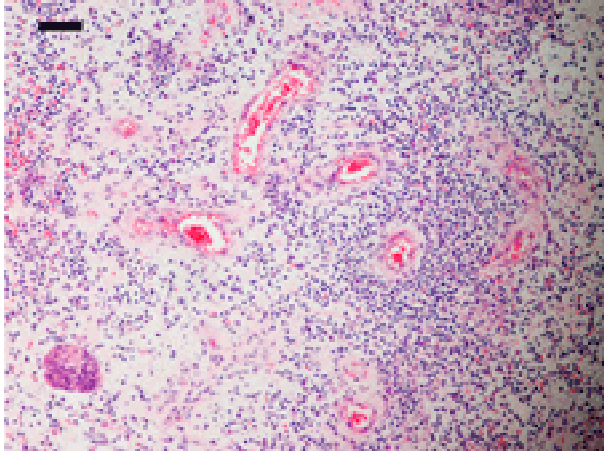

Fig. 3. There were a lot of capillary vessels in the granulation tissue taken from the left leg. The section was stained with hematoxylin-eosin. The degree was judged under a light microscope. The dark bar represents 100 μm.

gradually enhanced wound closure thereafter, and the wound finally closed in 14 weeks (Fig. 2). Histopathologic examination revealed proliferated microvessels in the increased granulation tissue from the wound treated by VAC (Fig. 3).

Right lower extremity

Because the patient wanted us to treat the gangrene in his right foot, we first tried VAC. However, VAC alone did not enhance wound closure for the ulceration on the tip of his right 1st toe. We decided on revascularization for the right lower extremity and resection of the toe, just as for the left side. We performed revascularization between the right common femoral artery and right proximal popliteal artery with an 8 mm knitted Dacron graft and resection of the right 1st distal phalanges and proximal phalanx including the necrotic tissues. We kept the stumps open like the left lower extremity.

Postoperative ABI was 1.08 on the right side. VAC was started on the 4th postoperative day and it rapidly enhanced wound closure in only 1 week in spite of MRSA infection. However, VAC gradually enhanced wound closure thereafter. The wound finally closed after 6 weeks (Fig. 4).

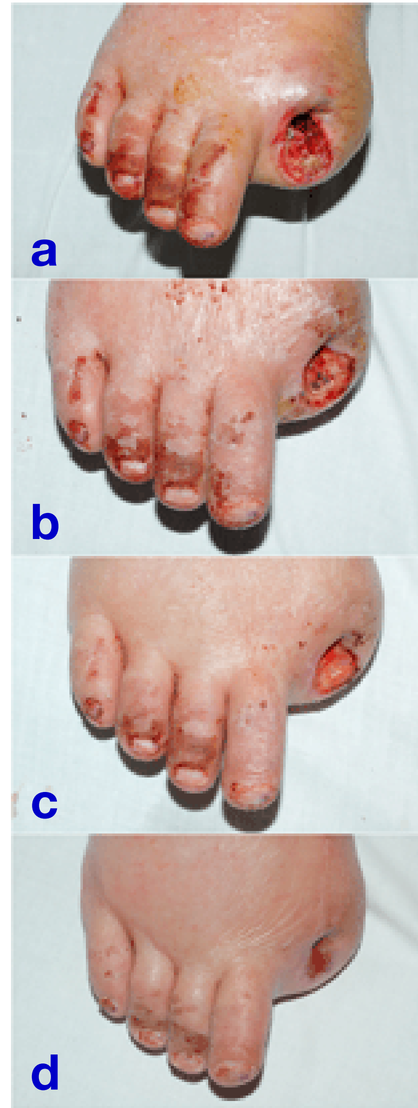

Fig. 4. Effect of the Vacuum-Assisted Closure (VAC) Therapy for the right leg. **a:** Before VAC. **b:** After 1 week of VAC. **c:** After 4 weeks of VAC. **d:** After 6 weeks of VAC.

Discussion

The VAC Therapy has been proven effective in treating both acute and chronic wounds regardless of infection (Argenta and Morykwas, 1997; McCallon et al., 2000; Armstrong and Lavery, 2005; Cowan et al., 2005). Haga et al. (2005) have reported that VAC is effective for diabetic foot wounds of patients with atherosclerosis. There were few reports on severe ischemic foot

in which VAC after revascularization facilitated wound healing. The mechanism of VAC is considered in part to act via the reduction of tissue edema, that may contain toxic by-products of infection and prolonged inflammation, and removal of factors that inhibit wound healing through the application of subatmospheric pressure with a vacuum (Argenta and Morykwas, 1997; Morykwas et al., 1997; McCallon et al., 2000), and also increase blood supply and reduce the incidence of infection in a porcine wound model (Morykwas et al., 1997). Tissue bacterial counts in infected wounds were also reduced by 21% with VAC compared with controls (Morykwas et al., 1997). VAC may also stimulate wound healing through the promotion of cell division, angiogenesis, and local proliferation of growth factors (Saxena et al., 2004). Nishimura et al. (2006) have reported that the effect of a high-frequency repetitive stretch or an intermittent stretch on the cell proliferation and survival of human dermal fibroblasts and the activation of any relevant signal pathways. In this case, histopathologic examination showed a lot of microvessels in the increased granulation tissue.

Femoral-femoral-popliteal artery bypass or right femoral-left popliteal artery bypass should have been considered initially as an appropriate treatment. However, in the present case, because the abdominal aorta had a stenosis and we may need to do a right axillo-femoral or femoral-femoral artery bypass in the near future, we performed a left axillo-popliteal artery bypass without exposure of the right femoral region. We also performed open minor amputation for fear of possible infection, even though there was no obvious sign of infection.

In the present case, VAC rapidly enhanced wound closure in only one week in spite of MRSA infection, and gradually enhanced wound closure thereafter. The wounds closed in 14 weeks on the left side and 6 weeks on the right side. Our case suggests that VAC may be effective even for infected wounds, especially within the 1st week after VAC started. On the other hand, as on the right side, this case also suggested that a lot of microvessels in the increased granulation after VAC therapy may be related to facilitate wound healing as well as VAC may not be effective when the blood supply is insufficient. In treating ischemic foot with gangrene, revascularization should be performed first, before applying VAC therapy. Moreover, as we confirmed the effectiveness of VAC on the left side, we have had better earlier apply VAC on the right side, not but the 4th postoperative day.

The benefit of VAC therapy is also in its cost-effectiveness. The polyurethane film and tube were changed only twice a week. Whenever patients want to leave their beds, VAC can be easily disconnected and connected once they go back to bed. This is why patients don't have to be totally confined to bed during VAC. Ischemic foot with gangrene can be treated only with revascularization, but patients always need disinfection and/or washing as a usual treatment in the hospital for a long period. VAC might possibly shorten the length of hospital stay. In some cases, VAC failed to enhance wound closure in spite of increased granulation tissue (Armstrong and Lavery, 2005; Cowan et al., 2005). Further studies are warranted regarding the following: i) what is the indication for VAC?; ii) which is better, continuous or intermittent negative pressure?; iii) how long should VAC continue? and iv) how does VAC affect a superficial wound?

In conclusion, we report a case of severe ischemic foot in which VAC after revascularization facilitated wound healing in spite of MRSA infection.

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