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Original Article

Tension-Free Management of Surgical Wound in Paramalleolar Bypass

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Objective: In paramalleolar bypass for critical limb-threatening ischemia (CLTI), excessive skin tension may occur for the closure of surgical wounds around the ankle. Furthermore, these surgical incisions are often proximal to infectious ischemic ulcers. Wound dehiscence caused by skin tension and surgical site infection carries a risk of graft exposure, anastomotic disruption, or graft insufficiency.
Patients and Methods: Tension-free wound management was adopted in eight patients who underwent paramalleolar bypass for CLTI. Tension-free closure was adopted for surgical incisions for distal anastomotic site of the paramalleolar bypass, whereas the incisions for saphenous vein harvest were left open. A relief incision was made as needed. The opened incisions were covered with artificial dermis.
Results: All surgical incisions and ischemic wounds healed successfully within 1.8 months after bypass. Two postoperative graft stenoses occurred, which were rescued by additional endovascular intervention. Secondary graft patency, wound healing, and limb salvage rates were 100% during an average follow-up period of 30 months.
Conclusion: Tension-free wound closure using artificial dermis was effective in selected cases of paramalleolar bypass for CLTI.

Keywords: critical limb-threatening ischemia, paramalleolar bypass, wound management, artificial dermis

Introduction

Paramalleolar bypass is a useful revascularization technique for treating critical limb-threatening ischemia (CLTI).[1–5] The reported outcomes of this bypass surgery appear to be acceptable, however, excellent patency rates and limb salvage rate of bypass surgery are veiled by the occurrence of wound complications.[1–19] In paramalleolar bypass, several incisions are made around the ankle where the skin is hard to extend; for exposure, from the dorsalis pedis artery to the pedal artery or from the posterior tibial artery to the plantar artery; and for harvesting the saphenous vein graft (SVG). Moreover, infectious ischemic ulcers are proximal to these surgical incisions and wound dehiscence caused by skin tension and surgical site infection has a risk of anastomotic disruption, graft thrombosis, and subsequent limb loss. Furthermore, the vein graft to the dorsalis pedis artery usually passes through the subcutaneous route and overrides in front of the tibia at the ankle level, and excessive skin tension induced by the vein graft passage promotes wound dehiscence and graft exposure.

In this study, we aimed to investigate the clinical outcomes of tension-free surgical wound management in paramalleolar bypass.

Patients and Methods

Tension-free wound management was chosen to close the paramalleolar surgical wounds of distal bypass when excessive skin tension was recognized in order to prevent wound dehiscence. The surgical incision for the distal anastomotic site of the bypass was closed tension-free by interrupted subcutaneous sutures using absorbable threads and interrupted cutaneous sutures using nonabsorbable threads. On the contrary, the incisions for the SVG harvest were left open. When wound tension could not be reduced only by wound opening for the SVG harvest, an appropriate-sized relief incision was made at the suitable site to reduce the tension of the skin incision on the distal anastomosis. The opened incisions were covered with artificial dermis (Pelnac, Gunze Limited, Japan or Terudermis, Terumo Corporation, Japan). The technical

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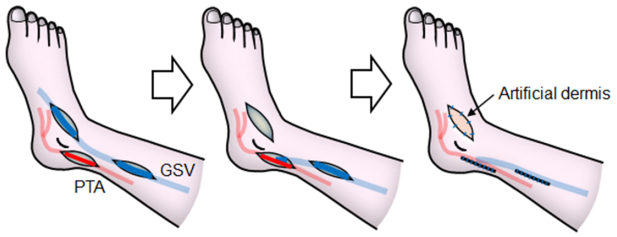

Fig. 1 Schema of the tension-free wound management in the bypass to the posterior tibial artery.
GSV: great saphenous vein; PTA: posterior tibial artery

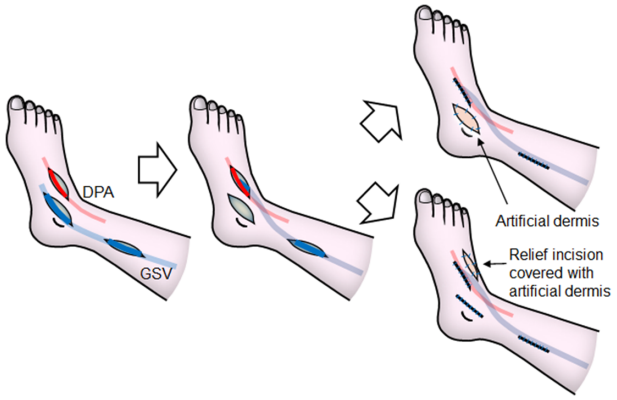

Fig. 2 Schema of the tension-free wound management in the bypass to the dorsalis pedis artery.
GSV: great saphenous vein; DPA: dorsalis pedis artery

methods of tension-free wound management in the paramalleolar bypass to the posterior tibial artery and dorsalis pedis artery are presented in **Figs. 1** and **2**, respectively.

From January 2010 to December 2018, 90 patients received distal bypass for CLTI. Among them, tension-free wound management, as described above, was adopted in one female and seven male patients (mean age, 64 years). Comorbidities of hypertension (n = 3 patients), diabetes mellitus (n = 7), hemodialysis (n = 4), a history of coronary artery disease (n = 4), and a history of cerebrovascular disease (n = 2) were noted in the included patients. The Rutherford system was used to classify the severity of ischemic ulcers. Seven patients had a stage-5 Rutherford and one patient stage-6 Rutherford. The bypass target arteries were the dorsalis pedis artery in five patients and the posterior tibial artery in three patients. The bypass grafts used were reversed SVG in three patients and non-reversed SVG in five. Open wound management with artificial dermis was performed at the SVG harvest incision in seven patients and a relief incision in one patient.

Antiplatelet regimens, such as aspirin, cilostazol, or sarprogrelate hydrochloride, were prescribed for all patients throughout the follow-up period. Clinical assessment and duplex ultrasonographic analysis were performed at discharge and every 3 months thereafter. The study endpoints were graft patency, limb salvage, survival, and wound healing. Major amputation was defined as limb loss above the ankle level, and limb salvage was defined as freedom from major amputation.

The study was approved by the ethical committee of our institute (approval number: ER-202001). Written informed consent was obtained from all patients by comprehensive agreement method.

Results

The postoperative course was unremarkable in all patients. Within 1.8 months (1–4 months) after the bypass, all surgical incisions, including the distal anastomotic site, healed without infection or opening (**Figs. 3** and **4**). Skin transplantation was performed in two patients under general anesthesia concomitant with ischemic wound debridement, because the size of their unclosed wounds was large and it seemed to take time for complete epithelization. Those surgical wounds also healed without complications. Minor amputation was necessary in seven of the eight ischemic ulcers (toe amputation, 7; trans-metatarsal amputation, 1), but there was no major amputation. Two postoperative graft stenoses occurred at 3 and 12 months after the bypass, which were successfully rescued by additional endovascular intervention.

Secondary graft patency, wound healing, and limb salvage rates were 100% during an average follow-up period of 30 months (2–51 months). Two of the patients died of cardiac events at 31 and 41 months, respectively, after the bypass.

Discussion

Paramalleolar bypass using SVG is a standard procedure for managing CLTI. The reported patency and limb salvage rates of this bypass are satisfactory.[1–5] However, patients with CLTI are at a high risk for various wound complications, such as surgical site infection, lymphorrhea, wound dehiscence, graft exposure, and subsequent graft failure.[1–19]

Wengrovitz et al. investigated wound complications in 163 infrainguinal bypasses.[13] Severe wound complications with wound dehiscence and graft exposure occurred in 12 of them, which led to 4 major amputations and 1 death. Ouriel et al. reviewed the outcomes of 16 patients with exposed SVG.[14] All patients were initially treated conservatively with moist sterile dressings, followed by split-thickness skin graft coverage of the wounds after cleaning. The wounds healed in seven patients, whereas nine patients developed complications of hemorrhage and graft thrombosis. Recent clinical studies have demonstrated that infection-related graft exposures after lower

extremity bypass were successfully treated using autologous tissue, such as pedicle muscle flaps.[15–17] This aggressive management of infected wounds might be effective, but involves increased length of hospitalization and cost.

Before the start of this clinical study, we encountered two patients with distal anastomotic rupture of the bypass to the dorsalis pedis artery following wound infection and dehiscence. One of them was a 58-year-old female patient with diabetes and stage-5 Rutherford ulcer. The anastomotic disruption with wound dehiscence occurred 3 weeks after popliteal-to-dorsalis pedis artery with non-reversed SVG. The other patient was a 78-year-old woman with diabetes and stage-5 Rutherford ulcer. The anastomotic rupture occurred 2 weeks after popliteal-to-dorsalis pedis artery with non-reversed SVG. Both patent SVGs had to be ligated and major amputation was inevitable in both patients, and we realized the importance of preventing wound dehiscence and decided to begin tension-free wound management. This wound management was adopted for selected patients in whom the skin tension was excessive for primary closure of paramalleolar surgical wounds; patients with several parallel skin incisions around the ankle for exposure of distal anastomotic site and the SVG harvest; patients with skin sclerosis by persistent ischemia or recurrent infection; and patients with inflammatory edema around the ankle. This method might be particularly effective for bypass to the dorsalis pedis artery which lies in the dorsum pedis with poor skin laxity and runs more peripheral than the posterior tibial artery.

Fig. 3 Healing course of the wounds after bypass to the posterior tibial artery (a 73-year-old male patient). Black arrows indicate the surgical wound on the distal anastomosis and white arrows indicate the wound for saphenous vein graft harvest covered with artificial dermis. Left: 4 days after bypass, Right: 6 weeks after bypass.

There are a few studies of inventions to relieve skin tension in paramalleolar bypass for preventing dehiscence of distal anastomotic wounds. Mouton et al. reported the surgical method of a proximalized lateral tunnel for the bypass to the dorsalis pedis artery to protect the SVG exposure induced by wound breakdown.[18] Robison et al. introduced the ancillary technique ("pie-crusting") to reduce skin tension in selected patients with pedal edema or difficult wound closure.[19] Multiple 4- to 5-mm stab incisions through the epidermis and dermis were made using a blade scalpel to facilitate wound closure. There were no

Fig. 4 Healing course of the wounds after bypass to the dorsalis pedis artery (a 60-year-old male patient). Black arrows indicate the surgical wound on the distal anastomosis, white arrows indicate the wound for saphenous vein graft (SVG) harvest covered with artificial dermis, and gray arrows indicate the wound for SVG harvest covered with artificial dermis and received skin transplantation. Left: 8 days after bypass, Right: 4 months after bypass.

distal wound problems among 15 patients who received this surgical technique and were considered to be at the greatest risk for wound breakdown.

In our tension-free wound management of paramalleolar bypass, an artificial dermis was used to cover the incision made for SVG harvest or the relief incision. Dermal regeneration templates, such as Pelnac or Terdermis, were designed to treat extensive burn injuries. To date, these techniques have been widely applied to manage various acute and chronic wound sites, and several clinical experiences of using these techniques have been reported in the field of plastic surgery.[20–23] In patients in whom artificial dermis is used for unclosed wounds, complete epithelization occurs in 4–8 weeks. Additional skin transplantation is occasionally needed; however, skin transplantation can be performed simultaneously with minor amputation or wound debridement, which are necessary in most patients with CLTI having ischemic ulcers or gangrene.

Conclusion

Tension-free management of surgical wound using artificial dermis seems to be effective in selective patients who receive paramalleolar bypass for CLTI.

Disclosure Statement

The authors have no conflicts of interest to declare.

Additional Note

The content of this study was partly presented at the 33rd Annual Meeting of European Society for Vascular Surgery on October 24–27, 2019, in Hamburg, Germany.

Author Contributions

Study conception: YosT
Data collection: IK, YorT
Analysis: YosT
Writing: YosT
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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