RESEARCH ARTICLE

First Metatarsophalangeal Joint Arthrodesis: A Retrospective Comparison of Crossed-screws, Locking and Non-Locking Plate Fixation with Lag Screw

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Abstract

Background: Locking plate fixation is increasingly used for first metatarsophalangeal joint (MTP-I) arthrodesis. There are still few comparable clinical data regarding this procedure. In this study we aimed to compare the clinical and radiographical outcomes of crossed-screws, locking and non-locking plate fixation with lag screw for first metatarsophalangeal joint arthrodesis.

Methods: A total of 60 patients who had undergone arthrodesis of the MTP-I between January 2008 and June 2010 were retrospectively evaluated. Locking plate fixation with lag screw as well as arthrodesis with crossed-screws or with a non-locking plate with lag screw was performed on three groups of 20 patients.

Results: There were four non-unions in patients with crossed-screws and one in non-locked plate group. All patients in locking plate group achieved union. 90% of the patients were completely or mildly satisfied in locking plate group, whereas this rate was 80% for patients in both crossed-screws and non-locking plate groups.

Conclusion: Use of dorsal plating for arthrodesis of MTP-I joint, either locking or non-locking, were associated with high union rate and acceptable and comparable functional outcome. Although the rate of nonunion was higher with two crossed-screws, however, the functional outcome was not significantly different compared to dorsal plating.

Keywords: Arthrodesis, Crossed-screws, First metatarsophalangeal joint, Hallux rigidus, Locking plate

Introduction

An arthrodesis of the first metatarsophalangeal joint (MTP-I) is indicated in severe cases of hallux rigidus, severe hallux valgus or foot deformities after failed conservative treatment. This procedure has been performed for many years and has shown good results (1). There are several surgical treatment options including total joint arthroplasty, cheilectomy and excision arthroplasty. However, arthrodesis of the MTP-I seems to provide the best long-term results (2). Different fusion techniques have been described including parallel or crossing wires or screws, steinman pins, staples, cerclage wires, bioabsorbable devices, dorsal plates and external fixators. The reported union rate varied from 80 to 100% (3-10).

In this study, 3 fixation techniques using crossed-screws, non-locking plate fixation with lag screw or a locking plate with lag screw were compared in 60 cases. Besides, hard data like biomechanical data and fusion rate we searched for more criteria to make a good choice of operative alternatives.

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Materials and Methods

Patients

This study was approved by the institutional ethical committee (Ethical Approval No: 1247-2011). A total of 60 patients who had undergone MTP-I arthrodesis in our institution between January 2008 and June 2010 were enrolled in this comparative study. The operation was performed in cases of symptomatic hallux rigidus with failed conservative therapy. The inclusion criteria included an isolated hallux rigidus with no previous operation at the operated foot. Missing follow up documentation, and further simultaneous operation procedures with or after MTP-I arthrodesis on the same foot were the exclusion criteria. Each group of patients (n=20) underwent MTP-I arthrodesis with either crossed-screws, locking plate fixation with lag screw, or non-locking plate with lag screw. Patients documents were reviewed retrospectively and the complications including nonunion and wound infection with consecutively performed revision were evaluated. The patients were contacted by phone at least 18 months after the surgery and asked to answer a questionnaire that was geared to the American Orthopedic Foot and Ankle Society-Hallux Metatarsophalangeal Interphalangeal (AOFAS-HMI) score and adapted by Wassink and colleagues (11).

Operative procedure

The patients were in supine position with local, spinal or general anesthesia. A straight dorsomedial incision was performed and the capsule was prepared. The arthrotomy was made to inspect the MTP-I. The articulating surfaces and, when indicated, the osteophytes were resected using a sagittal saw. The toe position was adjusted to a slight dorsiflexion and valgus and observed via intraoperative x-ray.

The crossed-screws were placed from medial into the lateroplantar corticalis [Figure 1a]. For the plate with lag screw procedures the lag screw was first inserted from proximal medial to distal lateral. Consecutively the plate was placed dorsally [Figure 1b and c]. The wound was

a) Crossed-screws

b) Nonlocking plate

c) Locking plate

Figure 1. Postoperative X-rays of each operation procedure.

closed in layers and a bandage was applied. Patients were mobilized in a shoe with a stiff sole (Verbandschuh, Darco International Inc., Huntington, WV) with full weight bearing.

Radiological examinations

Pre- and postoperative x-ray examinations with image acquisition in dorsoplantar and lateral direction with full weight bearing were performed for all patients. Postoperative x-rays were performed 12 weeks after the operation to evaluate bone fusion. Additionally, the metatarsophalangeal angle, the intermetatarsal angle I/II and the angle from metatarsal I to the axis of IP joint axis were analyzed. The lateral metatarsophalangeal angle was estimated in lateral view.

Statistical analysis

Data collection and analysis were performed with GraphPad Prism 5 (GraphPad Software, Inc., La Jolla, CA 92037). The radiological assessment values were expressed as mean and 95% confidence interval (CI). The statistical analysis of data on interval scale (Radiologic parameters) was performed using an unpaired two-sided Student t-test. The ordinal data (limitation, pain, satisfaction, and questionnaire) were analyzed using the Mann-Whitney-Test. Statistical significance was defined as a $P<0.05$.

Results

All contacted patients were willing to answer the questionnaire and hence were included in the study. The patients demographic data are summarized in Table 1. Of a total 60 patients, 55 united within 12 weeks. Five nonunion (8.3%) caseswere observed, four of whom were operated with crossed-screws, and one with a non-locking plate. All five patients with non-union received a second re-arthrodesis operation. Wound infection occurred in one patient, and one patient developed a suture dehiscence with consecutively revisions performed in both cases (revision rate except re-arthrodesis 3.3%). No further complications occurred.

The overall satisfaction rate was 83%, where 90% of the patients were completely or mildly

satisfied in locking plate group, and 80% in both crossed-screws and non-locking groups. Wearing normal shoes was possible in 35% of patients in crossed-screws, 45% in locking plate cases and 50% in non-locking group. Complete pain-free foot was reported in 45% in crossed screws group, 55% in locking plate and 50% in non-locking plate group [Table 2].

Radiological evaluation

In the anterior posterior direction the angle between the metatarsal I and the proximal phalanx (Halux valgus angle) was 19.1^0 (95% CI, 13.0-25.1) for crossed-screws, 12.2^0 (95% CI, 7.3-17.0) for nonlocking plate, and 11.0^0 (95% CI, 7.8-14.3) for locking plate. The angles between the metatarsal I and II (Intermetatarsal angle) were 8.8^0 (95% CI, 7.5-10.0), 8.5^0 (95% CI, 6.2-10.2) and 7.6^0 (95% CI, 5.8-9.5), respectively. In the lateral view, the angles between metatarsal I and the proximal phalanx was 26.5^0 (95% CI, 22.6-30.3) for crossing screws , 23.8^0 (95% CI, 20.7-27) for nonlocking plate, and 23.0^0 for locking plate (95% CI, 19.4-26.6), respectively. no significant differences was detected among the available patients ($P>0.05$).

Discussion

MTP-I fusion is indicated for severe cases of hallux rigidus (12). Locking plates have been increasingly used for MTP-I fusion due to their growing success. In the present study, we have compared this technique with two other widely used fusion techniques, the non-locking plate with lag screw and crossed-screws.

Limited number of patients, the retrospective design, and lack of a clinical follow-up examination were the limitations of this study. Nevertheless, the number of fusions, the comparison between the three procedures, and high number of satisfied patients were the strength points of our study.

The published results about mechanical superiority of different devices used for MTP1 fusion are ambiguous. A previous cadaveric study showed that locking plates were significantly stiffer than non-locking plates; however, a biomechanical study demonstrated that locking plate is inferior compared to nonlocking plate fixation in cases of MTP-I fusion (13, 14). Clinical studies have also yielded in contraversial results. While a higher nonunion rate with titanium locked plates (17.2%) was reported in comparison with non-locked stainless steel plates (11.7%); a different study reported a nonunion rate of only 2% with titanium hybrid-locking plates (15, 16). The nonunion rate in the current study was overally 8.3%, while, no nonunions were seen in the locking plate group. A possible reason

Table 1. Patients Demographic Data

	Crossed-screws	Locking plate	Non-locking plate
Total Number	20	20	20
Age (Range)	65 (49-85)	60 (30-83)	63 (50-72)
Sex (Female/Male)	15/5	13/7	13/7
Foot Side (Right/Left)	13/7	12/8	13/7
Follow-up (months (Range))	27 (19-37)	25 (18-30)	32 (17-39)

Table 2. Frequency of answers given in the questionnaire

		Crossed-screws Number of patients (%)	Locking plate Number of patients (%)	Non-locking plate Number of patients (%)
Swelling of the great toe	No. none	13 (65%)	12 (60%)	13 (65%)
	Sometimes	5 (25%)	5 (25%)	6 (30%)
	Daily	2 (10%)	3 (15%)	1 (5%)
	Always	0 (0%)	0 (0%)	0 (0%)
Great toe touch the ground	Yes	11 (55%)	14 (70%)	9 (45%)
	Not quite	7 (35%)	4 (20%)	7 (35%)
	No	2 (10%)	1 (5%)	3 (15%)
	Sticking up	0 (0%)	1 (5%)	1 (5%)
Shoes	Normal shoes	7 (35%)	9 (45%)	10 (50%)
	Normal shoes with insoles	11 (55%)	7 (35%)	6 (30%)
	Normal shoes with push of aid	2 (10%)	3 (15%)	2 (10%)
	Orthopedic shoes	0 (0%)	1 (5%)	2 (10%)
Resolving of problems	Yes	14 (70%)	18 (90%)	19 (95%)
	Not quite	5 (25%)	2 (10%)	0 (0%)
	No	1 (5%)	0 (0%)	1 (5%)
Having surgery again	Yes	16 (80%)	17 (85%)	16 (80%)
	No	4 (20%)	3 (15%)	4 (20%)
Further surgery	Yes	4 (20%)	1 (5%)	2 (10%)
	No	16 (80%)	19 (95%)	18 (90%)

could be that placing the plates in the previous study was followed by the lag screws, while, we did it conversely (15). Initial application of the lag screw enables reaching the compression and stabilizing the position with the locking plate.

No significant differences in complication rate, union rate and postoperative pain level were reported between the locking and non-locking plates; similarly, although we had one case of nonunion in the non-locking plate group, this was not statistically significant compared to the locking plate group (17).

The higher nonunion rate in the crossed-screws group (20%) compared to both plate groups is noticeable and can be attributed to the less stable construct produced by crossed screws in arthrodesis site (7, 10).

No significant differences in AOFAS score, overall satisfaction rate, ability to wear normal shoes, and limitation of activities between three groups was found.

Use of dorsal plating, either locking or non-locking, for MTP-I joint arthrodesis were associated with high union rate and acceptable and comparable functional outcomes. Although nonunion rate was high using two crossed screws, however, the functional outcomes were not significantly different compared to dorsal plating.

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