

# First Metatarsalphalangeal Joint Arthrodesis: A Retrospective Comparison of Two Methods of Fixation

M.A. Rashid\*, M. Parnell, W.S. Khan and A. Khan

Department of Trauma and Orthopaedics, Southend University Hospital NHS Foundation Trust, Essex, SS0 0RY, UK

**Abstract:** First metatarsalphalangeal joint arthrodesis is a well established and successful treatment; however there still remains controversy over the best choice of construct. We performed a retrospective study of patients undergoing first metatarsalphalangeal fusion over eighteen months (n=52) using either dorsal non-locking plate with additional compression lag screw fixation or dorsal non-locking plate alone. We found when assessing clinical criteria, patients with dorsal non-locking plates and additional compression lag screw fixation had a significantly higher rate of fusion (100% vs 77.8%), significantly higher rate of fusion within the first two months (55.6% vs 83.3%), significantly earlier time to fusion (52.2 days vs 75.6 days), and significantly lower rate of non-union (0% vs 22.2%). When blindly assessing radiographic criteria, the patients treated with the plate and compression screw had a significantly higher rate of fusion and lower rate of non-union (0% vs 33%). There was no statistically significant difference between the frequencies of complications in the groups. We believe that the interfragmentary compression is a crucial factor in achieving good union rates and recommend the use of non-locking pre-contoured plating with additional interfragmentary compression screw as the fixation method of choice for these procedures.

**Keywords:** Arthrodesis, methods of fixation, first metatarsalphalangeal joint, retrospective study.

## INTRODUCTION

First metatarsophalangeal joint arthrodesis is a well proven operation for various disorders of the first metatarsophalangeal joint including arthritis, severe deformities and for correcting deformity after surgery. Several different ways of achieving first metatarsophalangeal joint fusion have been described and range from Kirschner wires, dorsal non-locking plates, interfragmentary compression lag screws, or a combination of a dorsal non-locking plates with interfragmentary compression lag screws. New plate technology, such as the locking plate constructs have also recently been introduced to the market.

All of the above methods have reported success rates of between 80 and 100% in the literature for first metatarsophalangeal joint fusion [1-5]. Despite this being a common procedure, there is no clear consensus as to which fixation method achieves the best results. The identification of an ideal construct will allow a high rate of fusion with minimal complications. There is data showing that the two most popular methods, dorsal non-locking plate with and without a compression lag screw, achieve high rates of fusion [6, 7], but to our knowledge there is no published clinical literature directly comparing the two. There is some evidence that combining the plate and screws with a lag screw is superior biomechanically [8, 9] but it is not known if this would translate to clinical practice.

## METHODOLOGY

We performed a retrospective multi-surgeon study of all patients who underwent a first metatarsophalangeal joint arthrodesis over the previous 18 months at our institution using patient case notes and radiographs. The patients underwent first metatarsophalangeal joint arthrodesis using either a non-locking stainless steel plate and screw construct or a non-locking plate and screws combined with a compression lag screw. The choice of construct used was based on surgeon and patient preference. The indications and past medical history was noted. All patients followed the same post-operative rehabilitation protocol.

Patients were reviewed post-operatively at six weeks with antero-posterior and lateral weight bearing radiographs of the foot. Further follow-up was arranged at six weekly intervals depending on progression of fusion. Fusion was assessed clinically, by enquiring about pain and examining the joint, and radiologically, by an independent observer. The time point when fusion was observed clinically and radiologically was recorded and divided into three groups: union (0-60 days), delayed union (61-190 days) and non union. Post-operative complications were recorded.

Statistical analysis was carried out on rates of union, delayed union and non union using Fisher exact two-tailed test. The average time of fusion was analysed using unpaired t-test.

## RESULTS

In total, 52 feet in 51 patients underwent first metatarsophalangeal joint fusion during this period at our Institution. The indication for all procedures was hallux

\*Address correspondence to this author at the Department of Trauma and Orthopaedics, Southend University Hospital NHS Foundation Trust, Essex, SS0 0RY, UK; Tel: +44 (0) 1702 435555; Fax: +44 (0) 1702 435556; E-mail: [mamunalrashid@hotmail.com](mailto:mamunalrashid@hotmail.com)

**Table 1. Comparison of fusion between two fixation methods using clinical criteria. (P = tubular dorsal plate construct fixation, PCS= dorsal plate with additional interfragmentary compression screw fixation).**

	PCS Group (n=30)	P Group (n=18)	P-Value (Fishers Exact Two-Tailed Test)
Union (0-60 days)	25 (83.3%)	10 (55.6%)	0.0489
Delayed union (61-190 days)	5 (16.7%)	4 (22.2%)	0.711
Total union (>6 months)	30 (100%)	14 (77.8%)	0.0157
Non union	0 (0%)	4 (22.2%)	0.0157

rigidus. Out of the 51 patients, 50 had osteoarthritis and one had rheumatoid arthritis. Out of the 52 feet, 18 underwent tubular dorsal plate construct fixation (P group) and 34 underwent dorsal plate with additional interfragmentary compression screw fixation (PCS group). The patients were followed-up for an average of 19 weeks (range 2-54 weeks). Four patients were lost to clinical follow-up, and a further 10 patients refused radiographs.

Table 1 shows that using clinical criteria to assess fusion, the PCS group had a significantly higher union rate than the P group at 2 months (83.3% vs 55.6%, P=0.0489), and a significantly lower non-union rate at final follow-up (0% vs 22.2%, P=0.0157).

Patients in the PCS group also had a significantly higher rate of fusion irrespective of time to fusion than the P group (P=0.02). For the patients that did achieve fusion using clinical criteria, the PCS group achieved fusion significantly earlier at an average of 52.2 days, where as the P group achieved fusion at an average of 75.6 days (P=0.0467, Unpaired t-test).

Table 2 shows that using radiological criteria, although PCS group had a higher rate of fusion than the P group at 2 months (70% vs 47%, P=0.1903), this difference was not statistically significant. The non-union rate for the PCS group was however significantly lower than the P group (0% vs 33%, P=0.0059).

There were six post-operative complications in the PCS group and three in the P group at final clinical follow-up. There were four wound infections in the PCS group compared with none in the P group. Two patients in the PCS group experienced residual pain compared with one patient in the P group. One patient in the P group experienced loosening of metalwork that resolved on metalwork removal. Another patient in the P group was unhappy with the cosmetic appearance of the toe but declined further surgery. There was no statistically significant difference between the frequencies of complications in the groups.

**DISCUSSION**

First metatarsalphalangeal joint arthrodesis is the gold standard treatment for various conditions affecting the joint [10]. While it is accepted that first metatarsalphalangeal joint arthrodesis is better in terms of outcome and patient satisfaction than arthroplasty [11] there are many different ways of performing the arthrodesis. Success rates of between 80-100% are reported for first metatarsalphalangeal joint arthrodesis in the literature regardless of technique used [1-6]. It is therefore tempting to conclude that the method of fixation is less important than factors such as surgeon preference. However with large numbers of these procedures taking place every year, small improvements in fusion rate would be significant in terms of patient satisfaction and overall cost to the health service.

In our study we found that there was a difference in fusion rates between patients treated with a plate and compression lag screw and those treated only with a plate and screw construct. When assessing clinical criteria, patients in the first group had a significantly higher rate of fusion, higher rate of fusion within the first two months, earlier time to fusion and a lower rate of non-union. When blindly assessing radiographic criteria, the patients treated with the plate and compression screw had a higher rate of fusion. Although there were no metalwork failures in the plate and compression screw group, there were more wound infections than the plate only group, albeit not clinically significant.

This has not been reported previously in the literature. A previous study compared an interfragmentary screw only fixation with interfragmentary screw and dorsal plate fixation [12], and found no significant difference between the groups. Our work supports a biomechanical study by Politi *et al.* (2003) that showed the combination of dorsal plate and compression screw was the strongest construction [9]. Politi *et al.* found the next strongest biomechanical construct to be a single compression screw followed by the

**Table 2. Comparison of fusion between two fixation methods using radiological criteria. (P = tubular dorsal plate construct fixation, PCS= dorsal plate with additional interfragmentary compression screw fixation).**

	PCS Group (n=23)	P Group (n=15)	P-Value (Fishers Exact Two-Tailed Test)
Union (0-60 days)	16 (70%)	7 (47%)	0.1903
Delayed union (61-190 days)	7 (30%)	3 (20%)	0.7085
Total union (>6 months)	23 (100%)	10 (67%)	0.0059
Non union	0 (0%)	5 (33%)	0.0059

plate only constructed, and lastly the Kirschner wires. They suggested that the reason for the lack of rigidity in the dorsal plate construction could be that the dorsal position of the plate puts it at a biomechanical disadvantage as it is the compression side. Although our study is level 4 evidence and not a constructed clinical trial we believe that it does add useful information to the debate regarding construct choice, and is the first clinical study that supports previous biomechanical work in the field. *Ex vivo* studies are useful but cannot obviously be directly translated into clinical practice.

While it is tempting to suggest that plate and compression screw is the most effective method of fixation on the basis of previously recorded high fusion rates, biomechanical evidence and our work, it is perhaps more appropriate to consider that the plate only constructed is flawed. A more detailed prospective study comparing the available first metatarsophalangeal joint constructs is needed before any definitive conclusions can be drawn.

## CONCLUSION

A dorsal plate and compression screw construct is more stable than using a dorsal plate alone. In our study, this leads to higher rates of fusion earlier. We believe that the interfragmentary compression is a crucial factor in achieving good union rates and recommends the use of non-locking pre-contoured plating with additional interfragmentary compression screw as the fixation method of choice for metatarsophalangeal joint fusions. We believe that the interfragmentary compression screw has possibly a greater role in this construct than the plate. It remains to be seen whether these results are repeated in larger clinical trials and whether the plate and compression screw construct is superior to compression screws alone.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

## ACKNOWLEDGEMENTS

Declared none.

## REFERENCES

- [1] Bennett GL, Kay DB, Sabatta J. First metatarsophalangeal joint arthrodesis: an evaluation of hardware failure. *Foot Ankle Int* 2005; 26(8): 593-6.
- [2] Mann RA, Oates JC. Arthrodesis of the first metatarsophalangeal joint. *Foot Ankle* 1980; 1(3): 159-66.
- [3] Brodsky JW, Passmore RN, Pollo FE, Shabat S. Functional outcome of arthrodesis of the first metatarsophalangeal joint using parallel screw fixation. *Foot Ankle Int* 2005; 26(2): 140-6.
- [4] Gibson JN, Thomson CE. Arthrodesis or total replacement arthroplasty for hallux rigidus: a randomized controlled trial. *Foot Ankle Int* 2005; 26(9): 680-90.
- [5] Nash WJ, Al-Nammari S, Khan WS, Pengas IP. Surgical management of the forefoot in patients with rheumatoid arthritis - a review article. *Open Orthop J* 2015; 9: 84-9.
- [6] Kumar S, Pradhan R, Rosenfeld PF. First metatarsophalangeal arthrodesis using a dorsal plate and a compression screw. *Foot Ankle Int* 2010; 31(9): 797-801.
- [7] Bennett GL, Sabetta J. First metatarsophalangeal joint arthrodesis: evaluation of plate and screw fixation. *Foot Ankle Int* 2009; 30(8): 752-7.
- [8] Curtis MJ, Myerson M, Jinnah RH, Cox QG, Alexander I. Arthrodesis of the first metatarsophalangeal joint: a biomechanical study of internal fixation techniques. *Foot Ankle* 1993; 14(7): 395-9.
- [9] Politi J, John H, Njus G, Bennett GL, Kay DB. First metatarsophalangeal joint arthrodesis: a biomechanical assessment of stability. *Foot Ankle Int* 2003; 24(4): 332-7.
- [10] Yee G, Lau J. Current concepts review: hallux rigidus. *Foot Ankle Int* 2008; 29(6): 637-46.
- [11] Gibson JN, Thomson CE. Arthrodesis or total replacement arthroplasty for hallux rigidus: a randomized controlled trial. *Foot Ankle Int* 2005; 26(9): 680-90.
- [12] Sharma H, Bhagat S, Deleeuw J, Denolf F. *In vivo* comparison of screw *versus* plate and screw fixation for first metatarsophalangeal arthrodesis: does augmentation of internal compression screw fixation using a semi-tubular plate shorten time to clinical and radiologic fusion of the first metatarsophalangeal joint (MTPJ)? *J Foot Ankle Surg* 2008; 47(1): 2-7.

Received: December 11, 2014

Revised: March 3, 2015

Accepted: May 22, 2015

© Rashid *et al.*; Licensee *Bentham Open*.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.