**Skin closure after acute shortening**
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Z-plasty is used to lengthen scars and wounds. We describe the use of a modified technique to shorten wounds in ten consecutive patients undergoing acute shortening of a limb as part of an Ilizarov procedure. The modified technique gave good exposure, easy closure of the wound and fewer problems with healing than standard incisions.

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One of the more useful techniques of the Ilizarov method for treating segmental defects and nonunion is the ability to shorten a limb acutely and then subsequently lengthen it at a different site where the tissues are healthy. This method has been reported to have a lower rate of problems with alignment of the docking site. There is less need for bone grafting compared with classic bone transport in which a segment of bone is moved within its soft-tissue envelope while the limb is maintained at its normal length. Although there are fewer bony complications with procedures involving acute shortening, skin closure is often difficult. Sinuses, old scars and the relative inelasticity of the skin because of chronic inflammation add to the difficulty of closing the incision. Transverse incisions at the site of shortening are easier to close, but have the disadvantage of limited exposure of the bone during debridement, which is often of critical importance.

Z-plasty is a plastic surgical technique usually used to lengthen a scar. We have introduced its use for shortening scar tissues. The zig-zag incisions used in our design of Z-plasty are a method of exposure which allows great versatility in the closure of soft tissues.

We have evaluated the use of techniques of Z-plasty to provide good exposure of the ends of the bones for debridement as well as allowing easy skin closure.

**Patients and Methods**

The normal principle of Z-plasty is the transportation of two triangular-shaped flaps. The long and central limb of the ‘Z’ is usually placed along the line of the scar to be lengthened or reorientated. The two lateral limbs extend from this line at varying angles which determine the percentage lengthening of the central limb. Once these flaps have been raised they are transposed, resulting in reorientation of the scar and its effective lengthening, which is possible because of the recruitment of skin from the lateral to the long limb of the Z-plasty (Fig. 1a).

In limb shortening we use this principle in reverse.

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Hence, the long limb of the plasty is placed transversely with the short limbs extending proximally and distally. When transposed the resultant long limb of the Z-plasty lies longitudinally and there is some effective shortening (Fig. 1b).

Results

We reviewed ten consecutive patients in whom this technique had been used (Table I) and compared them with the preceding ten consecutive patients treated by acute shortening before the introduction of the new method. Their skin defects were divided into three groups as follows: 1) no skin loss; 2) partial skin loss; and 3) skin loss equal to the bone defect.

No skin loss. When the bone of the lower limb is shortened the soft tissue also has to be shortened. In tissues which are scarred and fibrosed shortening causes the standard longitudinal incision to shorten and become rhomboid-shaped (Fig. 2) creating difficulty with closure. The incisions for Z-plasty were made as marked (Fig. 3). After excision of the bone and acute shortening the flaps were either placed in their original site or transferred, depending on the position in which they lay most comfortably (Fig. 4).

Partial skin loss. In limb shortening for osteomyelitis or infected nonunion, sinuses are often present. Z-plasty-type incisions were created to incorporate existing sinuses or defects (Figs 5 and 6) and to take into account the area of skin loss.

Complete skin loss. If the skin loss (Fig. 7) is the same size as the bone defect, then acute shortening is used to obliterate the soft-tissue gap. Extensions of the wound are created to maximise exposure as well as to facilitate closure (Fig. 8).

Before the introduction of this technique of Z-plasty, 50% of patients either had delayed wound healing, as indicated by a raw area in the wound which had failed to heal primarily, or had difficulty in wound closure which required partial temporary relengthening of the fixator. This created a gap between the bone ends of 2 to 5 cm. After a delay of a week, the bone ends were approximated at a rate of 1 to 2 mm per day. In all the patients in whom the Z-plasty design had been used the incisions healed rapidly and without problems. In all of those with sinuses, it was possible to incorporate these into the Z-plasty so that they could be excised during the procedure.

Discussion

For cases in which the soft-tissue gap is greater than the bone defect, our preferred treatment is to cover using a pedicled flap or free tissue transfer. When the soft-tissue defect is the same size or smaller than the bone defect we now consider acute shortening, using the technique of modified Z-plasty. Acute shortening is an extremely useful technique.
**Fig. 4**
Diagram showing the skin incisions, the exposure which they produce and the options for wound closure.

**Fig. 5**
Diagram showing the Z-plasty design used to incorporate excision of sinuses or diseased skin.

**Fig. 6a** Fig. 6b Fig. 6c
Photographs of the Z-plasty technique used to treat a patient with partial skin loss after excision of the sinuses showing a) the incisions, b) the exposure, c) the position of the flaps after transposition following acute shortening of the bone defect, d) the flaps after wound closure and e) three months later. The short limbs of the incision have been made in a longitudinal direction because of old scars and the 'transverse' limb made obliquely.
treatment for segmental defects and nonunion. As well as treating bone defects and skin loss, it has been used in an experimental model to treat soft-tissue defects in muscle and nerve.\(^2\) Despite these advantages, certain difficulties, such as vascular occlusion, have been encountered with acute shortening. The amount of shortening which is needed before this happens varies according to the site and the pre-existing state of the blood vessels and soft tissues. For example, a patient with arteriosclerosis and non-compliant soft tissues secondary to chronic infection is likely to tolerate less shortening than a young patient without peripheral vascular disease and more elastic tissues.

We have found that using this technique of Z-plasty for exposure increased the ease of operating by achieving wide access. When the flaps were elevated the exposure was rhomboidal (Fig. 4). In addition to the wide exposure, this technique allows versatile closure. In some cases, transposition of the flaps, as in a standard Z-plasty, allowed easy closure and at other times the elevated flaps lay more readily in their original positions. This versatility contributed greatly to the reduction of wound problems.

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### References
