A novel treatment for plantar ulcers in leprosy: local superficial flaps

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Summary Plantar ulceration is the most common serious disability occurring in patients of leprosy. Growth and emergence of innovative procedures in plastic surgery has greatly revolutionized the treatment of this highly frustrating problem. In the present study, a total of 40 leprosy patients were included. These ulcers were managed using different types of local superficial flaps (advancement, rotation, transposition and first toe web flap). Majority of ulcers healed within 4 weeks and patients were discharged within 6–8 weeks postoperatively. Patients were followed up for a period of 6 months to 3 years. Ulcers recurred in only 25% of all the ulcers operated upon and we observed that management of plantar ulcers by using appropriate local superficial plantar flaps is a viable option and worth trying in view of low incidence of recurrence and relatively shorter duration of hospital stay.

Introduction

The term ‘plantar’, trophic or perforating ulcer was introduced by Price in 1959. It was defined as a chronic ulceration of the anaesthetic sole of the foot, situated in well defined areas overlying bony prominences, resistant to local or systemic therapy and characterized by a marked tendency to recurrence.1 Anaesthesia of the foot is the central factor in the pathogenesis of plantar ulcers and an anaesthetic foot is said to be ‘ulcer-liable’. The moment an ulceration occurs, this foot becomes ‘ulcer-prone’ and a vicious cycle of scar-ulcer-scar sets in.2 Plantar anaesthesia, unprotected walking, poor quality of scar resulting from previous ulceration, excessive load on this scar and persisting foci of infection are some of the main reasons for recurrence of plantar ulcers.3
Among major endemic countries, the proportion of new cases presenting with WHO grade 2 disability range from 6 to 21%. Plantar ulceration is the commonest serious disability in leprosy and they occur in about 10–20% of leprosy patients. In spite of recent advances and emergence of new drug therapy for combating leprosy, treatment of these ‘frustrating’ plantar ulcers has taken a backseat. Prior to the work of Hidalgo and Shaw raising a plantar flap required extensive ‘subfascial’ dissection. Hidalgo and Shaw showed that dissection superficial to the fascia is a practical and reliable alternative. It is easier to design local plantar flaps which include sensation and abundant blood supply without the need for meticulous subfascial dissection. These flaps are durable and allow normal weight bearing on the reconstructed surface. Prevention of recurrent plantar ulceration requires reduction of walking strains, improvement in the quality of scar, reduction of stresses and strains on the scar and eradication of infection.

Advancement flaps, including both approximation and V-Y advancement flap; rotation flap or a first toe web flap can be used for revision of scar in the forefoot. Island flaps and rotation flaps are helpful in heel scar revision. Availability of a large non-weight bearing area facilitates raising of transposition and island flaps for scar revision in the midfoot.

Materials and methods

In this study, 40 leprosy patients with plantar ulcers were included, based on inclusion criteria (Bacterial Index ≤ 1, not in reaction, either RFT or should have completed at least 6 months of multidrug anti-leprosy therapy) and exclusion criteria (paediatric age group, i.e. less than 14 years, patients with any other active disease at the time of presentation e.g.- hypertension, diabetes mellitus, varicose veins).

A detailed history was elicited with reference to plantar ulcer. A complete clinical examination was performed including examination of plantar ulcer and sensory deficits were evaluated using a ball point test. In all cases, routine blood and urine examination was done. Swabs were taken from the ulcer and culture and sensitivity studies were done using Kirby and Bauer technique. The foot was also assessed by taking a weight bearing lateral X-ray of the involved foot. This was done to rule out any bony pathology or deformity in that foot.

Patients were motivated to undergo the experimental procedure after explaining its necessity. They were explained about the possibility of failure and the recurrence of the ulcer. They were also informed about the likely postoperative complications (wound infection, delayed healing, other general complications of surgeries done under spinal anaesthesia) and given an option to refuse surgery. An informed consent was taken for the flap surgery.

This study was done at Government Wenlock District Hospital, Mangalore, attached to Kasturba Medical College, Mangalore (India), from November 2001 to October 2004.

Preoperative planning of flap

Debridement of the ulcer was done if deemed necessary. Early debridement of ulcer reduces the microbial inoculum by removing contaminants as well as non-viable tissues from ulcer and usually two to four debridements can achieve a surgical clean wound. Soft tissue reconstruction of a surgically clean but not sterile wound reduces the chances of infection.
Appropriate antibiotic coverage is chosen based on deep culture and antibiotic studies. Once the ulcer became clean, local superficial flaps were used to close the defects. To ensure proper vascular perfusion of the flap, palpable popliteal, tibial and dorsalis pedis artery pulsations were sought and in absence of any one of these, a doppler study was done.

**OPERATIVE PROCEDURE**

The following methods were used for treating plantar ulcers in this study: advancement surgeries (primary closure, primary closure aided by using wires and gradual mobilization of the skin margins, V-Y advancement flaps), transposition flaps (Figs 1–7), rotation flaps. (Figs. 8–10).

**FIRST TOE WEB FLAP**

The most appropriate method for closing the defect was chosen based on the individual requirement of the patient. The defect to be covered was carefully mapped on the donor area with an allowance of at least 25% excess to compensate for the normal shrinkage of the skin after flap elevation and to ensure tension free closure. Care was taken so that vascular pedicle was not acutely angulated or twisted. Most local flaps maintain a portion of their original sensation from the surrounding area and deep pressure sensibility usually persists in a flap, which is adequate to provide a durable surface for walking. Ulcers often have underlying bony pathology and partial or total resection of the head of the metatarsus or base of the proximal phalanx with or without proximalization of

*Figure 1.* A plantar ulcer on the lateral margin of left foot.
Figure 2. Same ulcer along with the margins of the transposition flap to be raised (marked).

Figure 3. Ulcer has been debrided and the margins have been triangulated.
Figure 4. Transposition flap raised.

Figure 5. Sutured flap covering the ulcer site.
extensor tendon to the metatarsal neck were performed in the same stage or as a secondary procedure when deemed necessary.

POSTOPERATIVE ASSESSMENT

Postoperatively, assessment or monitoring of vascular patency and tissue perfusion is an essential element in the successful outcome of flap surgeries. Exposure of a small portion of the flap can be the basis of the post op monitoring. The flap was observed daily for 5 days for colour, temperature, turgor and inability of bleeding from the raw surface. Limb was immobilized by applying a below-knee plaster cast and elevated above the heart level. Drains were removed after 48–72 hours and sutures on postoperative day 14. Partial weight bearing and functional exercises were initiated 4 weeks after surgery if there were no complications and delayed proportionately in flap surgeries with some postoperative complication. Patients were given protective shoes to be worn at the time of ambulation.

Figure 6. Secondary defect in the non-weight bearing site is being closed with a skin graft.
Results and observations

Out of 40 patients included in the study, 36 were males and four were females. In the present study, 20 out of 40 patients (50%) were in their 5th decade. The mean age was 45.5 years for males and 48 years for females. More than two-thirds of the patients (70%) had multibacillary type leprosy.

The exact cause of ulcer could not be ascertained in 90% of the patients in this study. A specific predisposing factor was present in only four patients (10%) in the form of trauma. Smallest and largest dimensions of the ulcers were $0.5 \times 0.5 \text{ cm}^2$ and $5 \times 4\text{ cm}^2$ respectively.

The majority of ulcers (60%) were seen in the forefoot. The site of least incidence was the midlateral portion of foot (10%) and the heel accounted for 30% of ulcers. Both, right and left feet were affected in similar proportions. In the forefoot, the most susceptible site of ulceration was the metatarsal head of first toe (58.33%) followed by the metatarsal head of...

Figure 7. Well healed ulcer along with the graft after 3 months.
second toe (25%) and the proximal phalanx of the great toe (16.6%). Other deformities were seen in 16/40 patients (40%). Absorption of toes was the most common among these deformities present in 10/16 patients (62.5%).

Table 1 shows the details of the types of surgeries done and the number of ulcers that

Figure 8. Plantar ulcer on left heel.

Figure 9. Sutured Rotation flap raised from medial side closing the defect due to ulcer.
showed recurrence. Advancement surgeries were performed on 18 ulcers (45%). The rest of the 22 ulcers (55%) were subjected to transposition or rotation flap surgeries. Primary outcome was re-epithelization and complete healing of the wound, which was seen in all the 40 patients. Secondary outcomes, consisting of reulceration and post-operative complications were seen in 10/40 (25%) and 12/40 (30%) ulcers respectively. Postoperative complications (Table 2) consisted of minor surgical complications: wound haematoma, infection, and superficial skin necrosis. Major life threatening complications and loss of flaps, either partial or total were not seen in this study.

Though minor postoperative complications were seen in one-third of all the patients operated on, these complications had no long term effect on the outcome of flap surgeries. The only drawback was delayed healing and later ambulation of the patients and none of these patients had recurrence of ulcer. All the recurrences were seen only in those feet, which had some bony deformity and ulcers recurred in such cases in spite of performing additional procedures for correcting the same.

In the absence of complications, majority of ulcers (28/40) healed within 4 weeks and these patients were discharged from hospital 6–8 weeks after a flap surgery. Healing was

Table 1. Surgical management of plantar ulcers

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>No. of ulcers operated</th>
<th>Total no. of ulcers operated (n = 40)</th>
<th>Recurrence of ulcers (%)</th>
<th>Postoperative complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fore foot</td>
<td>16 0 2</td>
<td>18 (45)</td>
<td>6 (33.33)</td>
<td>6 (33.33) 0</td>
</tr>
<tr>
<td>Mid lateral</td>
<td>2 4 0</td>
<td>6 (15)</td>
<td>2 (33.33)</td>
<td>6 (100) 0</td>
</tr>
<tr>
<td>Heel</td>
<td>6 0 10</td>
<td>16 (40)</td>
<td>2 (12.5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>24 4 12</td>
<td>40 (100)</td>
<td>10 (25)</td>
<td>12 (30.00) 0</td>
</tr>
</tbody>
</table>

Figure 10. Healed ulcer after 3 months.
delayed and hospital stay was prolonged proportionately in the remaining ulcers (12/40) which showed some complications (Table 2). These ulcers re-epithelialized in an average of 6–8 weeks, except one flap surgery with complication of superficial skin necrosis, which healed in 4 months. Maximum stay in the hospital was recorded for four and a half months. Patients were discharged from hospital within 2–3 weeks of healing after providing them protective footwear, occupational therapy, instructions regarding regular foot care and follow-up.

All the ulcers were followed up for a period of 6 months to 3 years. Patients were asked to come for a follow-up once in two months for the first 6 months and then once in 6 months. During follow-up patients were assessed for the integrity of the flap, any re-ulceration at the site of surgery or ulceration in any other part of the foot. Besides they were given instructions regarding regular foot care and proper footwear usage. The earliest recurrence was seen 4 months after surgery and the latest occurred after 2 years. Maximum re-ulcerations (6/10) occurred between 6 months to 1 year after surgery.

Discussion

Ulcer formation was spontaneous in the majority of cases (90%). This may be because minor trauma may not have been appreciated, as soles were anaesthetic or hypoaesthetic.

The forefoot accounts for 71–90% of plantar ulcers. In the forefoot, the medial part is more vulnerable than the lateral part. The proximal phalanx of the big toe is the most common site of trophic ulcers.15

Various surgical methods are available for management of plantar ulcers, including skin grafts and different types of flaps.11 The pioneering work of Hidalgo and Shaw8 abandoned the requirement of meticulous dissection and expertise to raise a flap, since it is possible to raise a flap by dissecting superficial to the fascia. The presence of friable adhesions between the new skin and deeper tissue or bone makes plantar ulcers recurrent.16

Ulcers which have been treated by the conservative method of rest and plaster cast usually recur within 1 month of healing because some inflammation still exists and there are friable adhesions between the new skin and deeper tissue or bone.16 In flap surgery, close postoperative monitoring and subsequent early resolution of vascular compromise can result in salvage rates of 70–100%.17 In our study, ulcers recurred in 25% of all the cases operated. This may be either due to non-compliance with the strict postoperative regimen by some patients, or due to our relative inexperience in performing superficial flap surgeries in leprosy.

Table 2. Postoperative complications

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>Minor complications</th>
<th>Major complications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wound haematoma (%)</td>
<td>Infection (%)</td>
</tr>
<tr>
<td>Advancement (n = 18)</td>
<td>3 (16.67)</td>
<td>3 (16.67)</td>
</tr>
<tr>
<td>Transposition flap (n = 6)</td>
<td>1 (16.67)</td>
<td>4 (66.67)</td>
</tr>
<tr>
<td>Rotation flap (n = 16)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Local superficial flaps
patients. In the present study, all the ulcers were followed up for a period of 6 months to 2 years, and no recurrence was seen in the first month after ambulation of the patient. The earliest recurrence was seen 4 months after surgery and the latest occurred 2 years after flap surgery.

Individually, while approximation surgeries showed the highest rate of recurrence, rotation flaps were most successful with no recurrences.

The growth and emergence of innovative procedures in plastic surgery has greatly revolutionized the treatment of this not uncommon but highly frustrating problem of plantar ulceration. But most of the currently used procedures require meticulous dissections and expertise, which is available in only a few referral centres. We observed that plantar ulcers can be very well treated by using appropriate local superficial skin flaps. A competent enough leprologist, surgeon or an orthopaedic surgeon can easily do these operations. Whereas the conservative management of plantar ulcers previously required a hospital stay of months to years, usage of flap surgery has resulted in faster ambulation and a shorter hospital stay. However, this is a pilot study and we recommend large scale and preferably multi-centric studies with longer duration of follow-up. In addition, it would be worthwhile to compare these flap surgeries with the gold standard in leprosy ulcer management (i.e. debridement and bed rest).

To conclude, management of plantar ulcers using appropriate local superficial plantar flaps is a viable option and worth trying if supplemented with proper and strict post-operative regimen adherence. Table 3 proposes the guidelines for the surgical management of plantar ulcers in a non-deformed foot.

### Table 3. Proposed guidelines for the management of plantar ulcer in a non-deformed foot

<table>
<thead>
<tr>
<th>Site of ulceration</th>
<th>Management options (in order of preference)</th>
</tr>
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<tbody>
<tr>
<td>1. Heel</td>
<td>Rotation flap, either medially or laterally based</td>
</tr>
<tr>
<td>2. Mid-lateral border of sole</td>
<td>Transposition flap (taken from non weight-bearing medial area of the sole)</td>
</tr>
<tr>
<td>3. Forefoot</td>
<td>First toe web flap; V-Y advancement flap</td>
</tr>
<tr>
<td>a. Head of first metatarsus</td>
<td>V-Y advancement flap; rotation flap; approximation surgery</td>
</tr>
<tr>
<td>b. Head of other metatarsus</td>
<td></td>
</tr>
</tbody>
</table>

References