WOLF AND HELAL METATARSAL OSTEOTOMIES IN METATARSALGIA TREATMENT

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ABSTRACT

PURPOSE OF STUDY
A common reason for painful forefoot is plantar shift of metatarsal heads. Progression of this condition creates painful keratoses. The aim of our study was to evaluate the results after Wolf osteotomy of metatarsals and after Helal telescopic metatarsal osteotomy in comparable groups of patients.
MATERIAL
Wolf osteotomy was performed in 62 patients (75 feet) in the period of 2002 through 2005. The average follow-up was 31 months. There were 55 females (88.7 %) and 7 males (11.3 %) in the group. The mean age was 53.6 years (27–82 years). Forty-one patients (51 feet) appeared for follow-up examination.
Helal osteotomy was performed in 98 patients (112 feet) in the period of 2001 through 2003. The average follow-up was 34 months. There were 87 females (88.8 %) and 10 males (11.2 %). The mean age was 52.8 years (35–76 years). Seventy-one patients (76 feet) appeared for follow-up examination.
METHODS
We performed Wolf osteotomy with small Luer pliers in the region just proximal from the heads of the second, third, and fourth metatarsals. We removed a small part of the dorsal cortex and created a V-shaped notch based dorsally, leaving the plantar cortex intact. The plantar cortex was then fractured by closing the osteotomy with fingers and turning the metatarsal head upwards.
We performed Helal osteotomy using an oscillating saw on the border between the distal and the middle thirds of the metatarsal bone. The direction of the osteotomy was 45° obliquely distad and towards the planta. Then we gently shifted the distal fragment proximally and dorsally. We resected the overlapping part of the dorsal cortex of the distal fragment. We performed the same procedure on the second, third, and fourth metatarsals.
The Gainor scoring system was used for the evaluation of our results.

RESULTS
We achieved 76.5 % excellent, 13.7 % good, 5.9 % satisfactory and 3.9 % bad results in the group with Wolf osteotomy and 81.2 % excellent, 12 % good, 4.3 % satisfactory, and 2.5 % bad results in the group with Helal osteotomy.
DISCUSSION
The indication for Wolf or Helal osteotomies is a static deformity of the forefoot with plantar depression of the second, third, and fourth metatarsal heads and painful plantar callosities. The goal of both osteotomies is the elevation of metatarsal heads. The prerequisite of a good result is a careful surgical technique. Mistakes in the technique can influence the final result. None of the two methods requires internal fixation. Both procedures allow early stressing of the limb, even if with crutches. We have achieved similar results with both techniques in comparison with other publications.
CONCLUSIONS
Similar results can be achieved using both types of osteotomies. Both methods have an identical effect on pain relief in the forefoot caused by plantar shift of metatarsal heads. The advantage of both methods is early stressing of the operated foot.

INTRODUCTION

Wolf and Helal metatarsal osteotomies were used in our departments for the treatment of metatarsalgia. The aim of our study was to evaluate the results after both techniques, to discuss our experience, and to compare the results in both groups of patients. We also focused our attention to differences between both groups regarding pain relief and non-union.

MATERIAL AND METHODS

Wolf osteotomy was performed in 62 patients (75 feet) in the period of 2002 through 2005. The average follow-up was 31 months. There were 55 females (88.7 %) and 7 males (11.3 %) in the group. The mean age was 53.6 years (27–82 years). Forty-one patients (51 feet) appeared for follow-up examination.
Helal osteotomy was performed in 98 patients (112 feet) in the period of 2001 through 2003. The average follow-up was 34 months. There were 87 females (88.8 %) and 10 males (11.2 %). The mean age was 52.8 years (35–76 years). Seventy-one patients (76 feet) appeared for follow-up examination.
The indication for surgery in both groups was plantar metatarsalgia associated with plantar depression of the heads of the middle metatarsals. This deformity did not disappear by non-stressing, but the normal transverse arch of the forefoot could be achieved by pressure from the plantar side. This deformity was not rigid. Depression of the metatarsal heads caused their plantar prominence and painful plantar keratoses. Contraindications for surgery included infection, impaired vascularity, skin disturbances, and non-cooperation of the patient.
We performed radiographic analysis using an anteroposterior and a lateral radiograph of the foot in the standard and stress positions preoperatively. We also used an oblique dorsoplantar view in supine position and a plantodorsal view in prone position [3,7]. We assessed the divergence of the metatarsal bones in both standard view and the view in stressing position (Figure 1).
We used the Gainor scoring system [8] for the evaluation of clinical results (Tables 1, 2) involving walking, walking aids, needs for special shoes, cosmetic effect, pain relief, and satisfaction of the patient. Radiographically we evaluated the healing of the osteotomy and the occurrence of both delayed unions and non-unions.

Operative technique

Wolf osteotomy [17]: the operation is performed in general anaesthesia or in a foot block, usually with a tourniquet.

Figure 1
Radiograph in anteroposterior view – evidence of metatarsal divergence

Figure 2
Wolf V-osteotomy with Luer pliers

We used two longitudinal incisions on the dorsum of the foot. We retracted the tendons of the extensor digitorum longus and brevis and the soft tissue to expose the metatarsal. At a point about 6 mm proximal to the metatarsal head, using a small rongeur (Luer, Liston), we created a V-shaped notch in the metatarsal down to but not including the plantar cortex. Then, by pressure on the plantar aspect of the metatarsal head, while stabilising the forefoot, we produced a greenstick fracture of the metatarsal shaft and closed the notch dorsally. We proceeded on the second, third, and fourth metatarsal bones. In that way we elevated the metatarsal heads dorsally and corrected the deformity. After releasing the tourniquet we stopped any bleeding and closed the wound in layers (Figure 3). We applied a soft dressing with a support underneath the metatarsal heads to maintain their position and model the transverse arch (Figure 4). Weight stressing was started with crutches the day after surgery. The patient was instructed to bear as much weight as possible on the forefoot, forcing the metatarsal heads superiorly to help keep the notch closed. The sutures were removed 12 to 14 days after surgery. Full weight stress without crutches was allowed after 4–6 weeks.

Helal osteotomy [10]: this is performed in general anaesthesia or in a foot block, usually with a tourniquet. We used two longitudinal incisions on the dorsum of the foot. Medial incision was placed over the second metatarsal and a lateral incision was placed between the third and fourth metatarsals. We retracted the extensor tendons and the soft tissue to expose the metatarsal. At the border between the middle and distal thirds of the metatarsal we performed an oblique osteotomy in plantar direction and distad at an angle of 45° with an oscillating saw (Figure 5). We performed this procedure on the second, third, and fourth metatarsal bones. Thereafter we shifted the distal fragment dorsally and proximally. We removed the overlapping dorsal cortex with Luer pliers. After releasing the

Figure 3
Closure of the wound, two dorsal incisions

tourniquet we stopped any bleeding and closed the wound in layers (Figure 3). We applied an elastic dressing with a support underneath the metatarsal heads (Figure 4). Postoperative management was the same as after Wolf osteotomy. Full weight stress without crutches was allowed after 6 weeks.

RESULTS

We evaluated both groups using the Gainor scoring system [8] (Tables 1, 2). In the group with Wolf osteotomy, we achieved 90.2 % excellent and good results; in the group with Helal osteotomy 91.5 % excellent and good results were achieved (Table 3). The final result was similar in both groups.
Our complications are listed in Table 4. We encountered superficial infection and marginal necrosis of the wound in 5 patients (12.2 %) after Wolf osteotomy and in 8 patients (11.3 %) after Helal osteotomy.

All cases healed with conservative methods without consequences. There was one case of deep infection (1.4 %) in the group with Helal osteotomy requiring a revision. It did not influence the final results in this case. Hypoesthesia of the operated foot was observed in one patient after Helal osteotomy (1.4 %) and in one patient after Wolf osteotomy (2.4 %). The hypoesthesia disappeared in both cases after 6 months.
There was one case of deep venous thrombosis after Wolf osteotomy (2.4 %) and three cases after Helal osteotomy (4.2 %). We did not encounter any painful or painless non-union in the groups with Wolf osteotomy, even if we disturbed the plantar cortex in two cases. The osteotomy was healed uneventfully. There were three cases (4.2 %) of painful non-union in the group with Helal osteotomy. In one case we performed a successful revision with subsequent healing of the bone. We observed a painless non-union in the group with Helal osteotomy in 17 patients (32.7 %).

Figure 4
Inserted support underneath metatarsal heads

DISCUSSION

Metatarsalgia is a common complaint of many patients visiting outpatient orthopaedic departments. There are several causes of the pain distally from the Lisfranc's joint. One of them is overloading of the middle metatarsals. Plantar depression of the second, third, and fourth metatarsal heads is often associated with other static deformities of the forefoot (bunion, hammertoe, clawing toe) [11]. Overweight, improper footwear, and other factors cause weakness of short muscles and laxity of ligaments of the foot. The transverse arch of the foot with metatarsal heads is gradually depressed and the forefoot becomes wider. This deformity produces painful callosities underneath the metatarsal heads.

At the onset we started with conservative treatment. We recommend proper footwear, supports into the shoes, non-steroid anti-inflammatory drugs, weight reduction, physiotherapy, and change of activity. After exhausting all conservative measures we can choose from several shortening osteotomies (Giannestras, Hoffman, Thomas, Weil, Wolf, Helal) [2, 5, 9, 10, 13, 15, 16, 17]. The aim of the osteotomy is to create a balance of strengths influencing the metatarsal heads. This can be achieved by several means:

1. shortening osteotomy (Giannestras) [9],
2. change of the alignment of metatarsals (Wolf) [17],
3. dorsal and proximal shifts of the distal fragment of metatarsals (Helal) [10]. The same principle can be found in modified chevron osteotomy [12].

The operation technique described by Wolf [17] in 1973 consists in elevation of the depressed metatarsal heads and in achieving a horizontal alignment of the metatarsals with the axis of rotation in the region of the plantar cortex. Closed wedge osteotomy allows early postoperative partial weight stress [1, 4, 16]. Helal osteotomy produces shortening of the

Figure 5
Helal telescoping osteotomy with oscillating saw

metatarsal by shifting the distal fragment dorsally and proximally. It does not change the longitudinal alignment of the metatarsals at the sagittal level. Early postoperative partial weight stress is also allowed [10, 16].

It is necessary to distinguish yet other causes of the painful forefoot (Morton's neuralgia, stress fractures, plantar fibromatosis, Freiberg's disease, vascular disorders, infections, tumours, etc.). We also have to exclude some other conditions such as rheumatoid arthritis, crystal arthropathy, gout, and psoriatic arthropathy [5].

An indication for Wolf and Helal osteotomy is a static deformity of the forefoot with plantar depression of the middle metatarsal heads. This deformity does not disappear by lifting the foot, but is correctable by pressure of fingers from below. This deformity is not rigid. Depression of metatarsal heads is associated with painful keratoses on the plantar side of the forefoot. The goal of the osteotomy made for pressure metatarsalgia is the elevation of metatarsal heads. There are several procedures influencing this deformity by different methods [9, 10, 12, 13, 16, 17].

Pilný [14] recommends to perform Wolf or Helal osteotomies in regional anaesthesia for the long-lasting analgesic effect and for a lower risk of complications than in general anaesthesia. We have to follow strictly all steps of the operation technique. Mistakes in the technique can adversely affect the final results. Wolf osteotomy should be performed in the subcapital region of the metatarsal. In the case of more proximal placement of the osteotomy we are unable to correct the alignment of the metatarsal. We also have to avoid producing longitudinal cracks of the metatarsal using Luer pliers and to avoid damage of the plantar cortex. In the case of disturbing the plantar cortex there is a risk of dislocation of the distal fragment and of formation of a non-union. After closing the osteotomy we have to maintain plantiflexion in

Table 1
Gainor score

1.	Walking distance	over 800 m up to 800 m at home	3 points 2 points 1 point
2.	Walking aids	none for other joints for operated foot	2 points 1 point 0 points
3.	Footwear	Ready-made special footwear	2 points 0 points
4.	Cosmetic effect	excellent good satisfactory bad	3 points 2 points 1 point 0 points
5.	Pain	painless small pain moderate pain severe pain	3 points 2 points 1 point 0 points

Table 2
Gainor scoring system

Points	**Result**
11–13	Excellent
8–10	Good
5–7	Satisfactory
0–4	Bad

Table 3
Results of Wolf and Helal osteotomies using Gainor scoring system

Results	Wolf osteotomy		Helal osteotomy	
Excellent	39	76.5 %	55	77.5 %
Good	7	13.7 %	10	14.1 %
Satisfactory	3	5.9 %	4	5.6 %
Bad	2	3.9 %	2	2.8 %

Table 4
Complications

	Wolf osteotomy (n) (%)		Helal osteotomy (n) (%)	
Superficial infection	5	12.2	8	11.3
Deep infection	0	0	1	1.4
Deep venous thrombosis	1	2.4	3	4.2
Hypoesthesia	1	2.4	1	1.4
Painful non-union	0	0	3	4.2
Painless non-union	0	0	17	32.7

the metatarsophalangeal joint at least in zero position. Otherwise, during the correction we could lever the distal fragment to dorsal angulation, which can lead to non-union.
It is necessary to perform Helal osteotomy at an angle of 45° for keeping the fragments in optimal contact. If we perform the osteotomy too much vertically, we do not achieve the telescoping of the fragments on each other; they could dislocate, which can lead to non-union. There is a good amount of trabecular bone at the level between the distal and middle thirds of the metatarsal for better healing.
There is no need for internal fixation in both osteotomies. Wolf osteotomy is performed with basic instruments and Luer pliers. In Helal osteotomy we need an oscillating saw. By comparison, we need special screws for internal fixation in Weil osteotomy [6, 15] and a wire in the Giannestras procedure [9].
We have achieved comparable clinical results in both groups. The only difference is a relatively high occurrence of painless pseudoarthroses after Helal osteotomy (32.7 %). They did not influence the final clinical results. Other complications are similar in both groups (Figure 4). The advantage of both methods is early weight stressing with the use of crutches [1, 4, 10, 17].
Helal [10] evaluated the results in a group of 38 patients (47 feet). He encountered one painless fibrous non-union in his study. He achieved 88.2 % of good results including pain relief and good recovery of the function. Wolf [17] published 85.3 % of excellent results in a group of 25 patients (31 feet) in his article in 1973. Ambler [1] achieved, with Wolf osteotomy in a group of 281 patients (340 feet), 96.5 % of good results regarding pain relief and remodelling of the transverse arch of the foot.

CONCLUSION

We have compared the clinical and radiological results after Wolf and Helal osteotomies performed for metatarsalgia with plantar depression of the middle metatarsal heads in similar groups of patients. We have achieved identical results in both groups. It is necessary to follow the correct operative technique and careful aftertreatment. The advantage of both procedures is low occurrence of complications and low demands on instruments for surgery. Both procedures can be performed in standard orthopaedic departments. Reasonable clinical and radiological results can be achieved in motivated patients.

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