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CONE ARTHRODESIS OF THE FIRST METATARSOPHALANGEAL JOINT

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An operation for arthrodesis of the first metatarsophalangeal joint described previously has been performed on 85 toes in 68 patients over a 20-year period. The notes and X-rays have been reviewed to determine the incidence of bony fusion and to find out whether the operative position was maintained until union occurred.

Arthrodesis was achieved in 83 (97.6 per cent) of the toes operated on. Where there had been no previous surgery to the metatarsophalangeal joint the incidence of bony union was 100 per cent.

As determined by certain defined criteria there is a strong indication that the technique maintained the operative position until bony union occurred.

Key words: cone arthrodesis; first metatarsophalangeal joint; long-term follow-up

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It has been shown that the precise operative technique for obtaining arthrodesis of the first metatarsophalangeal joint is not important provided the position obtained at operation is maintained until bony union occurs (Fitzgerald 1969). In a series of 100 cases using a variety of operative techniques Fitzgerald reported a significant change in the operative position in 24 per cent of cases and non union in 3 per cent.

In 1960 Marin described a technique for obtaining arthrodesis of the first metatarsophalangeal joint based on a peg and socket principle. By using specially designed reamers a proximal cone is fashioned on the first metatarsal head and a matching socket prepared in the proximal phalanx. A driving fit is then obtained between the two bones, after which a screw is passed across the arthrodesis site to prevent distraction of the fragments.

Wilson (1967) advised the use of an encircling wire instead of the screw, since by this method no metal crosses the arthrodesis site, coaptation of the surfaces is maintained and rotation is prevented. His report included 31 toes in 23 patients treated by this modified method. Now, over a 20-year period, 85 toes in 68 patients have been operated on using this modified technique. The notes and X-rays have been reviewed and the 23 patients who could be traced have been examined. The principle aims were to determine:

(a) The incidence of bony union.
(b) Whether the operative position was maintained until union occurred.

Operative technique and management

These have been described fully elsewhere (Wilson 1967). Postoperatively patients were treated in a non-weight-bearing plaster of Paris cast, full weight-bearing being permitted at 2 weeks. On average the plaster was removed 7 weeks after surgery and full mobilization was then encouraged.

MATERIAL AND METHODS

Clinical material

Only 23 patients attended for clinical review but the notes and X-rays of 68 patients comprising 85 toes were available for study. These consisted of 48 female and 20 male patients. Sixty-one arthrodeses were performed on females and 24 on males. Twenty-five operations were on the right side, 26 on the left and 17 bilateral. The patients had been operated on between 5 months and 20 years previously.

At the time of operation the average age of the males was 44 years, with a range of 18–71 years. The average age of the females was 47 years, with a range of 25–66 years.

A cone arthrodesis, as described, using wire for stabilization, was performed in all cases except for six of the early operations. In two of these, small staples were used while the remaining four had no added internal stabilization procedure. The indications for arthrodesis in this review are shown in Table 1.

Table 1. Indications for arthrodesis

Hallux rigidus	61 toes
Hallux valgus	9 toes
Hallux valgus with rigidus	7 toes
Failed Mayo procedure	4 toes
Correction of deformity in spastic patients	2 toes
Non-union of a previous arthrodesis	1 toe
Failed Keller operation	1 toe

Method

The hospital notes and X-rays were used to determine when the arthrodesis had united. Movement occurring in the region of the arthrodesis between the time of operation and radiological union was assessed using two criteria:

(1) *The Valgus Angle A*
This is the angle formed between the first metatarsal shaft and the proximal phalanx as measured on a true A.P. X-ray (Figure 1).

(2) *The Dorsiflexion Angle B*
This is the angle formed between the first metatarsal shaft and the proximal phalanx as measured on a true lateral X-ray (Figure 1).

The immediate postoperative values for these angles were compared with those after radiological union. A variation of 6 degrees or more was taken as an indication that movement had occurred in the appropriate plane.

Figure 1. Radiographs to show the Valgus Angle A on a true A.P. film (top) and the Dorsiflexion Angle B on a true lateral film (bottom).

A clinical assessment of any rotatory deformity was made in the 29 toes reviewed clinically.

FINDINGS

The arthrodesis sites in 83 of the 85 toes (97.6 per cent) were radiologically united. The time taken for union was between 5 and $12\frac{1}{2}$ weeks with an average of 7 weeks.

The two arthrodeses resulting in non-union were in the same patient. She had previously undergone bilateral metatarsal exostectomies as a treatment for bunions and in consequence the first metatarsal heads were considerably narrowed. This would have made any form of arthrodesis technically difficult.

Provided there had been no previous loss of bone substance at the metatarsophalangeal joint a hallux valgus deformity with or without rigidus did not adversely affect the incidence of union after cone arthrodesis. In this survey ten such toes united without complications. Their preoperative valgus angles varied between 25 and 48 degrees with an average of 33 degrees.

Movement at the arthrodesis site prior to radiological union

Six arthrodesed toes had to be excluded due to insufficient data. Out of the remaining 77 toes comparative values for the Valgus Angle A were available in 76 and for the Dorsiflexion Angle B in 22 toes.

Out of the 77 toes where one or both of these measurements were available there was evidence that movement had occurred between the proximal phalanx and the first metatarsal in three. In two toes the movement had taken place at a stress fracture of the metatarsal and not at the arthrodesis site. The third patient was the only one where movement was shown to have occurred at the arthrodesis itself. In this patient no additional wire or staple fixation had been used.

In the other three toes where stabilization had not been used uncomplicated union occurred without evidence of change in the operative position.

In none of the 29 toes examined clinically was there any evidence of a significant rotation deformity of the great toe.

Wire and staple fixation

A wire circle was used for stabilization in 79 toes. This had disrupted due to a fatigue fracture of the metal in the two ununited arthrodeses and in the patient with an ununited stress fracture across the base of the cone (Figure 2B). In the remaining 76 arthrodesed toes the circle was intact.

In no patient did the metal cause any significant symptoms or have to be removed.

Complications

(1) Stress fracture of the metatarsal occurred in two toes. One patient had a stiff ankle from a previous injury and sustained a

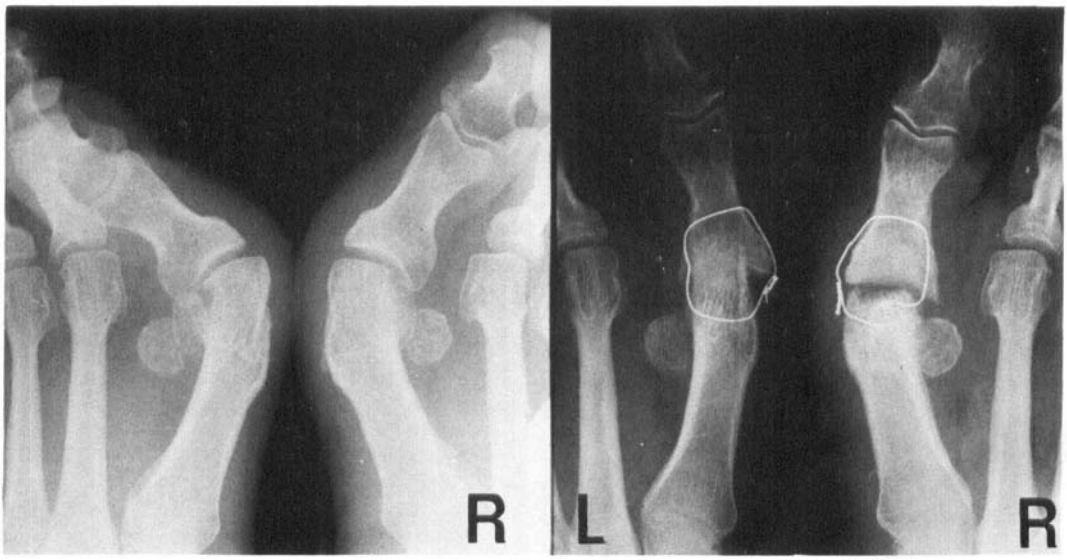

Figure 2. Radiographs showing a stress fracture through the base of the right cone in a patient who had previously undergone bilateral exostectomies. A. Before arthrodesis. B. 2 years after bilateral cone arthrodesis. The left side has united.

stress fracture of the first metatarsal neck 3 years after arthrodesis.

The second patient sustained a stress fracture through the base of the cone 12 weeks after surgery. Previously she had undergone bilateral exostectomies thus narrowing and weakening the metatarsal heads. Both arthrodeses united, but the stress fracture went on to non-union (Figures 2A and B).

(2) There was one patient with transient superficial sepsis of the wound. No deep sepsis was encountered.

No other complications of the operation itself were noted.

DISCUSSION

In patients who had undergone no previous surgery to the metatarsophalangeal joint, cone arthrodesis resulted in a union rate of 100 per cent. This probably relates to the ideal conditions for arthrodesis that can be achieved with this technique. A perfect driving fit is obtained between the proximal peg and distal cone thus bringing the cancellous surfaces into intimate contact.

These ideal conditions are much more difficult to achieve where bone has been removed at previous surgery. Such a procedure inevitably weakens and narrows the cone available for arthrodesis. Following previous simple metatarsal exostectomy two toes failed to unite and one sustained a stress fracture across the base of the cone. However, uncomplicated bony union occurred in four toes after simple exostectomy, four after a previous Mayo procedure and one after a Keller operation. Where previous surgery has resulted in loss of bone substance at the metatarsophalangeal joint, cone arthrodesis is probably the best method of obtaining bony union.

In this retrospective survey clinical assessment of rotation and the comparative values for valgus and dorsiflexion angles were not available in all patients. However, all three criteria were recorded in each of 18 toes and showed no evidence of a change in the operative position up to the time of bony union. At least one of the two angles was recorded in 59 arthrodesed toes. A change in the operative position at the time of union occurred in only one of these and in this case no additional stabilization had been used.

Although these records are incomplete they can be taken as a strong indication that cone arthrodesis using a wire stabilization technique does maintain the operative position until bone union occurs.

Conclusions

(1) Cone arthrodesis of the first metatarsophalangeal joint gave a 100 per cent union rate in patients who had not undergone previous surgery to the joint.

(2) A high incidence of union is achieved by this technique even in patients who have lost bony substance from the joint at previous surgical procedures.

(3) There is a strong indication that the technique described, using wire stabilization, does maintain the arthrodesis in the position obtained at operation until bony union occurs.

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