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Plate fixation versus flexible intramedullary nails for management of closed femoral shaft fractures in the pediatric population: A systematic review and meta-analysis of the adverse outcomes

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We read with interest the above publication by Singh et al.[1] We identified multiple inconsistencies between Singh et al.'s[1] reported data and the data listed in the included 13 publications. The studies included either open or submuscular plating or both plating types combined as one group, which was not differentiated by Singh et al.[1] Singh et al.[1] reported only one case of nail non-union but none for plate fixations. However, there were five plate non-unions (Caglar et al.[2] (×4 hardware failure), James et al.[3] (×1 revision for osteomyelitis with iliac crest grafting)), and the authors[1] did not mention that there was a third plate-related osteomyelitis case after plate removal.[4] The information on leg length discrepancies (LLDs) is highly unreliable, with one author group having measured leg length from the anterior superior iliac spine to the medial malleolus, one group having used long leg X-rays only if available (maybe none at all), one group did not consider an LLD ≤ 2 cm and the others did either not mention how leg length was measured or did not mention leg length. None of the studies presented data on assessment of rotational alignment, and the majority did not document if casts were used.

Singh et al.[1] stated that patient weight was similar in both groups, but patient weight was only documented in four studies. One study recorded an upper value of 58 kg for a nail patient compared to 40 kg for the plate group. Another study recorded a mean plate patient weight of 38.6 kg compared to 29.2 kg for the nail group. Two studies had a marked mean plate/nail age mismatch (plates/nails 6.55/10.36[5] and 7.7/ 9.7[6] years), without providing weight data. Luo et al.[7] provided only a combined mean age for the nail and plate group together, but Singh et al.[1] documented as if both groups had a perfect age match.

Singh et al.[1] did not consider the quality of the nail fixation techniques. Eight publications provided post-operative radiographs of 10 cases, with 9 showing inadequate nailing techniques (inadequate canal fill, nail apex not at the level of the fracture site, nail prominence and/or nails not bent), and James et al.[3] reported one exchange nailing to insert bigger nails.

Singh et al.[1] deemed the use of the term malunion within the included studies as adequate and stated that the pediatric femur can tolerate up to 15°[8] of malrotation and 25°[9] of angulation in any plane, quoting Davids[8] and Wallace and Hoffman.[9] Davids[8] measured that rotational deformities after femoral fractures do not remodel but reported that malrotation of up to 25° (not 15°) was well tolerated despite not having collected objective and/or patient-reported outcome measures. Singh et al.[1] did not realize that they were misguided by Wallace and Hoffman[9] whose original data show that the sagittal and coronal fracture site deformities generally also do not remodel. The latter[9] authors reported that, after malunion of a femoral shaft fracture, the interphyseal angle corrected in the sagittal and coronal plane by a mean 13.3°, but not the shaft deformity angle. In 7 of 28 children, the femoral fracture site deformity did not remodel at all, and in the other 21 children, only 26% of the malangulation improved at the fracture site. The vast majority (74%) of correction of the interphyseal angle occurred by development of an abnormal compensatory growth of the proximal and distal femur, leaving children with a marked Z-shaped deformity with abnormal angles at 3 levels. Despite the failure of remodeling of the true deformities Wallace and Hoffman[9] wrongly described these deformities as satisfactory

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remodeling of angulated shaft fractures of up to 25° in children ≤12 years of age, neither investigating clinical outcomes nor long leg alignment.

In conclusion, a high-quality meta-analysis includes prospective randomized trials only, providing the highest validity and least bias, followed by prospective cohort studies, case control-/retrospective cohort studies and case series, with increasing bias. Singh et al.'s[1] analysis includes mainly retrospective cohort studies with heterogenous mismatched data and therefore have increased bias.

The provided radiographs indicate a lack of training among those surgeons who performed the nailing procedures, which could be the cause for the majority of complications, with nail prominence being the main cause for skin irritation and superficial infections. Not leaving flexible nails prominent would most likely reduce these risks close to zero, with there being no need for routine metal removal.[10]

Singh et al.[1] did not identify that the majority of major complications, including osteomyelitis (3×), five of six non-union cases and the only three cases who underwent an epiphysiodesis for LLD (2×)[6,7] and angular deformity (1×)[3] were among the plate cases (major complications: 2.78% plate fixations; 0.22% nail fixations/0.45% including the flexible nail exchange).

The data support to use flexible nails were indicated rather than plates, that is, length stable fractures.

Author contributions

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References

1. Singh A, Bierrum W, Wormald J, et al. Plate fixation versus flexible intramedullary nails for management of closed femoral shaft fractures in the pediatric population: a systematic review and meta-analysis of the adverse outcomes. *J Child Orthop* 2023; 17(5): 442–452.
2. Caglar O, Aksoy MC, Yazici M, et al. Comparison of compression plate and flexible intramedullary nail fixation in pediatric femoral shaft fractures. *J Pediatr Orthop B* 2006; 15(3): 210–214.
3. James D, Martin D, Kumar A, et al. Elastic stable intramedullary nailing versus submuscular plating in pediatric diaphyseal femur fractures: a randomized controlled trial among children in South India. *J Pediatr Orthop* 2022; 31: e122–e129.
4. Chen LK, Sullivan BT and Sponseller PD. Submuscular plates versus flexible nails in preadolescent diaphyseal femur fractures. *J Child Orthop* 2018; 12: 488–492.
5. Wang W, Zheng X and Sun Z. Comparison of efficacy between internal fixation of minimally invasive elastic stable intramedullary nail and plate in the treatment of pediatric femoral shaft fracture. *Pak J Med Sci* 2019; 35(5): 1417–1421.
6. Milligan D, Henderson L, Tucker A, et al. Elastic nail fixation versus plate fixation of paediatric femoral fractures in school age patients—a retrospective observational study. *J Orthop* 2020; 19: 153–157.
7. Li Y, Heyworth BE, Glotzbecker M, et al. Comparison of titanium elastic nail and plate fixation of pediatric subtrochanteric femur fractures. *J Pediatr Orthop* 2013; 33(3): 232–238.
8. Davids JR. Rotational deformity and remodeling after fracture of the femur in children. *Clin Orthop Relat Res* 1994; 302: 27–35.
9. Wallace ME and Hoffman EB. Remodelling of angular deformity after femoral shaft fractures in children. *J Bone Joint Surg Br* 1992; 74(5): 765–769.
10. Siu JW, Chan C, Swarup I, et al. Rate of refracture after removal of hardware in pediatric femur fractures. *J Pediatr Orthop* 2023; 43: e674–e679.