developed wound gap with knee exposed, local rotation flap was done but because of ischemia in leg, local flap did not take up & wound gapped. We did cross leg to knee flap which take up excellent in 4 weeks & wound got healed completely. and could succeed to get good & full coverage.

necrosis, was operated by reverse rotation flap but it got necrosed & bone got exposed again. We did plastic coverage by cross leg to ankle flap & got good healing & bone coverage.

One more case of tendo Achilles exposed following injury was operated for sural nerve flap but got rejected necrosed making tendon again exposed. We did thigh pedicle to heel by figure of four position, and was taken up & healed completely.

2.6. Description of Cases

Case 1. Another case of exposed medial malleolus due to skin



Figure 1: Crush Injury Heel/ ext fix/-cross Thigh Pedicle Seen/ Cross Thigh Flap//Final Result with Pedicle Taken up. https://youtu.be/_FA8A-Qk2tk?si=azqOXxH8ffP520TJ. Watch the video: https://youtu.be/_FA8A-Qk2tk?si=NXrBqfmx8o6W3ppx

Case 2. In fractures of tibia cases, except in upper third leg, it is preferred not to go for local flaps as due to trauma & crushing, surrounding soft tissues are damaged and have compromised vasculature & viability and with local rotation it hampers much more. In such cases, cross legged pedicles are preferred as it

increases the vasculature of local part & bone as a hole. In our long-term experience, we have seen cases where at the end of soft tissue coverage, there are gaps of about 1.5 to 2cm at fracture gap, (Neo osteogenesis) over a period of few months this gap is filled by new bone & there is no need to have bone graft in many case.



Figure 2: Defect in Leg //Cross Leg Pedicle //Final Result After Detachment of Flap
Watch the video: https://youtu.be/_FA8A-Qk2tk?si=NXrBqfmx8o6W3ppx

Case 3. One case of brachial plexus injury with compound loss of soft tissues surrounding the shoulder and humerus and also limb paralysed anesthetic & useless. Primarily it looked like a case of

shoulder disarticulation in view of whole humerus bone exposed contaminated.



Figure 3: Post Electric Injury - Humerus Bone Exposed // Fillet Graft // Exposed Humerus Covered
Watch the video: https://youtu.be/_FA8A-Qk2tk?si=NXrBqfmx8o6W3ppx

We devised a novice idea, the bones distal to elbow ie. Forearm bones, hand & finger bones were excised carefully preserving the soft tissue envelop which was reversed back & rotated proximally & sutured back over denuded humerus so as to cover the whole denuded humerus bone. Thus, patient who was supposed to undergo shoulder disarticulation, ultimately converted to through elbow disarticulation saving his arm to be functional. Thus, reducing overall disability.

Case 4 For upper limbs soft Tissue defects, it is easier to approach as we have good vascular abdominal flaps & also chest wall flaps which are easier to raise mobilize & reattach to cover the defect by versatile approach. One of the case mentioned as below show whole elbow & lower humerus is open wound with compound comminuted fracture of humerus by conventional external fixation was done and for open extensive wound with underlying joint & bone was covered by rotation chest wall flap which was detached after maturation and ultimate cosmetic and functional result was excellent.



Figure 4: Compound Injury Elbow with Segmental Fracture Humerus // D Cross Flap from Chest Wall // Final Result After Detachment with Good ROM. Watch the video: https://youtu.be/_FA8A-Qk2tk?si=NXrBqfmx8o6W3ppx

Case 5. Another case of a child had crush injury forearm & wrist, soft tissue & bones stabilized by ex-fix and soft tissue defect was ultimately detached with good clinical cosmetic & functional result.



Figure 5: 360* Soft Tissue Defect with Loss of Bone // Cross Pedicle from Abdomen // After Flap Detachment Final Result Cosmetic & Functional

Case 6 One another case had post traumatic painful VAS 7 chest pigmented patch of about 12 * 8 cm diameter severely painful for last 5-6 years, not relieved by any treatment with sleepless nights all these years of agony. On proper clinical examination we thought of having neuralgic severe excruciation painful pigmented nevus. We excised the nevus on chest wall and covered by local

rotation flap. This dramatically & magically cured the patient of severe pain on next day of surgery.



Figure 6: Neuropathic Patch Lesion // Per Operative Excision // Follow up Result no Pain Cosmetic Functional Result. https://youtu.be/4MXqBpuKV4k?si=X45RdleE_4hLsKJP

Watch the video: https://youtu.be/_FA8A-Qk2tk?si=NXrBqfmx8o6W3ppx

2.7. Outcome Measures

- Functional outcome: Lower Extremity Functional Scale (LEFS)
- Aesthetic outcome: Clinical satisfaction and contour assessment
- Flap survival and Complications: Partial necrosis, flap failure, wound gap
- All surgeries were performed in settings where plastic surgery support was unavailable or unaffordable, emphasizing reproducibility in real-world orthopaedic practice.

3. Results

Of the 134 patients, 117 were male and 17 females. The majority sustained high-energy traumatic injuries. Overall flap survival exceeded 95%. Minor complications included partial marginal necrosis in three cases, (4.5%) managed conservatively or with minor revision. One flap failure revised successfully. Limb salvage: Achieved in all major cases Spontaneous bone union in tibial fractures with 1.5–2 cm residual gaps was observed after pedicled flap coverage, suggesting enhanced vascular biological environment. Functional outcomes showed satisfactory limb use and cosmetic acceptance Significant functional improvement was observed across all limb reconstructions. A unique and clinically relevant finding was spontaneous fracture union in gaps up to 2 cm without bone grafting, (Neo osteogenesis) following improved local vascularity from pedicled flap coverage.

4. Discussion

Free tissue transfer remains the gold standard in tertiary centres (1,5,6). However, it requires: Microsurgical expertise, Prolonged operative time, High cost, Advanced OT infrastructure and relatively contraindicated in elderly patients, smokers, diabetics, and those with peripheral

vascular disease. In contrast, fasciocutaneous and pedicled flaps: Are technically reproducible (2,7), Preserve muscle function (8) Have dependable vascularity (9,10), Can be performed under regional anaesthesia, have lower infrastructure requirements, Muscle flaps remain useful in specific tibial defects (3), while reverse sural flaps provide effective distal coverage (4). Contemporary evidence supports that fasciocutaneous flaps are not inferior to muscle flaps for appropriate indications (7).

5. Evidence Based Conclusion

Evidence from this cohort supports that fasciocutaneous and cross-extremity pedicled flaps performed by trained orthopaedic surgeons provide reliable, safe, cost effective. Given the Level IV evidence, the study validates that orthoplastic techniques mastered by orthopaedic surgeons are safe, effective, economical, and reproducible along with the limb salvage with high survival rates and favourable functional outcomes.

Incorporation of orthoplastic principles into orthopaedic training programs is strongly recommended [1-11].

5.1. Relevance to Current Practice

Fascio cutaneous and cross-extremity pedicled flaps are reliable, cost-effective, limb saving in hopeless cases and reproducible options for soft tissue reconstruction in compound limb injuries. Orthopaedic surgeons trained in basic orthoplastic techniques can successfully perform limb salvage surgeries, particularly in settings where plastic surgical services are limited or unavailable. Relevance to Current Practice. These are Highly applicable to government, district, industrial, and emergency trauma centres. These help in Reduction treatment delay, infection, disability, and amputation Supports inclusion of orthoplastic training in orthopaedic curriculum Promotes self-sufficiency of orthopaedic

surgeons in trauma reconstruction. In the present era of increasing trauma load, cost constraints, and uneven availability of plastic surgeons in remote areas, this study is highly relevant.

While micro vascular free flaps remain the gold standard in tertiary centre, they are not universally feasible due to: Long operative time, need for microsurgical expertise, High cost due to super speciality and special OT set up including microscopes, Contraindicated in elderly, diabetics, smokers, and PVD patients This work reinforces that orthopaedic surgeons trained in basic flap and pedicle surgical principles can independently manage complex limb injuries and demonstrated high survival rates, satisfactory outcomes, and reliable limb salvage. These techniques may represent a practical reconstructive option, particularly in set ups where microsurgical facilities are limited. The study strongly advocates incorporation of orthoplastic training into orthopaedic residency and fellowship programs, promoting timely intervention, reduced disability, cost-effective care, and improved patient outcomes. These techniques: Reduce treatment delay, reduce infection risk, prevent amputation Improve cost-effectiveness While microsurgical reconstruction remains ideal in tertiary settings (1,5,6), pedicled and fasciocutaneous flaps (2,7,8) remain practical and highly effective in real-world practice.

5.2. Final Take-Home Message

Orthopaedics has evolved from external fixation and delayed wound closure to microsurgical free tissue transfer (1,5,6). These advances are remarkable. However, in real-world settings, ideal resources are not always available. Reliable regional and local flap options remain indispensable (7). Fasciocutaneous flaps, established by Pontén (8,11) and classified by Cormack and Lamberty (9) and Nakajima (10), continue to demonstrate dependable vascularity. Pedicled perforator flaps (2), reverse sural flaps (4), and muscle flaps (3) remain valuable tools. Simplicity, when applied with sound biological principles, often provides the most durable outcomes. Orthoplastic surgery is no longer optional but essential for the modern orthopaedic surgeon particularly where resources, time, and patient affordability dictate pragmatic, life- and limb-saving solutions.

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Conflict of Interest

The authors declare no conflict of interest.

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References

1. Lu, T. C., Lin, C. H., Lin, C. H., & Wei, F. C. (2014). Successful lower extremity salvage with free flap after endovascular angioplasty in peripheral arterial occlusive disease. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 67(5), e122–e129.
2. Pu, L. L. Q. (2011). Versatility of the pedicled peroneal artery perforator flap for soft-tissue coverage of lower leg and foot defects. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 64(3), e76–e82.
3. Lee, H. I., Chung, M. S., Baek, G. H., & Gong, H. S. (2010). Soft-tissue coverage of an extensive mid-tibial wound with combined medial gastrocnemius and medial hemisoleus muscle flaps: The role of local muscle flaps revisited. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 63(2), e160–e165.
4. Acland, R. D. (2016). Reverse sural artery island flap with skin extension along the pedicle. *Journal of Foot and Ankle Surgery*, 55(3), e1–e5.
5. Wettstein, R., Schürch, R., & Banic, A. (1990). Refinements in lower extremity free flap surgery. *Clinics in Plastic Surgery*, 17(4), 733–744.
6. Hallock, G. G. (2008). Review of 197 consecutive free flap reconstructions in the lower extremity. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 61(5), e1–e8.
7. AlMugaren, F. M., Pak, C. J., Suh, H. P., & Hong, J. P. (2020). Best local flaps for lower extremity reconstruction. *Plastic and Reconstructive Surgery Global Open*, 8(4), e2774.
8. Pontén, B. (1981). The fasciocutaneous flap: Its use in soft tissue defects of the lower leg. *British Journal of Plastic Surgery*, 34(2), 215–220.
9. Cormack, G. C., & Lamberty, B. G. H. (1984). A classification of fasciocutaneous flaps according to their patterns of vascularization. *British Journal of Plastic Surgery*, 37, 80–87.
10. Nakajima, H., Fujino, T., & Adachi, S. (1986). A new concept of vascular supply to the skin and classification of skin flaps according to their vascularization. *Annals of Plastic Surgery*, 16(1), 1–8.
11. Pontén, B. (1992). Events leading to the rediscovery of the fasciocutaneous flap. In G. G. Hallock (Ed.), *Fasciocutaneous flaps* (pp. 10–12). Blackwell Scientific Publications.

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