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Review

Jones fracture of the fifth metatarsal: Is operative intervention justified? A systematic review of the literature and meta-analysis of results

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HIGHLIGHTS

- Metatarsal fractures occur commonly at 6.7 fractures per 10,000 people.
- There is lack of clarity in classifying and treating the Jones' fractures.
- The natural history of healing of Jones' fractures has been shown to be suboptimal.
- Our meta-analysis showed surgery gives significantly decreased odds of nonunion.
- We found surgery had faster rates of union, return to sports and activity.

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ABSTRACT

Background: This study assesses the outcomes of surgical vs. conservative management in the treatment of the Jones fracture.
Materials and methods: A systematic review using four databases from their inception until September 2014 was undertaken. Six studies were found evaluating operative therapy compared to conservative treatment.
Results: Six relevant studies were included, with a total of 237 patients. Of these, 51% were treated non-operatively, and 49% had surgical intervention. Those in the non-operative group were found to have a significantly higher odds ratio (OR) of fracture non-union (OR 5.74, 95% confidence interval (CI) 2.65–12.40, $P < 0.001$). Studies also reported a prolonged healing time and a longer time to return to sports. Of the trials with time to union as an outcome measure, 3 of 4 trials found favourable results in the operative cohort.
Conclusions: Surgical intervention is recommended for patients presenting with a Jones fracture as it is found to result in a lesser non-union rate and an improved time to union.

1. Introduction

1.1. Epidemiology and classification

Fractures of the metatarsal bones are a common injury presenting to orthopaedic clinics with a reported incidence of 6.7 fractures per 10,000 people. The most frequently fractured metatarsal is the fifth [1]. Sir Robert Jones first described his eponymous fracture of the proximal fifth metatarsal in 1902 [2], and optimal management for this has not gained consensus in the intervening century [3]. There is lack of clarity in the literature surrounding classification and treatment of Jones' fractures [4]. Torg et al. [5] described the most commonly used system of classification of fifth metatarsal fractures, although many other systems are available and used [3,6]. According to the Torg classification [5] the true Jones' fracture involves the proximal part of the diaphysis distal to the tuberosity of the fifth metatarsal. The patterns of

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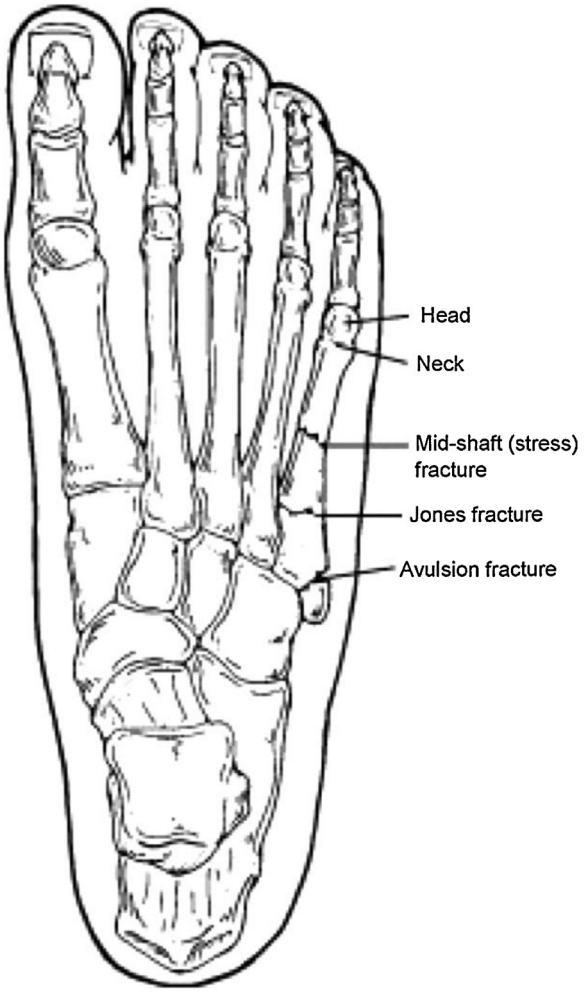

Fig. 1. Artist's impression of fifth metatarsal fractures. Adapted with permission from Zwitser and Breederveld [6].

fifth metatarsal fractures, including the Jones fracture, are shown in Fig. 1 [6].

1.2. Anatomy

The proximal section of fifth metatarsal is a vascular watershed region, resulting in high rates of delayed union or non-union subsequent to fracture [7,8]. An anatomical study by McKeon et al. [8] determined that branches of the dorsalis pedis artery (lateral tarsal branch), posterior tibial artery (lateral plantar artery), and peroneal artery all contribute branches to the blood supply of the fifth metatarsal. A nutrient artery from the fourth plantar metatarsal artery also supplies the area, inserting into the proximal diaphysis, supplying a retrograde branch to the fifth metaphysis.

1.3. Purpose

Conservative or surgical management options are described for a Jones' fracture. The natural history of healing of Jones fractures has been shown to be suboptimal [7,9–16]. Consensus on optimal surgical technique is lacking, although intramedullary fixation is the most popular choice [9]. This study aims to present a systematic review of the literature to assess the evidence for surgical and conservative management. We review the difference in outcomes of surgical and non-operative patients with Jones fractures in terms of non-union rates, time to bone union, and complications of the different treatment options.

Table 1
Boolean phrases used to attain abstracts.

Database	Search strategy
Cochrane Library	Jones OR Jone's OR Jones' OR metatarsal AND fracture
AMED	TX Jones OR Jone's OR Jones' OR metatarsal AND fracture
Embase	Jones OR metatarsal AND ('fracture'/exp OR fracture)
Medline/PubMed	((((Jones) OR Jone's) OR Jones') OR metatarsal) AND fracture

2. Materials and methods

2.1. Study eligibility

All randomized and non-randomized comparative studies assessing both surgical and conservative treatments of Jones fractures were included. In papers that reported on Jones' fractures as well as other metatarsal fractures, these papers were included but only information about the Jones' fractures were used. Studies which did not compare operative and non-operative methods, did not acutely intervene with surgical intervention, or did not focus on Jones' fractures were excluded. Animal and cadaver studies were not included in the review. Studies were also excluded in those papers where conservatively treated acute fractures are compared to surgically treated chronic or stress fractures.

2.2. Search strategy

The following online databases were searched from their inception to September 2014 using a preferred reporting items for systematic reviews and meta-analysis (PRISMA) compliant search strategy [17]: the Cochrane Library, the Allied and Complementary Medicine Database (AMED), Excerpta Medica Database (Embase), and Medline/PubMed. There was no restriction of papers due to language, publication status or publication type. The Boolean operations used Jones, metatarsal and fracture as keywords in all search fields. The search strategy for each database is shown in Table 1.

All titles and abstracts obtained using the search strategy was reviewed by one author. Potential articles were then reviewed by two authors (J.Y. and S.S.) to obtain a list of eligible studies. Any disagreements were resolved by discussion with a third author (I.F.). The PRISMA flow diagram is demonstrated as Fig. 2.

2.3. Data extraction

Relevant data from the eligible studies was extracted by two authors (J.Y. and I.F.) and included in Tables 2 and 3.

2.4. Outcome measures

Original outcomes of interest included non-union rates, delayed union rates, time to radiological union, and complication types and rates of occurrence. Time to sport and duration of sick leave were included as secondary measures. If no clear distinction between non-union and delayed union was stated as an outcome, it was considered non-union [18]. Time to healing is shown in Table 3 as reported in the original studies.

2.5. Statistical analysis

Statistical analysis was carried out using Review Manager (RevMan) Version 5.3 (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration). A chi-squared test and I^2 statistic were used to measure significant heterogeneity. Where significant

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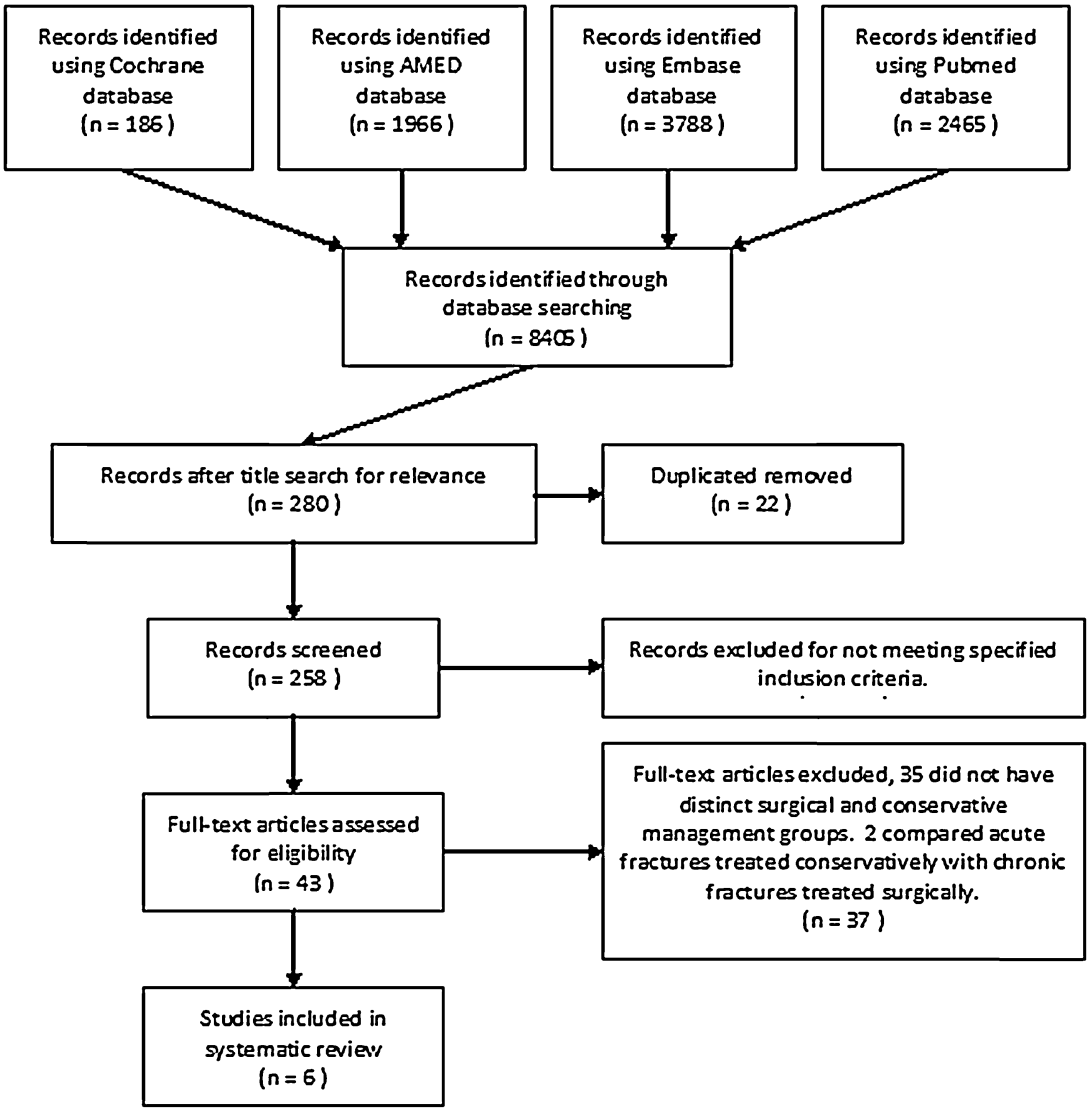

Fig. 2. PRISMA flow chart of literature search.

heterogeneity was found ($I^2 > 50\%$, $P < 0.05$ from chi-squared test), a random effects model was used instead of a fixed effects model. Because of the zero or low number of non-unions in the surgery group, a Peto odds-ratio method of estimation was used for this analysis.

2.6. Bias assessment

Individual studies were tested using the Cochrane tool for assessing bias as shown in Table 4.

3. Results

3.1. Study selection

The search strategy yielded 186 results from Cochrane Library, 1966 from AMED, 3788 from Embase and 2465 from Medline/PubMed, totalling 8405 articles. Screening of the initial search yielded nine studies from Cochrane Library, 50 from AMED, 77 from Embase and 144 from Medline/Pubmed were left totalling 280. Duplicates were removed, leaving 258. Abstracts of the 258 remaining papers were reviewed and after further screening 43 articles remained. These 43 articles were reviewed by two authors, of which six articles were deemed as satisfying inclusion and exclusion criteria. This is shown in Fig. 2.

3.2. Study characteristics

The six articles included are: Mologne et al. [14], Josefsson et al. [15], Chuckpaiwong et al. [19], Ekstrand et al. [16], Adhikari et al. [13], and Kavanaugh et al. [20] Ekstrand et al. [16] did not specify specific treatment regimens or follow-up times. An overview of the types of studies as well as interventions used, number of patients included and follow-up periods is included in Table 2.

A meta-analysis was performed to calculate the pooled odds ratio (OR) of non-union using conservative measures against surgical intervention. Our meta-analysis showed a statistically significant difference in the odds of non-union in those treated conservatively against those who underwent surgical intervention (29/122 vs. 3/115, OR 5.74, 95% CI 2.65–12.40, $P < 0.001$, $I^2 = 0\%$). The Forest plot illustrating odds ratio for non-union is shown in Fig. 3.

4. Discussion

We reviewed the literature to assess differences in outcomes between operative and non-operative management of the Jones'

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Table 2
Characteristics of the included studies.

Reference	Study design	Number of patients	Intervention	Mean follow-up period in months
Mologne et al. [14]	Prospective randomized trial	18 19	NWB cast for 8 weeks + WB cast until union Intramedullary screw + NWB splint for 2 weeks	25.3
Josefsson et al. [15]	Retrospective nonrandomized trial	44 22	Elastic bandage or cast for 5 weeks Intramedullary screws followed + cast for 2.5 weeks	60
Chuckpaiwong et al. [19]	Retrospective therapeutic study	17 18	NWB cast for 4–6 weeks + WB splint for 4–8 weeks Intramedullary screw fixation	40
Ekstrand et al. [16]	Prospective nonrandomized trial	9 28	– –	–
Adhikari et al. [13]	Prospective randomized trial	16 15	NWB cast for 8 weeks + walking cast for 4 weeks or until union Intramedullary screw fixation + NWB cast for 2 weeks	12
Kavanaugh et al. [20]	Retrospective analysis	18 13	NWB cast for 5–6 weeks + further NWB if not healed Intramedullary screw fixation + NWB cast for 4–6 weeks or WB cast for 10 days.	42

NWB, non-weight-bearing; WB, weight-bearing.

fracture. Previous systematic reviews on the topic have been equivocal, the most recent being Kerkhoffs et al. [4]. This review includes an additional 3 studies with both conservative and surgical groups. The outcomes of interest were time to union, non-union rate, time to sporting activity, time off work and complications from the treatment. Our study shows a significant difference in the outcomes of those treated surgically compared to conservative management, with lower rates of non-unions in the former, with a range from 0 to 11%; non-operative management being shown to have a non-union range of 11–50%.

Three of the four studies which reported time to union found it to be significantly less in patients treated surgically [13,14,20], as was time to return to sports [14,19] and return to normal activity [13], although there did not appear to be a correlation with length of sick leave [15,19]. There was no reported statistical significance in satisfaction rate between non-surgically

Table 3
Data from included studies.

Paper	Treatment	Non-union rate	Time to union (weeks)	Return to sport (weeks)	Sick leave (weeks)	Satisfaction rate	Return to normal activity (weeks)	Visual analogue pain score	Complications
Mologne et al. [14]	C	5/18	14.5	15.6					5 non-unions, 1 delayed union, 2 refractures
	S	1/19	6.9	7.9					1 non-union
Josefsson et al. [15]	C	8/44			6 .14				8 delayed unions, 2 refractures
	S	0/22			5 .86				5 screw discomfort, 3 refractures
Chuckpaiwong et al. [19]	C	3/17	26.1	30	2 .65	80 .5%			3 non-unions
	S	2/18	27	15.3	5 .8	75 .5%			2 non-unions, 2 screw discomfort
Ekstrand et al. [16]	C	1/9		10.6					5 refractures, 1 non-union
	S	0/28		11.4					7 refractures
Adhikari et al. [13]	C	3/16	13.2				15.15	1.5	3 non-unions, 3 malunions
	S	0/15	8.3				9.67	0.2	No major complications
Kavanaugh et al. [20]	C S	9/18 0/13	24.5 All healed by 13 weeks	18.4 All returned by 6 weeks			18.4 All returned by 6 weeks		11 refractures 1 screw discomfort

C, conservative; S, surgery.

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Table 4
Cochrane tool for assessing bias.

	Mologne et al. [14]	Josefsson et al. [15]	Chuckpaiwong et al. [19]	Ekstrand et al. [16]	Adhikari et al. [13]	Kavanaugh et al. [20]
Adequate sequence generation	Y	N	N	N	Y	N
Allocation concealment	Y	N	N	N	Y	N
Blinding	N	N	N	N	N	N
Incomplete outcome data addressed	Y	Y	Y	Y	Y	Y
Free of selective reporting	Y	Y	Y	Y	Y	Y
Free of other bias						
Description of statistics	Y	U	Y	Y	Y	U
Selection/recruitment stated	Y	Y	Y	Y	Y	Y
Sample typical of normal practice	Y	Y	Y	Y	Y	Y
Free from treatment selection bias	Y	U	U	U	Y	U
Co-interventions stated	Y	Y	Y	Y	Y	Y

Y, yes; N, no; U, unclear.

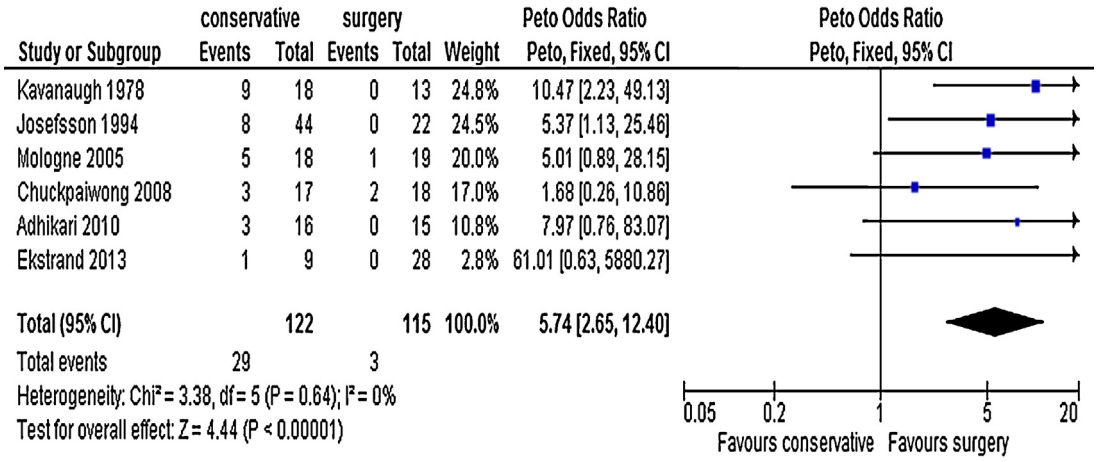

Fig. 3. Forest plot for odds ratio of non-union: conservative vs. surgery.

and surgically treated patients [19]; but there was a significant improvement in visual analogue pain score in patients who underwent surgery [13]. There were more complications in the non-operative groups, which often required surgical correction. A pooled total of 38 out of 122 (31%) patients needed surgery after conservative treatment compared to 9 out of 106 (8.5%) surgical patients needing a repeat operation. Complications common to both groups included re-fractures, delayed union, and non-union while some surgically treated patients complained of screw discomfort.

All papers included populations largely consisting of young athletic men. Mologne had 35 of 37 patients male, 58 of 64 fractures were in male patients reported by Josefsson, Ekstrand had exclusively male patients and Kavanaugh included only 1 female. Patients were in groups of increased activity as shown by Mologne having 36 of 37 patients being active duty servicemen, Ekstrand's cohort were all elite athletes, Kavanaugh had mostly college level athletes and Chuckpaiwong had the majority of patients either recreational or elite athletes. Also, all papers who reported average age of patients were found to have young populations with mean ages ranging from 20.3 years by Kavanaugh, 23 years with Ekstrand, 25.6 years with Mologne to 27 years with Chuckpaiwong. Both Kavanaugh and Chuckpaiwong reported no statistically significant differences in body mass index or ethnicity in terms of healing. As all papers had similar populations, no demographic data included can explain differences between papers.

Other reviews have seen similar results. It has been expressed in the literature that surgical intervention results in significantly better union rates than conservative treatment [3,4,10,21], with reduced complication rates [3,10,22], earlier return to pre-injury activities, and shorter time to fracture union [3,4,10,22].

There is a lack of consensus pertaining to the definition of a Jones fracture within the literature [3,18,19]. Torg et al. [5] described the most commonly used system for classification of the 5th metatarsal fracture [6]. Fractures are classified into one of two types: those involving the tuberosity, and the true Jones fracture which involves the proximal part of the diaphysis distal to the tuberosity [5]. Torg et al. [5] further divided the Jones fractures into three types as show in Table 5. The true Jones fracture is considered difficult to treat, as indicated by its prolonged time to union [12–14], high delayed union and non-union rates [7,9–16].

Other systems include Lawrence and Botte [23] and the Stewart classification [24] which both divide the fifth metatarsal into zones to classify fractures.

Table 5
Torg classification of 5th metatarsal fracture.

Torg class	Description
Type 1	• No history of previous trauma • Fracture line with sharp margins • Minimal cortical hypertrophy or periosteal reaction to chronic stress
Type 2	• Having previous injury or fracture • Fracture line involving both cortices • Associated with periosteal new bone • Widened fracture line with adjacent radiolucency due to bone resorption
Type 3	• Evidence of intramedullary sclerosis • History of repetitive trauma and recurrent symptoms • Wide fracture lines with periosteal new bone and radiolucency • Complete obliteration of the medullary canal at the fracture site by sclerotic bone

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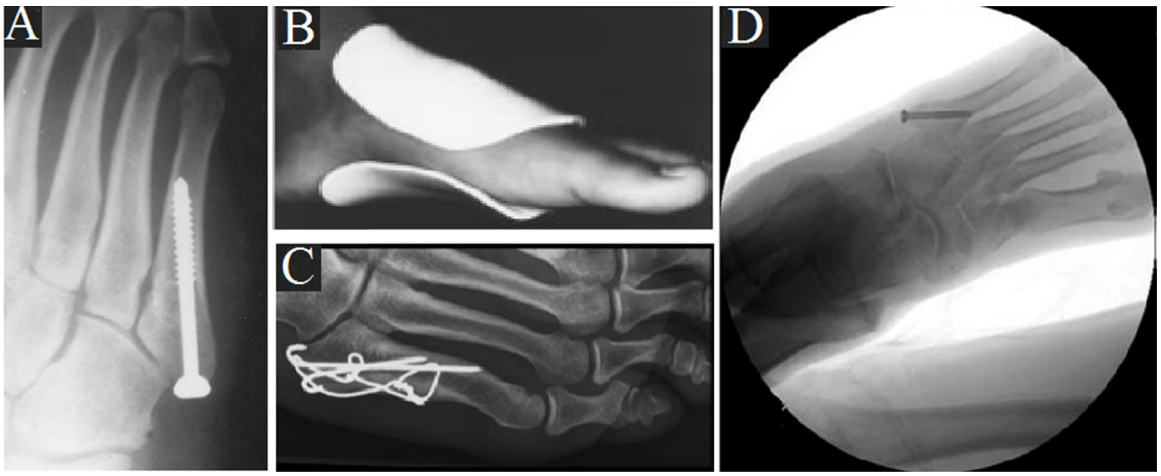

Fig. 4. Various fixation methods for Jones fractures (all images adapted with permission): (A) intramedullary screw fixation (Mologne et al. [14]), (B) functional brace (Dameron [25]), (C) tension wiring and lateral compression (Josefsson et al. [15]), and (D) bicortical screw fixation (McKeon et al. [8]).

Historically, the management of Jones fractures has been largely driven by consensus [21]. Patients requiring a shorter time to recovery, those with a displaced or angulated fracture, those with cubometatarsal joint involvement, chronic stress fractures, and Torg Type III (as detailed in Table 5) tend to undergo surgical management [6,10,18]. Various operative techniques are described, including crossed K-wire fixation, intramedullary devices, and tension band constructs, illustrated in Fig. 4 [7]. For those where there is little to no displacement, Torg Type I and II fractures, or those patients who are hesitant about having surgery, both conservative and surgical treatments remain viable options [6,10,18]. However we have shown in this meta-analysis that the rate of non-union is significantly higher in the conservatively treated groups.

Various surgical techniques are in use for treatment of the Jones fracture. From this systematic review, we have shown the standard technique used in previous comparison trials is with a cannulated intramedullary (IM) screw. This method results in central compression [16] and resistance to tensile forces [26], but fails to provide lateral compression of the cortex [16] and offers little resistance against rotational forces [26]. IM screws can be technically demanding, with post-operative complications including screw breakage and persistent discomfort [27]. To improve lateral compression of the bone and provide increased support vs. rotational force, compression-plate fixation or tension band wiring could be viable alternatives to IM screws [16,26], however these options may cause greater disruption in the blood supply to 5th metatarsal fracture fragments [26]. Alternatively Mahajan et al. [9] suggest bicortical screw fixation may provide greater stability than IM screws. Optimal surgical treatment for the Jones fracture has yet to be determined but the ideal method is one that can withstand torsional stress as well as tension and bending of the metatarsal [26,27]. Due to the many different surgical methods available further randomized control trials must be conducted in order to determine the best surgical technique for management of the Jones fracture.

Cochrane's Risk of Bias assessment was used and is shown in Table 4, and demonstrates some of the limitations of this study. Only two randomized control trials are available, both non-blinded due to the difficulty in blinding of patients to treatment. All studies successfully included data for all pre-specified outcomes; however there was no clear inter-study consensus regarding definition of non-union and delayed union. Josefsson et al. [15] and Chuckpaiwong et al. [19] included the outcome of sick leave. Reasons for sick leave and for length of time out of work were not included, and indeed would be patient occupation specific. It is a difficult outcome to standardize across patients and practitioners [28]. Four of our included studies are not randomized control trials, with inherent risk for selection bias whereby patients that were deemed most likely to heal by conservative management would have been put into the conservative treatment group [3]. Interventions and post-operative instructions were not homogenous throughout the studies reviewed.

5. Conclusions

This systematic review of level 3 and 4 studies find in favour of surgical intervention of a Jones fracture. We found there to be a lower non-union rate, faster time to union and return to sports and activity in patients treated surgically. Our findings are similar to others in the literature; however, further randomized control trials to determine optimal operative treatment is needed.

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Conflict of interest

None.

References

[1] Petrisor BA, Ekrol I, Court-Brown C. The epidemiology of metatarsal fractures. Foot Ankle Int 2006;27(3):172–4.
[2] Jones RI. Fracture of the base of the fifth metatarsal bone by indirect violence. Ann Surg 1902;35(6):697–702.
[3] Dean BJ, Kothari A, Uppal H, Kankate R. The Jones fracture classification, management, outcome, and complications: a systematic review. Foot Ankle Spec 2012;5(4):256–9.
[4] Kerkhoffs GM, Versteegh VE, Sierevelt IN, Kloen P, van Dijk CN. Treatment of proximal metatarsal V fractures in athletes and non-athletes. Br J Sports Med 2012;46(9):644–8.
[5] Torg JS, Balduini FC, Zelko RR, Pavlov H, Peff TC, Das M. Fractures of the base of the fifth metatarsal distal to the tuberosity: classification and guidelines for non-surgical and surgical management. J Bone Joint Surg Am 1984;66:209–14.
[6] Zwitser EW, Breederveld RS. Fractures of the fifth metatarsal; diagnosis and treatment. Injury 2010;41(6):555–62.
[7] Ding BC, Weatherall JM, Mroczek KJ, Sheskier SC. Fractures of the proximal fifth metatarsal: keeping up with the Joneses. Bull NYU Hosp Jt Dis 2012;70(1):49–55.

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[8] McKeon KE, Johnson JE, McCormick JJ, Klein SE. The intraosseous and extraosseous vascular supply of the fifth metatarsal: implications for fifth metatarsal osteotomy. Foot Ankle Int 2013;34(1):117–23.
[9] Mahajan V, Chung HW, Suh JS. Fractures of the proximal fifth metatarsal: percutaneous bicortical fixation. Clin Orthop Surg 2011;3(2):140–6.
[10] Thevendran G, Deol RS, Calder JDF. Fifth metatarsal fractures in the athlete: evidence for management. Foot Ankle Clin 2013;18(2):237–54.
[11] Inokuchi S, Usami N. Jones' fracture. Foot 1997;7(2):75–8.
[12] Fernandez Fairen M, Guillen J, Busto JM, Roura J. Fractures of the fifth metatarsal in basketball players. Knee Surg Sports Traumatol Arthrosc 1999;7(6):373–7.
[13] Adhikari BR, Thakur R, Gurung G. Comparative study of early screw fixation versus cast application on the treatment of acute Jones fracture. Postgrad Med J Natl Acad Med Sci 2010;10(2):4–9.
[14] Mologne TS, Lundeen JM, Clapper MF, O'Brien TJ. Early screw fixation versus casting in the treatment of acute Jones fractures. Am J Sports Med 2005;33(7):970–5.
[15] Josefsson PO, Karlsson MF, Redlund-Johnell IF, Wendeberg B. Jones fracture: surgical versus nonsurgical treatment. Clin Orthop Relat Res 1994;299:252–5.
[16] Ekstrand J, van Dijk CN. Fifth metatarsal fractures among male professional footballers: a potential career-ending disease. Br J Sports Med 2013;47:754–8.
[17] Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and met-analyses of studies that evaluate healthcare interventions: explanation and elaboration. Br Med J 2009, http://dx.doi.org/10.1136/bmj.b2700.
[18] Sakellariou VI, Kyriakopoulos S, Sofianos IP, Papagelopoulos PJ. Fractures of the proximal part of the 5th metatarsal. J Trauma Treat 2014:S2–005, http://dx.doi.org/10.4172/2167-1222.
[19] Chuckpaiwong B, Queen RM, Easley ME, Nunley JA. Distinguishing Jones and proximal diaphyseal fractures of the fifth metatarsal. Clin Orthop Relat Res 2008;466(8):1966–70.
[20] Kavanaugh JH, Brower TD, Mann RV. The Jones fracture revisited. J Bone Joint Surg Am 1978;60(6):776–82.
[21] Roche AJ, Calder JDF. Treatment and return to sport following a Jones fracture of the fifth metatarsal: a systematic review. Knee Surg Sports Traumatol Arthrosc 2013;21(6):1307–15.
[22] Smith TO, Clark A, Hing CB. Interventions for treating proximal fifth metatarsal fractures in adults: a meta-analysis of the current evidence-base. Foot Ankle Surg 2011;17(4):300–7.
[23] Lawrence SJ, Botte MJ. Jones' fractures and related fractures of the proximal fifth metatarsal. Foot Ankle 1993;14(6):358–65.
[24] Stewart IM. Jones's fracture: fracture of base of fifth metatarsal. Clin Orthop 1960;16:190–8.
[25] Dameron Jr TB. Fractures of the proximal fifth metatarsal: selecting the best treatment option. J Am Acad Orthop Surg 1995;3:110–4.
[26] Vertullo CJ, Glisson RR, Nunley JA. Torsional strains in the proximal fifth metatarsal: implications for Jones and stress fracture management. Foot Ankle Int 2004;25(9):650–6.
[27] Lee SK, Park JS, Choy WS. LCP distal ulna hook plate as alternative fixation for fifth metatarsal base fracture. Eur J Orthop Surg Traumatol 2013;23::705–13.
[28] Lindholm C, Arrelov B, Nilsson G, Lofgren A, Hinas E, Skaner Y, Ekmer A, Alexanderson K. Sickness-certification practice in different clinical settings; a survey of all physicians in a country. BMC Public Health 2010;10:752–60.

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