A comparison of fasciocutaneous and adipofascial methods in the reverse sural artery flap for treatment of diabetic infected lateral malleolar bursitis

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Abstract

Purpose: Infected lateral malleolar bursitis occurring as a diabetic complication requires debridement and flap surgery because it cannot be treated by conservative methods. The most accessible flap is the reverse sural artery flap, which can be harvested as a fasciocutaneous flap or an adipofascial flap. The purpose of this study was to compare the two types of flap methods performed in patients with diabetic infected lateral malleolar bursitis. Methods: Twenty-nine cases of diabetic infected lateral malleolar bursitis treated with reverse sural artery flap between 2006 and 2017 were analyzed retrospectively. Fasciocutaneous flap methods were performed in 15 cases (group A), and adipofascial flap methods were performed in 14 cases (group B). Patients in the two groups did not differ in sex or age. The mean follow-up period was 16 months. Results: All flaps survived. Infection was controlled at a mean of 2.4 months in both groups. At final follow-up, infection recurred in one case of each group, which was treated with antibiotics. No case developed an ulcer in the flaps. The patients were able to ambulate in regular shoes. All but one of the patients (28 patients) expressed satisfaction with the aesthetic appearance following treatment. No case required a debulking operation. Conclusion: Both the fasciocutaneous and adipofascial methods for reverse sural artery flaps were shown to be viable options for the control of diabetic lateral infection. In addition, the two groups did not differ in terms of appearance or complication rate following treatment.

Keywords
Adipofascial or fasciocutaneous, infected bursitis, Lateral malleolus, reverse sural flap

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Introduction

Lateral malleolar bursitis can be treated by conservative methods, although they are not always effective. In such cases, complete bursa resection and simple sutures can be applied.¹ The treatment of infected malleolar bursitis, however, requires surgical excision. In cases of compromised patients with lack of sensitivity and reduced blood supply in the lower extremities, infected malleolar bursitis can develop (though rarely) into intractable infected bursitis, which is challenging to treat and requires soft tissue debridement accompanied by reconstruction using a flap with sufficient blood supply.² Particularly for infected lateral

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malleolar bursitis caused by diabetes, reconstruction using a flap with adequate blood supply is necessary because blood circulation in the lower extremities of patients is not sufficient to be treated with conservative methods.

Among a number of flaps available for reconstruction of defects around the ankle, reverse sural artery flaps, which are technically simple and easy to perform, have been applied for reconstruction of defects resulting from trauma, osteomyelitis, pressure sores, and unstable scars. In particular, reverse sural artery flap procedures have been widely used to reconstruct defects caused by a diabetic foot with deficient blood supply, because reverse sural artery flap procedures do not require microsurgery techniques.3–7 Methods of either fasciocutaneous flaps with the inclusion of a skin paddle or adipofascial flaps without skin can be used for reverse sural artery flap procedures.8,9 Adipofascial flap methods require skin grafting and are less suitable for soft tissue reconstruction in high-pressure zones.10 On the other hand, adipofascial flap methods facilitate elevation and allow for primary closure of the donor site.9,11 The fasciocutaneous flap is bulky and might require a secondary thinning procedure for a patient to wear a regular shoe following treatment. Because a bulky flap causes cosmetic problems as well as discomfort with the use of regular shoes, soft tissue reconstruction of lateral malleolar defects might require a thinning procedure.8,9 In addition, the adipofascial flap is disadvantageous regarding infection control because the method does not involve any skin and thus can cause the development of an ulcer with the use of a shoe following treatment.9 The purpose of this study is to compare and analyze the efficacy and complications of the two types of flap procedures for the treatment of patients with diabetic infected lateral malleolus associated with soft tissue defects.

**Materials and methods**

A total of 29 cases of intractable infected lateral bursitis associated with diabetes were reconstructed with the reverse sural artery flap between June 2006 and March 2017. The cases were analyzed retrospectively. Coronary disease was observed in three patients. Five patients had chronic renal failure and were under hemodialysis. One patient had undergone kidney and liver transplantation. In all patients, computed tomography (CT) angiography was performed to assess the condition of the major arteries of the lower extremities. Angioplasty was performed in 5 of the 29 patients before placing the flap. All patients were insulin-dependent diabetics, but operations were performed with the diabetes fully under control in all cases. The lateral malleolus and peroneal tendon were exposed in all cases and osteomyelitis was observed in six patients. Operations were performed using a fasciocutaneous flap in 15 cases (group A) and an adipofascial flap in 14 cases (group B). The mean age at the time of operation was 57.4 years (range, 39–84 years) in group A and 57.8 years (range, 46–67 years) in group B. The mean time from the manifestation of symptoms to operation was 2.3 months (range, 1.5–5 months) in group A and 2.5 months (range, 1.2–6 months) in group B. The mean size of soft tissue defects in group A was 3.8 cm² (range, 2–5 cm²) in group A and 3.3 cm² (range, 2–4.5 cm²) in group B. The mean size of flaps was 4.7 × 3.8 cm² (range, 3.7–4.3 cm²) in group A and 4.5 × 3.4 cm² in group B (range, 3–4 cm). Angioplasty was performed in three cases of group A and two cases of group B. To analyze the bulkiness of flaps in the two groups of patients, the circumference of the ankle joint was measured at 2 cm superior to the tip of the lateral malleolus and compared against that of the normal ankle. Sex differences between the two groups were assessed with χ² test. Characteristics including patient sex, age, operative time, size of defects, and size of flaps were evaluated between the two groups using Mann–Whitney U test. All statistical analyses were performed with SPSS software, version 21 (IBM, Armonk, New York, USA) to identify differences between the two groups. The level of significance was set at p < 0.05. Characteristics including patient sex, age, operative time, size of defects, and size of flaps showed no statistically significant differences between the two groups (Table 1). In addition, there was no statistically significant difference in the above characteristics between the angioplasty group and the non-angioplasty group. Coronary heart disease, hypertension, and chronic renal failure that were considered significant comorbidities were encountered in 11 patients (73%) of group A and in 11 patients (78%) of group B (p > 0.05). The preoperative mean ankle/brachial systolic index was 0.92 (range, 0.88–1.08) in group A and 0.94 (range, 0.90–1.10) in group B (p > 0.05). The static two-point discrimination (TPD) was preoperatively assessed at medial foot of the affected site in 12 cases of group A and in 13 cases of group B. The mean static

| Table 1. Demographic data of patients. |
|----------------------------------------|
|                                | Fasciocutaneous flap | Adipofascial flap | p Value |
|----------------------------------------|
| Cases                                  | 15                   | 14               |        |
| Male: female                           | 11: 4                | 10: 4            | 0.83   |
| Mean ages (years)                      | 57.4                 | 57.8             | 0.339  |
| Mean time from symptoms to operation (months) | 2.54               | 2.33             | 0.582  |
| Mean defect size (cm)                  | 3.4 × 3              | 3.3 × 2.7        | 0.246  |
| Mean flap size (cm)                    | 4.7 × 3.8            | 4.5 × 3.4        | 0.279  |
| Mean follow-up (months)                | 18.7                 | 18.2             | 0.555  |
| Duration of healing (months)           | 2.39                 | 2.43             | 0.346  |
| Circumference of the ankle joint compared of the normal ankle (%) | 108.2                | 103.5            | 0.006  |
TPD was 6.8 mm (range, 4.5–8.5 mm) in group A and 6.4 mm (range, 4.5–8.5 mm) in group B ($p > 0.05$).

Operative method
Operations were performed under general or spinal anesthesia. Patients were placed in the lateral position with a tourniquet control. The operation site was elevated for 5 min before the pressure of the tourniquet was increased. First, complete debridement was performed on the lateral malleolus. Bone debridement was performed for patients with osteomyelitis. Following debridement, features including the size and shape of defects were identified. The path of the lesser saphenous vein was drawn on the donor site. The location of the perforator was preoperatively identified with a Doppler. This study was approved by the Institutional Review Board of Gangdong Kyung Hee University Hospital. Every involved patient provided informed consent.

Fasciocutaneous flap (group A). A flap was designed at the donor site, and a reverse sural artery fasciocutaneous flap procedure was performed. To prevent complications with the flap caused by compression of the pedicle, a tear-drop design was added below the flap. The pedicle was made with a width of at least 3 cm. Once the flap was elevated, a skin incision was made at the point where the pedicle would be located and where the flap was placed. The tourniquet was then released, and circulation in the flap was assessed. Skin suture was performed loosely at the site where the pedicle was located to prevent compression of the pedicle. When primary closure of the donor site was not possible, a split-thickness skin graft (STSG) was performed on the donor site.

Adipofascial flap (group B). After designing a flap, a longitudinal incision was made to expose the subcutaneous fat layer. Features of size and shape of the required flap at the subcutaneous fat layer were designed again, and the flap was then elevated with the pedicle. The pedicle was made with a width of at least 3 cm. A skin incision was made at the point where the pedicle would be located and where the flap was placed. The tourniquet was released, and circulation in the flap was assessed. Then, a STSG from the anterolateral thigh was performed on the adipofascial flap. Skin suture was performed loosely at the site where the pedicle was located to prevent compression of the pedicle.

Postoperatively, five or more Silastic drains were inserted. Bulky dressing was performed, and short leg splints were applied. Wound dressing was performed on a daily basis to assess the blood supply in the flaps. The drains were removed one at a time depending on the amount of drainage. Antibiotics were used until drainage from operation site was no longer seen.

Results
All flaps completely survived and no partial necrosis was observed. Venous congestion did not occur. STSG was performed on the donor site in two patients in group A, and the graft was well accepted. Of the 14 cases in which skin grafting was done on the flap, 2 cases developed partial skin graft loss, but the partial skin graft loss was healed by daily wound dressing without the need for additional procedures. The mean follow-up period was 18.7 months (range, 10–30 months) for group A and 18.25 months (range, 8–32 months) for group B, showing no statistically significant difference ($p = 0.555$). Operative time required for flap procedures was 1.5 h for group A and 1 h and 40 min for group B, with no statistical difference.

The mean time from operation to complete healing of the wound was 2.39 months (range, 1.5–4 months) for group A and 2.43 months (range, 1.5–5 months) for group B, demonstrating no significant difference ($p = 0.346$). The recurrence of infection until final follow-up was observed in one case of group A and in one case of group B, both of which were addressed with antibiotics and general wound dressing. No case reported a recurrent ulceration in the flaps before the final evaluation and an ulcer in the flaps at final follow-up. All patients wore normal shoes and ambulated without a problem following the procedures. The circumference of the ankle measured at the lateral malleolus was 108.2% (range, 106–113%) of the normal side in group A and 103.5% (range, 104–105%) of the normal side in group B, presenting a statistically significant difference between the groups ($p = 0.006$). From a cosmetic perspective, however, patient satisfaction was high in all but one case (wherein the flap was elevated at a large size of $7 \times 6 \text{ cm}^2$). No case required a debulking operation.

Case reports

Case 1
A 57-year-old male patient visited our clinic for a soft tissue defect and infection that had developed on the right lateral malleolar area of the ankle joint 3 months prior to the patient’s visit. The patient had had diabetes since his 20s and was managing it with insulin. The patient had consistently treated the wound following the occurrence of the soft tissue defect, but the condition had not resolved. Accordingly, reconstructive surgery using a reverse sural artery flap was planned. The defect measured $3 \times 3 \text{ cm}^2$ in size preoperatively (Figure 1(a)). A tear drop-shaped, $3.5 \times 3.5 \text{ cm}^2$ fasciocutaneous flap was designed (Figure 1(b) and (c)) and a fasciocutaneous reverse sural artery flap was performed. The flap survived well. The patient was able to wear normal shoes and live a normal life without any recurrent ulcers or infection during a follow-up period of three years (Figure 1(d)).
A 60-year-old patient who had been undergoing treatment for diabetes for 20 years visited our clinic for septic bursitis and a soft tissue defect on the right lateral malleolar area of the ankle joint. Although the wound was smaller in size following consistent treatment at another hospital, the patient complained of no improvement within the 3 weeks prior to the patient’s visit to the clinic (Figure 2(a)). Reconstructive surgery using a reverse sural artery adipofascial flap was planned. Adipofascial (4 × 4 cm²) flap was elevated. STSG was performed on the flap from the lateral side of the lower limb (Figure 2(b)). The patient was followed up for 1 year and 8 months. No recurrence of infection or ulcer was reported, and the patient had no difficulties in daily living during this period (Figure 2(c)).

Discussion
Operative options can be considered for the treatment of lateral malleolar bursitis that does not respond to conservative methods. Where infection occurs in lateral bursitis, surgical excision and primary closure are recommended. In a patient who has poor body conditions or deficiency of blood supply or sensitivity—as with diabetes—infected lateral bursitis can develop into intractable infected bursitis, which is challenging to treat.

One of the recommended options is debridement and reconstruction of defects using a flap with adequate blood supply. Hashimoto et al. described the successful reconstruction of two patients with intractable infected lateral malleolar bursitis using lateral calcaneal artery adipofascial flaps. One of the two patients had diabetes. The authors reported that placing the soft tissue with adequate blood supply over the remaining subcutaneous fat layer was essential for the treatment of intractable infected bursitis. In the present study, we performed reverse sural artery flap procedures on patients with deficient blood supply and sensitivity in lower extremities due to diabetes and who developed lateral ulcers with skin defects and infection that did not heal, even following sufficient conservative treatment.

Reverse sural artery flap procedures have been cited as a viable option because they are easy to perform, the pedicle is reliable, postoperative treatment and follow-up are simple, the major artery is not sacrificed, donor site morbidity is low, and flap survival rates are satisfactory—even in conditions of poor blood supply in the lower extremities of patients as observed in diabetes. The disadvantages of flaps are a long scar remaining on the calf and the sacrifice of the sural nerve, which leads to a sensory decrease in the lateral malleolus. The flap can be raised as a fasciocutaneous flap involving the skin, subcutaneous tissue, and muscle fascia or as an adipofascial flap involving the muscle fascia and subcutaneous fat tissue. The fasciocutaneous flap is bulky and might require thinning procedures to allow patients to wear regular shoes following treatment. The adipofascial flap requires skin grafts and might not be suitable for soft tissue reconstruction in high-pressure zones. Adipofascial flaps, however, are cosmetically pleasing because secondary skin thinning procedures are not required, the flaps are easy to harvest, and primary closure of the donor site is allowed, providing cosmetic advantages. In a comparison between fasciocutaneous flaps and adipofascial flaps, Schmidt et al. reported that the adipofascial flap demonstrated a shorter operative time and better aesthetic outcomes, but complications did not differ

Figure 1. A 57-year-old male patient presented with a soft tissue defect and infection on the right lateral malleolar area of the ankle joint (a). A tear drop-shaped, fasciocutaneous reverse sural artery flap was elevated (b) and a fasciocutaneous reverse sural artery flap was performed (c). At the last follow-up, the patient was able to wear normal shoes without any recurrent ulcers or infection (d).

Figure 2. A 60-year-old patient complained of a septic bursitis and a soft tissue defect on the right lateral malleolar area of the ankle joint (a); 4 × 4 cm² adipofascial flap was elevated and STSG was performed (b). In 20 months after surgery, the patient had no difficulties in daily living without any infection or ulcer (c). STSG: split-thickness skin graft.

Case 2
A 60-year-old patient who had been undergoing treatment for diabetes for 20 years visited our clinic for septic bursitis and a soft tissue defect on the right lateral malleolar area of the ankle joint. Although the wound was smaller in size following consistent treatment at another hospital, the patient complained of no improvement within the 3 weeks prior to the patient’s visit to the clinic (Figure 2(a)). Reconstructive surgery using a reverse sural artery adipofascial flap was planned. Adipofascial (4 × 4 cm²) flap was elevated. STSG was performed on the flap from the lateral side of the lower limb (Figure 2(b)). The patient was followed up for 1 year and 8 months. No recurrence of infection or ulcer was reported, and the patient had no difficulties in daily living during this period (Figure 2(c)).
between the two types of flaps. It is very challenging to reconstruct soft tissues in a diabetic foot due to secondary neuropathy, ischemia, deformity, immunosuppression, and vulnerability to infection. Yildirim et al. described successful soft tissue reconstruction with reverse sural artery fasciocutaneous flap procedures in seven diabetic feet. Three of the seven feet had defects in the lateral malleolus, which were all reconstructed with sural artery flaps. Al Qattan also described successful reconstruction with reverse adipofascial sural artery flap methods in two of the three diabetic patients with unstable heel scars. In the present study, reverse sural artery flap procedures performed in 20 cases of infected lateral malleolar bursitis associated with diabetes were successful in terms of infection control and soft tissue reconstruction without any partial flap necrosis. However, discharge at recipient sites of patients was resolved only at a mean of 10 weeks postoperatively, demonstrating that wound dehiscence is the most common complication with reverse sural artery flap procedures in multimorbid patients. This complication did not show significant differences between the two groups, which suggests that both methods are reliable for infection control. Thorough intraoperative debridement is considered necessary to prevent complications.

Operative time is known to be shorter with the adipofascial flap method than with the fasciocutaneous flap method, but we could not conclude that the adipofascial flap method was technically faster, because no statistically significant difference was found in operative times between the two groups. This indicates that the adipofascial flap method required additional time for skin grafting, which was taken into account in our comparative analysis. It has been argued that the fasciocutaneous flap is thick, whereas the adipofascial flap is thin with better cosmetic outcomes. In the present study, the circumference of the ankle joint was measured at the lateral malleolus to compare bulkiness between the two groups. The fasciocutaneous flap was measured at 108.2% of the normal ankle, and the adipofascial flap was measured at 103.5% of the normal ankle. Both groups showed an increase in the circumference of the ankle, but there was a statistically significant difference between the groups. By objective measures, we confirmed that the fasciocutaneous flap was thick. Patient satisfaction from a cosmetic perspective was high in all but 1 case, however, implying that patient subjective assessment was not significantly different between the groups. This might be attributable to the fact that adipofascial flaps tended to show skin color changes due to skin graft, while fasciocutaneous flaps, though thick, tended to have a skin color similar to the recipient site, thus mitigating the disadvantage of their bulkiness.

Adipofascial flaps are known to be less suitable for soft tissue reconstruction in high-pressure zones, but neither group in this study reported any ulcers at final follow-up. Based on this finding, we consider adipofascial flaps to be a tolerable option in high-pressure zones. The sample size of this study is too small to strongly support the conclusion; however, there have been reports on successful reconstruction of diabetic soft tissue defects around the ankle with reverse sural artery flaps, but no previous research has studied the time required for infection control. In the present study, we confirmed that it took a long time to control infection in patients with diabetic soft tissue defects. Thorough debridement is considered essential for infection control. We performed debridement to the utmost possible extent in each patient, and where osteomyelitis was likely, debridement of the fibula was performed concurrently. Still, there was a delay in infection control, probably because deficient blood supply due to diabetes and long-term exposure to infection occurring along the sural tendon did not allow for complete debridement. Based on these observations, patients should be told that soft tissue reconstruction of the diabetic lateral malleolus might take a longer time in comparison to the reconstruction of defects resulting from trauma. This study has limitations of small sample size and retrospective analysis. Conclusions herein cannot be applied across cases of reverse sural artery flaps. Nevertheless, this study is meaningful in its comparison of two types of flap procedures for patients with diabetic soft tissue defects at the lateral malleolus.

Conclusion

Both the fasciocutaneous and adipofascial methods for reverse sural artery flaps were shown to be viable options for the control of diabetic lateral infection. In addition, two patient groups did not differ in terms of cosmetic appearance or complication rate following treatment.

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