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CENTRIPETAL COMPRESSION TRIPLE ARTHRODESIS

M. H. EL GHAWABI

Department of Orthopaedic Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Forty-nine compression triple arthrodeses were performed in 45 patients whose average age was 16 years. An external compression device was applied to secure rigid fixation of the tarsal bones. The device consisted of two large rings, six compression screws and six small transfixion rings. Union of the tarsal joints was obtained within 6 weeks in 93.7 per cent of cases, and within 8 weeks in the remaining 6.3 per cent. Non-union was completely avoided and the period until fusion reduced to almost half that expected after conventional operations. The compression also ensured maintenance of the correction of deformity initially obtained.

Key words: foot; arthrodesis; triple arthrodesis by centripetal compression

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Since Ryerson described triple arthrodesis of the foot in 1923 the methods used for internal fixation of the tarsal bones have been either transfixation by Kirschner wires (Caldwell 1949) or staples (Burns 1946). The present paper presents a modified external compression technique which ensures a more rigid fixation of the tarsal joints. The use of compression shortens the healing time and prevents the occurrence of non-union.

PATIENTS AND METHODS

Forty-nine operations were performed in 45 patients (Table 1), 21 on the right side, 20 on the left and 4 bilaterally.

The age of the patients ranged from 12 to 35 years with an average of 15.6 years. Thirty-eight patients were males, seven were females.

All patients were followed up clinically and roentgenologically for 1–6 years after the operation (average 4 years).

The fixation device is illustrated in Figures 1–3. It consists of

(1) Three Steinmann pins
(2) Two large rings each with three blocks with three transfixion screws in the end
(3) Six small transfixion rings

Table 1. Indications for centripetal compression triple arthrodesis

	Number of patients
Spasmodic flat foot	23•
Rigid painful static flat foot	3
Fractures of the calcaneus with involvement of the subtalar and calcaneocuboid joints	4
Poliomyelitis with deformed unstable feet	12
Pes cavus associated with spina bifida occulta	1
Neglected congenital talipes equinovarus	1
Chronic tarsal tuberculosis	1
Total	45

• Four of these patients had bilateral operations.

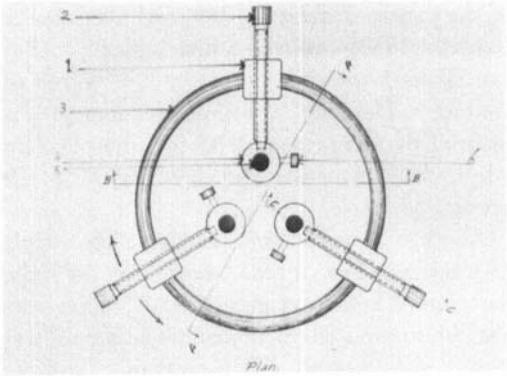

Figure 1. Diagram of the compression apparatus: The movable block (1). The compression screw (2) whose smooth tip fits into a small hole in the small transfixion ring (4), which is anchored to the Steinmann pin (5) using a small screw (6). The large ring (3).

Each of the two large rings, 11 cm in diameter, has three movable blocks. Each block measures $3 \times 2 \times 2$ cm with a central core 8 mm in diameter. This permits free mobility around the ring and its axis. The block may be fixed at any desired point on the ring and in any desired plane by means of a screw. Passing centrally through each block is a compression screw 45 mm in length. To the end of this screw a small transfixion ring is attached. Through the transfixion ring the Steinmann pin is passed into the tarsal bones. By rotating the compression screw in the block its tip exerts pressure on the pins thus producing a centripetal compression of the resection surfaces.

The operation is performed through a medial incision centred over the talonavicular joint and an appropriate wedge is excised according to the deformity present. Following this a lateral incision starting 1 inch below the lateral malleolus and ending over the base of the fifth metatarsal is made. The peroneal tendons are retracted and the extensor digitorum brevis dissected distally and medially. Another wedge is excised from the calcaneocuboid joint. This facilitates posterior displacement of the forefoot. The talocalcaneal joint is thereafter resected with removal of an appropriate wedge in order to correct any heel deformity. The first Steinmann pin is introduced laterally and downwards through the navicular and cuboid bones. The second is placed horizontally across the talar neck. The third pin is placed horizontally in the postero-inferior part of the os calcis.

The small transfixion rings are fixed to each end of the Steinmann pins a few centimetres away

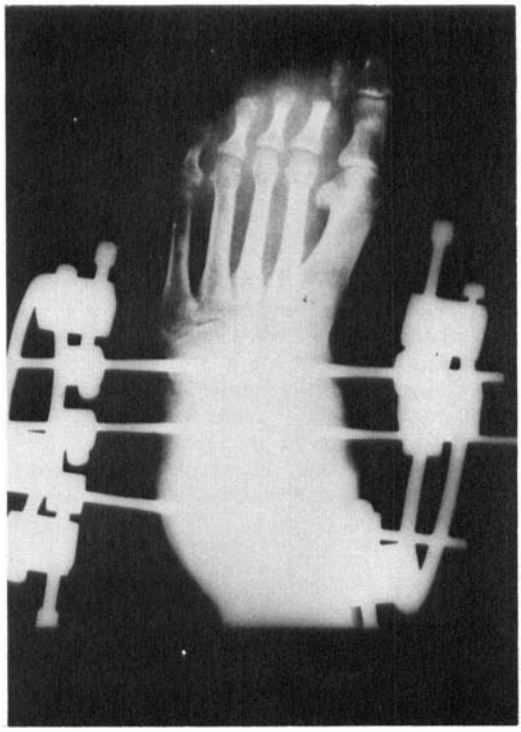

Figure 2. Postoperative X-ray showing the centripetal compression device applied to the foot.

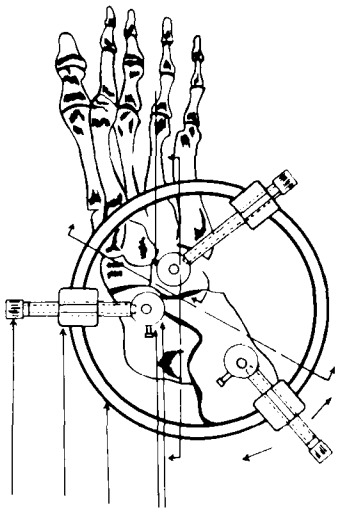

Figure 3. Diagram of the centripetal compression apparatus applied to the foot. Note that one large ring is shown and that the three movable blocks can be moved to any part of the large ring.

from the foot. The two large rings are placed around the ends of the Steinmann pins – one medial and the other lateral – in the same vertical plane as the small transfixion rings. Moving the corresponding blocks causes the tips of the compression screws to fit into the holes of the corresponding small transfixion rings. Finally the compression screws are tightened in order to secure a rigid fixation and compression of the resected joints.

After-treatment: A below the knee splint or plaster slab is worn for 10 days, following which active exercises of the ankle are started. The compression device was usually removed 4 weeks after the operation but in three cases it was kept for 6 weeks. Removal of the compression apparatus is followed by gradually increased weight-bearing, though a walking cast was applied for 2 weeks in 10 cases.

RESULTS

Complete union of the tarsal bones was achieved in 93.7 per cent (46/49) of the cases within 6 weeks. The remaining three feet healed after 8 weeks. Thus there was not a single case of non-union. Union was assessed clinically, radiologically and also by histological means. A needle biopsy was taken from the talonavicular and subtalar joints 4 to 6 weeks after the operation. Union was confirmed in all cases. Correction of deformity was satisfactory and the compression maintained until consolidation was complete. No cases of infection were encountered in this series.

DISCUSSION

Despite the variety of methods of internal fixation and grafting in triple arthrodesis, non-union occurs in 18–29 per cent of cases in the various series reported (Wilson et al. 1956). Non-union occurs mainly in the talonavicular joint. Wilson et al. demonstrated gaps between the opposing sufaces of bone in 42.3 per cent of the postoperative radiographs. They attributed this to the difficulty of obtaining immobilization of the bones in plaster after the excision of the joints. Charnley (1950) and Charnley & Baker (1952) proved histologically that cancellous bone unites only at the points of contact. Definite continuous contact is insured by compression and this may explain why pseudoarthrosis did not occur in the present series.

Another cause of failure of triple arthrodesis has been recurrence of the deformity (Patterson et al. 1950) which may also be attributed to inadequate immobilization in plaster. Compression ensures maintenance of the initial postoperative position without any need for change of plaster or remanipulation until fusion of the joints is complete.

In spite of the different planes of the three joints, the device used distributed the built-in compression forces over their surfaces equally. The compression screws acting from a fixed point on the large ring exert a centripetal force on the small transfixion rings anchored to the Steinmann pins. This centripetal force could be resolved into two perpendicular vectors. Such vector forces exert compression on two joints; thus the centripetal compression provided by these screws is resolved into six different forces acting on the three differently orientated joints.

Compression arthrodesis may be used in any type of subtalar arthrodesis where a two-stage conventional operation can be performed in one sitting using the centripetal compression device after excision of the appropriate dorsal and posterior subtalar wedges.

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Correspondence to: Prof. M. H. El Ghawabi, M.S., 2 Malek Afdal Str., Zamalek, Cairo, Egypt.