The medial sural artery perforator pedicle propeller flap for lower middle-third anterior tibial soft tissue defect reconstruction: Case report and literature review

Vu Trung Truc, Vu Anh Duc, Tran Xuan Thach, Bui Mai Anh

Viet Duc University Hospital

Keywords:
Lower extremities defects reconstruction, perforator flap, medial sural artery perforator flap, propeller flap.

Corresponding author:
Vu Trung Truc,
Viet Duc University Hospital
40 Trang Thi Street, Hoan Kiem District, Ha Noi City
Mobile: 0983 383 009
Email: drvutrungtruc@gmail.com

Received: 14 July 2021
Accepted: 17 August 2021
Published: 30 September 2021

Abstract

Lower extremity reconstruction still issues a challenge for plastic surgeon. The medial sural artery perforator (MSAP) flap has been reported for using to reconstruct the defects of the knee and proximal-third leg defects in many papers. But there is a few paper described the technique of using this flap for reaching the middle third led defects. The authors report the first using MSAP propeller flap in Vietnam to cover the defect in 45-year-old female patient who suffered from chronic ulcer with bone exposure over the middle third anterior tibial and evaluate the result of 4 months post-op.

Introduction

In orthopedic and plastic reconstructive surgery, it is a challenge to treat soft tissue defects or replace low quality soft tissue in the lower extremities, especially in the mid and lower third of the leg. In the past, patients often had to accept wound dressing for a long period to wait for primary wound healing, autologous skin grafts, local random skin flaps or cross-limb flaps, causing many inconveniences and low treatment efficiency, so the introduction of vascular pedicled flaps is an inevitable need and is increasingly applied routinely. The medial sural arterial perforator flap (MSAP) has been successfully studied and applied by many authors around the world [1],[2], with high efficiency in reconstructing soft tissue defects in the knee and upper third of the leg, avoiding microsurgery with complicated technical and technological requirements.

As a developing country, the rate of traffic accidents, labor accidents, and malignant cancer diseases in Viet Nam is still high, so the number of defective lesions both in the extremities as well as in other parts of the body are increasing. Some authors have studied the anatomy of MSAP flaps, either clinically applied in the form of a pedicled flap to cover the defects around the knee and upper third of the leg or used as a free flap [3]. However, there are no reports on the use of this pedicled flap

for reconstruction of soft tissue defects in the medial and lower thirds of the leg. We present a case report of using the MSAP flap in reconstruction to cover the defect in the middle third of the anterior tibia along with a detailed description of the design, the technique of using the flap and the evaluation of the results after 4 months follow-up.

Case report

A 45-year-old female patient was admitted to the hospital because of a chronic ulcer scar in the front of the mid-third of the tibia with exposed bone. The patient had a history of two bone fractures of the right calf that healed by itself 20 years ago, an ulcer scar on the middle third of the tibia 10 years ago, and a month before surgery, a large ulcer scar that did not heal with pus discharge, and exposed bone. On X-ray film, tibia is deviated, osteomyelitis. Cytological examination showed chronic inflammation. Surgical method: Debridement osteotomy + 180^{o} rotated MSAP propeller.

Surgical technique

Step 1: The patient was put on supine position with the thigh was extended and externally rotated + flexed knee, an additional surgical pillow can be added under the calf for more convenience in the flap design and harvesting. Lesion removed and prepared the receipeint site.

Step 2: Orientation line was drawn from the midpoint of the polliteal fossa to the top of the medial malleolus of the leg. Using a hand-held doppler ultrasound to identify the percutaneous perforator branch of the medial sural artery (2 perforating branches were identified at 8cm and 11cm below the popliteal fold, respectively, as shown in Figure 1). Designed the 4.8x15cm MSAP flap as shown in the figure based on the size of the defect.

Step 3: Dissecting the flap, ligation the proximal branch using suture, a tunnel was created, the flap was moved and rotated 180 degrees to cover the defect with a pedicle 17cm in length. Autologous thin skin graft was used to reconstruc the donor site.

Figure 1. Technical steps

(A) Soft tissue defect 12,5 x 4,5 cm; (B) Flap design 15 x 4.8 cm; (C) Harvesting the flap, ligation the proximal branch using suture; (D) Moving and rotating the flap 180 degrees to cover the defect.

The patient was discharged from the hospital on the 7th day after surgery, the wound was delay healed distally. After 1 month, the wound was completely healed, the skin graft also healed well. After 4 months: the wound healed well, the scar cosmetically sastifactory, the inflammation is no longer purulent, the patient can walk normally and the quality of life is improved.

Discussion

There are two gastrocnemius muscles located in the posterior calf region, including the medial gastrocnemius muscle (MGM) and the lateral gastrocnemius muscle (LGM), in which the MGM is larger, has a long flattened oval shape. Each of those has a muscle hilum where the vascular-nerve bundles enter and exit at the superior posterior aspect and near the dorsal midline of the lower limb. Most are supplied by an artery that separates directly from the popliteal artery (91%) with an origin ranging from the popliteal fold to the superior border of the femoral condyles. Veins divide into many small branches in the muscle (usually 5 branches), which gather and then exit the muscle hilum more superficially than the artery and connect to the popliteal vein, with a connect to the posterior tibial vein. There are 2 branches of the MGM and LGM cutaneous nerve that separate from the posterior tibial nerve into the muscle and into the skin to innervate the skin of the calf, respectively. The gastrocnemius muscles represent group 1 muscles (with 1 main supplying vessel) according to the Mathes and Nahai classification [3].

The MSAP flap is a flap that develops directly from the calf skin flap but differs in that it does not have to sacrifice the gastrocnemius muscles and does not need to determine the extent of vascular supply on the skin as in the classic fascia flap. In 2001, Cavadas first reported the flap anatomy through dissection of 10 samples that were fixed in formalin [2]. Later studies [4],[5],[6] showed that the MSAP flap had the following anatomical features: the appearance of perforating branches was quite constant with the number of 1-5 perforating branches, the average being 2 perforating branches/1 MGM artery. The location of the perforating branch is 5-9cm below the popliteal fold, the first branch is about 8cm away, 0.5-7cm inferiorly from the mid-calf line. The length of the pedicle is usually ≥ 7.7cm, the diameter of the accompanying vein approximately 2mm. In Vietnam literature, Ngo Xuan Khoa (2002), after dissection of 17 cadaveric lower extremities were fixed with formalin [3] showed the following results: MGM artery directly separated from the posterior wall of the popliteal artery in 91% of cases and had a trunk shared with other arteries in the remaining 9%. The average length of the artery from the origin to the hilum of MGM muscle is 4.2cm, from the origin to the first branch for the muscle is 2.8cm. The mean outer diameter at the origin is 1.9mm (1-3.2mm), the focal point of the perforating branch is shown in Figure 2. The parameters of our clinical case are also fully consistent with those in previous studies: the number of transverse branches was 2, the distance from the popliteal fold to the proximal branch was 8cm and the distal branch was 14cm.

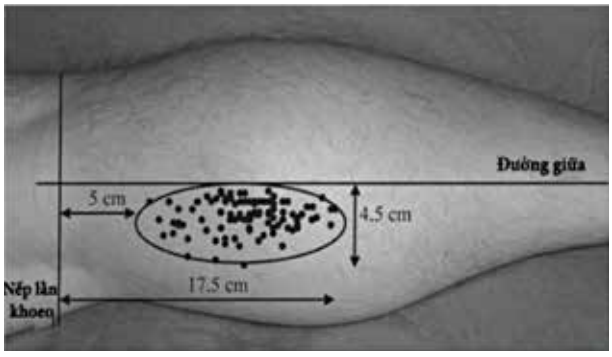

Figure 2. Distribution of perforating branches below the popliteal fold [3].

The MSAP flap was first used by Montegut to reconstruct leg defects in 1996 [1], after that many authors have used it in the form of a pedicled flap [4],[6],[7],[8]. With defects in the lower third of the thigh, around the knee and proximal lower leg, most of them found the flap to have many advantages over the classic local flaps. The MASP is thin skin

flap and skin graft is not required if the defect is not too large, so it is suitable for defects in front of tibia – the area is required for a thin flap. The flap vitality is good, the anatomical characteristics are relatively constant, so the design technique as well as the flap dissection is quite simple, the surgery time is short, surgical risk is lower when comparing with the microsurgical flap transfer. Another advantage of this flap is that harvesting MSAP does not affect the function of the lower leg due to muscle preservation. The aesthetic properties of the flap are similar to the lost tissue at the defect, so the cosmetic effects are better.

The MSAP can be used in the form of a pedicled propeller flap, making flap transfer more flexible. Most clinical reports use a proximal perforator branch located at the center of the flap to cover around knee and upper third of the leg, this flap design reduces the rotation and its ability to cover defects in the distal third of the leg. Tee S (2019) first reported the use of a distal perforating branch-based flap in the form of a 180-degree rotating propeller to reconstruct defects in the medial third of the lower limb. In addition, the flap can also be used as a retrograde pedicled flap to cover the lower third of the leg, but the flap vitality is still controversial. MSAP is designed with flexible sizes from the smallest of 5x3cm to the largest of 20x9cm [9].

In our clinical case, the defect was located in the middle third of the anterior tibia bone. The main methods of covering so far have been using muscle flaps such as the soleus, gastrocnemius muscles or microsurgery free flaps. These methods have many disadvantages such as functional impairment and the need for skin grafting if using muscle flaps, or high technical requirements and many risks when using microsurgery flaps. We have chosen to use the latest form of MSAP flap, which used the distal perforator in the form of a propeller flap, with good results (Figure 3).

Figure 3. Postoperative results

(A) right after surgery; (B) 5 days after surgery; (C) 2 weeks after surgery; (D) 4 months after surgery

However, in addition to the advantages on the flap, there are still some disadvantages such as: the possibility of skin grafting if the flap is large, the ability to cover defects at the distal end of the leg can still be risky. When using the MSAP flap with the distal transverse branch, it is necessary to assess the blood supply to the flap of this branch by temporarily clamping the proximal branch during surgery, if the blood supply is not guaranteed, the propeller design cannot be used. Therefore, it is necessary to have a preoperative plan, converting to a free MSAP flap for microsurgery or taking other microsurgery flaps such as anterior lateral thigh, groin flap... These points should be discussed carefully with the patient before procedure.

Conclusion

With the features of a thin skin flap, anatomically stable, good viability due to a rich blood supply network, preservation of leg motor function as well as simple technique and given the similarity of aesthetics in both the donor and recipient sites, the MSAP flap is a new option with many advantages and reliability for reconstructing knee and leg defects as a local flap. Flap designed and used as a pedicled propeller flap will be able to cover the defect in the middle third of the leg. The retrograde flow using form for the reconstruction of lower third of the leg defect is limited and needs further investigation and evaluation.

References

1. Montegut W.J., and Allen R.J. (1996). Sural artery perforator flap as an alternative for the gastrocnemius myocutaneous flap. In Proceedings of the 90th Annual Scientific Assembly of the Southern Medical Association, Baltimore, Md.,. p 20-24.
2. Cavadas P.C., Sanz-Gimńez-Rico J.R., la Ćmara A.G. et all. (2001). The Medial Sural Artery Perforator Free Flap. *Plastic and Reconstructive Surgery,* 108(6), 1609–1615.
3. Ngo Xuan Khoa (2002). *Anatomy of some flaps in the posterior leg: muscle flaps and musculocutaneous gastrocnemius flaps, proximal and distal pedicles fasciocutaneous flaps,* soleus muscle flap. PhD Thesis, Full Text Database. <*http://luanan.nlv.gov.vn/luanan?a=d&d=TTbFlGvDxDXe2002.1.9#*>, *accessed: 05/09/2021.*
4. Hallock G.G. (2001). Anatomic Basis of the Gastrocnemius Perforator-Based Flap:. *Annals of Plastic Surgery,* 47(5), 517–522.
5. Thione A., Valdatta L., Buoro M. et all. (2004). The medial sural artery perforators: anatomic basis for a surgical plan. *Ann Plast Surg,* 53(3), 250–255.
6. Shim J.S. and Kim H.H. (2006). A novel reconstruction technique for the knee and upper one third of lower leg. *Journal of Plastic, Reconstructive & Aesthetic Surgery,* 59(9), 919–926.
7. Umemoto Y., Adachi Y., and Ebisawa K. (2005). The sural artery perforator flap for coverage of defects of the knee and tibia. *Scandinavian Journal of Plastic and Reconstructive Surgery* and Hand Surgery, 39(4), 209–212.
8. Kim K.S., Kim E.S., Hwang J.H. et all. (2012). Medial sural perforator plus island flap: A modification of the medial sural perforator island flap for the reconstruction of postburn knee flexion contractures using burned calf skin. *Journal of Plastic, Reconstructive & Aesthetic Surgery,* 65(6), 804–809.
9. Tee R., Jeng S.-F., Chen C.-C. et all. (2019). The medial sural artery perforator pedicled propeller flap for coverage of middle-third leg defects. *Journal of Plastic, Reconstructive & Aesthetic Surgery,* 72(12), 1971–1978.