Article published online: 2024-08-16

Medial Sural Artery Islanded Pedicled Perforator Flap for Resurfacing Areas in the Popliteal Fossa Following Postburn Contracture Release Using Normal versus Scar Tissue

Sanjay Kumar Giri[1] Santanu Suba[1] Ahana Bandyopadhyay[1] R. K. Sahu[1] Aparna Kanungo[1] Reena Minz[1]

[1] Department of Burns and Plastic Surgery, All India Institute of Medical Sciences, Bhubaneswar, Odisha, India

Indian J Plast Surg

Address for correspondence Sanjay Kumar Giri MBBS, MS, MCh, Department of Burns and Plastic Surgery, All India Institute of Medical Sciences, Bhubaneswar, Odisha 751019, India (e-mail: drsanjugiri@gmail.com).

Abstract

Background The medial sural artery perforator (MSAP) flap is reliable in resurfacing defects of the popliteal fossa. There is possibility of resurfacing the popliteal fossa defects after postburn contracture release with scarred MSAP flaps with good overall long-term outcomes.

Materials and Methods A study was conducted from June 2017 to July 2023 to evaluate the functional and surgical scar aesthetic outcome in patients with soft-tissue defects in the popliteal fossa after postburn contracture release that were reconstructed using scarred and unscarred MSAP flap with 10 patients in each group.

Results The clinical outcome was assessed in terms of the perioperative and late postoperative complications, range of motion of the knee joint along with surgical scar outcome using the Patient and Observer Scar Assessment Scale (POSAS). The functional results in the scar tissue flap group were comparable with those in the normal tissue flap group, but the aesthetic outcome of surgical scar was found to be better in the normal tissue flap group.

Conclusion The MSAP flap provides ideal tissue for soft-tissue reconstruction with minimal donor site morbidity for popliteal fossa defects after postburn contracture release in both the scarred and unscarred flap groups.

Keywords
- medial sural artery perforator flap
- scarred flap
- popliteal fossa contracture

Introduction

Scar contractures are one of the significant sequelae of burn injuries.[1] These can develop over time, sometimes despite following preventive measures. Severe contractures involving joints can be extremely debilitating and can even hamper activities of daily living.[2,3] The primary idea of reconstruction over joint contractures in these cases is to have a soft-tissue coverage that is supple, stretchable, and stable allowing a full functionality.[4,5]

Application of skin grafts following release of joint contractures is a simple and easy method to deal with them. However, skin grafts carry with them the possible late complication of secondary contractures. Flap cover, on the contrary, is more effective than skin grafts in releasing scar

DOI https://doi.org/10.1055/s-0044-1788922.
ISSN 0970-0358.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

contractures and avoiding such long-term secondary contractures.[6]

The usual prerequisite for perforator-based flaps is a good-quality donor area, which is a challenge in excessively burnt regions, considering the possible risk of injury to the perforators following burns.

The medial sural artery perforator pedicled flap is a reliable flap in reconstructing postburn popliteal fossa contractures even in cases with extensive scarring in the leg. The medial sural artery perforator arises from the popliteal artery that pierces the gastrocnemius muscle with a concomitant vein and supplies skin. This perforator flap provides comparatively thin fasciocutaneous tissue similar to adjacent normal soft tissue with an improved contour. In the majority of the patients, the deep course of pedicle is usually not injured even in excessively scarred legs. By performing an intramuscular dissection of the perforator intraoperatively, an increased arc of rotation is achievable for an islanded medial sural artery perforator (MSAP) flap.

The aim of the study was to compare the functional and surgical scar aesthetic outcome between MSAP flaps composed of scarred and normal skin, when used for resurfacing defects in the popliteal fossa following release of postburn contractures.

Materials and Methods

A study was conducted from June 2017 to July 2023 in patients with soft-tissue defects in the popliteal fossa after postburn contracture release that were reconstructed using an MSAP flap. There were two groups of scar tissue flap and normal tissue flap, with 10 patients in each group.

The patient population comprised 13 women and 7 men, and their ages ranged from 17 to 42 years. Six patients had a concomitant nonhealing ulcer in the popliteal fossa and both lower extremities involved in two of them.

The scar tissue group had 8 of 10 patients with popliteal fossa postburn contractures secondary to flame burn, whereas the normal tissue group had an equal number of patients with contractures due to flame and scald burns (►**Table 1**).

All the patients were preoperatively assessed with documentation of the range of motion for functional evaluation. For the preoperative aesthetic assessment, the Patient and Observer Scar Assessment Scale (POSAS) scale was used.

Surgical Technique

A line was drawn from the middle of the popliteal fossa to the medial malleolus to mark the axis of the MSAP flap. All the patients in both groups underwent preoperative marking of the perforator with Doppler along the axis of the MSAP flap. All the patients were operated upon in the prone position.

The flap was harvested with a medial exploratory incision till the perforator was identified in the subfascial plane, following which the flap design was committed to by taking the lateral incision.

An intramuscular microsurgical dissection was performed till sufficient pedicle length was obtained to reflect the flap on to the popliteal fossa defect.

The parameters of the defect size at the popliteal fossa, pedicle length, number of days of postoperative stay, method of donor site closure, and flap site and donor site complications were tabulated and assessed.

Functionality was evaluated in terms of change in the postoperative range of motion at 3 and 6 months. The aesthetic outcome was assessed using the POSAS at 3 and 6 months postoperatively.

Results

On evaluation of the 10 patients in the scarred tissue group, the maximum defect size was noted to be 17×11 cm. Skin graft was used for resurfacing all the donor sites with no donor site or flap site complications. All the patients were followed up for a period of 6 to 12 months. The range of motion was assessed preoperatively and at 6 months postoperatively. The aesthetic outcome was assessed using the POSAS scale for the patient and observer separately (►**Table 2**; ►**Fig. 1**).

The maximum defect size in the normal tissue flap group was noted to be 18×11 cm. Three out of the 10 patients underwent primary closure of the donor site with no flap or donor site complications. Range of motion was noted at presentation and at 6 months of follow-up postoperatively. The preoperative aesthetic outcome of scar was assessed and documented (►**Table 3**; ►**Figs. 2** and ►**Fig. 3**).

The mean preoperative range of motion in the normal tissue and the scarred tissue group was comparable ($p = 0.51$) prior to surgical intervention as well at follow-up at 3 months postoperatively.

Table 1 Patients demographics

Characteristic	Normal tissue flap (*N*)/%	Scar tissue flap (*N*)/%
Sex		
Male	4	3
Female	6	7
Burn etiologies		
Flame burns	5	8
Scalds	5	2

Table 2 Scarred tissue flap group

Sl. no.	Sex/age (y)	Burn	Defect size (cm × cm)	Pedicle length (cm)	Post-op stay (d)	Donor closure method	Flap related complications	Donor site complications	Follow-up (mo)	Range of motion (degrees), preoperative and at the 6-mo follow-up	POSAS: patient and observer
1	M/26	Flame	10 × 5	12	5	STSG	–	–	12	90 and 120	20 and 18
2	M/35	Flame	15 × 7	11	8	STSG	–	–	9	90 and 120	18 and 18
3	M/21	Flame; Nonhealing ulcer	8 × 7	10	12	STSG	–	–	9	90 and 120	18 and 17
4	M/34	Flame	10 × 4	10	15	STSG	–	Wound dehiscence	9	90 and 110	24 and 18
5	F/31	Scald	6 × 5	10	5	STSG	–	–	9	100 and 140	18 and 18
6	F/19	Scald	10 × 8	10	7	STSG	–	–	9	100 and 120	20 and 18
7	F/30	Flame	17 × 11	12	10	STSG	–	–	6	50 and 120	19 and 18
8	F/37	Flame; Marjolin's ulcer	17 × 10	14	7	STSG	–	–	6	70 and 120	18 and 17
9	F/42	Flame; nonhealing ulcer	11 × 7	12	5	STSG	–	–	6	80 and 110	18 and 18
10	F/31	Flame	12 × 10	10	7	STSG	–	–	6	80 and 115	18 and 17

Abbreviations: POSAS, Patient and Observer Scar Assessment Scale; STSG, split-thickness skin graft.

Fig. 1 (**A**) Postburn contracture of the right popliteal fossa with nonhealing ulcer. (**B**) Medial sural artery perforator (MSAP) flap harvest. (**C**) Intramuscular dissection of the MSAP till the main pedicle. (**D**) Flap inset with primary closure of the donor site.

On comparing the range of motion at 3 months of follow-up, the normal tissue flap group showed better results than the scarred tissue flap group, but it was statistically not significant. However, at 6 months postoperatively, the normal tissue flap group had a better functional outcome than the other group, which was statistically significant.

The aesthetic outcome was better in the normal tissue flap group as compared with the scarred tissue flap group with the POSAS score being less in the former, reflecting statistical significance (►**Table 4**; ►**Figs. 4**–**6**).

Discussion

Postburn contractures involving the popliteal fossa warrant a flap coverage after release, under ideal circumstances. Opting for flap reconstruction is not only beneficial in safeguarding the function of knee joint as compared with a graft coverage but also helps protect the vital neurovascular structures in the popliteal fossa. Resurfacing with a flap thus allows a more efficient functional recovery and is more aesthetically pleasing.

The MSAP flap is one of the most reliable options for flap coverage in defects of the popliteal fossa. The literature describes a maximum pedicle length of 25 cm,[7] with one to two perforators from the medial sural artery and flap sizes of 15-cm width and 23-cm length.[8]

The MSAP flap encompasses certain advantages such as the following: it provides ideal tissue for reconstruction around the knee with fewer complications including minimized morbidity at donor site. On performing an intramuscular dissection of the identified perforator, an increased pedicle length can be obtained, which in turn also helps in increasing the arc of rotation of the flap.[9,10]

In cases of postburn contractures with extensive scarring in adjacent areas, the biggest challenge is in implementing a stable coverage within the scarred region that can provide optimum functional and aesthetic results. The designing and application of scarred flaps dates back to studies by Hyakusoku et al in designing secondary flaps in scarred regions.[11,12] In the studies, both musculocutaneous and fasciocutaneous flaps were used over the scarred regions. However, it was concluded that scarred flaps should not be a primary option for reconstruction when feasible due its precarious blood supply.

Over the last couple of decades, multiple local flaps have been attempted over scarred regions based on mostly random pattern as compared with the axial pattern blood supply. Most of the local flaps performed in scarred regions have been local transposition flaps or a combination of multiple modified transposition flaps such as Z plasty and V-Y plasty.[13]

Our study attempts to assess the functional and aesthetic outcome over popliteal fossa defects created after releasing postburn contractures that have been resurfaced using MSAP flaps composed of scarred tissue as compared with those composed of normal tissue. There is a dearth of literature on the application of scarred pedicled flaps to resurface joint contractures with almost no documented evidence in resurfacing postburn contractures of the popliteal fossa with scarred MSAP flap. This flap carries the benefit of its perforator having an intramuscular course that does not get affected even in deep dermal burns, thus allowing a scarred flap harvest. Although pliability of the tissue is less than that of the normal tissue flaps, a scarred flap coverage is always better than resurfacing using skin graft.

Our study showed better functional results in the normal tissue flap group as compared with the scarred tissue flap group. However, statistical significance was not present in normal tissue flaps over the scarred flaps at 3 months. The statistically significant hindrance in joint movement in the scarred group at a later date of 6 months could be due to increased collagen deposition during the scar remodeling process as compared with the normal tissue flaps. In this study, functional results in the scar tissue flap group were comparable with those in the normal tissue flap group, and more superior than skin grafts, the latter also supported by Issa et al[14] and Iwuagwu et al.[15]

On comparing the aesthetic outcome of the surgical scar between both the groups using the POSAS scale, a statistically significant better result was obtained in the normal tissue flaps over the other group.

Table 3 Normal tissue flap group

Sl. no	Sex/age (y)	Burn	Defect size (cm × cm)	Pedicle length (cm)	Post-op stay (d)	Donor closure method	Flap related complications	Donor site complications	Follow-up (mo)	Range of motion (degrees), preoperative and at the 6-mo follow-up	POSAS: patient and observer
1	F/31	Scald	9 × 4	11	6	Primary	–	–	12	90 and 120	12 and 12
2	M/30	Flame	14 × 7	11	8	STSG	–	–	9	100 and 130	14 and 13
3	M/22	Flame; nonhealing ulcer	9 × 7	11	10	STSG	–	–	9	80 and 120	12 and 13
4	M/25	Flame	11 × 5	12	12	Primary	–	–	9	80 and 130	13 and 14
5	F/30	Scald	7 × 5	12	4	STSG	–	–	9	100 and 130	15 and 14
6	F/17	Scald	11 × 9	11	7	STSG	–	–	9	100 and 135	14 and 12
7	F/31	Scald	18 × 11	11	8	STSG	–	–	9	100 and 140	15 and 14
8	F/35	Flame; nonhealing ulcer	17 × 11	14	4	STSG	–	–	6	80 and 120	14 and 13
9	F/40	Flame; nonhealing ulcer	12 × 7	14	4	Primary	–	–	6	80 and 125	15 and 15
10	F/35	Scald	10 × 9	10	6	STSG	–	–	6	70 and 125	13 and 12

Abbreviations: POSAS, Patient and Observer Scar Assessment Scale; STSG, split-thickness skin graft.

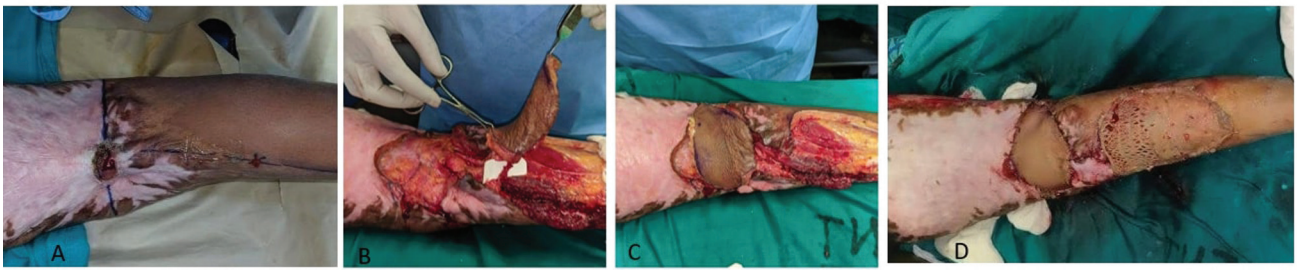

Fig. 2 (**A**) Postburn contracture of the right popliteal fossa with nonhealing ulcer (posterior view of the right lower limb). (**B**) Arc of rotation of the harvested medial sural artery perforator (MSAP) flap. (**C**) Flap placement over the popliteal fossa. (**D**) Flap inset with skin grafting over the donor site.

Fig. 3 (**A**) Postburn contracture of the right popliteal fossa with Marjolin's ulcer (posterolateral view of the right lower limb). (**B**) Harvested medial sural artery perforator (MSAP) flap. (**C**) Flap inset with skin grafting over the donor site. (**D**) Follow-up at 3 months with complete range of motion at the knee.

Table 4 Comparison of the functional (range of motion) and aesthetic outcome (POSAS) preoperatively and at 3 and 6 months postoperatively

	Range of motion	POSAS: patient, observer
Preoperative		
Scarred tissue flap Normal tissue flap	84 ± 15.05 88 ± 11.35 ($p = 0.51$)	
3 mo postoperatively		
Scarred tissue flap Normal tissue flap	98.4 ± 10.21 ($p = 0.0221$) 100.2 ± 11.11 ($p = 0.0258$) $p = 0.71$	
6 mo postoperatively		
Scarred tissue flap Normal tissue flap	119.5 ± 8.31 ($p < 0.0001$) 127.5 ± 6.77 ($p < 0.0001$) $p = 0.0298$	36.8 ± 2.14 26.9 ± 1.96 $p < 0.00001$

Note: The *p* values written below the values signify the comparison between scarred and normal tissue flap groups at different intervals-preoperative, at 3 and 6 months respectively. The *p* values written in the 3 month group beside the scarred tissue group signifies the comparison between the values in scarred tissue group in preoperative time and at 3 months' with the similar meaning for the the value written beside normal tissue group. The values written beside the value in 6 month group in the scarred tissue group signifies the comparison between the values in scarred tissue group in preoperative time and at 6 months'.
Abbreviation: POSAS, Patient and Observer Scar Assessment Scale.

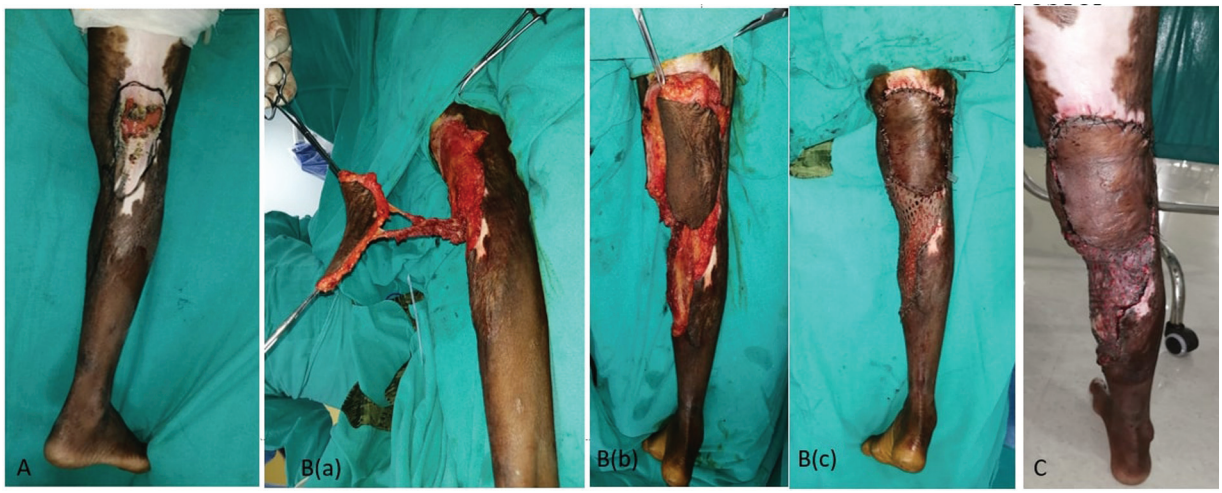

Fig. 4 (A) Postburn contracture of the right popliteal fossa with nonhealing ulcer with scarred proximal one-third of the leg. (B) (a) Scarred tissue flap harvest with intramuscular dissection of the perforator till the pedicle. (b) Flap placement over the popliteal fossa. (c) Flap inset with skin grafting over the donor site. (C) Follow-up at 2 weeks.

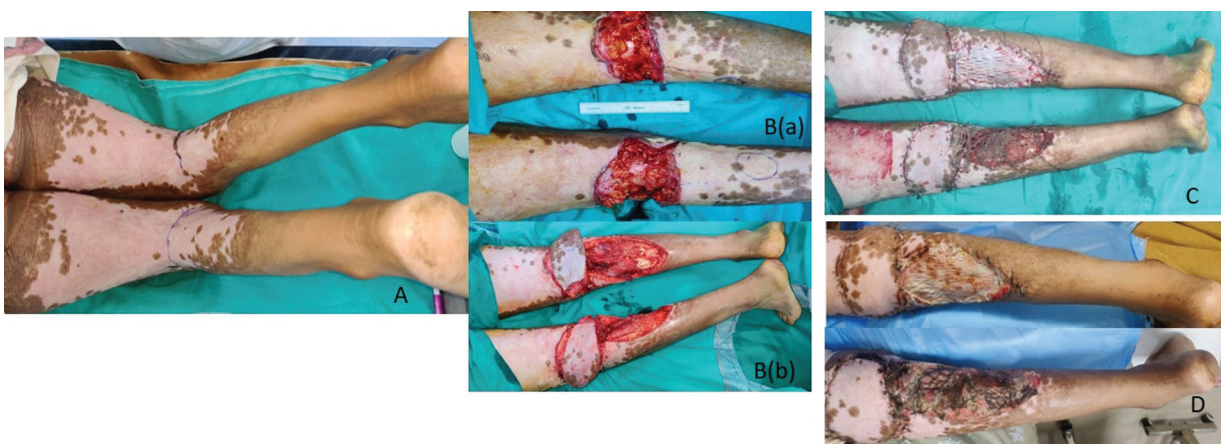

Fig. 5 (A) Bilateral popliteal fossa postburn contracture and restricted knee extension by 60 degrees with bilateral scarred thighs till the proximal one-third of the legs. (B) (a) Bilateral popliteal fossa defect following incisional release. (b) Bilateral scarred tissue medial sural artery perforator (MSAP) flaps harvested and placed over the defects. (C) (a) Bilateral scarred tissue flap inset with skin grafting over both donor sites: skin graft harvested from the scarred left thigh. (D) Follow-up at 1 month.

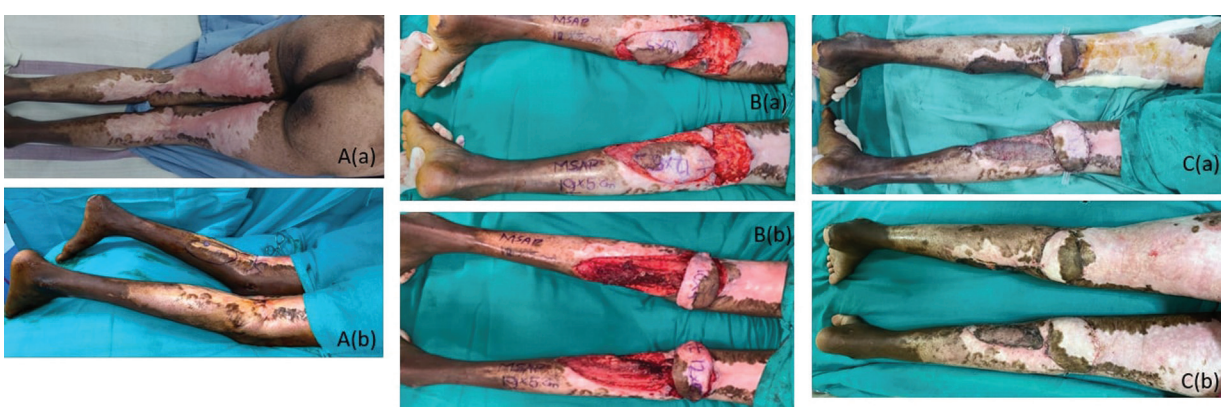

Fig. 6 (A) (a), (b) Bilateral popliteal fossa postburn contracture and restricted knee extension by 40 degrees with bilateral scarred thighs till the middle one-third of the legs. (B) (a) Bilateral scarred tissue medial sural artery perforator (MSAP) flap harvest. (b) Bilateral scarred tissue MSAP flap placement over the popliteal fossa. (C) (a) Flap inset with skin grafting over the donor site. (b) Follow-up at 6 months.

The majority of the patients in the scarred flap group, although with higher POSAS scores, were content with the functionality of the knee with no marked dissatisfaction with the surgical scar or the grafted donor sites.

All the donor areas of scarred tissue flaps had to be resurfaced with split-thickness skin graft in comparison to possible primary closure in the normal tissue flap group for defects less than 5 cm. This was a setback for the scarred tissue flap group in terms of adding to graft donor site morbidity. However in the scar tissue group, flap was harvested from an already scarred region, thus not enhancing the burden of scar to the patients as has also been reinforced by Ge et al.[6]

Our study carries the limitation of a small sample size in each group. We recommend management of a higher number of cases in a similar way in the near future so that larger studies can be undertaken with significant impact. With only one reoperation in the scar tissue flap group, the complication rate for this perforator flap is acceptably low.

Conclusion

The MSAP flap provides ideal tissue for soft-tissue reconstruction with minimal donor site morbidity for popliteal fossa defects after postburn contracture release. In patients with excessively scarred leg areas, similar functional results can be obtained when compared with normal tissue MSAP flaps.

Funding
None.

Conflict of Interest
None declared.

References

1 Ehanire T, Vissoci JR, Slaughter K, et al. A systematic review of the psychometric properties of self-reported scales assessing burn contractures reveals the need for a new tool to measure contracture outcomes. Wound Repair Regen 2013;21(04):520–529
2 Jordan RB, Daher J, Wasil K. Splints and scar management for acute and reconstructive burn care. Clin Plast Surg 2000;27(01): 71–85
3 Khor D, Liao J, Fleishhacker Z, et al. Update on the practice of splinting during acute burn admission from the ACT study. J Burn Care Res 2022;43(03):640–645
4 Chinese Association of Plastics and Aesthetics Scar Medicine Branch. National expert consensus on early management of scars (2020 version). Zhonghua Shao Shang Za Zhi 2021;37(02): 113–125
5 Seago M, Shumaker PR, Spring LK, et al. Laser treatment of trau matic scars and contractures: 2020 international consensus recommendations. Lasers Surg Med 2020;52(02):96–116
6 Ge X, Sun Y, Tang Y, Zhou F, Yao G, Su X. Flexible application of scar tissue flaps in scar contracture release surgery: a retrospective study. J Cosmet Dermatol 2023;22(03):907–912
7 Shim JS, Kim HH. A novel reconstruction technique for the knee and upper one third of lower leg. J Plast Reconstr Aesthet Surg 2006;59(09):919–926, discussion 927
8 Hallock GG. Anatomic basis of the gastrocnemius perforator-based flap. Ann Plast Surg 2001;47(05):517–522
9 Suba S, Giri SK, Pant P, Kanungo A. Versatility of medial sural artery islanded pedicled perforator flap for resurfacing areas around the knee. Ann Plast Surg 2022;88(06):647–657
10 Hsiao JC, Deek N, Lin CH, et al. Versatility of the medial sural artery perforator flap: experience with 200 consecutive cases. Plast Reconstr Surg 2015;136(Suppl 4):17
11 Hyakusoku H, Reconstruction Umeda T, Shiozuka M, et al. Reconstruction using the secondary axial pattern flap made by burying the superficial temporal vascular bundles in 2 patients. J Plast Reconstr Surg 1984;21:552–558
12 Hyakusoku H, Okubo M, Suenobu J, Fumiiri M. Use of scarred flaps and secondary flaps for reconstructive surgery of extensive burns. Burns 1986;12(07):470–474
13 Hassanpour SE, Motamed S, Ghazisaidi M. Treatment of wide scar contracture of antecubital fossa with bipedicle flap from scar tissue. Burns 2007;33(02):236–240
14 Issa M, Badawi M, Bisheet G, et al. Skin graft versus local flaps in management of post-burn elbow contracture. Cureus 2021;13 (12):e20768
15 Iwuagwu FC, Wilson D, Bailie F. The use of skin grafts in postburn contracture release: a 10-year review. Plast Reconstr Surg 1999; 103(04):1198–1204

