THE REVERSE FLOW SURAL FLAP IN THE TREATMENT OF
THE SOFT TISSUE DEFECTS, DISTALLY PART OF THE LEG –
A PRELIMINARY REPORT

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The appliance of the reversed-flow sural flap is an alternative method for another procedures covering soft tissue skin defects, which are localized in the distal part of the leg. Based on three cases which were treated in The Department of Trauma Surgery and Emergency Medicine of the Medical University of Lublin, the procedure was introduced together with the disadvantages and advantages of this surgical method. All patients were treated for opened fractures of the leg (Gustillo IIIb).
The complete healing of the soft tissue defects were obtained in two cases and in one case necrosis of the distal part of the flap occurred.
The operating procedure on account of the simplicity is an alternative for more complicated surgical methods, which are used in covering tissue defects in this region.

Key words: sural perforator flap, reverse blood flow

The reconstruction techniques used in treatment of soft-tissue defects of the distal calf include using of cross flaps, fasciocutaneous flaps, muscle flaps and free flaps (1-4). From the mid-80’s researchers drew attention to the possibility of using a single perforating vessel to supply an island skin flap (5, 6). The consequence of the development of this method was an island flap based on a single perforator artery from the peroneal artery or the posterior tibial artery, used as a propeller flap (7, 8).In 1992 Masqualet and later Hasegawa described an operating method about moving a distally based cutaneous flap in healing of soft-tissue defects of the distal calf and the foot (9, 10).
The aim of this study is a report of a reverse-flow sural flap as a good treatment method of soft-tissue defects in open fractures of the distal calf.

MATERIAL AND METHODS

The reverse-flow sural flap was used in treatment of 3 patients in 2005-2007, the observation time after the operation was 12 months. The patient group contained one female and one male (tab. 1). The patients had open fractures (Gustillo IIIb), and were initially treated outside of our hospital. They were admitted because of soft-tissue loss above the fracture on the anteromedial surface of the distal calf. In all cases the tibia was exposed.
All wounds were infected (tab. 1). After admission, wound debridement and external fixation of the fractures was performed on all patients. In all cases wound cultures were taken and culture-specific antibiotic treatment started.
In the second step, we used reverse-flow flaps for patient treatment: in one case an island fasciocutaneous flap with pedicle containing the fascia and subdermal tissue, in the second case a fascial flap and in the third case a fasciocutaneous flap (tab. 1).

Operative procedure

The operation is performed with the patient in a prone position, without bloodless field. On
the leg, we marked the approximate position of the sural artery and in the distal third of the calf the intramuscular septum with the fasciocutaneous perforators which are alongside a drawn line connecting the popliteal fossa with the lateral malleolus. The marked line is the axis of the planned flap. After the planning of the flap in the medial third of the calf, the flap dissection and elevation is performed from the upper part to locate subfascially the sural nerve and small saphenous vein. We move under the bundle down, where it perforates the fascia. On this spot the bundle was tied on the upper edge of the flap. The remaining side edges were set free so the axis of the flap was made out of the neurovascular bundle. The fascia was included in the flap. Usually, the elevated flap had the shape of an upside-down triangle (fig. 1).

In one case the flap was moved as an island flap with a 3-4 cm wide fascio-subcutaneous pedicle. In the second case a fascial flap was used with a pedicle containing a 4 cm wide fascia only (fig. 2). In the third case a fasciocutaneous flap was used with a 4 cm wide pedicle (fig. 3).

Five centimeters above the apex of the lateral malleolus, besides the lateral edge of the Achilles tendon, there is a permanent anastomosis with a perforator artery of the peroneal artery. This anastomosis is the pivot point for the distally based superficial sural flap (9, 11, 12).

### Table 1. Case presentation

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Defect size in cm</th>
<th>Infection type</th>
<th>Fracture stabilization</th>
<th>Fracture stabilization</th>
<th>Additional problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>m</td>
<td>57</td>
<td>8x6,5</td>
<td>Staphylococcus aureus MRSA</td>
<td>external fixation</td>
<td>fasciocutaneous island flap</td>
<td>depression</td>
</tr>
<tr>
<td>2</td>
<td>f</td>
<td>41</td>
<td>6x4</td>
<td>Staphylococcus aureus MRSA</td>
<td>zespolenie</td>
<td>fascial flap</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>m</td>
<td>35</td>
<td>7,5x6</td>
<td>Pseudomonas aeruginosa</td>
<td>external fixation</td>
<td>fasciocutaneous flap</td>
<td>alkoholism</td>
</tr>
</tbody>
</table>

Fig. 1. Case 1. Dissected sural island fasciocutaneous flap

Fig. 2. Case 2. Dissected sural fascial flap

Fig. 3. Case 3. Dissected sural fasciocutaneous flap
The elevated flap was moved and sutured in the defect. Excessive rotation with too much bending of the pedicle was avoided. While moving the island flap the pedicle was covered with a split-thickness skin graft. The donor site was closed by suture or covered with a split-thickness skin graft.

RESULTS

The measures of the moved flaps are presented in tab. 2. The length was measured from the proximal end to the pivot point and the width in the widest point. In all cases of transposed flaps venous congestion occurred in the post-operative time. In two cases hirudotherapy was used with good effect (fig. 4). In the second case the largest venous congestion was observed with the consequence of necrosis of the distal part of the flap. The fracture was exposed again. In the third case no venous congestion was observed and the leeches were not applied. Two cases resulted in a complete healing of the wounds (fig. 5). In two cases the fractures healed, in one case the patient quit the therapy in our hospital. Table 2 presents the results.

<table>
<thead>
<tr>
<th>Case</th>
<th>Flap size in cm</th>
<th>Venous congestion</th>
<th>Hirudotherapy</th>
<th>Healing of donor and receiving site</th>
<th>Fracture healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19x7</td>
<td>+</td>
<td>+</td>
<td>without problems</td>
<td>after 10 months</td>
</tr>
<tr>
<td>2</td>
<td>16x6</td>
<td>++</td>
<td>+</td>
<td>necrosis of the distal flap part</td>
<td>resignation from treatment</td>
</tr>
<tr>
<td>3</td>
<td>18x7</td>
<td>+ / -</td>
<td>-</td>
<td>without problems</td>
<td>after 7 months</td>
</tr>
</tbody>
</table>

DISCUSSION

Reconstruction of distal calf defects remains a great challenge for surgeons. Local muscle flaps over the distal calf region are too small for reconstructing large tissue losses. Skin flaps with random blood vessels are unreliable because of the necessary pedicle width to flap length ratio (1, 3). Therefore the method of choice for larger reconstructions are free flaps (4).

In 1983, Donski and Fogdestam performed a sural flap procedure without knowing the exact vascularization (1). The conception of the fasciocutaneous flap based on a single perforator artery from peroneal artery or the posterior tibial artery was developed in the mid-80’s (5). Since that time this technique was used more widely for soft-tissue defects of the distal calf (6-9). The conception of the neurovascular sural flap was first proposed by Masqualet in 1992 (10). Hasegawa refined this technique and was first to publish a report of the reverse-flow sural flap in 1994 (9). The appliance of this flap was confirmed in further clinical trials (11, 12, 13).
The advantages of the described flap as well as other perforator flaps include a reliable vascular pedicle, the possibility of large flap sizes and avoidance of microvascular anastomoses. In this method there is no necessity to sacrifice large sural vessels (6, 7, 9). The results, presented in the literature, of the appliance of a perforator distal flap (propeller flap) in treatment of defects with exposed tibia are positive (7, 8). They require from the surgeon the microsurgical dissection inside the fascial septum for maximal flap mobilization (6, 7, 8). We have taken into account the use of this method, however, because of the location of the defects on the anteromedial region and the nature of the fractures we have not decided to its use because of possible damage to the fascial and skin vessels during the trauma. The appliance of the sural flap was safer and easier because all our patients had a proximal fibula fracture and the skin covering this area was not affected by the trauma. In the method our team used, it was not necessary to dissect the perforating artery, which significantly simplifies the procedure (11, 12, 13).

Venous congestion is characteristic for reverse-flow flaps (11, 13, 14). The pedicle dissection in island flaps damages venous connections which predispose the venous congestion (14). We observed this condition in the second case which ended in a partly necrosis of the distal flap. To minimize this condition we used a modified flap with a 4 cm wide pedicle which included skin (case 3) (11, 15). The flap healed completely without excessive venous congestion.

The conception of using leeches in reconstructive surgery for decreasing the venous congestion is not new (16). Leeches improve perfusion within congested tissue by drawing off blood and anticoagulants in their saliva injected into the bite (17). Top et al. used successfully leech therapy in venous congestion treatment of a sural flap (18). In our two cases of hirudotherapy treatment we observed a reduction of venous congestion. We applied different numbers of leeches dependent of the congestion and flap size two times a day in the first three postoperative days.

The supplying vessel of the flap is large enough so, according to literature, the procedure can be done on patients with diabetes and arteriosclerosis (19). To improve the success of this kind of flap in these patients a delayed method is used (19).

CONCLUSIONS

Sural flap is a valuable addendum for surgical methods for soft-tissue losses in the distal calf and the procedure is relatively simple and not stressful for the patient.

REFERENCES

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Received: 11.12.2008 r.
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