TISSUE EXPANSION IN THE LOWER LIMBS OF CHILDREN AND YOUNG ADULTS

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We report the successful use of tissue expansion in the lower limbs of five children and one young adult. It was possible to replace dense adherent skin grafts by expanded skin and subcutaneous tissue. Such expansion needs to be undertaken slowly, but expanded tissue matches the normal local tissue and has normal sensation. These qualities were particularly important in three amputations which were revised.

The expansion of normal skin is a useful means of obtaining healthy tissue to replace unstable skin grafts in the lower limb of children and young adults. We report six patients in whom such replacement allowed improvement of skin cover over skeletal deformities or amputation stumps.

Split skin grafts are frequently used in children for skin loss from trauma or other causes. Occasionally these are troublesome and need replacement with normal skin. Z-plasties and other flap designs are sometimes suitable but large defects may require cross-leg or free vascularised flaps (O'Brien and Morrison 1987), which both have disadvantages. The advancement of expanded local skin was found to be a better alternative in our six cases; it resembles the normal skin of the area, has normal sensation and is not bulky. These qualities were particularly important in the three children who had tissue expansion of amputation stumps.

OPERATIVE TECHNIQUE

We used expanders with remote injection ports (Fig. 1); they are easier to locate than those with integrated ports. The size and shape of the expander depends on the area of skin (Doyle and Bennett 1988). The base of the expander is usually 2.5 to 3 times the size of the defect to be reconstructed, though the limited circumference of the lower limb may restrict the size of the expander (Morgan and Edgerton 1985; van Rappard et al 1988) and make the use of two expanders necessary.

The expander is placed flat in the subcutaneous plane through an incision that is usually at the edge of the scarred area. Closed suction drains are inserted into the pocket and prophylactic flucloxacillin is given. A compression bandage and elevation are used to minimise bleeding and seroma formation. A plaster slab is added to immobilise the knee when expanders are inserted at or near it. When the wound is healed children are able to return to school and attend as out-patients for injections into the expander port.

At operation the expander contains a small volume of sterile normal saline. After the wound has healed, injections are given once or twice weekly, the volume injected depending on the size of the expander and

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Fig. 1

A tissue expander with a remote injection port.

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comfort of the patient. The maximum volume that can be given without pain is added; this is usually about 30 ml for a 300 ml expander. Expansion is complete when measurement over the implant shows a margin of 1 to 3 cm in excess of the defect to be covered (Manders et al 1988; van Rappard et al 1988). Expanders can safely be inflated to 150% of their nominal volumes if this is needed to provide enough expanded skin for reconstruction.

The expander is removed under general anaesthesia. The remote injection port is usually buried in scar and it should be carefully isolated before removing the expander. The flap is mobilised by back-cutting the capsule but this should be only enough to allow full advancement of the flap: much of the blood supply comes from the capsular margin (Manders et al 1988). Other procedures such as osteotomies may be undertaken at the same time. Suction drains are placed under the flap. If joint mobilisation is required before undertaking intra-articular procedures, the later incision is made at the healed free edge of the flap.

**CASE REPORTS**

Table I gives the details of the six cases. In all, sufficient skin was obtained by tissue expansion.

**Case 1.** As a result of meningococcal septicaemia and widespread gangrene at the age of 14 months, this patient had a left below-knee amputation and split skin grafting of many areas of tissue loss. He had developed dislocation of the right patella due to fibrosis of the quadriceps and old adherent split skin grafts.

At the age of 20 years his right knee was repeatedly giving way, and required quadriceps lengthening and patellar re-alignment. Before this could be done it was necessary to replace the scarred skin. A tissue expander was placed under the normal skin on the medial side of the patella and expanded to 496 ml over 11 weeks (Fig. 2). When the expander was removed, the new flap was advanced to replace the scarred area. Four months later,

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**Table I.** Details of six patients having tissue expansion

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr)</th>
<th>Duration of expansion (wk)</th>
<th>Total expansion (ml)</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>11</td>
<td>496</td>
<td>Anteromedial knee</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>8</td>
<td>220</td>
<td>Posterior below-knee stump</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>10</td>
<td>305</td>
<td>Posterior below-knee stump</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>12</td>
<td>430 and 265</td>
<td>Anterior leg*</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>28</td>
<td>650</td>
<td>Anterior knee*</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>18</td>
<td>578</td>
<td>Lateral thigh</td>
</tr>
</tbody>
</table>

*haematoma complications

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**Fig. 2a**

Case 1. This patient has a left below-knee amputation following meningococcal septicaemia in infancy. Figure 2a – The right patella is dislocated and stuck to dense scar tissue on the lateral side of the knee. The anteromedial skin of the knee has been expanded. Figure 2b – One month after excision of the scarred tissue and advancement of the expanded skin. Further surgery was performed when knee flexion had been regained (see text).
when he had regained full knee flexion, patellar realignment and quadriceps lengthening was performed through an incision made along the lateral margin of the flap. He now has a full range of knee motion and the patella remains reduced. The appearance of his leg is better and he has requested further tissue expansion to remove unsightly scars on his arm.

**Case 2.** Following meningococcal septicaemia at the age of two and a half years this girl had extensive distal gangrene of the leg, requiring a below-knee amputation and skin grafting of the stump. These grafts were adherent and unstable and in addition the end of the tibia developed a bony spike.

At the age of four years, a rectangular tissue expander was placed under normal skin on the back of the stump and expanded to 220 ml over eight weeks. It was then possible to excise the anterior adherent skin graft and replace the tibial spike with an osteochondral graft from the iliac crest (Marquardt 1981). The expanded skin is stable and prosthetic fitting is now satisfactory.

**Case 3.** After a below-knee amputation for trauma in a six-year-old boy, skin grafts on the posterior surface of the stump had become hard, fissured and ulcerated, causing difficulty with the fitting of his prosthesis.

At 13 years of age, a tissue expander under normal proximal skin was expanded to 305 ml over 10 weeks. The flap was advanced after excision of the graft, providing stable skin over the stump and no further fitting problems.

**Case 4.** At the age of 10 years, split skin grafting was used for a degloving injury of this boy's leg in a motorcycle accident. The grafts adhered to the tibia and were unstable and painful.

At 11 years of age, two tissue expanders were inserted: a 400 ml size inserted proximal and lateral to the scar and a 250 ml distal and medial to the scar. Ten days later a haematoma was drained without further complication. Over 12 weeks, the proximal expander was inflated to 430 ml and the distal one to 265 ml. After excision of the scar, the flaps were advanced to give a stable and comfortable Z-plasty repair.

**Case 5.** A seven-year-old girl also had severe degloving of the right leg with compound injuries of the ankle and knee. Repair was with split skin grafts and a free latissimus dorsi myocutaneous flap. Her knee had become increasingly valgus by 13 years of age and a distal femoral osteotomy was advised, but skin grafts that were adherent to the femur prevented safe access.

A 640 ml expander was inserted anteriorly, but a haematoma and mild infection required drainage and fluocoxacinil. Several weeks later inflation was started, reaching 650 ml by 24 weeks. It was then possible to excise the old scar and perform a medial closing wedge osteotomy with Kirschner wire fixation. Both flap and osteotomy healed without complication, giving a great improvement in alignment and appearance.

**Case 6.** An above-knee amputation stump in a 13-year-old boy was conical and covered anteriorly by unstable, corrugated, split skin grafts. The proximal extent of the scar prevented the use of a total contact socket. A 340 ml tissue expander was inserted and inflated to 578 ml over 18 weeks. The scar was then excised and the flap advanced to cover the defect. A total contact quadrilateral socket was provided two months later and is being successfully used.

**DISCUSSION**

In all our six patients, the expanded skin matched the normal local skin and had normal sensation. This was important in providing stable skin, especially on amputation stumps.

The technique, however, has several disadvantages. Tissue expansion is slow, requiring many visits and injections. During this time, amputees could not wear their prostheses and had to use crutches. The rate of expansion in young children is determined by their comfort and level of co-operation; when expansion was undertaken slowly the children tolerated the procedure well. Haematoma and cellulitis in two of the six children were treated satisfactorily. Manders et al (1988) report this complication in 13 of their mainly adult series of 17 cases. Meticulous surgical technique is required; the early recognition and treatment of these complications is essential. None of our expanders required premature removal.

Despite these disadvantages we conclude that expansion of local skin and subcutaneous tissue provides a satisfactory solution to the difficult clinical problems we have described.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**REFERENCES**


