THE MANAGEMENT OF THE PAINFUL FIRST METATARSOPHALANGEAL JOINT IN THE OLDER PATIENT

ARTHRODESIS OR KELLER'S ARTHROPLASTY?

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We report a prospective randomised trial comparing Keller's arthroplasty and arthrodesis of the first metatarsophalangeal joint for the management of symptomatic hallux valgus and hallux rigidus in the older patient. In 81 patients (110 feet), with a minimum of two years follow-up, both procedures gave a similar degree of patient satisfaction and symptom relief. The incidence of metatarsalgia was also similar. As there were no obvious advantages to arthrodesis, and since six out of 50 arthrodesed toes required revision, we suggest that Keller's arthroplasty is the better operation in these patients.

The ideal surgical procedure for the management of symptomatic hallux valgus and rigidus in older patients remains a controversial subject (Scranton 1983; Turnbull and Grange 1986). All the established operations have given good results in some patients, but each carries an incidence of undesirable side effects and complications. The vast literature on the subject is of little help, due to lack of a standard method of assessment (Edgar 1982). Furthermore, there are few reports which prospectively compare one treatment with another.

In older patients the two procedures commonly performed are Keller's arthroplasty and arthrodesis of the first metatarsophalangeal joint. To compare these two procedures we undertook a randomised prospective study of patients over the age of 45 years, and we now report on those patients who have been followed up for at least two years. To our knowledge this is the first prospective comparison of these two procedures in the literature.

PATIENTS AND METHODS

One hundred consecutive patients over the age of 45 years presenting with a symptomatic hallux valgus and/or rigidus were enrolled into the study. Of these, 81 patients (110 feet) followed up for at least two years, comprise the basis of this report. None had undergone previous surgery to the foot. Patients with degenerative joint disease were described as 'hallux valgus' if the valgus angle was greater than 20°, and as 'hallux rigidus' if the angle was less. There were 70 females and 11 males; their mean age was 60.5 years (range 45 to 81). They were prospectively randomised to undergo either arthrodesis of the first metatarsophalangeal joint (37 patients; 50 feet) or Keller's arthroplasty (44 patients; 60 feet). The choice depended upon whether the patient's year of birth was an odd or even number. The two groups were similar for age, sex and diagnosis (Table I). The mean follow-up was 31.1 months (range 24 to 42) with a minimum follow-up of 24 months.

Assessment. Detailed protocols were developed, based on the guidelines of the Research Committee of the American Orthopaedic Foot and Ankle Society (Smith, Reynolds and Stewart 1984), to record subjective, objective and radiological criteria. All patients were assessed prior to surgery and reviewed at regular intervals postoperatively by at least one of the authors in a specially organised clinic.

Subjective. Questions were aimed at assessing the location and duration of symptoms, the degree of functional impairment, and problems with footwear. Postoperatively, one of four replies was allowed to each question:

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no residual problems at all, some improvement, no change, worse.

Objective. Examination assessed the location of tenderness, the range of motion of the first metatarsophalangeal joint, rotational malalignment of the hallux, and callosities and abnormalities in the lesser toes. Postoperatively the presence of cock-up deformity of the hallux was assessed by testing the ability of the patient actively to touch the pulp of the hallux on the ground with the foot plantigrade.

The hallux valgus angle was measured, on weight-bearing radiographs, as the angle between the longitudinal axes of the first metatarsal and the proximal phalanx. The results were analysed using the chi-square test (with Yates' correction where appropriate) or the Fisher exact probability test.

Surgical techniques. The operations were performed by one of two surgeons (IGL and PAM), using a consistent operative technique and with a standardised postoperative regimen for each procedure. All the procedures were performed under general anaesthesia, using a tourniquet. *Keller's arthroplasty.* After making a dorsomedial skin incision, the soft tissues were retracted, a medial exostectomy performed, and dorsal and medial osteophytes trimmed as necessary. The base of the proximal

phalanx was exposed and between one-third and one-half of the proximal phalanx was excised. No distraction or soft-tissue interposition was employed. Where necessary the extensor hallucis longus tendon was lengthened. Before releasing the tourniquet a soft bulky compression bandage was applied with the hallux in its corrected position. Postoperatively the foot was elevated for three days, following which the patient was mobilised on crutches, bearing weight on the heel. The bulky dressing

Table I. Basic clinical data for each treatment group

	Keller's arthroplasty	Metatarsophalangeal arthrodesis
Age (years)	61.5 (45 to 81)	59.0 (46 to 73)
Number of patients	44	37
Number of feet	60	50
Male (%)	13	13
Female (%)	87	87
Hallux valgus (%)	85	86
Hallux rigidus (%)	15	14
Length of follow-up (months)	30.8 (24 to 42)	31.5 (25 to 41)

Table II. Symptoms before and after surgery (number and *per cent*)

	Keller's arthroplasty				Metatarsophalangeal arthrodesis					
					United		Ununited			
	Before	After	Before	After	Before	After	Before	After	Before	After
Pain	60 100	7 12*	26 100	3 12*	18 100	3 17*				
Cosmetic dissatisfaction	56 93	14 23*	24 92	9 35*	16 89	5 28*				
Footwear problems	54 90	15 25*	24 92	9 35*	17 94	6 33*				
Limited walking distance	28 47	9 15*	13 50	8 31	9 50	2 11†				

significance of differences from pre-operative incidences, * $p < 0.001$, † $p < 0.05$

Table III. Clinical signs before and after surgery (number and *per cent*)

	Keller's arthroplasty				Arthrodesis			
					United		Ununited	
	Before	After	Before	After	Before	After	Before	After
Tender bunion	39 65	3 5§	22 85	4 15§	16 89	0 §		
Malrotation of hallux	25 43	19 32	18 69	16 62	14 78	5 28†		
Lateral callosities	16 27	24 40	17 65	11 42	10 56	7 39		
Callosities on hallux*	0	10 17†	0	15 58§	0	3 17		
Cock-up deformity†	–	25 42	–	8 31	–	3 17		

* on the medial aspect of the interphalangeal joint

† no pre-operative data available

‡ significance of difference from pre-operative incidences $p < 0.01$

§ significance of difference from pre-operative incidences $p < 0.001$

was worn for two weeks, at which time the dressing and sutures were removed. Following this, weight-bearing was allowed when comfortable.

Metatarsophalangeal joint arthrodesis. The method used was similar to that described by Hooper and Phillips (1986). The joint was exposed through a dorsomedial skin incision, and dorsal and medial osteophytes were trimmed as necessary. Transverse drill holes were made in the neck of the first metatarsal and in the base of the proximal phalanx and a 20-gauge wire was passed through in a loop. The remains of the articular cartilage and subchondral bone were removed from the base of the proximal phalanx and the head of the first metatarsal and the two surfaces were shaped as in a cone arthrodesis. A Kirschner wire was introduced in retrograde fashion across the joint with the toe positioned, and the fusion was completed by tightening the wire loop. Postoperatively the foot was elevated for three days and then the patient resumed walking but without bearing weight on the operated foot. At out-patient review, two weeks after surgery, the sutures were removed and a plaster slipper was applied. Following this, heel weight-bearing was

allowed. At six weeks the K-wire was removed and the slipper discarded.

RESULTS

Since several of them failed to unite, we have subdivided patients in the arthrodesis group into those who united and those who developed nonunion.

Pre-operative assessments. The demographic features of the two treatment groups were very similar (Table I). Prior to surgery all patients in the study complained of pain in the region of the first metatarsophalangeal joint, most had experienced difficulties in purchasing footwear, and approximately half reported limitation in the distance they could walk (Table II). In every instance symptoms had been present for at least one year prior to surgery.

Malrotation of the hallux and callosities under the heads of the lateral metatarsals were more common in the arthrodesis group ($p < 0.05$) and lateral metatarsalgia occurred more commonly in the subgroup who failed to unite ($p < 0.02$). No other differences were noted between the groups (Tables II, III, IV and VI).

Lesser toe abnormalities, such as clawing or hammer deformity were equally common in the two groups, and no differences were observed between patients with hallux valgus and those with hallux rigidus.

The mean hallux valgus angle before surgery was similar for the two groups (Table IV), 35° in those who had Keller's arthroplasty (range 11° to 68°) and 41° in those who had arthrodesis (range 13° to 92°).

Postoperative assessments. Patient satisfaction was high following either procedure (Table V), with about 75% expressing complete satisfaction and 98% noting at least some improvement. Pain related to the first metatarsophalangeal joint was completely relieved in almost 90%. Nearly every patient (78 out of 81) stated that they would be prepared to undergo the same procedure again for similar pre-operative problems. The two procedures were equally successful at relieving first metatarsophalangeal joint pain, improving walking distance and the cosmetic appearance of the foot, and reducing problems with footwear (Table II). Correction of the hallux valgus angle was also similar for the two procedures (Table IV). The results of surgery were not related to the age or sex of the patient, nor to the pre-operative diagnosis (hallux valgus or hallux rigidus).

Among the patients who underwent arthrodesis, nonunion occurred in 22 out of 50 feet (44%), but the majority (18 out of 22) were asymptomatic. Six toes needed revision surgery before the two-year review, because of painful nonunion (4), poor position of fusion (1), or a fracture through a sound union (1). In each case the same method of arthrodesis was again employed and solid union was achieved, producing complete relief of pain and complete patient satisfaction with the outcome (Table V). These patients are included in the assessment

Table IV. Mean hallux valgus angles in degrees before and after surgery (mean $\pm$ s.d.)

	Before	After
Keller's arthroplasty	35 ± 12.3	25 ± 12.4
Arthrodesis	41 ± 16.3	25 ± 10.0

Table V. Patient satisfaction and pain relief in the two quoted groups (number and *per cent*)

	Keller's arthroplasty		Arthrodesis*			
			United		Ununited	
Overall response						
Completely satisfied	45	75	20	71	17	77
Improved	14	23	8	29	4	18
Worse	1	2	0		1	5
Pain						
Completely relieved	53	88	25	89	19	86
Improved	7	12	3	11	2	9
Worse	0		0		1	5

* in the arthrodesis group the results include the final outcome in six patients who had revision surgery

Table VI. Effect of surgery on lateral metatarsalgia (number and *per cent*)

	Before surgery		After surgery		Developed		Resolved	
Keller's arthroplasty	15	25	12	20	3	5	6	10
Arthrodesis								
United	10	38	6	23	1	4	5	19
Ununited	11	61	2	11*	0		9	50

* significance of difference from pre-operative incidences $p < 0.01$

of patient satisfaction but not in the assessment of specific symptoms and signs (Tables II, III and VI). In addition, one patient required general anaesthesia to remove a K-wire.

A small, but not significant, reduction in the number of patients with metatarsalgia was seen following Keller's arthroplasty and also in those in whom a sound arthrodesis was achieved (Table VI). There was a marked reduction in the incidence of metatarsalgia when arthrodesis failed and nonunion occurred ($p < 0.01$). However, it should be noted that the postoperative incidence of metatarsalgia was similar for the two groups.

Surgery had little effect on callosities under the lateral metatarsal heads, but in some patients new callosities appeared on the medial aspect of the first interphalangeal joint. These were most prominent in patients who had achieved a sound arthrodesis, and they were associated with an increased incidence of hallux malrotation ($p < 0.05$).

We did not encounter patients with marked cock-up deformity of the hallux but did observe that some patients in each group were unable actively to touch the pulp of the hallux to the ground when the foot was plantigrade. Although this was more common in the Keller's group the difference was not statistically significant.

The time taken to achieve the best possible response was variable but usually prolonged, the mean time being 10 months (range 1 to 30) for those who underwent Keller's arthroplasty and nine months (range 1 to 24) for those who underwent arthrodesis ($p = \text{NS}$). The results were similar for hallux valgus and hallux rigidus.

DISCUSSION

In this study patient satisfaction with surgery was high for both Keller's arthroplasty and arthrodesis of the first metatarsophalangeal joint. In terms of patient satisfaction, relief of pain, improvement in walking distance, and reduction in footwear problems we found no significant differences between the two procedures. These similarities notwithstanding, certain aspects need to be highlighted. We were surprised at the incidence of nonunion (44%), although a high rate has been observed by others (Wand et al 1989). The method of arthrodesis used in this study was chosen because the surgeons were familiar with it and the results would not be biased by a 'learning curve'. However, from a biomechanical viewpoint it may be less than optimal (Sykes and Hughes 1986), and a more rigid method of internal fixation might be expected to improve the union rate. Although the majority of our patients with nonunion were asymptomatic, and only four out of 22 required revision, we would consider modifying our technique for the future.

We found Keller's arthroplasty gave good results. The advantages of the procedure lie in its technical simplicity, the low incidence of complications and the low revision rates. We agree with Jahss (1984) who has

suggested that the poor results sometimes associated with the procedure are more often due to poor surgical technique than to any defect inherent in the procedure itself. We employed a meticulous technique, trying to avoid excising too much bone, and we lengthened the extensor hallucis longus tendon when necessary. The patients were not left with a floppy, unstable toe as has sometimes been reported, and unlike those who underwent arthrodesis, no further operative procedures were necessary.

Neither procedure had a significant effect upon the incidence of metatarsalgia. Although we noted a marked reduction in the incidence following failed arthrodesis, this is explicable in terms of the much higher incidence of metatarsalgia in this subgroup prior to surgery. If metatarsalgia is taken as an index of the function of the first ray, these results suggest that neither procedure provides a significant improvement in function and suggests that the major role for both procedures is to relieve local pain. Any functional improvement is probably related to this pain relief.

We took great care in the selection of patients for surgery and did not operate in the absence of significant pain. It is probable that at least part of our success is the result of careful pre-operative assessment and selection. We emphasise the prolonged period to full recovery, as many patients expect almost instant results and this can lead to dissatisfaction.

In summary, we found both procedures gave good results in terms of patient satisfaction and symptom relief. However, arthrodesis is technically more difficult and is more likely to require revision. As we were unable to demonstrate any advantage for arthrodesis over Keller's arthroplasty in terms of a reduced incidence of postoperative metatarsalgia, we feel that a meticulously performed Keller's arthroplasty may be the better choice in the older patient.

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