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COMPARISON OF PLATING VERSUS INTRAMEDULLARY NAILING IN METAPHYSEAL FRACTURES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT
Metaphyseal fractures are common orthopedic injuries that often require surgical intervention for optimal management. The choice between plating and intramedullary nailing as fixation methods remains a subject of debate among orthopedic surgeons, with considerations including fracture type, patient characteristics, and surgical outcomes. This study aim to compare the efficacy, safety, and outcomes of plating versus intramedullary nailing in the treatment of metaphyseal fractures.Methods: A comprehensive search was conducted across major electronic databases for relevant studies published up to 2023. Studies comparing plating and nailing techniques in metaphyseal fracture fixation were included. Data regarding study characteristics, patient demographics, surgical techniques, outcomes, and follow-up durations were extracted and analyzed using appropriate statistical methods. Our primary outcomes were union rate and time, functional outcome using patient reported outcome measure, and complications. Results: The initial search yielded a total of 687 studies, of which 7 studies met the inclusion criteria, consisting of a total of 758 skeletally-mature patients with metaphyseal fractures treated with either intramedullary nailing or plate fixations. The meta-analysis revealed that there is no evidence to draw definitive conclusions on which indicates the best method in treating metaphyseal fractures. Subgroup analyses were performed based on fracture type, patient age, and other relevant factors to further elucidate the comparative effectiveness of plating versus screwing.Conclusion: The meta-analysis findings indicated that using intramedullary nailing led to shorter surgical and complications when compared to plate fixation. Additionally, both treatments frequently resulted in similar union times and union-related issues. However, further randomized controlled trials (RCTs) are necessary to bolster the existing evidence base.

Keywords: intramedullary nailing; metaphyseal fracture; outcome; plating

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INTRODUCTION

Metaphyseal fractures represent a significant subset of orthopedic injuries, often occurring at the transition zone between the shaft and the articular surface of long bones. These fractures pose unique challenges due to the complex biomechanics and the importance of preserving the growth plate for optimal long-term outcomes, especially in pediatric patients. In adult populations, metaphyseal fractures can also present complexities related to fracture stability, articular involvement, and functional recovery.(Guo et al., 2018; Hartono et al., 2024)Plating and intramedullary nailing are two primary surgical techniques employed in the management of metaphyseal fractures, each offering distinct benefits and considerations. Plating involves the fixation of fractures using plates and screws applied to the bone's surface, providing excellent stability and control over fracture reduction. This technique is particularly advantageous in cases where precise anatomical reduction is essential, such as fractures involving the joint surface or fractures with significant comminution. Plating allows for direct

visualization of the fracture site during surgery, facilitating accurate alignment and fixation.(Guo et al., 2018; Iqbal & Pidikiti, 2013)

On the other hand, intramedullary nailing involves the insertion of a nail into the medullary canal of the bone, providing a load-sharing construct that stabilizes the fracture internally. This technique is well-suited for metaphyseal fractures with intact cortical bone and good bone quality, offering biomechanical advantages such as preservation of periosteal blood supply and load transfer along the axis of the bone. Intramedullary nailing is particularly favored in fractures with oblique or spiral patterns, as it allows for controlled axial compression and rotational stability.(Hu et al., 2019; Ocalan et al., 2019)The choice between plating and intramedullary nailing in metaphyseal fractures often depends on several factors, including the fracture pattern, patient age, bone quality, presence of associated injuries, and surgeon preference. Plating excels in cases where precise anatomical reduction is paramount, especially in fractures involving the joint surface or significant comminution. Its ability to provide rigid fixation and maintain alignment makes it a preferred option in these scenarios. Intramedullary nailing, on the other hand, offers advantages in terms of minimal soft tissue disruption, preservation of blood supply, and biomechanical advantages in certain fracture patterns.(Mao et al., 2015; Yang et al., 2006). This systematic review and meta-analysis aim to comprehensively evaluate and compare the outcomes of plating versus intramedullary nailing in the treatment of metaphyseal fractures. By synthesizing the available evidence, we aim to elucidate the nuanced benefits, drawbacks, and clinical considerations associated with each technique, ultimately aiding clinicians in making informed decisions tailored to individual patient needs and fracture characteristics.

METHOD

This systematic review and meta-analysis were conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.(Page et al., 2021) The search was performed in March 2024 on Pubmed. The search strategy used keywords conforming to Medical Subject Headings (MeSH) and Emtree to identify relevant articles. The search terms used were "(Plating OR Plate fixation OR Plating technique OR Intramedullary nailing OR Nail fixation OR Nailing technique) AND (Metaphyseal fractures OR Metaphyseal injury OR Fracture at metaphysis)."

Inclusion and Exclusion Criteria

Included studies were required to have original data published in English and focus on diagnosis, imaging, and treatment of metaphyseal fractures using either plating or intramedullary nailing. Studies not in English, those involving intraarticular, biomechanical studies, and conference abstracts were excluded.

Quality Appraisal and Risk of Bias Assessment

Two independent reviewers conducted the identification, selection, data extraction, and quality assessment. Discrepancies were resolved through reassessment and discussion with an expert in orthopedic surgery. The level of evidence was assessed using the Oxford Centre for Evidence-Based Medicine guideline. Quality appraisal and risk of bias were assessed using the Cochrane Risk of Bias assessment.(Cochrane, 2022)

Data Extraction and Analysis

Data were extracted from included studies on articles, patient demographics, preoperative characteristics, intraoperative details, and postoperative outcomes related to plating or

intramedullary nailing in metaphyseal fractures. A narrative report was produced based on qualitative assessment. Subgroup analysis was performed for intraoperative characteristics in the open surgery group. Statistical analysis was conducted using Review Manager version 5.4.1, employing a random-effects model to assess heterogeneity between studies. Forest plots were used to visualize outcomes, and significance was determined at $p < 0.05$. Data were summarized in tables using Microsoft Excel.

RESULT

A total of 889 articles were initially identified. After a thorough screening based on titles and abstracts, 687 full publications were reviewed, with duplicates (n = 202) removed. Subsequently, after underwent assessment, 7 studies met the eligibility criteria with a total of 758 patients.(Costa et al., 2017; Fang et al., 2016; Li et al., 2014; Mauffrey et al., 2012; Polat et al., 2015; Wani et al., 2017; Zha et al., 2008) The risk of bias assessment is shown in figure 1. The demographic characteristics are outlined in Table 1.

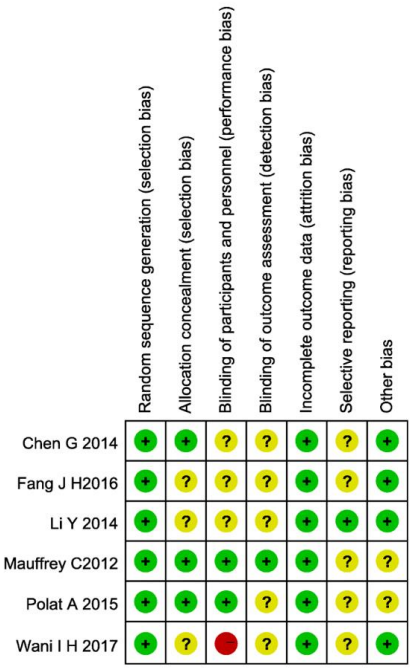

Figure 1. Risk of Bias of the included studies

Table 1.
The characteristics of included studies

Study	Year	Country	Patients		Age (Years)		Study Type	Fracture Type
			IMN	Plate	IMN	Plate		
(Wani et al., 2017)	2017	India	30	30	36.4 ± 9.7	38.4 ± 8.7	RCT	OTA42 A1-3
(Fang et al., 2016)	2016	China	28	28	35.0 ± 9.2	38.6 ± 7.5	RCT	OTA 42
(Zha et al., 2008)	2014	China	60	120	53.0 ± 8.1	25.53 ± 8.73	RCT	AO 42A-B
(Li et al., 2014)	2014	China	46	46	44(18-78)	43(18-79)	RCT	OTA42
(Mauffrey et al., 2012)	2012	UK	12	12	50(39-60)	33(24-43)	RCT	EAFDT
(Costa et al., 2017)	2017	UK	161	160	44.3 ± 16.3	45.8 ± 16.3	RCT	EAFDT
(Polat et al., 2015)	2015	Turkey	10	15	34.0 ± 9.7	36.4 ± 10.7	RCT	OA42/43A1

Union Time

The average union time was 131.3 in patients treated with intramedullary nailing and 119.5 in patient treated with plate and screw. Four studies reported data on union time in the intramedullary nailing group compared with the plate group. There is a significant difference (p=0.03) in union time noted between the nailing group and the plate group as illustrated in Figure 2.

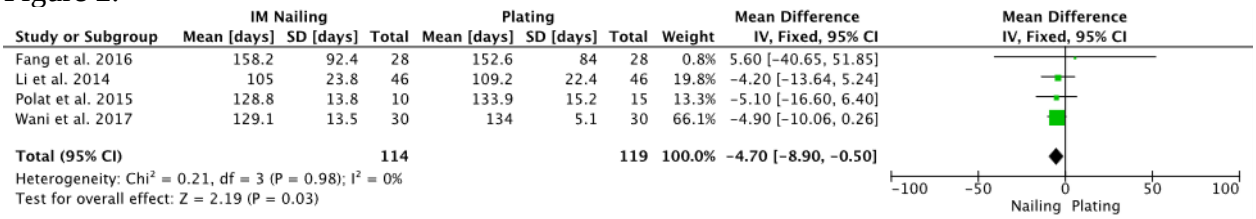

Figure 2. Analysis of union time between two groups

Complications

Five studies provided data on non-union. There was no significant difference in the non-union rate between the intramedullary nailing group and the plate group. Meanwhile, there were six studies that reported malunion event. The analysis showed that malunion event was significantly higher (p= 0.03) in the nailing group compared to the plate group.

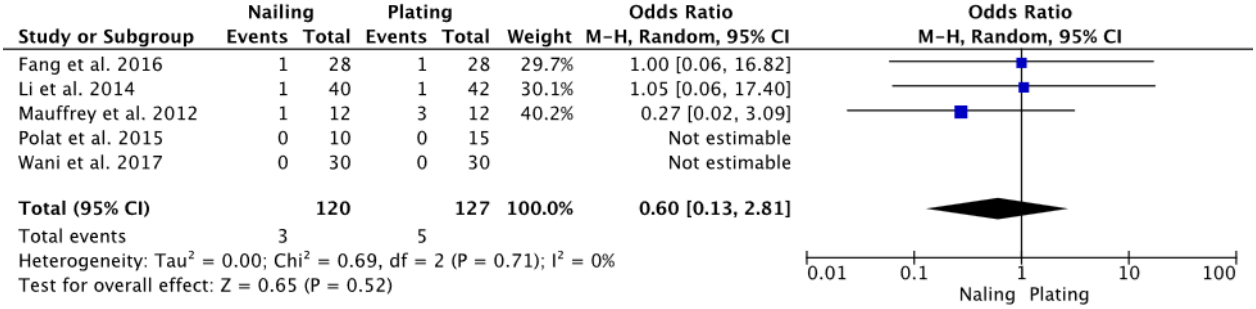

Figure 3. Analysis of non-union event between two groups

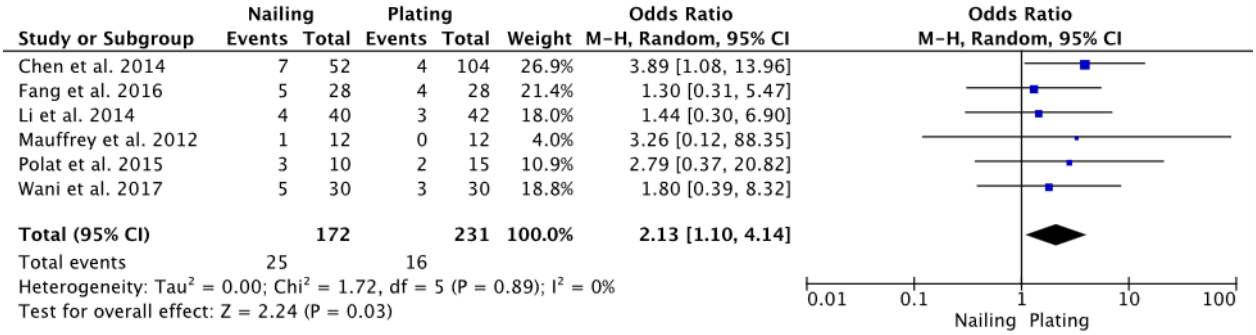

Figure 4. Analysis of malunion event between two groups

Functional Outcome

Two studies with 236 patients reported the 6-months follow-up AOFAS score, with no significant difference between two groups. There were two other studies which provided FFI score, and there was no significant difference regarding FFI score.

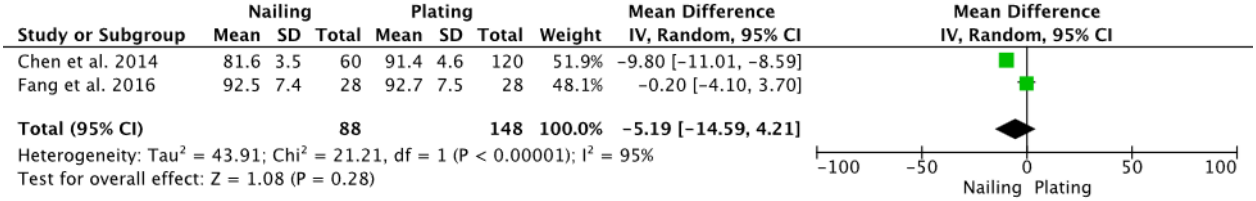

Figure 5. Analysis of AOFAS score between two groups

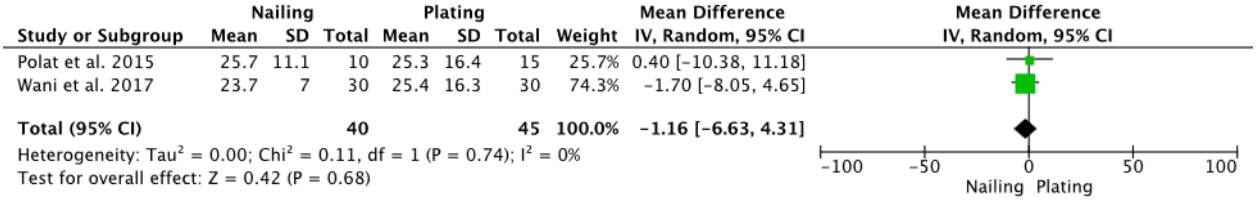

Figure 6. Analysis of FFI score between two groups

DISCUSSION

This study included data from 7 randomized controlled trials (RCTs) involving a total of 347 patients who received intramedullary nail (IMN) treatment and 411 patients who received plate fixation treatment. The primary outcomes examined were the duration of union, occurrence of non-union, and occurrence of malunion. Our meta-analysis found no statistically significant difference in non-union events, AOFAS scores, and FFI scores when comparing IMN with the plate group. Nevertheless, the IMN group outperformed the plate group in terms of union duration. However, when it came to the malunion event rate, the plate group exhibited better results. The results demonstrate that both IMN and plate fixation procedures are efficacious for metaphyseal fractures, with no notable disparities in fracture healing time and operative duration. The option between intramedullary nailing and plating for metaphyseal fractures is a crucial issue in orthopedic therapy, as each procedure has unique benefits and factors to consider. The objective of our study is to thoroughly examine and analyze the similarities and differences between these two surgical methods, and how they affect the results for patients and the process of making clinical decisions.

The first documented instance of intramedullary nails being utilized for fracture treatment was in a 1946 publication by Otoole, which described the treatment of femoral fractures. This technique was then employed for the treatment of tibiofibular fractures and eventually became widely utilized for limb lengthening. Even in irregular bones like clavicle fractures, the bone exhibits a high level of protection for the blood supply to the outer layer of the bone (periosteum) and causes minimal irritation to the surrounding soft tissues at the site of the fracture. This creates a favorable environment for the healing of the fracture. Intramedullary nailing (IMN) can be performed with or without reaming, with reaming being more advantageous for achieving reduction. Animal investigations have shown that there is no notable augmentation in blood perfusion and osteophyte strength at the fracture site when comparing the use of reamed and unreamed intramedullary nails. Nevertheless, the application of pressure on the fracture site might result in the deterioration of the fracture's structural integrity and ultimately lead to unfavorable clinical results. These occurrences are anticipated to diminish as instrument design techniques and surgical procedures continue to advance. Once the fractured end is properly realigned, the locking nail is securely fastened and pressured to induce micro-motion at the fracture site, which facilitates the healing process.

However, excessive fixation can lead to misalignment, rotational deformity, or even breakage of the nail. Open reduction and internal fixation involves directly aligning and fixing the fracture, resulting in better alignment of the fracture end compared to intramedullary nail fixation. Furthermore, the management of metaphyseal fractures encompasses several approaches such as external fixation, external fixation in combination with limited open reduction and internal fixation, intramedullary nail, and steel plate fixation. However, it is important to note that these specific treatment methods are not within the scope of this meta-analysis. (Borrelli et al., 2002; Filardi, 2015; Francois et al., 2004; Lefaivre et al., 2008;

O'TOOLE, 1946)Previous studies examining the effectiveness of intramedullary nailing have demonstrated that there is no advantage of intramedullary nailing over plate fixation when comparing the two procedures. The observed positive outcomes of intramedullary nailing in the majority of studies might be attributed to inadequate techniques of blinding. The findings of our study indicate a notable disparity in malunion rates between the intramedullary nailing and plate groups, with a greater incidence observed in the intramedullary nailing group, which statistically significant.(Chen et al., 2018; Chun et al., 2022; Shen et al., 2016; Yao et al., 2013)

Despite providing results which are aligned to the available literatures, our study also comes with several limitations. Initially, the present meta-analysis specifically targets studies that have already been published. The incorporation of unpublished research may have augmented the heterogeneity and altered the existing findings. Furthermore, the frequency of follow-up differed among the research, with five studies conducting follow-up for a duration exceeding 18 months, five studies restricting follow-up to one year, and one study conducting follow-up for a mere 6 months. This variable has the potential to impact the diversity and hence the outcomes. In addition, there was inconsistency in the choice of incision type and plate across the various investigations. Various sorts of surgical incisions are employed in plate fixation procedures. Additional meticulously constructed randomized controlled trials (RCTs), with bigger sample tsizes, are required to more effectively compare the effectiveness of intramedullary nailing and plate fixation.

CONCLUSION

In summary, based on our study findings, intramedullary nailing emerges as a preferable option for distal tibial metaphyseal fractures due to its shorter surgical and radiation times and lower risk of wound complications compared to plate fixation. However, it is important to note that our analysis is based on existing evidence from published studies, and further randomized controlled trials (RCTs) are warranted to strengthen and validate these findings. Future research should focus on larger sample sizes, longer follow-up periods, and standardized outcome measures to enhance the evidence base and provide more robust guidance for clinical practice in the management of distal tibial metaphyseal fractures.

REFERENCES

Borrelli, J., Prickett, W., Song, E., Becker, D., & Ricci, W. (2002). Extraosseous Blood Supply of the Tibia and the Effects of Different Plating Techniques: A Human Cadaveric Study. J Orthop Trauma, 16(10), 691–695. http://journals.lww.com/00005131-200211000-00002

Chen, F., Huang, X., Ya, Y., Ma, F., Qian, Z., & Shi, J. (2018). Finite element analysis of intramedullary nailing and double locking plate for treating extra-articular proximal tibial fractures. J Orthop Surg Res, 13(1), 12. https://josr-online.biomedcentral.com/articles/10.1186/s13018-017-0707-8

Chun, D., Min, T.-H., Kang, E. M., Yu, W., Won, S. H., Cho, J., & Yi, Y. (2022). Comparison of Radiological and Clinical Outcomes in Patients Treated with Standard Plating versus Intramedullary Nailing in Distal Tibial Fracture. Orthopaedic Surgery, 14(3), 536–542. https://doi.org/10.1111/os.13210

Cochrane. (2022). Risk of Bias 2 Cochrane Review Group Starter Pack.

Costa, M. L., Achten, J., Griffin, J., Petrou, S., Pallister, I., & Lamb, S. E. (2017). Effect of Locking Plate Fixation vs Intramedullary Nail Fixation on 6-Month Disability Among Adults With Displaced Fracture of the Distal Tibia. JAMA, 318(18), 1767. http://jama.jamanetwork.com/article.aspx?doi=10.1001/jama.2017.16429

Fang, J. H., Wu, Y. S., Guo, X. S., & Sun, L. J. (2016). Comparison of 3 Minimally Invasive Methods for Distal Tibia Fractures. Orthopedics, 39(4). https://journals.healio.com/doi/10.3928/01477447-20160606-01

Filardi, V. (2015). The healing stages of an intramedullary implanted tibia: A stress strain comparative analysis of the calcification process. J Orthop, 51–61. https://linkinghub.elsevier.com/retrieve/pii/S0972978X15000173

Francois, J., Vandeputte, G., Verheyden, F., & Nelen, G. (2004). Percutaneous plate fixation of fractures of the distal tibia. Acta Orthop Belg, 70(2), 148–154. http://www.ncbi.nlm.nih.gov/pubmed/15165017

Guo, C., Ma, J., Ma, X., Wang, Y., Sun, L., & Lu, B. (2018). Comparing intramedullary nailing and plate fixation for treating distal tibail fractures: A meta-analysis of randomized controlled trials. International Journal of Surgery, 5–11. https://linkinghub.elsevier.com/retrieve/pii/S1743919118306241

Hartono, F., Ananditya, T., Augustinus, Y., Nicholas, H., & Significances, S. (2024). Metaphyseal trauma of the lower extremities in major orthopedic surgery as an independent risk factor for deep vein thrombosis American Academy of Orthopaedic Surgeon American College of Chest Physicians. European Journal of Orthopaedic Surgery & Traumatology, 34(5), 2797–2803. https://doi.org/10.1007/s00590-024-03960-4

Hu, L., Xiong, Y., Mi, B., Panayi, A. C., Zhou, W., & Liu, Y. (2019). Comparison of intramedullary nailing and plate fixation in distal tibial fractures with metaphyseal damage: a meta-analysis of randomized controlled trials. J Orthop Surg Res, 14(1), 30. https://josr-online.biomedcentral.com/articles/10.1186/s13018-018-1037-1

Iqbal, H. J., & Pidikiti, P. (2013). Treatment of distal tibia metaphyseal fractures; plating versus intramedullary nailing: A systematic review of recent evidence. Foot and Ankle Surgery, 19(3), 143–147. https://linkinghub.elsevier.com/retrieve/pii/S1268773113000507

Lefaivre, K. A., Guy, P., Chan, H., & Blachut, P. A. (2008). Long-Term Follow-up of Tibial Shaft Fractures Treated With Intramedullary Nailing. J Orthop Trauma, 8, 525–529. https://journals.lww.com/00005131-200809000-00004

Li, Y., Jiang, X., Guo, Q., Zhu, L., Ye, T., & Chen, A. (2014). Treatment of distal tibial shaft fractures by three different surgical methods: a randomized, prospective study. Int Orthop, 38(6), 1261–1267. http://link.springer.com/10.1007/s00264-014-2294-1

Mao, Z., Wang, G., Zhang, L., Zhang, L., Chen, S., & Du, H. (2015). Intramedullary nailing versus plating for distal tibia fractures without articular involvement: a meta-analysis. J Orthop Surg Res, 10(1), 95. https://josr-online.biomedcentral.com/articles/10.1186/s13018-015-0217-5

Mauffrey, C., McGuinness, K., Parsons, N., Achten, J., & Costa, M. L. (2012). A randomised pilot trial of "locking plate" fixation versus intramedullary nailing for extra-articular fractures of the distal tibia. J Bone Joint Surg Br, 94(5), 704–708. https://online.boneandjoint.org.uk/doi/10.1302/0301-620X.94B5.28498

O'TOOLE, M. (1946). Fracture of shaft of the femur treated with Küntscher intramedullary nail. Nurs Times, 42(34), 640. http://www.ncbi.nlm.nih.gov/pubmed/20999215

Ocalan, E., Ustun, C. C., & Aktuglu, K. (2019). Locking plate fixation versus antegrade intramedullary nailing for the treatment of extra-articular distal femoral fractures. Injury, 55–62. https://linkinghub.elsevier.com/retrieve/pii/S0020138319304073

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. The BMJ, 372. https://doi.org/10.1136/bmj.n160

Polat, A., Kose, O., Canbora, K., Yanık, S., & Guler, F. (2015). Intramedullary nailing versus minimally invasive plate osteosynthesis for distal extra-articular tibial fractures: a prospective randomized clinical trial. Journal of Orthopaedic Science, 20(4), 695–701. https://linkinghub.elsevier.com/retrieve/pii/S0949265815300464

Shen, J., Xu, J., Jie, T. M., Feng, L. C., & Qing, Z. C. (2016). Extra-articular distal tibia facture (AO-43A): A retrospective study comparing modified MIPPO with IMN. Injury, 47(10), 2352–2359. https://linkinghub.elsevier.com/retrieve/pii/S0020138316303011

Wani, I. H., Gani, N., Yaseen, M., Bashir, A., Bhat, M. S., & Farooq, M. (2017). Operative Management of Distal Tibial Extra-articular Fractures – Intramedullary Nail Versus Minimally Invasive Percutaneous Plate Osteosynthesis. Ortop Traumatol Rehabil, 19(6), 537–541. https://ortopedia.com.pl/gicid/01.3001.0010.8045

Yang, S. W., Tzeng, H. M., Chou, Y. J., Teng, H. P., Liu, H. H., & Wong, C. Y. (2006). Treatment of distal tibial metaphyseal fractures: Plating versus shortened intramedullary nailing. Injury, 37(6), 531–535. https://linkinghub.elsevier.com/retrieve/pii/S0020138305003839

Yao, Q., Ni, J., Bin, P. L., Xin, Y. D., & Ming, Y. X. (2013). Locked plating with minimally invasive percutaneous plate osteosynthesis versus intramedullary nailing of distal extra-articular tibial fracture: a retrospective study. Zhonghua Yi Xue Za Zhi, 93(47), 3748–3751. http://www.ncbi.nlm.nih.gov/pubmed/24548389

Zha, G., Chen, Z., & Qi, X. (2008). Minimally invasive percutaneous locking compression plate internal fixation in the treatment of tibial fractures. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi, 22(12), 1448–1450. http://www.ncbi.nlm.nih.gov/pubmed/19137887