

# RETROSPECTIVE COMPARISON OF TWO DIFFERENT FIXATION METHODS FOR FIRST METATARSOPHALANGEAL JOINT ARTHRODESIS

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## ABSTRACT

**Purpose:** Arthrosis of the first MTP joint is a common condition. Among the available arthrodesis methods, plate/screw and screw methods are the current treatment methods of choice. In this study, we investigated whether there is a difference between these two methods.

**Material and Methods:** Thirty-four toes of 32 patients with advanced arthrosis were included in the study. Eighteen arthrodesis were fixed with locking plates/screws and 16 with cross-screws. In the radiological evaluations, malunion and nonunion were examined. Clinical evaluation was made according to AOFAS-HMI scoring.

**Results:** The mean age of the patients was 57.74 +/- 10.079 years and the mean follow-up period was 22.21 +/- 9.108 months. There was no statistically significant difference in clinical scores or union times between the two groups. As complications, superficial skin problems developed in 2 (5.9%) cases, deep infection in 3 (8.8%) cases, and nonunion in 3 (8.8%) cases. There was no statistically significant difference between the two groups in this regard.

**Conclusion:** Plate/screw and cross-screw techniques give similar clinical and radiological results in cases of arthrodesis of the first MTP joint. The cross-screw technique, which can be performed more easily and has lower costs, should be the first choice.

**Keywords:** Arthrodesis, hallux rigidus, hallux valgus, plate, screw

## INTRODUCTION

The first metatarsophalangeal (MTP) joint is often affected by arthrosis. (1). The most common cause is hallux rigidus. Other causes include degeneration due to advanced hallux valgus and arthrosis in the joint due to traumatic or rheumatological reasons. It most frequently affects middle-aged female patients (1). The first MTP joint is an important joint for the body. It has a role in both carrying and transferring body weight (2).

Many methods have been described in the treatment of arthrosis of the first MTP joint. The treatment method is selected according to the stage of the disease and the patient's specific complaints. In radiological staging, the first MTP joint is divided into 4 categories (3). Stage 3-4 should be treated with joint arthroplasty or arthrodesis using implants (4). Patients diagnosed as stage 3-4 have advanced joint damage. Although there is still no consensus on the best treatment, arthrodesis has come to the fore in

recent years (5). Arthroplasty has become less commonly preferred for reasons including incomplete relief of the patient's pain, loosening of the prosthesis, instability, infection risk, and increased need for additional surgical intervention (5). The main treatment of problematic arthrosis of the first MTP joint is arthrodesis, and it is still the gold standard (5). There are many methods for arthrodesis application and each method has its own advantages and disadvantages. K-wires, U-nails, and coil-over wires were used frequently in the past (6). Although these fixation methods are still used today, more biomechanically stable fixation methods have grown in popularity, including screw and plate/screw fixation (3,7-9). The most important advantages of the screw method are its low cost and less dissection of the soft tissue (10). The most important advantage of plate/screw fixation is that it is the most biomechanically stable method (11).

The number of comparative arthrodesis studies with different methods in first MTP joint arthrodesis is few. In most of the studies, the results of a single surgical method are presented as case series. In this study, we compared the clinical and radiological results of two different methods.

## MATERIAL AND METHODS

After receiving ethics committee approval (İzmir Bakırçay University, no:525-505), patients with arthrosis of the first MTP joint were identified retrospectively. Patients who had undergone arthrodesis by screw or plate/screw method were determined. Cases of infection, patients who underwent surgery due to tumors, arthrodesis performed with applications such as K-wire or staples, patients treated with other different methods, patients who underwent arthrodesis with an iliac wing graft due to bone defect, patients under 18 years of age, and patients without adequate preoperative, postoperative, and control radiographs or clinical follow-up were not included in the study.

The preoperative diagnoses of the patients were made with direct radiographs. The grading of the arthrosis of the first MTP joint was performed according to a hybrid radiological staging system. With this system, stage 1 is classified as mild, stage 2 as moderate, stage 3 as advanced, and stage 4 as very advanced arthrosis (3). We included stage 3 and 4 patients in our study group.

For the surgical techniques, patients were operated on under spinal or general anesthesia. The first MTP

joint was opened with a medial incision. Attention was paid to the sensory nerve branches. The joint capsule was opened, and osteophyte removal was performed. Metatarsal and phalangeal bone surfaces were prepared with special reamers for patients treated by plate/screw method (Figure 1). A curette and a rongeur were used for patients treated with screws (Figure 2). The arthrodesis position was established for the first MTP joint with 5-15° valgus and 15-25° dorsiflexion, with an attempt to achieve a 15° angle with the ground in the lateral plane (1). It was fixed with distal locking and proximal compression screws for patients who were treated with plates (hallux rigidus arthrodesis plate). In patients treated with screws, 3.5-mm cannulated screws were applied crosswise with radioscopic control.

In order to prevent edema after the operation, rest and stabilization with a short leg splint were applied for the first 7-10 days. After the 10th day, progressive weight bearing was encouraged with special walking boots. Monthly direct radiographs were obtained. Bone bridging in at least three cortices on bilateral direct radiographs was considered as evidence of adequate union. Mobilization with full weight bearing was allowed after adequate union was achieved.

Clinical scoring of the patients was performed according to the AOFAS-HMI criteria postoperatively (American Orthopedic Foot and Ankle Society Score, *Hallux-Metatarsophalangeal-Interphalangeal*; 0-100 possible points) (3). Upon review of the subsequent radiographs, patients who did not have adequate union at the end of 12 weeks were evaluated as having delayed union, and those who still did not have union at the end of 24 weeks were considered as cases of nonunion. Hallux valgus and lateral first MTP angles were measured (1,12). More than 25° for the hallux valgus or hallux varus and more than 30° for dorsal first MTP angulation or plantar first MTP angulation were evaluated as malunion (12). At the end of the wound healing period, skin necrosis was recognized in the event of cleaning and re-suturing of skin ends that did not heal despite the absence of deep infection/osteomyelitis. Superficial skin problems that healed with dressing were not considered as skin necrosis. Patients who underwent debridement and implant removal in addition to antibiotherapy in the treatment of purulent drainage originating from the arthrodesis line were considered as cases of deep infection. Tinel sign at or near the incision line and severe pain and numbness were evaluated as neuropraxia.

**Table 1:** Demographic data (\*Mann-Whitney U test, \*\*Pearson chi-square test, \*\*\*Fisher's exact test).

Table 1		Plate /Screw		Screw		Total		p
Age (years)		57.28	+/- 11,731	58.25	+/- 8,185	57.74	+/- 10,079	0.917*
gender	Male	9	50%	5	31.3%	14	41.2%	0.268**
	Female	9	50%	9	68.8%	18	58.8%	
Side	Right	12	66.7%	10	62.5%	22	64.7%	0.800**
	Left	6	33.3%	6	37.5%	12	35.3%	
Preliminary diagnosis	Rigidus	15	83.3%	13	81.3%	28	82.4%	1.000***
	Valgus	3	16.7%	3	18.8%	6	17.6%	
Radiological stage	3	7	38.9%	6	37.5%	13	38.2%	0.934**
	4	11	61.1%	10	62.5%	21	61.8%	
Additional hammer toe	(+)	2	11.1%	5	31.3%	7	20.6%	0.214 ***
	(-)	16	88.9%	11	68.8%	27	79.4%	
Follow-up time (months)		22.78	+/- 8,789	21.56	+/- 9,702	22.21	+/- 9,108	0.986*

**Table 2:** Clinical and radiological results and complications (\*Mann-Whitney U test, \*\*Fisher's exact test, AO-FAS HMI: American Orthopedic Foot and Ankle Society Score, Hallux-Metatarsophalangeal-Interphalangeal, MTP: metatarsophalangeal).

Table 2		Plate /Screw		Screw		Total		p
AO-FAS HMI score		86.28	+/- 9,724	88.69	+/- 6,560	87.41	+/- 8,353	0.383*
Union time (weeks)		7.24	+/- 1,640	8.25	+/- 2,646	7.73	+/- 2,212	0.178*
Hallux valgus angle		11.39	+/- 5.446	13.94	+/- 5,013	12.59	+/- 5,326	0.080*
Lateral MTP angle		20.56	+/- 3,329	21.63	+/- 5.402	21.06	+/- 4,390	0.767*
malunion	(+)	0	0.0%	2nd	12.5%	2	5.9%	0.214**
	(-)	18	100.0%	14	87.5%	32	94.1%	
Infection	(+)	3	16.7%	0	0.0%	3	8.8%	0.230**
	(-)	15	83.3%	16	100.0%	31	91.2%	
Skin problem	(+)	2	11.1%	0	0.0%	2	5.9%	0.487**
	(-)	16	88.9%	16	100.0%	32	94.1%	
Nonunion, delayed union	(+)	1	5.6%	2	12.5%	3	8.8%	0.591**
	(-)	17	94.4%	14	87.5%	31	91.2%	

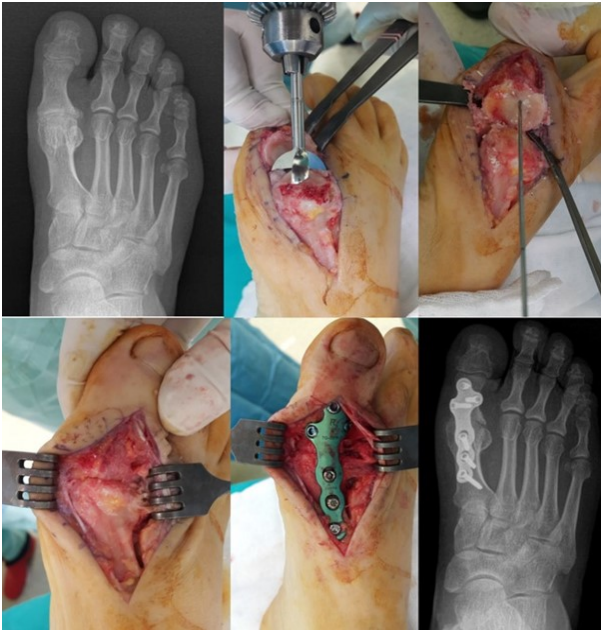
All demographic, radiological, and clinical data of the patients were uploaded to Microsoft Excel. SPSS was used for statistical analysis. Mean and median values were used in the evaluation of continuous data, while percentage values were used in the evaluation of categorical data. The Kolmogorov-Smirnov test was used to determine whether the distribution of continuous data was normal and the Levene test was used for homogeneity testing. Parametric tests were applied in cases where the data conformed to normal distribution, and non-parametric tests were applied when they did not. Pearson's chi-square or Fisher's exact test was used to evaluate categorical data. The significance level was accepted as  $p < 0.05$ .

**Ethical Consideration**

The study, approved by the İzmir Bakırçay University Ethics Committee (Date and report number: 02.03.2022, 525-505).

**RESULTS**

Thirty-four toes of 32 patients with adequate radiological and clinical follow-up were included in the study. Eighteen of these patients were treated with plate/screw fixation (%53) and 16 with screw fixation (%47). Fourteen (41.2%) of the patients were male and 18 (58.8%) were female. Their mean age was 57.74 (30-78) (+/- 10.079) years. For 22 (64.7%), the right side was operated on, and for 12 (35.3%), the left side. The mean follow-up period of the patients



**Figure 1:** Preparing the joint surfaces with a special reamer in a case of arthrosis of the first MTP joint and placing the plate in the appropriate position.



**Figure 2:** Fixation of joint surfaces with curette and rongeur in the appropriate position with cross-screws in arthrosis of the first MTP joint.



**Figure 3:** Complications: deep infection and skin necrosis, exposure of the plate, delayed union and implant failure, and damage to the dorsal sensory branch of the peroneal nerve within the scar.

was 22.21 (5-48) (+/- 9.108) months. Twenty-eight patients were operated on for hallux rigidus and 6 for hallux valgus. Three patients with hallux valgus had rheumatoid arthritis. Of those patients, 2 patients were treated with plate/screw fixation and 1 with screw fixation. Three patients had undergone previous surgery (1 due to arthrosis after hallux valgus distal osteotomy, 1 patient due to a failed prosthesis, and 1 patient due to unsuccessful arthrodesis). The grade of arthrosis was stage 3 in 13 (38.2%) cases and stage 4 in 21 (61.8%) cases. Seven patients (20.6%) were also operated on for accompanying hammertoe. In the statistical evaluation, there were no significant differences between the two groups in terms of age, follow-up period, or radiological staging ( $p > 0.05$ , Table 1).

The mean AOFAS-HMI score was 86.28 +/- 9.724 (54-95) in the plate/screw-treated group and 88.69 +/- 6.560 (75-95) in the screws-only group postoperatively. There was no statistically significant difference between the two groups in this regard ( $p: 0.383$ ,  $p > 0.05$ , Mann-Whitney U test). The mean union time was 7.24 +/- 1.640 weeks among plate/screw-treated patients and 7.73 +/- 2.212 weeks in the screws-only group. There was no statistically significant difference between the two groups in this regard ( $p: 0.178$ ,  $p > 0.05$ , Mann-Whitney U test, Table 2). The mean hallux valgus angle was 11.39° +/- 5.446 (5-24°) in the plate/screw-treated group and 13.94° +/- 5.013 (5-27°) in the screws-only group. The lateral first MTP angle was 20.56° +/- 3.329 (16-27°) in the plate/screw group and 21.63° +/- 5.402 (14-32°) in the screws-only group. There was no statistically significant difference between the hallux valgus and first MTP angles between the two groups (0.080 versus 0.767,  $p > 0.05$ , Mann-Whitney U test).

Skin problems occurred for 2 (5.9%) patients. They were both treated with plates/screws (11.1%). They recovered with wound debridement-resuturing and antibiotic therapy. Deep infection developed in 3 (16.7%, 8.8%) cases, all among patients for whom plates/screws were applied. They recovered with removal of the plates/screws, debridement, and antibiotic therapy. No nonunion was observed in these patients. All 3 infections occurred 2 weeks after the stitches were removed. Union problems were seen in 3 (8.8%) cases. Nonunion was observed for 1 patient (5.6%) for whom plate/screw fixation was applied, while union was delayed in 2 cases (12.5%) from the screws-only group. For the patient with

nonunion, the plate and screw were removed, and union was achieved with a screw alone. For patients with delayed union, union was achieved after 12 and 16 weeks, respectively, and no additional surgical procedures were performed. In the statistical evaluation, the rates of skin problems, infection, and delayed union were similar between the groups ( $p$ : 0.487, 0.230, and 0.591,  $p > 0.05$ , Fisher's exact test, Table 2). In addition, neuropraxia developed in the dorsal sensory branch of the peroneal nerve for 1 patient who underwent plate/screw fixation. This case was treated with neurolysis and plate removal (Figure 3).

## DISCUSSION

Arthrodesis has become the gold standard in the treatment of arthrosis of the MTP joint. This is due to its low complication rates, good long-term clinical outcomes, and patient satisfaction (1,4,5). The results of arthrodesis applied in an appropriate position with rigid fixation will be good. Plate/screw and screw application have come to be preferred among the fixation methods used in arthrodesis (1,4).

The most important advantage of plate/screw arthrodesis is biomechanical stability (11). The use of curved or bendable plates according to the desired position of the toe provides more appropriate arthrodesis. In previous studies, the union rate of patients treated with plates varied between 87.9% and 100% (8,9,13,14). In our study, this rate was 94.4%. Plate/screw application is an open procedure and requires extensive soft tissue dissection for the plate. This can lead to complications such as superficial skin problems, deep infection, and irritation around the plate. In previous studies, infection was seen at rates of 0-3.7% and skin problems at rates of 0-9.3% after plate fixation (8,9, 13-15). In the present study, the rate of skin problems was 11.1% and the rate of deep infection was 16.7%. Malunion is not a frequent problem after plate fixation (8,9,13-15). No malunion was observed among our patients treated with plate/screw fixation.

Double cross-screw fixation is still the most preferred arthrodesis approach because it makes it easier to reach the implant and it is cheaper (10,16). In previous studies, union rates between 93% and 100% were obtained in arthrodesis performed for the first MTP joint by applying screws (17-19). This rate was 87.5% among our patients treated with screws. In the literature, the malunion rate after hallux rigidus surgery was previously reported to be 6.1% (20). This

rate was 12.5% in the patient group treated with only screws. Our patients with nonunion and malunion in the screws-only group were patients with rheumatoid arthritis. This may be why the rates presented here were slightly higher than in previous reports.

In comparative studies of screw and plate/screw applications, union rates, clinical outcomes, and complication rates were found to be similar (10,16, 21). The only clear difference between these two treatment modalities is the cost. Obviously, plate/screw applications are more expensive than screws alone (10,16). Moon et al. reported in a review study that the main reason for the success of arthrodesis was good preparation of the joint, rather than the fixation method, along with good postoperative follow-up of the patient (22). In our study, there was no statistically significant difference in union rates, clinical scores, or complication rates (skin problems, deep infections, or nonunion) between the two groups ( $p > 0.05$ , Table 2).

Although not statistically significant in our study, more skin problems (11.1% vs. 0.0%) and infections (16.7% vs. 0.0%) were observed in the plate/screw group. The reason for this may be that plate application requires wider dissection, and the plate takes up more space under the skin with the bone. Screw application causes less damage to the surrounding tissues and the majority of the implants remain in the bone, taking up less space. Therefore, fewer infections and skin problems are to be expected with screws-only applications. We also observed a higher rate of delayed union in the screws-only group, although there was no statistically significant difference. We think that the reason for this is the osteoporotic bone structure, as the biomechanical stability of the screw method is less than that of the plate/screw method.

The limitations of our study are the small number of patients and the study's retrospective nature.

## CONCLUSION

Both plate/screw and screw methods are effective and safe in the treatment of arthrosis of the first MTP joint by arthrodesis. The clinical and radiological results are similar, and both methods have low complication rates. We recommend that screw fixation be the first choice due to the higher costs of plate/screw fixation. However, due to the lower biomechanical stability of screw fixation, we think that plate/screw fixation would be more appropriate in the

cases of some selected patients with osteoporotic bone defects.

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