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The long-term results of resection arthroplasties of the first metatarsophalangeal joint in rheumatoid arthritis

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Abstract We performed a retrospective study in 188 patients (254 feet) with rheumatoid arthritis and compared the late results of Keller's procedure with those of Hueter-Mayo's technique after 7.9 years. More than 60% of the Keller group and 30% of the Hueter-Mayo group were suffering from persistent metatarsalgia due to increased forefoot pressure as well as experiencing pain around the great toe. Plantar callosities, recurrent hallux valgus deformity, lack of plantar flexion and weakened push-off were more frequent after Keller's procedure.

Résumé Nous présentons une étude rétrospective de 188 patients (254 pieds) atteints de polyarthrite rhumato et avons comparé le résultat de la technique de Keller avec celle de Hueter-Mayo après 7.9 années. Plus de 60% des patients du groupe Keller et 30% du groupe Hueter-Mayo a souffert de métatarsalgies persistantes dû à l'augmentation de la pression de l'avant-pied et de douleurs du premier orteil. Callosités plantaires, hallux valgus récurrent, manque de flexion plantaire et de force de poussée du premier orteil étaient plus fréquents après le procédé de Keller.

Introduction

Rheumatoid arthritis frequently causes painful forefoot deformities interfering with standing and walking. The metatarsophalangeal (MTP) joints are the most common sites of the disease, which presents with an aggressive synovitis, cartilage damage and joint destruction. Arthritic changes in the first MTP joint occur in more than 50% of these patients [9]. Pain relief, restoration of walking ability and restoration of joint congruency are the primary aims of therapy. Thus, resection arthroplasties of the MTP joints as suggested by Hoffmann in 1911 [12] are still accepted as one reliable method of treatment. For the first ray Hueter [13] and Mayo [18] favoured metatarsal head resection, while in 1904 Keller [15] preferred resection of the base of the proximal phalanx.

We report a retrospective study made in order to compare the late results of these two different resection arthroplasties for the first MTP joint in rheumatoid patients when this was combined with resection of the lesser metatarsal heads.

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Materials and methods

Two-hundred and seventy-eight patients suffering from rheumatoid arthritis presented with forefoot deformities between 1984 and 1992. Of these 366 forefeet were corrected surgically. Two-hundred and nine patients with 278 'operated' feet were reviewed at a mean of 7.9 years (range: 5.8–11.3 years). There were 147 women and 62 men and their average age at the time of surgery was 47 years (range: 25–74 years). All the patients had failed to respond to conservative management (insoles, custom-made shoes) and were receiving appropriate drug therapy. Local symptoms had been present for an average of 6.9 years (range: 1.6–12.8 years). Primary radiological assessment revealed moderate to major MTP joint destruction. Thirty-one first MTP joints were graded as Larsen stage III, 154 as stage IV and 93 as stage V. Both groups were shown to be comparable as they displayed no statistically significant differences (chi-square test >0.976) in the radiological staging of the first MTP joint.

The surgical management of the first ray consisted of partial metatarsal head resection (Hueter-Mayo's procedure) in 152 feet and Keller's procedure in 126 feet. The surgeon had chosen which operative procedure to carry out. No differential indication criteria were found retrospectively to suggest any bias in choosing which operation to perform. A plantar approach [22] was used for resection of the heads of lesser metatarsals.

Patients were questioned regarding their overall satisfaction, pain relief, standing and walking ability, shoe wear and functional improvement. During physical examination we concentrated on toe deformities, callosities and the range of motion of the MTP joints. Pedobarographic pressure distribution was measured using the EMED (Novel) system. Weight-bearing radiographs of the forefoot were assessed for hallux valgus angle, first intermetatarsal angle, position of the sesamoid complex and pan-metatarsal alignment.

Results

In the period studied 32 feet of 28 patients underwent revision surgery, which was performed after an average of 3.5 years (range: 0.8–5.1 years). Correction of the metatarsal alignment was required in eight of the feet. These patients remained within the study as revision surgery did not involve the great toes. The remaining 24 feet (19 after Keller's procedure, five after Hueter-Mayo's procedure) required revision surgery of the first MTP joint. In 22 of these joints arthrodesis was used to correct a recurrent painful hallux valgus deformity and a silicone implant was inserted in two feet; these 24 feet were excluded from the study.

The relevant data therefore refer to 254 feet (188 patients): 147 feet were treated with Hueter-Mayo's technique and 107 with a Keller's procedure.

After Keller's procedure metatarsalgia of the lesser rays was reported in 67 feet, while 45 feet were painful after Hueter-Mayo's operation. Patients suffered pain around the great toe in 51 feet after Hueter-Mayo's operation and in 66 feet after Keller's procedure.

Concerning the improvement of pain, 77 feet treated with Hueter-Mayo's procedure were estimated as excellent or good but only 35 feet after Keller's procedure.

Fewer patients were able to walk more than 1 mile after Keller's procedure. It was evident that, in general, walking ability did not depend on the type of resection arthroplasty of the great toe and that there was no improvement after 8 years.

Prior to surgical treatment 47 patients wore custom-made shoes or insoles. At the time of review 83 patients presented with 'pedorthic' devices and there was no clear difference concerning shoe wear between patients treated with Keller's procedure and those treated with Hueter-Mayo's procedure.

Patients' evaluation concerning their overall satisfaction revealed different results. Ninety-nine feet treated with Hueter-Mayo's procedure were reported as excellent or good. In the Keller group, nearly half the patients (52 feet) considered the outcome as excellent or good.

On physical examination, obvious painful callosities of the plantar forefoot were localised mainly beneath the lesser metatarsal 'stumps'. In the Keller group 77 feet had calluses, while 56 feet treated with Hueter-Mayo's operation had this problem ($P<0.001$ Mann-Whitney *U*-test). During weight-bearing the lesser toes often did not touch the ground. This finding was more frequent in 68 feet in the Keller group compared with 53 feet in the Hueter-Mayo group ($P<0.01$ Mann-Whitney *U*-test). Most of the lesser toes in 173 feet showed significant lateral deviation, which did not relate to the type of first ray surgery. Measurement of hallux valgus deformity varied (15–40°) and there was often an associated pronation deformity. Keller's procedure was followed by hallux valgus deformity (>20°) in 53 feet. Recurrent hallux valgus deformity ($P<0.001$ Mann-Whitney *U*-test) was noted in 40 feet following Hueter-Mayo's procedure. In 71 feet the majority of great toes did not touch the ground during weight-bearing following Keller's procedure. Despite a hallux valgus deformity nearly all the patients were able to stand on tiptoe, and this demonstrates an adequate range of dorsiflexion. In contrast there was a lack of active plantar flexion in 73 feet following Keller's procedure. There was no plantar flexion in 31 feet ($P<0.001$ Mann-Whitney *U*-test) following Hueter-Mayo's operation.

Radiological assessment of metatarsal alignment revealed adequate length correction in 156 feet. After Keller's resection, which did not affect metatarsal length, 87 feet showed good metatarsal alignment. Hueter-Mayo's technique produced poorer results with only 69 feet having an adequate metatarsal length ratio. Elongation of the second metatarsus was noted in all the other feet. Ossification and plantar osteophytes around the lesser metatarsal 'stumps' was seen in 92 feet. The Keller group showed slightly worse results with 46 feet being affected compared with 48 feet in the Hueter-Mayo group. No significant change was noted in the intermetatarsal angle in either group, the measurements being 13.9° pre-operatively, 15.6° post-operatively in the Keller group, and 13.5° pre-operatively, 15.2° post-operatively in the Hueter-Mayo group. The average hallux valgus angle increased significantly ($P<0.01$ Mann-Whitney *U*-test) in the Keller group although most of the pre-operation radiographs were taken without weight-bearing (26.7° pre-operatively, 34.4° post-operatively), and these findings were similar in the Hueter-Mayo group (23.7° pre-operatively, 28.1° post-operatively). A distinct proximal migration of the sesamoids was noted in all feet treated with Keller's procedure but this did not occur in those treated with Hueter-Mayo's procedure.

Static pedobarography showed a greater lack of ground contact for the lesser toes in 64 feet following Keller's procedure compared with that of the Hueter-Mayo group of 57 feet ($P<0.01$ Mann-Whitney *U*-test). The great toe did not adequately reach the ground in 67 feet after Keller's operation; a better result was achieved after Hueter-Mayo's technique with only 29 feet having little or no ground contact ($P<0.001$ Mann-Whitney *U*-test). Both resection arthroplasties did modify heel-to-toe walking, and total ground contact time in those patients operated on 'unilaterally' (66 feet) was studied. Despite the method of treatment, the total ground contact period was significantly reduced for all the operated feet ($P<0.001$ Mann-Whitney *U*-test). Pedobarography also showed an increased forefoot pressure beneath the lesser metatarsals. These findings were more evident within the Keller group of 72 feet compared to the Hueter-Mayo group of 66 feet ($P<0.01$ Mann-Whitney *U*-test). During the 'push-off' phase 69 feet in

Table 1 Relevant clinical findings concerning the lesser toes

	Lack of ground contact	Plantar callosities
Hueter-Mayo	53 (36%)	56 (38%)
Keller	68 (53%)	77 (72%)

Fig. 1 Seven years after panmetatarsal head resection (Hueter-Mayo) without significant callosities: well-aligned metatarsal length, increased but homogenous pressure load beneath the lesser metatarsals

Table 2 Relevant clinical findings concerning the great toe

	Hallux valgus >20°	Lack of ground contact	Lack of plantarflexion
Hueter-Mayo	40 (27%)	33 (22%)	31 (21%)
Keller	53 (49%)	71 (66%)	73 (68%)

the Keller group presented with a total lack of ground reaction compared to 27 feet in the Hueter-Mayo group ($P<0.001$ Mann-Whitney U-test). When compared to the untreated side, the centre line of weight-bearing was transferred laterally after Keller's operation on 69 feet and after Hueter-Mayo's operation on 56 feet (Tables 1, 2).

Discussion

Improvement of pain as one of the most important criteria was judged as excellent or good in 35 feet (38%) after Keller's procedure and in 77 feet (52%) after Hueter-Mayo's operation. These results correspond well to previous studies [5, 6].

In both groups walking ability did not improve and this may be related to the progressive arthritic changes, which occur in the proximal joints of both lower limbs. Karbowski et al. [14] noted that one-fourth of their patients who had undergone panmetatarsal head resection complained of a limited walking distance at an average of 13 years. In contrast to these results, Mann and Schakel [17] reported an improvement in standing and walking ability, although only 20 patients with a short-term follow-up (average 3.7 years) were studied. Despite the encouraging subjective assessment of patients, 67 feet (62%) treated by a Keller's type of resection suffered metatarsalgia, whereas the percentage was lower in 45 feet (30%) in the Heuter-Mayo group. In the literature recurrent plantar callosities and metatarsalgia have been noted by other authors in 30–60% of patients who had undergone lesser metatarsal head resection, although no account was taken of any associated surgery on the first ray [7, 19, 24]. Metatarsalgia caused by incorrect alignment or by plantar osteophytes was distributed fairly evenly in both groups. Metatarsal alignment was worse in the Hueter-Mayo group and it is of interest that this seemed to have only a limited influence in the development of metatarsalgia (Fig. 1). However, Keller's operation was followed by a significantly higher amount of forefoot pain. Lesser toe deformities with lack of ground contact were significantly more frequent after Keller's resection, which supported this hypothesis. Pedobarographic studies also confirmed these clinical findings.

Hallux valgus deformity recurred more often after Keller's procedure with functional instability resulting from the detachment of the short flexor tendons as the likely cause. An unexpected finding was that lateral deviation of the adjacent lesser toes was not related to recurrent hallux valgus deformity. In fact permanent joint instability of the lesser MTP joints and a disturbance of the windlass mechanism seems to be more important. Few authors agree that resection arthroplasty of the first MTP joint leading to joint instability causes recurrent hallux valgus [5, 17, 19, 24]. Graham [8] stated that hallux valgus deformity after metatarsal head resection is similar to the type of deformity which may occur after amputation of the second toe [1, 23]. Recurrence of hallux valgus has also been mentioned as the major reason for re-operation [10].

Fig. 2 Eleven years after lesser metatarsal head resection and Keller's procedure: lesser MTP joint dislocation and lateral deviation, distinct callosities and high pressure area beneath the first and second metatarsal

Lack of ground contact and weakened plantar flexion of the great toe during the push-off phase further impairs forefoot function. Again, Keller's technique produced poorer results in 67 feet (62%) compared to 29 feet (19%) following Hueter-Mayo's procedure. Similar findings were confirmed by Vallier et al. [25] who reviewed their results of Keller's arthroplasty in 54 patients at 2–10 years and found no active plantar flexion in 67%. We observed also that the centre line of weight-bearing was transferred laterally and this can be considered as a response to the altered biomechanics. Again, this occurred more often in the Keller group than in the Hueter-Mayo group.

In addition, Keller's operation leads to a lengthening of the first metatarsal and this is responsible for a higher pressure load beneath the first metatarsal head. These results have been confirmed by several authors [2, 20, 21]. As a result Tillmann [22] suggested that Keller's operation should not be combined with a metatarsal head resection of the lesser toes. In contrast to his opinion, Broeng et al. [3] recommended Keller's procedure in combination with a metatarsal head resection of the lesser toes, but in assessing their results it is important to consider the small number of patients (16) and the short-term follow-up (57 months). Clayton et al. [4] advised panmetatarsal head resection together with removal of the base of the first phalanx in severe hallux deformity in order to shorten and re-align the first ray. Nevertheless it is important to consider that this technique further increases instability and also has all the disadvantages of Keller's procedure.

As a result of comparing two different types of resection arthroplasty of the first MTP joint in rheumatoid patients, we believe that Keller's procedure should no longer be recommended (Fig. 2). Resection and reshaping of the first metatarsal head (Hueter-Mayo's procedure) leads to better overall results, although recurrence of hallux valgus deformity, joint instability and impaired plantar flexion alters the gait pattern. To avoid these disadvantages, arthrodesis should be considered as an alternative. This has been mentioned by several authors, although the number of patients was often small and follow-up periods were short [8, 10, 11, 16, 17, 24, 26]. Prospective long-term studies on the development of metatarsalgia and the degenerative changes of the interphalangeal joint of the great toe are essential in order to assess the value of first metatarsophalangeal joint athrodesis in rheumatoid patients.

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