Reconstruction of Axillary Defect due to Necrotizing Fasciitis and Debridement Using a Free-Flap Transfer: A Report of Three Cases

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Abstract

Background Necrotizing fasciitis is a well-known disease that causes extensive tissue infection and requires radical debridement of the infected tissue. It can occur in all parts of the body, but there are few reports of necrotizing fasciitis in the axilla. We treated three patients with axillary necrotizing fasciitis.

Methods In all cases, patients were referred to us after radical debridement of the infected soft tissue in the emergency department. At the first visit to our department, there were fist-sized soft tissue defects in the axilla. Moreover, the ipsilateral pectoralis major and latissimus dorsi muscles were partially resected because of the debridement of necrotizing fasciitis. In all cases, the ipsilateral thoracodorsal vessels were severely damaged and free-flap transfer was performed to close the axillary wound.

Results All free flaps survived without complications. The patient's range of motion for shoulder abduction on the affected side was maintained postoperatively.

Conclusion If necrotizing fasciitis occurs in the axilla, tissue infection can spread beyond it. In such a case, free-flap transfer can be an optimal treatment. Radical resection of the infected tissue results in the absence of recipient vessels in the axilla. Surgeons should bear in mind that, because of radical resection of the infected tissue, they may need to seek recipient vessels for free-flap transfer far from the axilla.

Keywords
- axilla
- necrotizing fasciitis
- free flaps

The need for axillary reconstruction usually results from a variety of illness and sequelae, such as releasing postburn scar contractures,[1–3] excision of hidradenitis suppurativa,[4] and excision of various types of tumors.[5–7] In these cases, primary wound closure is often difficult, and some kind of tissue transplantation is necessary. Currently, skin grafting is not often used in such cases, as stated in many literatures, because of its disadvantage.[7,8]

Locoregional flap transfer for axillary reconstruction has become widespread in recent years, and there are many reports on this procedure. The ipsilateral upper arm is one of the ideal flap collection sites for axillary reconstruction. The

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posterior arm flap or the flap from inner arm is a good option for axillary reconstruction, because they have sufficient blood supply, flexible skin, and soft tissue, which are desirable during axillary reconstruction.[8–12] The drawbacks of these flaps are the poor aspect of the donor scars and the limitation of the flap's skin paddle's dimension. Therefore, they are suitable for small- or medium-sized axillary reconstruction, such a hair-bearing axilla's reconstruction.

Flaps for axillary reconstruction can also be collected from the trunk. Classically, the flaps that could be collected from the trunk and used for axillary reconstructions include a latissimus dorsi flap,[13] scapular flap,[14] and pectoralis major myocutaneous island flap.[15] However, perforator flaps have recently become widely used for axillary reconstruction. They are VY advancement flaps,[16,17] propeller flaps,[7,18,19] or other island flaps.[20] Most of these flaps are based on the perforator from the thoracodorsal vessels, lateral thoracic vessels, or circumflex scapular vessels.[7,16,17,20] The advantage of harvesting the flap from the trunk is that a larger flap can be collected compared with the size of a flap that is collected from the upper arm. Therefore, flaps collected from the trunk appear to be suitable for the reconstruction of large axillary defects, such as axillary defects that extend beyond hair-bearing regions. On the other hand, to use these reconstructive procedures, vessels that arise from the axillary vessels, such as thoracodorsal vessels, lateral thoracic vessels, and the circumflex scapular vessels, must be intact. If these vessels are severely damaged, especially near their origin from the axillary vessels, regional flaps from the trunk cannot be used in most cases. Furthermore, if the axillary defect is too large to be covered using the flap from the ipsilateral upper arm, free-flap transfer from distant areas of the body should be required.

Axillary necrotizing fasciitis is an uncommon disease that is rarely reported.[21–23] The axilla contains adipose tissue, lymph nodes, vessels, nerves, and muscles. Necrotizing fasciitis in the axilla causes extensive soft tissue damage. Subsequent radical debridement of these infected tissues can result in a large three-dimensional soft tissue defect. Furthermore, tissues close to the axilla, such as the pectoralis major, latissimus dorsi muscle, and ipsilateral upper arm soft tissues, can be damaged by infection and debridement. In addition, branches of the axillary vessels, such as the thoracodorsal, circumflex scapular, and lateral thoracic vessels, can be severely damaged and disconnected in the axilla. As a result, free vascularized flaps may be required to reconstruct such three-dimensional tissue defects.

We treated three patients with axillary necrotizing fasciitis. After removing the infected tissue, we performed free-flap transfers for axillary soft tissue reconstruction. The free flaps survived without complications and shoulder joint functions were preserved. Our experience with these cases demonstrates optimal surgical management for axillary skin and soft tissue defects caused by necrotizing fasciitis.

Case Reports

Case 1

A 52-year-old man presented to the emergency department of our institution with necrotizing fasciitis that extended to his right anterior and lateral chest, and axilla. Radical debridement was performed on the day of hospitalization. On day 14 of hospitalization, skin graft transplantation was performed on the anterior and lateral chest walls. On day 25 of hospitalization, the patient presented to our plastic surgery department. At the patient's first visit to the plastic surgery department, we observed a fist-sized soft tissue defect that was approximately 20 cm × 6 cm inside the patient's axillary cavity. The axillary vessels were partially exposed. The lateral portion of the right latissimus dorsi muscle had been excised. The ipsilateral thoracodorsal vessels had also been excised just a little peripherally from its origin of the axillary vessels. The caudal two-thirds of the pectoralis major muscle was ablated because of infection. As a result, the pectoralis major muscle and the remaining latissimus dorsi muscle were contracted, and abduction of the right shoulder joint was restricted (►**Fig. 1A**). To maintain shoulder joint function and prevent the occurrence of axillary scar contracture postoperatively, we decided that both the skin and soft tissue should be transplanted.

On day 35 of hospitalization, we performed a combined free-flap transfer of a latissimus dorsi muscle flap and a scapular flap. The dimension of the scapular skin paddle was 20 cm × 6 cm and the entire ipsilateral latissimus dorsi muscle was included in the combined flap. Furthermore, the flap's vascular pedicle length was approximately 5.5 cm. Before harvesting the flap, we searched the affected axilla for recipient vessels for microvascular anastomosis. However, we could not find a vessel that was suitable for vascular anastomosis. We also noticed that the entire axillary wound was covered with hard granulation, and that the surgical procedure for exposing the vessels could cause severe bleeding from large vessels, such as the axillary vessels (►**Fig. 1B, C**). As a result, we decided to search for recipient vessels except the axilla. We suspected the occurrence of widespread necrotizing fasciitis infection under the pectoralis major muscle, and this was confirmed to be present on the caudal side of the clavicle. We used the superior thyroid artery and external jugular vein as the recipient vessels (►**Fig. 1D**). We considered that these vessels were not affected by the infection because they were cranially distant from the affected axilla.

We closed the axillary wound with a combined scapular and latissimus dorsi muscle flap in the following two steps. In the first step, we filled the latissimus dorsi muscle flap into the axillary space. The axillary space was successfully closed with this procedure. However, the surface of the latissimus dorsi muscle flap could not be covered with the remaining axillary skin. In the second step, the surface of the exposed latissimus dorsi muscle flap was covered with the scapular flap (►**Fig. 1E**). Additionally, we performed split-thickness

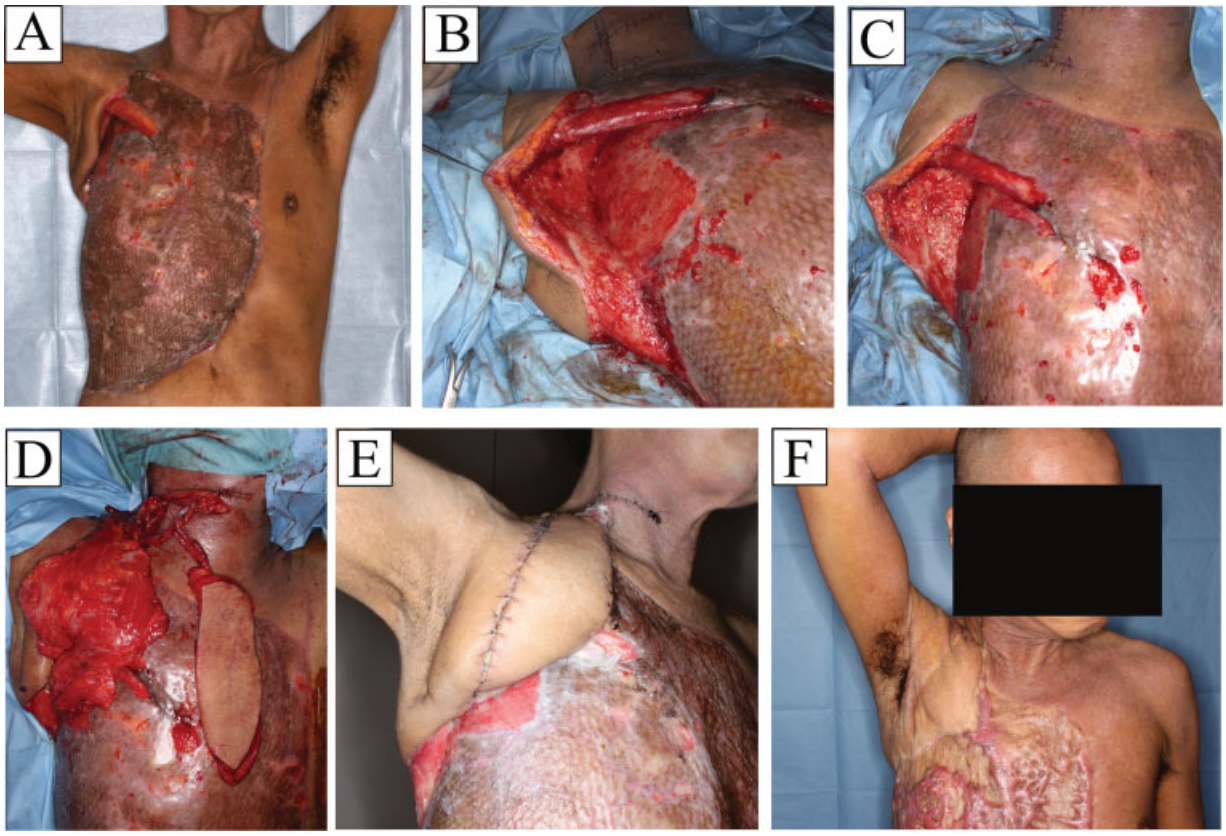

Fig. 1 Case 1. (**A**) The caudal two-thirds of the patient's right pectoralis major muscle was resected and abduction of the ipsilateral shoulder joint was restricted. (**B**) Radical debridement of the necrotizing fasciitis resulted in a fist-sized soft tissue defect that was approximately 20 cm × 6 cm inside the patient's axillary cavity. (**C**) The ipsilateral thoracodorsal vessels or other branches of the axillary vessels were absent in the affected axilla due to the initial debridement at the emergency department. (**D**) A combined free flap of the latissimus dorsi muscle flap and the scapular flap was transplanted using the superior thyroid artery and external jugular vein as recipient vessels. (**E**) The latissimus dorsi muscle flap was filled into the axillary space. The surface of the latissimus dorsi muscle flap was covered with a scapular flap. (**F**) The range of motion of the right shoulder abduction was 160° 6 months after surgery.

skin graft transfer on the remaining raw surface on the chest wall under local anesthesia 2 weeks after the free-flap transfer.

The free flap survived successfully without any postoperative complications. Six months after the operation, the patient's range of motion during right shoulder abduction was 160° and there was no axillary scar contracture (►**Fig. 1F**).

Case 2

A 52-year-old man was referred to the plastic surgery department after debridement for a necrotizing fasciitis infection of his right axilla at the emergency department. The debridement had been performed on the day of hospitalization. During his first visit to the plastic surgery department, it was established that he had a soft tissue defect that was approximately 12 cm × 5 cm in his right axillary fossa (►**Fig. 2A**). The right thoracodorsal vessels were excised along with the lateral portion of the ipsilateral latissimus dorsi muscle. At preoperative clinical examination, the axillary wound was covered with granulation tissue and we could not find the vessels. Therefore, we considered that it was difficult to obtain recipient vessels for free-flap transfer in the affected axilla.

On day 22 of hospitalization, we performed free deep inferior epigastric artery perforator flap transfer to reconstruct the patient's right axilla (►**Fig. 2B**). During intraoperative examination, we could not find the thoracodorsal, lateral thoracic, and circumflex scapular vessels in the patient's affected axilla, and the granulation that covered the axillary wound was hard. It appeared to be difficult to expose the recipient vessels in the axilla. We chose the right thoracoacromial vessels as recipient vessels (►**Fig. 2C**) because the necrotizing fasciitis infection appeared to be localized from the right axilla to the right lateral chest wall and did not reach the deep layers of the right pectoralis major muscle. After securing the ipsilateral thoracoacromial vessels as recipient vessels, we harvested the right anterolateral thigh free flap. The dimension of the flap's skin paddle was 15 cm × 5 cm, and the length of the vascular pedicle of the flap was approximately 8 cm. The volume of the free deep inferior epigastric artery perforator flap matched the patient's axillary tissue defect, and the flap was filled successfully.

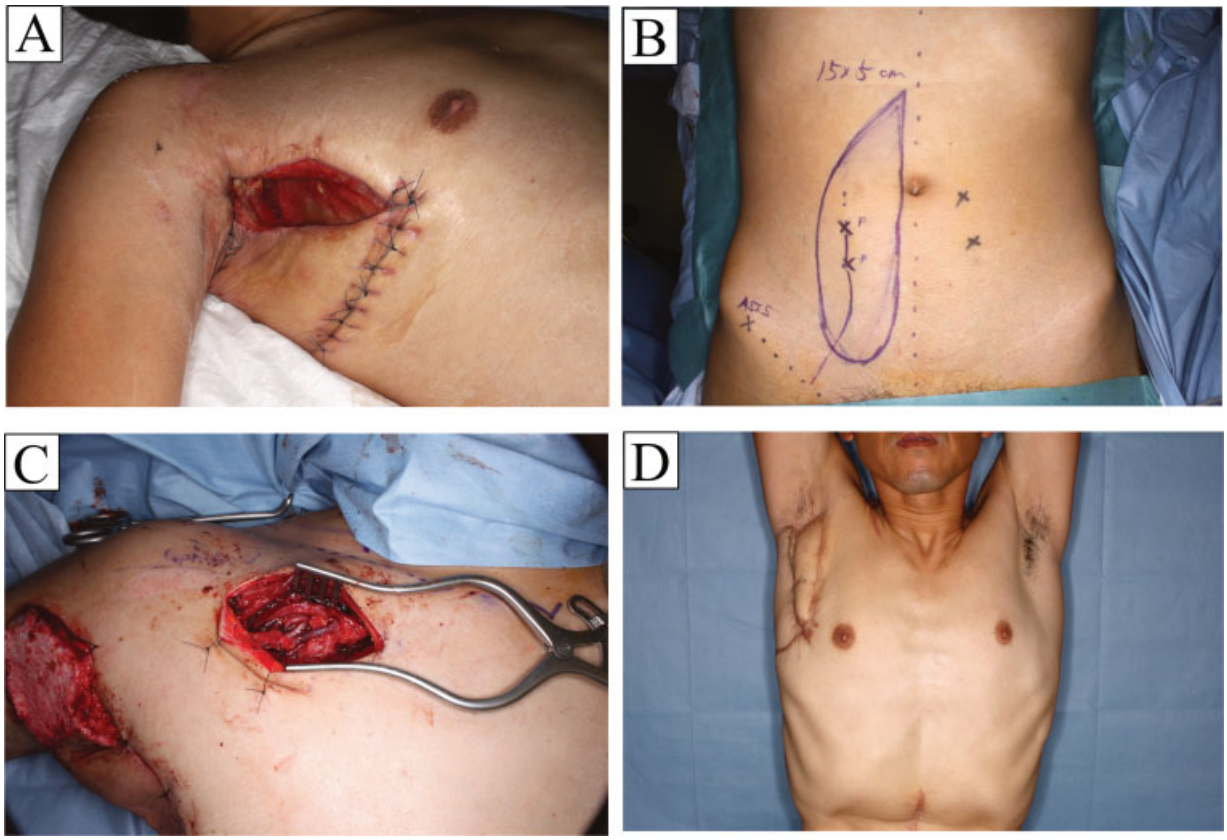

Fig. 2 Case 2. (**A**) The soft tissue defect in the patient's right axillary fossa was approximately 12 cm × 5 cm. (**B**) Free deep inferior epigastric artery perforator flap transfer for reconstruction of the axillary defect. (**C**) The right thoracoacromial vessels were used as recipient vessels for the free-flap transfer. (**D**) One year after the operation, the range of motion for the right shoulder abduction was 180°.

The free flap survived without any complications. One year after the operation the flap appeared slightly bulky, and a slight hypertrophic scar had developed. The range of motion of the right shoulder abduction was 180° (►**Fig. 2D**).

Case 3

A 39-year-old man presented to our emergency department with necrotizing fasciitis of his left upper limb. On the day of hospitalization, his left upper limb was amputated at the shoulder joint and debridement of the remaining right upper limb was conducted. According to the surgical records of the emergency department, the patient's right thoracodorsal vessels were excised at a little peripheral side of the bifurcation from the axillary vessels. On day 10 of hospitalization, a skin graft transfer was performed on his right upper limb at the emergency department. Thereafter, a fist-sized wound which was approximately 15 cm × 8 cm remained in his right axilla (►**Fig. 3A**). Preoperative clinical examination using Doppler flowmeter demonstrated the absence of the thoracodorsal vessel of the affected side.

On day 60 of hospitalization, we performed a free anterolateral thigh flap transfer to the right axilla (►**Fig. 3B**). Intraoperative examination revealed hard granulation that covered the axillary wound. It appeared to be difficult to expose recipient vessels from the axilla. Therefore, we decided to find recipient vessels beyond the axilla. Due to the damage to the right thoracodorsal vessels and the spread of the necrotizing fasciitis infection to the right pectoralis major muscle, we used the right superior thyroid artery and the right common facial vein as recipient vessels for free-flap transfer. After exposing the recipient vessels, we harvested the right anterolateral thigh flap. The dimension of the flap' skin paddle was 25 cm × 10 cm, and the flap's vascular pedicle length was approximately 10.5 cm. Owing to the long distance from the recipient vessels to the axilla, we added two steps to the surgical procedure. The first was to harvest an artery and a vein approximately 5 cm from the wound of the flap donor site and to perform vascular transplantations between the vessels of the flap and the recipient vessels in the neck. The second was to make a full-thickness incision into the central third of the right pectoralis major muscle; the incision was continued to the posterior surface of the pectoralis major and the flap—the central part of which was denuded—was passed through and set in the axilla (►**Fig. 3C**). By performing these additional steps, we were able to implant the flap into the axilla without tension.

The flap survived without complications. Six months after the operation, the passive range of abduction of the right shoulder was 90°, and the patient was able to dress himself with assistance (►**Fig. 3D**).

Written informed consent was obtained from all three patients.

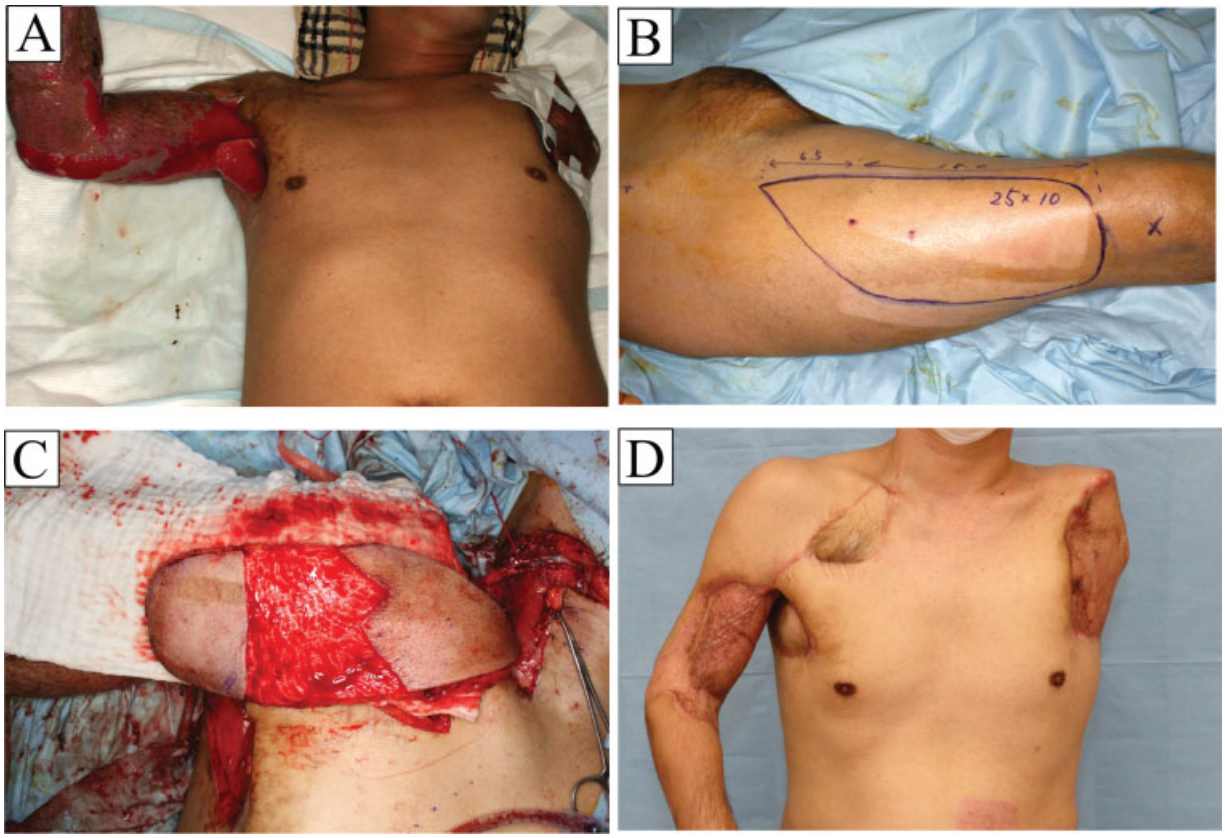

Fig. 3 Case 3. (**A**) The defect which was approximately 15 cm × 8 cm remained in the patient's right axilla. (**B**) The free anterolateral thigh flap was transferred to the patient's right axillary soft tissue defect. (**C**) A full-thickness incision through the central third of the right pectoralis major muscle was performed, and the anterolateral thigh flap, in which the central part was denuded, was passed through the incision. (**D**) The flap survived without any complications.

Discussion

Necrotizing fasciitis is widely known to be a life-threatening disease. Extensive debridement of all infected tissues is essential for the survival of patients.[24,25] There are few reports of necrotizing fasciitis of the axilla.[21–23] In the few reported cases, skin grafts were used to close the axillary wound.[22,23]

Many reports recommend the use of pedicled or free-flap transfers rather than skin grafts to treat severe postburn scar contracture in the axilla.[2,3] This is because skin grafting might cause secondary skin contracture, which could restrict shoulder joint function. In the surgical management of axillary necrotizing fasciitis, Yamasaki et al performed skin grafting on the axillary skin defect of a patient.[22] However, they later performed a pedicled latissimus dorsi myocutaneous flap transfer because scar contracture developed on the axilla of that patient. In our opinion, skin grafting after debridement for axillary necrotizing fasciitis may result in axillary scar contracture, similar to postburn scar contracture. To prevent this, we recommend that a pedicled or free flap be used to cover skin and soft tissue defects caused by debridement of axillary necrotizing fasciitis.

Unlike previous reports, the damage caused by necrotizing fasciitis in the three patients we treated extended beyond the axilla. The ipsilateral pectoralis major and latissimus dorsi muscles were damaged to different degrees in all three patients, and were unsuitable for axillary reconstruction. When performing free-flap transfer to the axilla, Chen et al stated that the thoracodorsal vessels were the most used recipient vessels.[2] However, in all three of our patients, the ipsilateral thoracodorsal vessels were too severely damaged to be used as recipient vessels for free-flap transfer. In addition, we could not find healthy lateral thoracic or circumflex scapular vessels in the affected axilla, neither could we finds vessels that were useful as recipient vessels for free-flap transfer. We therefore sought vessels for free-flap transfers in areas other than the affected axilla.

In Case 2, the patient's ipsilateral thoracoacromial vessels could be used as recipient vessels. The short distance from the axilla to the thoracoacromial vessels allows the surgeon to choose a free flap without needing to consider the vascular pedicle length. In Case 2, we considered the deep inferior epigastric artery perforator flap to be the most suitable option to compensate for the axillary soft tissue and skin defects and therefore used this for the transfer.

In Cases 1 and 3, the patients had no viable recipient vessels near the axilla as the infection had extended below the pectoralis major muscles. We used vessels from the neck region as recipient vessels for free-flap transfer because they were sufficiently far from the axillary wound to be undamaged by both the infection and debridement.

We prefer using a free flap with long vascular pedicles when we use vessels from the cervical region as recipient

vessels for free-flap transfer to the axilla. The distance from the recipient vessels in the neck to the axilla is too great to transplant short pedicles. In Case 1, we used a combined flap consisting of tissue from the latissimus dorsi muscle and parascapular flaps. We based our decision on the fact that (1) the latissimus dorsi muscle flap has a long pedicle and sufficient volume to fill the axillary cavity, and (2) after filling the axilla with the latissimus dorsi muscle flap, the surface of the latissimus dorsi muscle in the axilla could be easily covered with a parascapular fasciocutaneous flap.

We could not use a latissimus dorsi muscle flap for the patient in Case 3 as both thoracodorsal vessels were damaged. We used a free anterolateral thigh flap and recipient vessels from the neck region. Since the axilla was too remote from the neck recipient vessels to allow free anterolateral thigh flap transfer to the axilla, we performed vascular transplantation between the vessels of the flap and recipient site. We made a full-thickness incision in the middle third of the ipsilateral pectoralis major muscle, slightly caudal to the clavicle, to create a passageway from the neck to the ipsilateral axilla and thereby reduce the physical distance from the neck to the axilla. We successfully placed the anterolateral thigh flap into the axilla through this passageway. Thus, when the axilla was reconstructed with a free flap using the cervical vessels as the recipient, we found that some ingenuity was necessary when using flaps other than the latissimus dorsi muscle flap.

We considered free-flap surgery to be the most suitable surgical treatment for closing the soft tissue defects in the axilla. Yamasaki et al performed free-flap surgery as a secondary surgical treatment for a similar reconstruction.[22] Tanaka et al stated that in treating axillary postburn scar contracture, patients with long postinjury periods took longer to achieve a stable range of abduction.[26] In light of this, if proper debridement is performed and wound infection controlled, we believe that performing the free-flap transfer primarily to the axillary skin and soft tissue defects helps to maintain shoulder joint function and prevent additional surgery.

Conclusion

Free-flap transfer is effective for treatment of axillary necrotizing fasciitis after debridement. However, axillary necrotizing fasciitis often damages recipient vessels in the axilla. Surgeons may need to carefully seek recipient vessels for free-flap transfer far from the axilla.

Financial Disclosure
The authors have nothing to disclose.

Conflict of Interest
The authors declare no conflicts of interest associated with this manuscript.

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