Lengthening of congenital below-elbow amputation stumps by the Ilizarov technique

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Patients with short congenital amputations below the elbow often function as if they have had a disarticulation of the elbow. We have reviewed the results in six patients who had lengthening of such stumps by the Ilizarov technique to improve the fitting of prostheses.

The mean lengthening was 5.6 cm (3.4 to 8.4), and in two patients flexion contractures of the elbows were corrected simultaneously. Additional lateral distraction was used in one patient to provide a better surface on the stump. There were no major complications. All six patients were able to use their prosthesis at the latest follow-up after 39 to 78 months.

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Congenital amputation of the forearm is rare and is seen in about one in 20 000 live births.¹ Possible methods of management include the fitting of a prosthesis or a Krukenberg operation, but both of these require an adequate length of stump.² When the stump is too short, the patients behave as if they had disarticulation of the elbow. Lengthening of the forearm is needed to provide a longer below-elbow amputation with improved function.³

We have reviewed our experience of the lengthening of congenital forearm amputations using the Ilizarov technique.

Patients and Methods

At the time of operation, the mean age of our six patients with unilateral congenital amputation of the forearm was

13.8 years (8 to 18; Table I). All except one were male, and two had flexion contractures (case 2, 70°; case 5, 60°). The mean length of the stump before operation was 3.3 cm (2.2 to 4.3).

All six patients had lengthening of both the radius and ulna, with simultaneous correction of the two elbow contractures.

Operative technique

Ilizarov fixation was applied using one full ring proximally with three wires and a second ring with two wires placed as distally as possible. All the wires were inserted in order to transfix the radius to the ulna. One reference wire was passed through both the radius and ulna proximally and distally, perpendicular to the direction of distraction. The other two proximal wires and one distal wire were inserted at acute angles to the reference wires.

Subperiosteal corticotomy was then performed in the metaphyseal region of both bones. Distraction began after seven days at 0.25 mm four times daily until sufficient length had been achieved. The frames were then retained until solid radiological union was seen.

One patient (case 3) had simultaneous lateral distraction to correct the convergence of the forearm bones. The two patients with elbow contractures each required two additional full rings with three wires in the humerus. These were connected to the forearm rings by two anterior distraction rods, placed medially and laterally in the axis of the desired correction. The rods were distracted by 0.5 mm twice daily, producing about 3° to 4° of correction each day. The four patients not requiring treatment for contractures were encouraged to perform active movements of the elbow during lengthening.

Results

The mean period of distraction was 62.6 days (40 to 85) with a mean of 5.3 months (4 to 8) from the day of the operation to the removal of the frame. The mean increase in the length of the forearm was 5.6 cm (3.4 to 8.4; Table I and Fig. 1).

There were no major complications during treatment. Mild pin-track infection in two patients did not influence

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Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Fig. 1e

Case 4. Photographs showing a) the preoperative view b) the result, c) with the prosthesis and d) during distraction. Figure 1e – Radiograph at the end of distraction.

Table I. Details of the six patients who had lengthening of below-elbow amputation stumps

Case	Age (yr)	Gender	Stump length (cm)			Duration of treatment (mth)	Follow-up (mth)
			Initial	Increase	Final		
1	18	M	3.0	8.4	11.4	8	78
2*	10	F	2.8	4.3	7.1	4.5	39
3†	8	M	2.2	5.8	8.0	4	62
4	16	M	4.3	3.4	7.7	4	54
5*	18	M	4.1	6.3	10.4	6	65
6	14	M	3.2	5.7	8.9	5.5	60

* flexion contracture of the elbow also treated

† divergent forearm bones also treated

the treatment. There were no signs of protrusion of the bone through the skin, and rounded ends were obtained for all the amputation stumps, including the patient with the divergent radius and ulna treated by lateral distraction.

At the most recent follow-up after 39 to 78 months all six patients were able to use their prostheses comfortably (Fig. 1c). The two patients with elbow contractures had ranges of movement from about 10° to 120° of flexion, after intensive physiotherapy.

Discussion

The Ilizarov technique to lengthen long bones is well described, but there are few reports on its use with amputation stumps.³⁻⁸ We could find only two other cases of the lengthening of below-elbow amputation stumps by the Ilizarov technique, only one of them for a congenital abnormality.⁸ Abe et al⁹ also reported a similar case, but used unilateral fixation.

Fig. 2a

Fig. 2b

Case 3. Radiographs showing a) the pre-operative appearance with the convergence of bones and b) correction of the deformity to provide a wider stump.

To gain improved function, patients with congenital below-elbow amputations need a properly fitted prosthesis. Given good contact fitting, three other factors are important. There must be an adequate range of movement of the joint, sufficient power (muscle strength times lever arm) and enough surface at the stump.⁶ The length of the stump is more important than the other factors, in order to provide stable suspension and an effective lever arm.¹⁰ We used the Ilizarov technique to lengthen the forearm bones because it is less invasive and can provide simultaneous stretching of the soft tissues.^{4,5,7,11-13} We had no problems with protrusion of the bones through the skin.

The Ilizarov technique stabilises the bone fragments in all planes, and by the use of thin wires, minimises damage to the soft tissues, periosteum and blood supply to the bone. It also allows the simultaneous correction of other deformities,^{11,12} such as the flexion contractures in two of our patients (cases 2 and 5). Another option is to carry out operative release at the time of the application of the Ilizarov frame, but we avoided this for fear of heterotopic ossification due to the dissection,¹⁴ and to obtain plastic deformation of the soft tissues.¹⁵

We lengthened both the radius and the ulna in all our patients to achieve a rounded stump rather than a conical shape for fitting of the prosthesis. This required simultaneous lateral distraction in one patient (case 3), to correct convergence of the forearm bones (Fig. 2). Lengthening of both bones carries a risk of loss of rotation due to synostosis caused by transfixing both bones with the same wire.¹⁶ We did not see this, but in short congenital amputations rotation is already impossible because of loss of integrity of the interosseous membrane.

The extent of lengthening needed to give better fitting of the prosthesis will depend on the type which is to be used. In our series the amount varied, but the 8.4 cm of lengthening in one patient (case 1) is the longest which has been reported.

Lengthening of congenital below-elbow amputation stumps by the Ilizarov technique is a reliable method to

obtain an adequate stump. It also allows some correction of elbow contractures and other abnormalities of the stump.

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