

# Reverse Anterolateral Thigh Flap to Reconstruct a Below-Knee Amputation Stump: Two Case Reports

Duke Whan Chung, M.D., Chung Soo Han, Jae Hoon Lee, M.D.\*, Se Hyuk Hong, M.D.\*

*Department of Orthopaedic Surgery, Kyung Hee University Hospital, School of Medicine, Kyung Hee University  
Department of Orthopaedic Surgery, Kyung Hee University Hospital at Gangdong,  
School of Medicine, Kyung Hee University\**

## — Abstract —

During below knee amputation, the amputation stump must be covered with well-vascularized and sensate soft tissue. Many flaps can be used for this purpose, but available reconstructive options are limited. We performed reverse flow ALT flap elevation on two patients with below knee amputations to reconstruct defects in the stumps.

The sizes of the defects in the stumps were  $4 \times 16$  cm and  $5 \times 5$  cm, respectively. The most distal portion of the defects were located 20 cm and 16 cm lateral to the knee joint in a curve, respectively. The size of the elevated flap was  $5 \times 18$  cm for case 1 and  $18 \times 10$  cm for case 2. The respective pivot points of the pedicles were 7 cm and 6 cm above the patella and the respective lengths of the pedicles were 17 cm and 16 cm. In both cases, venous congestion occurred on the second postoperative day and the flap distal to 10 cm or more from below the knee joint was necrotized at the second postoperative week.

Surgeons should be cautious when using a reverse ALT flap to reconstruct a soft tissue defect located 10 cm or more distal from below the knee joint. Since a pedicle longer than 15 cm may develop partial necrosis of the flap, simultaneous application of antegrade venous drainage is recommended.

**Key Words:** Amputation stump, Reverse anterolateral thigh flap

## Introduction

The ideal below knee amputation maintains a tibial length of at least 6 cm below the tibial tubercle and covers the stump with well-vascularized and sensate soft tissue<sup>1</sup>. Insufficient coverage of the distal stump with soft tissue during application of a below knee prosthesis results in frequent scars, which are not easily healed. In

addition, a short stump requires more energy for ambulation and causes several problems during prosthetic fitting<sup>2</sup>. Many flaps can be used to save the stump during below knee amputation, but the available reconstructive options are limited. Possible flaps include latissimus dorsi, rectus abdominis, scapular, groin, and pedicled fillet foot flaps; the most commonly used option is a latissimus dorsi flap. However, as a free flap

\*통신저자: Jae Hoon Lee

Department of Orthopaedic Surgery, Kyung Hee University Hospital at Gangdong, School of Medicine, Kyung Hee University, 149, Sangil-dong, Gangdong-gu, Seoul 134-090, Korea  
Tel: +82-1-440-6153, Fax: +82-1-440-6296, E-mail: ljhos69@naver.com

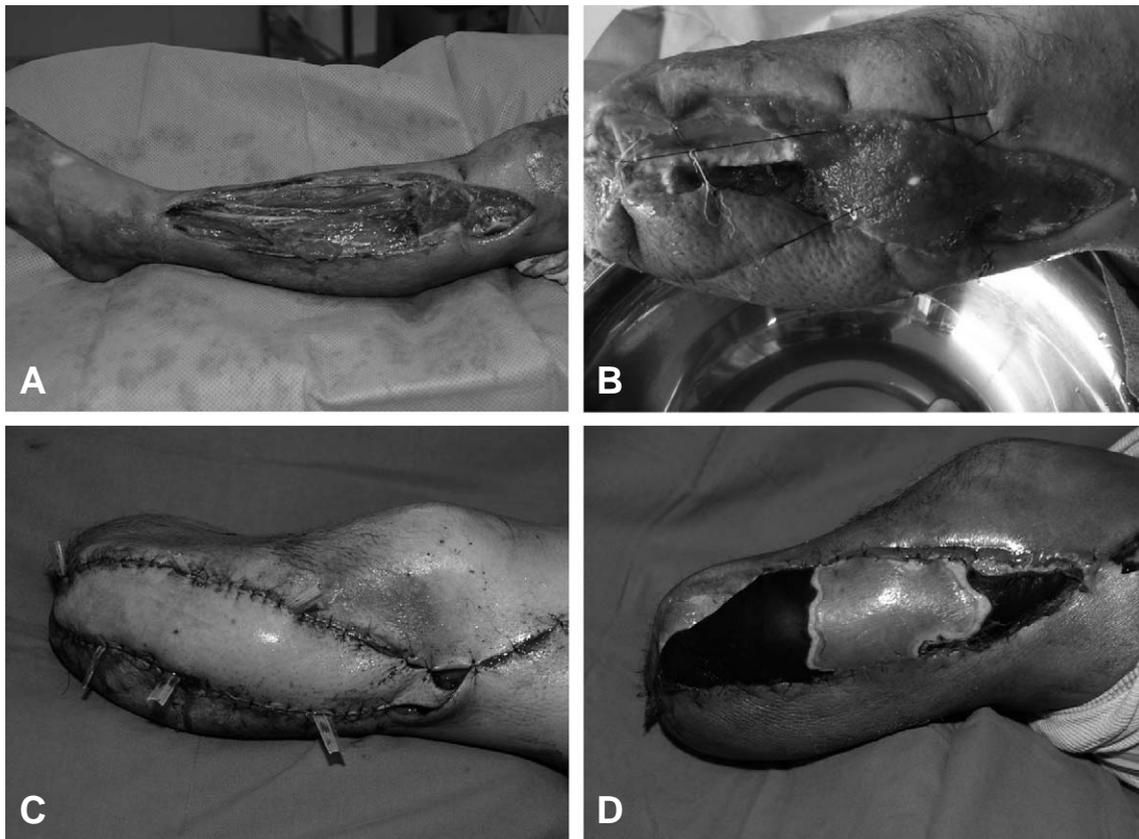
it requires microvascular anastomoses. Moreover, it is technically challenging, time consuming, and sacrifices donor site muscles.

The anterolateral thigh flap has been widely accepted since it was first described by Song et al<sup>3</sup>. This flap may also function as a distally-based flap with reverse flow and can be used to reconstruct the technically demanding soft tissue around the knee joint<sup>4,9</sup>. To our knowledge, case reports have been written regarding reverse ALT flaps for burn contractures of the knee and soft tissue defects resulting from trauma; however, they are few in number and no report has focused on stump salvage during below knee amputation. We present our experience of using reverse flow ALT flaps to reconstruct stump defects in two patients with below knee amputations.

## Case Reports

### Case 1

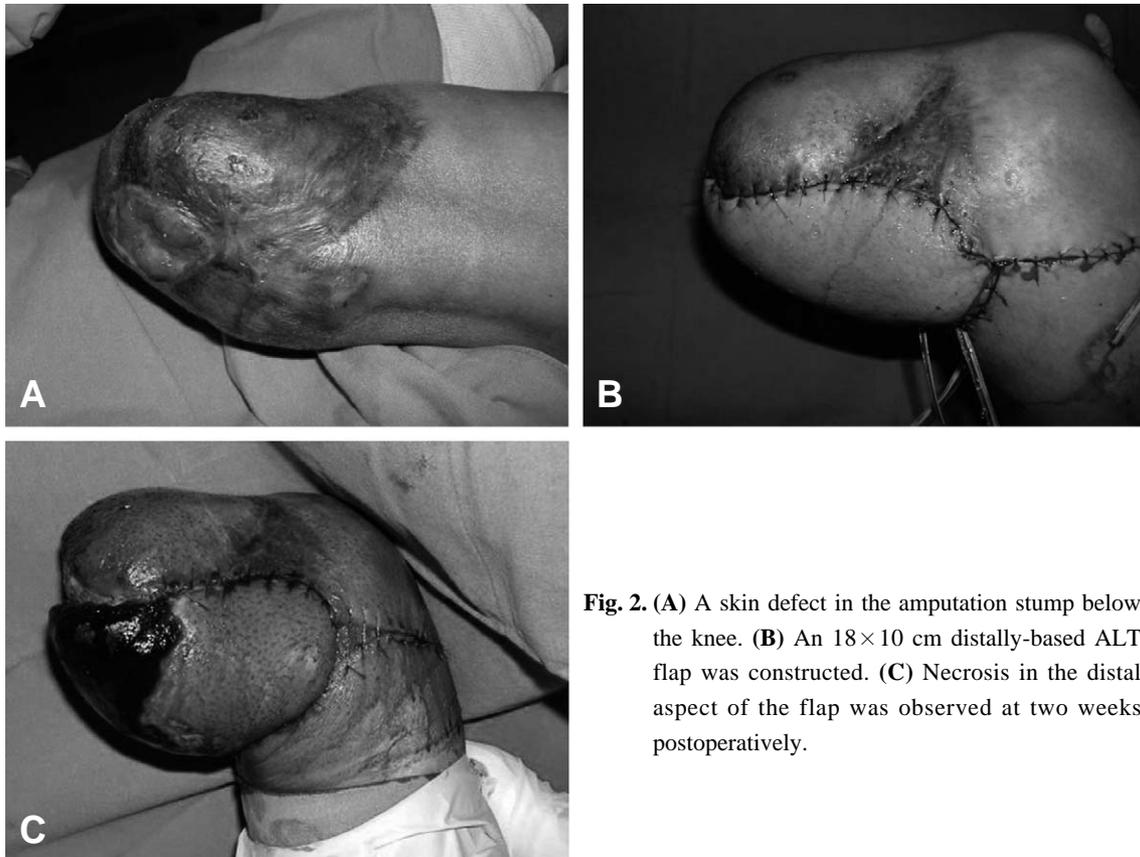
A 45-year-old male patient developed a contusion in the left calf muscle after falling from a ladder. He was diagnosed with compartment syndrome at a private clinic and underwent fasciotomy twice. At day 14 after the trauma, he was referred to our clinic for postoperative infection and soft tissue defects. At his initial presentation to our clinic the muscles in his lower extremity were necrotized and an abscess was noted; we subsequently performed an open below knee amputation(Fig. 1-A). The soft tissue defect lateral to the knee joint for which fasciotomy had been performed could not be repaired during amputation and remained a defect; this led to bone exposure in the stump



**Fig. 1.** (A) Muscles of the lower extremity that necrotized due to compartment syndrome. (B) An open below knee amputation was performed and the tibia was exposed. (C) A 5 × 18 cm distally-based ALT flap was constructed. (D) Partial necrosis of the flap was observed at two weeks postoperatively.

(Fig. 1-B). To control the infection we applied sustained irrigation and a wet dressing. At day 14 after amputation, a reverse flow ALT flap was performed to reconstruct the inferior and lateral defect in the stump(Fig. 1-C). The size of the stump defect was 4×16 cm. The most distal portion of the defect was located 20 cm from the knee joint in a curve and 26 cm above the lateral patella. The size of the flap was 5×18 cm. The perforator was placed over the distal 1/3 of the outlined flap so that the proximal portion of the flap could cover the distal portion of the defect during 180-degree rotation of the flap. We elevated the flap using the method described by Pan et al<sup>4</sup>. The pivot point of the pedicle was 7 cm above the patella and the length of the pedicle was 17 cm. During flap elevation, the descending branch of the lateral femoral circumflex artery (LFCA) was observed to run downward along the intermuscular sep-

tum between the vastus lateralis and rectus femoris. It branched toward the vastus lateralis at 5 cm above the patella and toward the rectus femoris at 6 cm above the patella. We made a dissection involving as much soft tissue as possible in the pedicle. The skin on which the pedicle was placed was incised to prevent compression of the pedicle. Venous congestion of the flap occurred on postoperative day 1; this was further aggravated the following day. Subsequently, the skin suture site on which the pedicle had been located was stitched out for decompression. However, at postoperative week 2, the area distal to 10 cm or more from below the knee was necrotized, the only viable tissue was the 6~7 cm centering on the site where the perforators were located(Fig. 1-D). The necrotized tissue was removed and the tibia was dissected an additional 4 cm. The amputation stump was covered using the adjacent muscle.



**Fig. 2.** (A) A skin defect in the amputation stump below the knee. (B) An 18×10 cm distally-based ALT flap was constructed. (C) Necrosis in the distal aspect of the flap was observed at two weeks postoperatively.

## Case 2

A 39-year-old male patient underwent below knee amputation and skin grafting at another clinic following a motorcycle accident 8 months prior. He visited our clinic for sustained infection and soft tissue defects of the amputation stump. The tibia of the stump was 8 cm long, skin had been grafted around the stump. There was a 5×5 cm skin defect at the end of the stump that would not heal and continued to express discharge(Fig. 2-A). We performed a reverse flow ALT flap. The flap was 18×10 cm in size. The end of the defect site was located 16 cm from the knee joint and 22 cm from the upper pole of the patella in a curve(Fig. 2-B). The pivot point of the pedicle was 6 cm above the patella and the length of the pedicle was 16 cm. As with case 1, the pedicle ran downward along the intermuscular septum. It branched toward the rectus femoris at 6 cm above the patella; a branch to the vastus lateralis was not confirmed. After sufficiently involving soft tissue in the pedicle the flap was rotated 180 degrees and transposed to the recipient site. Then, a skin incision was followed by dissection of the subcutaneous adipose tissue on which the pedicle was located. Venous congestion occurred on postoperative day 2. At day 14, the flap distal to 10 cm or more from the knee was necrotized, with an area of 10×9 cm (50% of the total size) surviving(Fig. 2-C). The necrotized flap was removed and the amputation stump was dissected an additional 1 cm for skin grafting. As complete take-up was not observed after skin grafting, treatment continued and was completed at 2 months from the time of flap elevation.

## Discussion

The use of a reverse ALT flap around the knee and the proximal tibia has not been clearly presented<sup>7</sup>. Pan et al<sup>4</sup>. performed reverse ALT

flaps for defects around the knee joint and in the proximal 1/3 of the lower extremity in 3 cases. They described that the descending branch of the LFCA always possessed an anatomical connection with the lateral superior genicular artery. The pivot point of the flaps was located 3~10 cm above the patella. They observed that venous drainage was made possible by the venae comitantes; valves were also observed. Uygur et al<sup>6</sup>. utilized reverse ALT flaps in 4 patients with knee contractures. Every case initially exhibited minimal transient venous congestion which disappeared spontaneously by the second postoperative day with lower extremity elevation. The authors considered the reverse ALT flap a safe and reliable flap when excessive skeletonization of the pedicle was prevented and a sufficient amount of the adipose tissue around the pedicle was preserved.

Wang et al<sup>5</sup>. performed reverse ALT adipofascial flaps in 5 patients with knee and proximal leg defects. The reverse ALT adipofascial flaps provided a large thin pliable layer; however, there was variability in the vascular pedicles and pivot points. In particular, when the descending branch ran into the muscle it was difficult to dissect the flaps. They advised including part of the muscle in the pedicle to prevent vasospasm.

Liu et al<sup>7</sup>. also performed reverse ALT flaps in 3 cases with knee defects. The maximum size of the flaps was 26×8 cm; all 3 flaps survived. However, 2 cases developed marginal necrosis; 1 of these cases had a defect in the lateral knee joint with the distal end of the defect 12 cm below the knee. Marginal necrosis was noted at the distal aspect of the flap. They noted that dissection towards the distal site of the descending branch carried a risk of compromising flap perfusion; they went on to suggest that a good treatment option for a skin defect around the knee could involve staged or delayed operation when utilizing a large flap.

Yildirim et al<sup>10</sup>. used reverse ALT flaps in the

treatment of contractures in the popliteal area in 2 cases: 1 case developed superficial necrosis in the distal aspect of the flap while the other case was reconstructed uneventfully. They described that arterial and venous insufficiency was a challenge during reverse ALT flap elevation because the pedicle was compressed within the subcutaneous tunnel. Although they preserved the second perforator to supermicrosurgically anastomose to a small artery in the popliteal area, superficial necrosis was not prevented. They concluded that the reverse ALT flap was an unsafe method that could be applied only in certain cases.

Lin et al<sup>11</sup>. suggested that the problem with a reverse ALT flap involves venous congestion and edema, which threatens flap survival. They observed venous congestion in each of their 3 cases. Although the venous congestion subsided within a few days, 1 of the cases exhibited partial flap necrosis. In order to overcome this obstacle of the reverse ALT flap, they applied antegrade venous drainage to resolve the venous congestion. They recommended the use of a free flap when the perforator branch arises from the transverse branch of the LCFA.

Summarizing the literature to date, a reverse ALT flap has been reported to be useful in reconstructing defects around the knee joint; however, the risk of partial necrosis in the flap due to venous congestion should be considered when reconstructing defects in the proximal 1/3 of the lower extremity. In addition, the reverse ALT flaps reported thus far suggest that the maximum length of the pedicle should be 15 cm and that partial necrosis may occur in defects located within 12 cm below the knee joint.<sup>6,7</sup> Both of the cases reported herein had pedicles longer than 15 cm with defects located 16 cm and 20 cm below the knee, respectively. These sites were more distal than the locations reported in the aforementioned studies. In addition, both cases developed necrosis in the flap distal to 10 cm or more below the knee. This suggests

that a pedicle longer than 15 cm should be used when a reverse ALT flap is used to reconstruct soft tissue defects located distal to 10 cm or more from the knee, which in turn requires caution as it may lead to partial necrosis of the flap. The 2 cases presented herein in which soft tissue defects were reconstructed with a reverse ALT flap in the amputation stump below the knee may serve as good references when determining indications for the use of reverse ALT flaps. The use of reverse ALT flaps in the reconstruction of soft tissue defects in an amputation stump below the knee joint must be carefully considered when the defect site is located distal to 10 cm or more below the knee. To prevent partial necrosis of the flap, additional venous drainage is recommended.

## REFERENCES

1. Gallico GG 3rd, Ehrlichman RJ, Jupiter J, May JW Jr: Free flaps to preserve below knee amputation stumps: long term evaluation. *Plast Reconstr Surg.* 1987; 79: 871-8.
2. Gonzalez EG, Corcoran PJ, Reyes RL: Energy expenditure in below-knee amputees: correlation with stump length. *Arch Phys Med Rehabil.* 1974; 55: 111-9.
3. Song YG, Chen GZ, Song YL: The free thigh flap: a new free flap concept based on the septocutaneous artery. *Br J Plast Surg.* 1984; 37: 149-59.
4. Pan SC, Yu JC, Shieh SJ, Lee JW, Huang BM, Chiu HY: Distally based anterolateral thigh flap: an anatomic and clinical study. *Plast Reconstr Surg.* 2004; 114: 1768-75.
5. Wang XC, Lu Q, Li XF, Burd A, Zhao BC, Wang YY, He JY, Liu XP: Reversed anterolateral thigh adipofascial flap for knee and proximal calf defects. *Burns.* 2008; 34: 868-72.
6. Uygur F, Duman H, Ulkür E, Celiköz B: Are reverse flow fasciocutaneous flaps an appropriate option for the reconstruction of severe postburn lower extremity contractures? *Ann Plast Surg.* 2008; 61: 319-24.
7. Liu TY, Jeng SF, Yang JC, Shih HS, Chen CC, Hsieh CH: Reconstruction of the skin defect of the knee using a reverse anterolateral thigh island flap: cases report. *Ann Plast Surg.* 2010; 64: 198-201.
8. Komorowska-Timek E, Gurtner G, Lee GK: Supercharged reverse pedicle anterolateral thigh flap in reconstruction of

- a massive defect: A case report. *Microsurgery*. 2010; 30: 397-400.
9. Gravvanis AI, Tsoutsos DA, Karakitsos D, Panayotou P, Iconomou T, Zografos G, Karabinis A, Paradopoulos O: Application of the pedicled anterolateral thigh flap to defects from the pelvis to the knee. *Microsurgery*. 2006; 26: 432-8.
10. Yildirim S, Avcı G, Akan M, Misirlioğlu A, Akö T: Anterolateral thigh flap in the treatment of postburn flexion contractures of the knee. *Plast Reconstr Surg*. 2003; 111: 1630-7.
11. Lin CH, Hsu CC, Lin CH, Chen YC, Wei FC: Antegrade venous drainage in a reverse-flow anterolateral thigh flap. *Plast Reconstr Surg*. 2009; 124: 273e-4e.