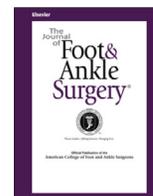




Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Early Weight-Bearing After Arthrodesis of the First Metatarsal-Phalangeal Joint: A Systematic Review of the Incidence of Non-Union

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ARTICLE INFO

Level of Clinical Evidence: 4

Key words:

fusion
great toe
hallux
metatarsophalangeal
postoperative course

ABSTRACT

Arthrodesis of the first metatarsal-phalangeal joint is a reliable procedure for correction of both hallux limitus/rigidus and severe hallux abducto valgus deformities. However, 1 potential contraindication to the procedure is the extended period of non-weight-bearing immobilization that is typically associated with the postoperative course. The objective of this investigation was to perform a systematic review of the incidence of non-union after early weight bearing in patients who underwent arthrodesis of the first metatarsal-phalangeal joint. We performed a review of electronic databases with the inclusion criteria of retrospective case series, retrospective clinical cohort analyses, and prospective clinical trials with $n \geq 15$ feet, a mean follow-up of ≥ 12 months, a defined postoperative early weight-bearing protocol (defined as ≤ 2 weeks), a clear description of the fixation construct, a reported incidence rate of non-union, and patients who underwent primary surgery for hallux abducto valgus or hallux limitus/rigidus deformities. Seventeen studies met our inclusion criteria, with a total of 898 feet analyzed. Of these, 57 (6.35%) were described as developing a non-union. This would likely be considered an acceptable crude, heterogeneous incidence of non-union when considering this procedure. It might also indicate that arthrodesis of the first metatarsal-phalangeal joint does not always require an extended period of non-weight-bearing postoperative immobilization.

Published by Elsevier Inc. on behalf of the American College of Foot and Ankle Surgeons.

Arthrodesis of the first metatarsal-phalangeal joint is a reliable procedure for correction of both hallux limitus/rigidus and severe hallux abducto valgus deformities (1). However, one potential relative contraindication to the procedure is the extended period of non-weight-bearing immobilization that is typically associated with the postoperative course. Because asymptomatic consolidation of the arthrodesis site is required for successful outcome, a 6- to 8-week period of non-weight-bearing cast immobilization is often prescribed (2–8). However, not all patients are able to tolerate this recommendation, in addition to the potential complications associated with prolonged immobilization (muscular atrophy, thrombotic events, etc.) (9,10). Secondary to these considerations, several authors have proposed early or immediate weight-bearing after the procedure (11–14). These have typically consisted of Level 4 retrospective case series with varying fixation constructs and numbers of patients.

The objective of this investigation was to perform a systematic review of the incidence of non-union after early weight-bearing in

patients who underwent arthrodesis of the first metatarsal-phalangeal joint.

Materials and Methods

We performed a systematic review of medical literature, including on PubMed and Ovid through Medline (available at <http://www.ncbi.nlm.nih.gov/pubmed> and <http://ovidsp.ovid.com/autologin.cgi>), Embase (available at <https://www.embase.com/login>), and the Cochrane Database of Systematic Reviews (available at <http://www.cochranelibrary.com/cochrane-database-of-systematic-reviews>). Additionally, we performed a manual search of the references of any article that we identified as meeting our inclusion criteria. The search was performed in July 2016 with no restriction on publication date and with the word query: (“arthrodesis” OR “fusion”) AND (“first metatarsal-phalangeal” OR “first metatarsophalangeal” OR “1st MPJ” OR “1st MTPJ” OR “first MPJ” OR “first MTPJ” OR “hallux valgus” OR “hallux rigidus” OR “hallux limitus”). The abstracts returned from these searches were initially individually reviewed by a single author (A.J.M.) for potential relevance. Each potentially relevant report was then reviewed by all study authors (A.C., J.C.V., and A.J.M.) for our specific inclusion/exclusion criteria. Complete agreement was necessary for final inclusion.

Inclusion criteria consisted of retrospective case series, retrospective clinical cohort analyses, and prospective clinical trials with $n \geq 15$ feet, a mean follow-up of ≥ 12 months, a postoperative early weight-bearing protocol (defined as ≤ 2 weeks), a clear description of the fixation construct, a reported incidence of non-union, and patients who underwent primary surgery for hallux valgus or hallux limitus/rigidus deformities (Table). Reports of patients who underwent revisional procedures or procedures for rheumatoid arthritis and other inflammatory conditions were excluded. If an investigation consisted of patients who underwent arthrodesis for a

Financial Disclosure: None reported.

Conflict of Interest: None reported.

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variety of indications and revisional, rheumatoid, or inflammatory groups could not be factored out of the provided results, then the study was excluded. Only full-text reports were considered, and studies not published in English were excluded.

Results

The searches for potentially relevant articles yielded 125 unique studies. We then obtained and reviewed each of these for our specific inclusion/exclusion criteria, which resulted in the final inclusion of 17 (13.60%) published reports (15–31). Nine (52.94%) of the included studies were retrospective cohort analyses (15,16,18–20,24,25,27,31), 1 (5.88%) was a prospective cohort analysis (28), 6 (35.29%) were retrospective comparative cohort analyses

(17,22,23,26,29,30), and 1 (5.88%) was a prospective randomized controlled trial (21). In total, these 17 studies included analysis of 898 arthrodeses; of these, 57 (6.35%) were described as developing a non-union.

In terms of the described fixation constructions, 306 (34.08%) arthrodeses were fixated with some form of plate (17,20,23,26,28,29,31); 192 (21.38%) arthrodeses were fixated with crossed compression screws (18,26,27,30); 125 (13.92%) arthrodeses were fixated with a single compression screw (23,24); 87 (9.69%) arthrodeses were fixated with catgut suture (16); 84 (9.35%) arthrodeses were fixated with Kirshner wires or cerclage wire (21,30); 70 (7.80%) arthrodeses were fixated with staples (19,25); and 34 (3.79%) arthrodeses were not stabilized with any internal

Table
Summary of included articles and results

Authors	Study Design	Number of Arthrodeses	Fixation Construct	Postoperative Weight-bearing Protocol	Reported Incidence of Non-union
Humbert et al., 1979 (15)	Retrospective cohort analysis	n = 34 (3.79%)	No fixation	Immediate progressive weight-bearing as tolerated (no device specified)	10/34 (29.41%)
Chana et al., 1984 (16)	Retrospective cohort analysis	n = 87 (9.69%)	Catgut suture	Heel weight-bearing in a cast at 3 postoperative days	9/87 (10.34%)
Coughlin and Abdo, 1994 (31)	Retrospective cohort analysis	n = 26 (2.90%)	Dorsal plate	Immediate weight-bearing in a surgical shoe	0/26 (0.0%)
Coughlin and Shurnas, 2003 (17)	Retrospective comparative cohort analysis	n = 34 (3.79%)	Dorsal plate with screw construct	Immediate partial weight-bearing in a surgical shoe	2/34 (5.88%)
Ettl et al., 2003 (18)	Retrospective cohort analysis	n = 38 (4.23%)	Crossed screws	Full weight-bearing in a surgical shoe at 2 postoperative weeks	0/38 (0.0%)
Choudhary et al., 2004 (19)	Retrospective cohort analysis	n = 25 (2.78%)	Dorsal staples	Immediate full weight-bearing in a surgical shoe	1/25 (4.0%)
Coughlin et al., 2005 (20)	Retrospective cohort analysis	n = 21 (2.34%)	Dorsal plate with screw and/or wire	Heel weight-bearing in a surgical shoe at 10 postoperative days	3/21 (14.29%)
Gibson and Thomson, 2005 (21)	Prospective randomized controlled trial	n = 36 (4.01%)	Cerclage wire bucket handle construct	Immediate weight-bearing as tolerated in a cast	0/36 (0.0%)
Beertema et al., 2006 (22)	Retrospective comparative cohort analysis	n = 4 (3.79%)	Crossed screws	Immediate weight-bearing as tolerated in a cast	3/34 (8.82%)
Sharma et al., 2008 (23)	Retrospective comparative cohort analysis	n = 34 (3.79%)	Combination of a screws and screw with a dorsal plate	Immediate heel weight-bearing in a surgical shoe	1/34 (2.94%)
Wassink and van den Oever, 2009 (24)	Retrospective cohort analysis	n = 109 (12.14%)	Single screw	Immediate weight-bearing as tolerated in a cast	4/109 (3.67%)
Besse et al., 2010 (25)	Retrospective cohort analysis	n = 45 (5.01%)	Dorsal staples	Immediate weight-bearing as tolerated in a cast	1/45 (2.22%)
Sung et al., 2010 (26)	Retrospective comparative cohort analysis	n = 58 (6.46%)	Combination of crossed screws, dorsal plates, and dorsal plates with a screw	Weight-bearing in a cast boot at 14 postoperative days	3/58 (5.17%)
Van Doeselaar et al., 2010 (27)	Retrospective cohort analysis	n = 62 (6.90%)	Crossed screws	Immediate heel weight-bearing in a surgical shoe	3/62 (4.84%)
Doty et al., 2013 (28)	Prospective cohort analysis	n = 42 (4.68%)	Dorsal plate and screw	Immediate heel weight-bearing in a surgical shoe	1/42 (2.38%)
Hyer and Morrow, 2014 (29)	Retrospective comparative cohort analysis	n = 116 (12.92%)	Combination of a dorsal plate and a dorsal plate with screw	Weight-bearing initiated within 10 postoperative days	13/116 (11.21%)
Storts and Camasta, 2016 (30)	Retrospective comparative cohort analysis	n = 97 (10.80%)	Combination of crossed screws and wires	Immediate weight-bearing in a surgical shoe	3/97 (3.09%)
Total		n = 898			57/898 (6.35%)

fixation (15). In terms of postoperative weight-bearing protocols, 320 (35.63%) arthrodeses were allowed some form of immediate weight-bearing in a surgical shoe (17,19,23,27,30,31); 311 (34.63%) arthrodeses were allowed some form of immediate weight-bearing in a cast (16,21,22,24,25); 150 (16.70%) arthrodeses were allowed variable forms of weight-bearing ≤ 14 days (15,29); 59 (6.57%) arthrodeses were allowed delayed weight-bearing in a surgical shoe ≤ 14 days (18,20); and 58 (6.46%) arthrodeses were allowed delayed weight-bearing in a cast boot ≤ 14 days (26).

Discussion

The objective of this systematic review was to evaluate the incidence of non-union in patients who underwent arthrodesis of the first metatarsal-phalangeal joint with implementation of an early weight-bearing protocol. We observed an incidence of non-union of 6.35% (57/898), and we conclude that this is a reasonably acceptable incidence of non-union when considering this procedure. For example, in another systematic review of this procedure without specifically examining for weight-bearing restrictions, Roukis (8) found a non-union incidence of 5.4%. This indicates that arthrodesis of the first metatarsal-phalangeal joint likely does not always require an extended period of postoperative non-weight-bearing immobilization.

As with any scientific investigation, critical readers are encouraged to review and assess the study design and specific results and reach their own independent conclusions. However, the preceding represents our conclusions based on the data. We also understand that all investigations have limitations, and this one had several to consider that are inherent to systematic reviews. First, we did not use every available electronic database for our search, only those that we find most useful in our clinical practices. Additionally, this type of search process, particularly the initial abstract screening for potentially relevant articles, is prone to human error and subjectivity. Because of this, it is possible that other investigations met our inclusion criteria but were not included in this report.

Second, we excluded articles based on our specific inclusion/exclusion criteria that could be considered limiting/restrictive. Another group of authors undertaking a similar investigation with another group of less strict inclusion/exclusion criteria would likely report a different incidence rate of non-union. As an example, we chose to define early weight-bearing as ≤ 14 days, whereas other studies have chosen to define early weight-bearing as several weeks. On the other hand, our inclusion/exclusion criteria could also be considered too lenient. As an example of this, we did not include any restrictions with respect to fixation constructs. Because of this, we identified 2 studies that met our inclusion criteria that included no fixation or the use of catgut suture for fixation (15,16). These would probably best be considered historical and not consistent with contemporary clinical practice. Exclusion of these 2 studies would have resulted in bringing the total number of included studies down to 15, the total number of arthrodeses to 777, and the total number of reported non-unions to 38. This would have resulted in a reported non-union rate of 4.89% (38/777).

We also did not include any restrictions with respect to pathology. It might have been more conservative to include only investigations examining hallux abducto valgus, for example. This investigation also did not include any reporting of functional outcome measures and instead relied solely on non-union rates. Our aim, moreover, was to simply describe the observed incidence of non-union in patients who underwent arthrodesis of the first metatarsal-phalangeal joint. We did not undertake tests of heterogeneity to determine if the data were suitable for pooling, and, as such, we did not undertake a quantitative meta-analysis of the published reports that met our inclusion criteria.

Finally, this type of investigation is reliant on the details and descriptions provided by other authors. It is most conservative to exclude reports or results that do not provide appropriate detail. Most relevant to this investigation is the varying and sometimes vague definitions used by authors for the diagnosis of non-union. This is also a study of complications and is therefore reliant on authors accurately and truthfully reporting their complications. Additionally, it is possible that accurate reporting of surgical complications is underreported in the medical literature if authors chose to focus primarily on successful surgical outcomes. Finally, we did not statistically test the heterogeneity of the reports that we reviewed; and, instead, assumed that a high degree of heterogeneity existed between the different studies. As such, we did not employ a weighted average, and simply described to observed, pooled average as reported in the selected reports.

In conclusion, we observed a pooled incidence of non-union after arthrodesis of the first metatarsal-phalangeal joint with an early weight-bearing protocol of 6.35%. This investigation adds to the body of knowledge with respect to arthrodesis of the first metatarsal-phalangeal joint. It will hopefully lead to further investigations on the topic; provide foot and ankle surgeons with an objective measure of the perioperative risk associated with the procedure; and allow foot and ankle surgeons to more effectively communicate these risks to their patients during the education and consent process.

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