Review Article

Journal of Clinical Orthopaedics 2022 January-June;7(1):60-63

A systematic review and meta-analysis: Postoperative outcome comparison of intramedullary nailing and external fixation in charcot neuroarthropathy

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Abstract

Charcot neuropathic osteoarthropathy or neuroarthropathy of the foot and ankle is due to sensory and motor neuropathies which lead to a chronic and progressive destruction of the foot architecture involving bones, joints, and soft tissues. The aim of the present study was to compare the results of EF and retrograde IMN in ankle arthrodesis for patients with Charcot neuroarthropathy of the ankle joint. This study conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement. Literature Search was done on using the databases of PubMed, EMBASE, and Cochrane Library were systematically retrieved. From the selected databases, 205 references were obtained. By screening the titles and abstracts, 48 references were excluded The remaining potentially relevant 12 studies underwent a detailed and comprehensive evaluation. Finally, five studies were included in our meta-analysis. Based on the report in this meta-analysis, IMN could showed better results compared to EF for Charcot joint arthrodesis, with IMN showing higher rate of fusion, and lesser risk of complication.

Keywords: Systematic Review, Meta-analysis, Charcot Neuroarthropathy, Intramedullary Nailing, External Fixation

Introduction

Charcot neuropathic osteoarthropathy or neuroarthropathy of the foot and ankle is due to sensory and motor neuropathies which lead to a chronic and progressive destruction of the foot architecture involving bones, joints, and soft tissues. Secondary fractures and dislocations predispose to deformity and ulceration with a great decrease of the gait-related quality of life and an increasing potential for major amputation [1].

Fusion is usually the surgical treatment which is indicated in severe, progressive, unstable deformity of the hindfoot. The aims of the arthrodesis reconstructive procedure are realignment and stabilization of the severely deformed ankle in order to avoid ulcers and amputation. Retrograde intramedullary nails (IMN) and ring external fixators (EFs) are two of the most common fixation techniques used for arthrodesis. Proponents of EF argue that this method limits soft tissue trauma in a population with vascular compromise and poor wound healing potential. Since no cast is usually required following ring fixator, swelling and ulcer recurrence could be monitored. On the other hand, advocates of retrograde nails cite the high incidence of pin tract infections, risk of tibia fracture, and the need for a second surgery for EF removal as reasons to choose a nail over EF [1, 2, 3].

The aim of the present study was to compare the results of EF and retrograde IMN in ankle arthrodesis for patients with Charcot neuroarthropathy of the ankle joint.

Materials and Methods

Inclusion Criteria

Studies included if matched the following criteria:

1. Comparative prospective or retrospective studies on IMN versus EF in charcot arthroneuropathy patients
2. Samples of patients with charcot arthroneuropathy
3. Patients 18 years of age and above
4. Outcome measurements included fusion rate, post-operative infection and revision surgery.

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Submitted Date: 14 Jan 2022, Review Date: 20 Jan 2022, Accepted Date: 7 Feb 2022 & Published Date: 31 Mar 2022

| *Journal of Clinical Orthopaedics* | *Available on www.jcorth.com* | *DOI:10.13107/jcorth.2022.v07i01.473*

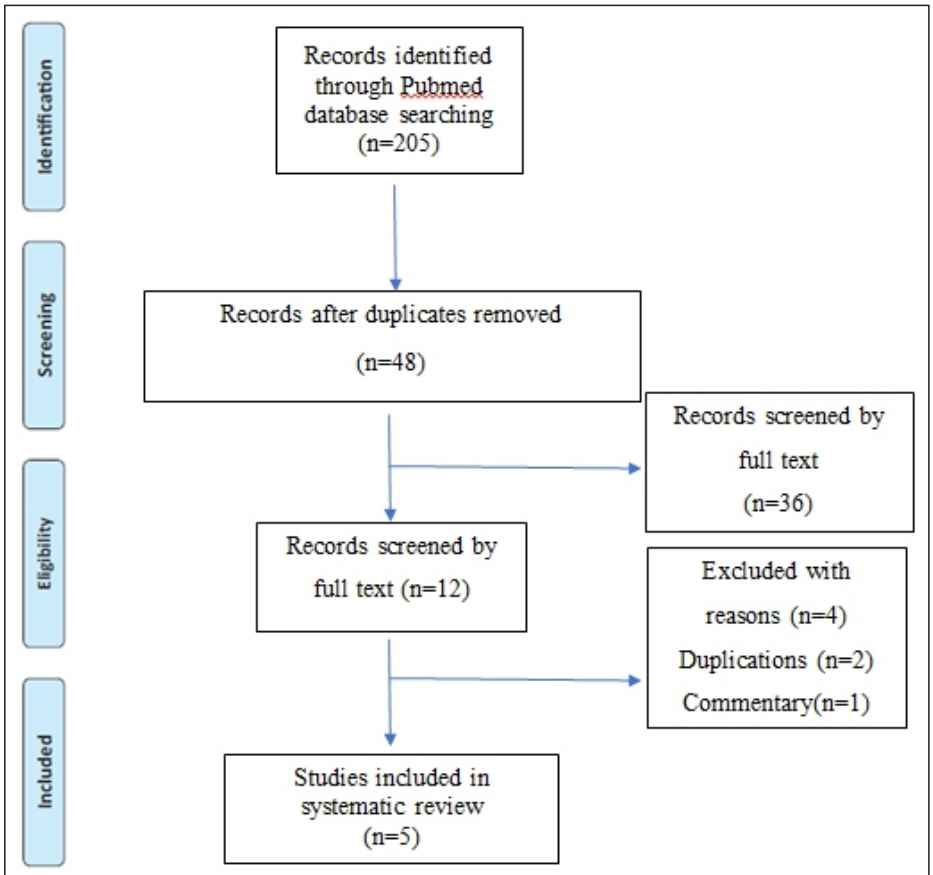

Figure 1: The flowchart of study selection.

Exclusion Criteria

Study will be excluded if; (1) combined IMN and EF; (2) had an average follow-up time of <1 year; (3) history of immunodeficiency, infection. Studies involving patients with cervical myelopathy caused by ossification of posterior longitudinal ligament (OPLL) were excluded because this condition is different from cervical spondylotic myelopathy in terms of etiology, pathogenesis, and natural history; hence, this may have affected the surgeon's decision-making regarding the surgical approach used.

Search Methods and Studies Identification

This study conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement. Literature Search was done on using the databases of PubMed, EMBASE, and Cochrane Library were systematically retrieved. The keywords were used, including charcot neuroathropathy, intramedullary naling, EF, systematic review, and meta-analysis. The search was independently conducted by eight authors, with the restriction of English language. The references of the included studies were also checked to find possible meta-analysis on this topic. The titles and abstracts were first reviewed, and the full texts were acquired if the information was not enough.

Data Extraction and Statistical Analysis

The following information was extracted from each study by reviewers:

1. Basic characteristics consist of study ID, study design, study location, patient demographics, length of follow-up, and surgical approach for each group
2. Post-operative evaluation including fusion rate, post-operative infection and revision surgery
3. Complications such as intraoperative bleeding, reoperation rate, and operation time.

We performed all meta-analyses with the Review Manager software (RevMan Version 5.4; [Cochrane Collaboration, Oxford, UK]).

Continuous variables are presented as mean differences and 95% confidence intervals (CI), whereas dichotomous variables are presented as odds ratios and 95% CI. Random-effects or fixed-effects models were used depending on the heterogeneity of the studies included.

Results

Search Result

The process of identifying relevant studies is summarized in Fig. 1. From the selected databases, 205 references were obtained. By screening the titles and abstracts, 48 references were excluded due to duplicates, irrelevant studies, case reports, not comparative studies, review articles, not human studies, combination of anterior and posterior technique, more than two groups comparison, and involved patients with OPLL related cervical myelopathy. The remaining potentially relevant 12 studies underwent a detailed and comprehensive evaluation. Finally, five studies were included in our meta-analysis [4, 5, 6, 7, 8]. The characteristics

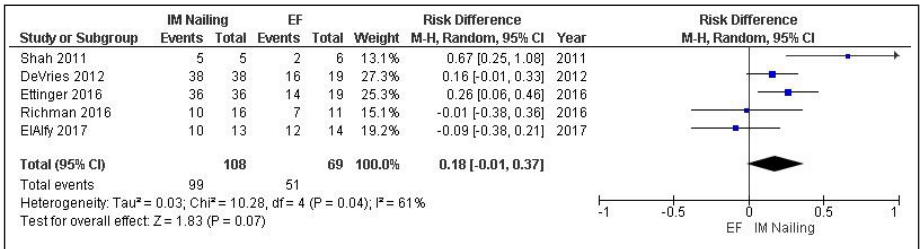

Figure 2: Fusion rate of intramedullary nailing versus external fixation in charcot neuropathy.

Table 1: The Characteristics of the studies

		Sampel population		Fusion Rate		Infection Rate		Re-operative	
Studies	Year of Studies	IMN	EF	IMN	EF	IMN	EF	IMN	EF
Shah	2011	5	6	5	2	0	4	1	4
DeVries	2012	45	7	6	3	NA	NA	NA	NA
Ettinger	2016	36	16	36	14	0	2	NA	NA
Richman	2016	16	11	10	12	8	2	8	1
ElAlfy	2017	13	14	10	7	0	8	2	3

of these studies are summarized in Table 1.

Quality Assessment

The meta-analysis quality was evaluated by the Oxford Levels of Evidence and the Assessment of Multiple Systematic Reviews (AMSTAR) instrument. AMSTAR has been proven as a methodological assessment tool with good reliability, validity, and responsibility. It is widely used to evaluate the quality of systematic reviews. Meta analyses quality was independently evaluated by six authors. Disagreements between authors were settled by discussion, and a seventh author was consulted if necessary.

Clinical Outcome

Fusion rate

Five studies of total 177 patients (108 IMN group, and 69 EF group) showed no significant higher fusion rate in both groups ($P > 0.05$, heterogeneity: Tau2 = 0.03, Chi2 = 10.29, df = 4 [P = 0.07]; I2 = 61%, random effect model). (Figure 2)

Infection rate

Infection rate was obtained in four studies of 122 patients (72 IMN Group, and 50 EF groups) were analysed resulting not significant higher rate of infection on IMN group compared to EF group ($P > 0.05$, heterogeneity: Tau2 = 0.85, Chi2 = 4.80, df = 3 [P = 0.19], I2 = 38%, Random effect model). (Figure 3)

Re-operative risk

Three studies of 52 patients (34 IM group, and 31 EF group) showed no significant difference in re-operative risk on IM group when compared to EF group. ($P > 0.05$, heterogeneity: Tau2 = 0.93, Chi2 = 3.55, df = 2, [P = 0.17], I2 = 44%, Random effect model). (Figure 4)

Discussion

Both fixation tools for arthrodesis are commonly used for ankle arthrodesis in charcot neuropathy patients. Each technique was shown to provide good result since charcot joint has high risk of reoperation, infection, and unfused post operative result. This study determines to reveal which fixation is better by analysing several included studies consists the total of 176 patients and evaluate main results while performing several meta-analyses for each indicator. We conducted three outcomes by pooled plot.

The result of the pooled data showed no significance result statistically. Even though the result shown no significant difference, in the study conducted by Elalfy et al. the authors reported that there were three patients showing non-union radiological result following IMN, and they also reported after a minimum 26-month follow-up there were two patients with pain free stable ankle. Based on the report that we assessed, we would suggest that IMN would be a preferable option to EF for fusion rate arthrodesis in Charcot joint [4, 5, 8].

We also pooled the infection rate compared between EF and IMN, resulted in no significant differences statistically in both group to the infection rate. Although the result showed no statistically significant difference, Ettinger et al attached in their study that infection was present in all cases treated by EF, but in the three other study they reported no infection in the EF group. This statement made us suggests that IMN have a lower hardware and wound infection than EF. Although more studies needed to conclude a better and significant result.

For the re-operative risk compared between IMN and EF also showed no significance difference statistically. In the study conducted by Shah et al. reported that revision of EF was required in four patients accounts 66.7% from included patients, but none reported in the internal fixation group. In the other study by Richman et al. there were total 11 out of 16 patients in the retrograde IMN required revision. Three out of 16 patients requiring minor revision, and 8 out of 16 requiring major revision. Also in the study by Elalfy et al. reported that

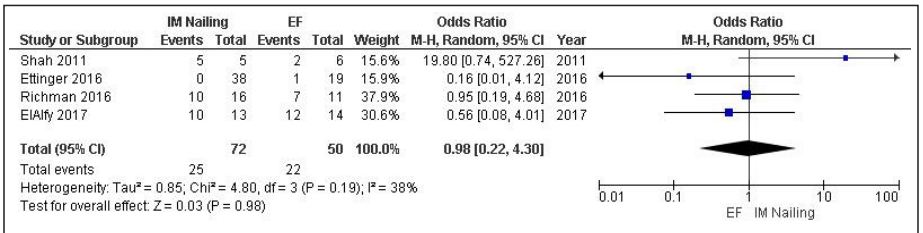

Figure 3: Infection rate of intramedullary nailing versus external fixation in charcot neuropathy.

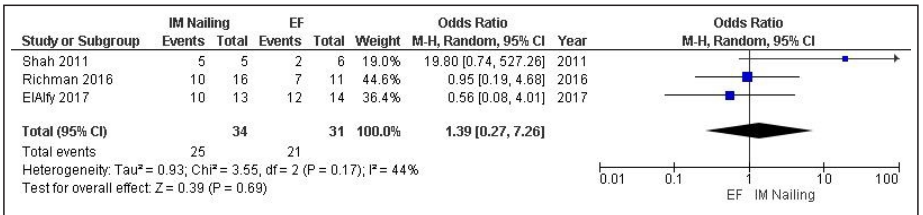

Figure 4: Re-operative risk of intramedullary nailing versus external fixation in charcot neuropathy.

in the EF group had revision surgery in two patients which in IMN group had none. Although the result is not significantly difference in statistic, the revision or reoperative surgery had mildly higher risk for the event in the IMN group compared to EF group as reported by the study included in this meta-analysis [2, 3, 8].

Eventhough, three pooled data concluded in this study showed no significant differences statistically. The study about outcomes compared between IMN and EF is still limited. There is limitation in this study, the study concluded in this meta-analysis is still quite a bit due to limitation of the references, hence more research needed to conclude a better result for this study. This study is promising for the future treatment of choice for Charcot joint arthropathy. Hence, the authors hope more study will be conducted to assess more about advantages and disadvantages for outcomes and complication compared in IMN and EF group.

Conclusion

Based on the report in this meta-analysis, IMN could showed better results compared to EF for Charcot joint arthrodesis, with IMN showing higher rate of fusion, and lesser risk of complication. But, more researches needed to conclude better result to added in the future study about this.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Dharmayuda CGO, Bracika DG, Arnaya K, Mahadana S, Aryanugraha PT, Deriano B, Wiraputri NA, Pranata IKGS. Postoperative outcome comparison of intramedullary nailing and external fixation in charcot neuroarthropathy: A systematic review and meta-analysis. Journal of Clinical Orthopaedics Jan-June 2022;7(1):60-63.