Implantation of a soft-tissue expander before operation for club foot in children

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PPrimary skin closure after surgery for club foot in children can be difficult especially in revision operations. Between 1990 and 1996 a soft-tissue expander was implanted in 13 feet before such procedures. Two were primary operations and 11 were revisions. A standard technique was used for implantation of the expander. Skin augmentation was successful in 11 cases. There was failure of one expander and one case of wound infection. Sufficient stable skin could be gained at an average of five weeks. Primary skin closure after surgery was achieved in 12 cases.

We conclude that soft-tissue expansion can be used successfully before extensive surgery for club foot. The method should be reserved for revision procedures and for older children. The technique is not very demanding, but requires experience to achieve successful results.

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Extensive operations are usually necessary for the treatment of severe deformities in club foot. In these cases primary skin closure can be difficult, particularly in revision procedures and in older children. A variety of solutions has been proposed, including primary skin closure in an undercorrected position followed by progressive casting^{2,3} or plastic surgery with myocutaneous flaps.^{4,5} We have studied retrospectively 12 children who had surgical correction of 13 club feet after skin augmentation using soft-tissue expanders.

Patients and Methods

Between 1990 and 1996 a soft-tissue expander (Perthese TE; Laboratoire Perouse Implant, Bornel, France) (Fig. 1) was implanted in 13 feet (12 children) before corrective surgery for deformities of club foot graded as III or IV according to Dimeglio et al.⁶ Ten patients (11 feet) had been operated on previously in the first year of life and had suffered a recurrence. In the other two (aged 4.4 and 5.17 years) the expander had been implanted before primary correction.

Of the 13 feet, 12 had congenital talipes equinovarus and one was associated with myelomeningocele. There were five girls and seven boys. The mean age at the time of the implantation of the soft-tissue expander was 4.4 years (2.4 to 7.25). Three left and ten right feet were affected. One girl had bilateral recurrence. Her right foot was operated on at the age of four years and the left 16 months later.

Operative technique. The Perthese TE rectangular expander has a remote injection port. This makes it easier to handle than expanders with integrated ports. We used the same size of expander (volume 50 cc) and a thigh tourniquet for exsanguination in all patients. A longitudinal incision is made posteriorly approximately 3 to 4 cm above the heel since circumferential incisions extend across the vascular supply of the skin.^{7,8} The skin around the ankle is thus protected for the subsequent process of augmentation and further dissection towards the calf is facilitated.

By blunt dissection a pocket is created subcutaneously, extending medially and laterally towards the ankle. In order to avoid skin necrosis it is important not to expand an overlying scar. In patients who have had previous surgery the expander should be implanted above the ankle. A separate pocket is dissected towards the calf so that the injection port can be positioned 10 cm proximal to the heel.

This port is attached by a metal connector to a suitable length of tubing which can be shortened as necessary. The system is tested by injecting Methylene Blue into the port to verify that there is no leakage. If all is well the tourniquet can be deflated. Haematomas can be associated with infection and fibrosis and therefore meticulous haemostasis is important. After repeated irrigation with saline, the balloon is placed in the pocket which has been created. Care is

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Fig. 1a

Fig. 1b

Figure 1a – Photograph of the Perthese TE percutaneous tissue expander with remote injection port and connecting tube of variable length. Figure 1b – Diagram to show how saline injections are performed in the injection port which is placed subcutaneously. This port is constructed of self-sealing material with a dome to aid palpation. An important feature is the inclusion of a stainless-steel stop which helps to prevent inadvertent perforation by the needle.

taken not to wrinkle the walls of the balloon. The wound is then closed with the expander empty. The implant must not be punctured during wound closure. The expander is removed at the subsequent operation.

Results

Skin augmentation was successful in 11 out of 13 feet with no complications. The mean stay in hospital was four days. Percutaneous injection of the expander with sterile normal saline was begun at a mean of 14 days (7 to 15) after implantation in the absence of any sign of inflammation. Initially, about 5 ml of sterile normal saline were injected. Later, when the wound was completely healed, the maximum volume that could be injected without impairment of the circulation and without causing tension and pain was used.^{9,10}

We did not use local anaesthesia for the saline injections into the expander. As far as the children were concerned injection of saline was similar to a venepuncture. If necessary local surface anaesthesia can be applied before injection. Usually, after one or two injections, the children became familiar with the procedure and tolerated it very well. They were accompanied by a parent and all the injections were carried out by one of two authors (AR or WEL). The injections were given once a week, initially, and then twice a week in the outpatient clinic (Fig. 2). Sufficient, stable skin with normal sensation was gained at an average of five weeks (2 to 6). After this the definitive operation was carried out using a modified Carroll procedure¹¹ within a mean of nine days after the last injection. Primary wound closure was possible in a fully corrected position after surgery without skin tension (Fig. 3).

There were two complications. In one patient early removal of the expander was necessary because of leakage,

while in another, a wound infection occurred after superficial skin necrosis. In the first case, despite repeated instillation of saline into the injection port, the balloon did not expand. The device was explored and leakage of the tubing between the balloon and injection port was found. The implant was changed and after wound healing, satisfactory skin expansion was obtained; at operation primary skin closure was achieved. In the second patient, we observed superficial skin necrosis due to excessive injection of saline. Ischaemia of the skin with subsequent necrosis occurred. The necrotic area extended approximately 5 × 5 mm. There was a small blister from which serous fluid was expressed. Wound cultures were negative. The patient was treated with intravenous antibiotics and local wound care, and 2.5 weeks later had removal of the expander and correction of the club foot. At operation there was no sign of deep infection or necrosis. Primary wound closure was achieved but the foot had to be immobilised in a cast, initially, in an undercorrected position because of failure of the skin expansion. The final result showed a well-corrected foot and a well-healed scar.

Discussion

Soft-tissue expanders are widely used in surgery today. Expansion of an area of skin by progressive distension of a subcutaneous balloon was first described by Neumann.¹² He used an air-inflated rubber balloon in a patient with congenital absence of the ear. Since then several modifications have been reported. In 1985 a self-contained expander was described by Lapin, Elliott and Juri¹³ and a modification with a magnet-marked injection port by Elliott and Dubrul in 1988.¹⁴ A self-inflating expander using a hypertonic solution inside a semipermeable silicone envelope was used by Austad and Rose.¹⁵ All have a remote subcutaneous injection port which is inserted by a separate inci-

Fig. 2a

Fig. 2b

Fig. 2c

Figure 2a – Photograph showing recurrent club foot with an implanted expander before starting the injections of saline. This foot is resistant but partly reducible, with fixed equinus, supination, subtalar derotation and limited dorsiflexion. Figure 2b – A podometer view of the same foot. Figure 2c – The same foot five weeks later. Sufficient skin has been gained. A site is chosen above the malleolus for the expander in order not to expand the scar of the former Cincinnati approach.

Fig. 3a

Fig. 3b

Fig. 3c

Figure 3a – Photograph showing the intra-operative site before removing the expander. The balloon is filled almost completely with saline. Figures 3b and 3c – The wound closure after a modified Carroll procedure. There is no tension in the skin.

sion. Tissue expanders with external injection ports have also been noted.¹⁶

There have been very few descriptions of the use of soft-tissue expanders in operations for club foot.^{17,18} The aim has been to achieve primary skin closure after extensive corrective procedures. This is a particular problem in older

children and in surgery after recurrence.¹ Atar et al¹⁷ reported a 15-month old child who had implantation of an expander before primary correction of club foot. Bassett et al¹⁸ used this method in children with an average age of 32 months. We have never had problems of skin closure in children of this age undergoing primary correction of club

foot. We therefore would not recommend implantation of an expander in such cases. The average age of our patients at operation was four years, which is much higher than those previously described.^{17,18}

Two expanders were implanted in children at the age of four and five years who had not had previous surgery. The others were placed in ten children (11 feet) with recurrent deformities which were severe, with rigid forefeet and hind feet, fixed equinus and a rotation of the calcaneo-forefoot block around the talus, the so-called 'stiff-soft' and 'stiff-stiff' feet described by Dimeglio et al.⁶

Skin augmentation with soft-tissue expanders should be reserved for recurrent club foot and for older children. Closure under tension can be successfully avoided. We are unable to assess the influence on further recurrences in our present limited series. The average time to obtain sufficient skin expansion was five weeks which is considerably shorter than that reported by Bassett et al.¹⁸ The same authors had only two successful implantations out of seven whereas 11 out of our 13 procedures did well without complications.

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References

1. **Lehman WB, Silver L, Grant AD, Strongwater AM, Weg O.** The anatomical basis for incisions around the foot and ankle in clubfoot surgery. *Bull Hosp Jt Dis Orthop Inst* 1987;47:218-27.
2. **Herold HZ, Torok G.** Surgical correction of neglected club foot in the older child and adult. *J Bone Joint Surg [Am]* 1973;55-A:1385-95.
3. **Lehman WB.** *The clubfoot*. Philadelphia, etc: JB Lippincott Co, 1980.
4. **Ger R.** The management of chronic ulcers of the dorsum of the foot by muscle transposition and free skin grafting. *Br J Plast Surg* 1976;29:199-204.
5. **Pontén B.** The fasciocutaneous flap: its use in soft tissue defects of the lower leg. *Br J Plast Surg* 1981;34:215-20.
6. **Dimeglio A, Bensahel H, Souchet P, Mazeau P, Bonnet F.** Classification of clubfoot. *J Pediatr Orthop B* 1995;4:129-36.
7. **Crawford AH, Marxen JL, Osterfeld DL.** The Cincinnati incision: a comprehensive approach for surgical procedures of the foot and ankle in childhood. *J Bone Joint Surg [Am]* 1982;64:1355-8.
8. **McKay DW.** New concept of and approach to club foot treatment. Section II: correction of the club foot. *J Paediatr Orthop* 1983;3:10-21.
9. **Argenta LC.** Controlled tissue expansion in reconstructive surgery. *Br J Plast Surg* 1984;37:520-9.
10. **Radovan C.** Tissue expansion in soft-tissue reconstruction. *Plast Reconstr Surg* 1984;74:482-90.
11. **Carrol NC, Gross RH.** Point/counterpoint: operative management of clubfoot. *Orthopaedics* 1990;13:1285.
12. **Neumann CG.** The expansion of an area of skin by progressive distension of a subcutaneous balloon: use of the method for securing skin for subtotal reconstruction of the ear. *Plast Reconstr Surg* 1957;19:124-30.
13. **Lapin R, Elliott M, Juri H.** The use of an internal tissue expander for primary breast reconstruction. *Aesthetic Plast Surg* 1985;9:221-6.
14. **Elliott MP, Dubrul W.** Magna-site tissue expander: an innovation for injection site location. *Plast Reconstr Surg* 1988;81:605-7.
15. **Austad ED, Rose GL.** A self-inflating tissue expander. *Plast Reconstr Surg* 1982;70:588-94.
16. **Jackson IT, Sharpe DT, Polley J, Costanzo C, Rosenberg L.** Use of external reservoirs in tissue expansion. *Plast Reconstr Surg* 1987;80:266-71.
17. **Atar D, Grant AD, Silver L, Lehman WB, Strongwater AM.** The use of a tissue expander in club-foot surgery: a case report and review. *J Bone Joint Surg [Br]* 1990;72-B:574-7.
18. **Bassett GS, Mazur KU, Sloan GM.** Soft-tissue expander failure in severe equinovarus foot deformity. *J Pediatr Orthop* 1993;13:744-8.