Flexible Versus Rigid Intramedullary Nailing of Tibial Shaft Fractures in Skeletally Immature Adolescents

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Purpose: Flexible intramedullary nails are commonly used for definitive operative treatment of tibial shaft fractures in skeletally immature patients. The use of rigid intramedullary nails has been limited in children due to potential physeal arrest with subsequent deformity and/or limb-length discrepancy. This study seeks to compare the outcomes of rigid versus flexible intramedullary nailing (IMN) of tibial shaft fractures in adolescent patients with open physes.

Methods: Chart review included skeletally immature patients between ages 10 and 16 years presenting to a Level I pediatric trauma center between January 2009 to January 2019 with a tibial shaft fracture treated with an intramedullary device. Electronic medical records and radiographic imaging were reviewed. Student t and $\chi 2$ tests were performed.

Results: 55 patients were included, 28 patients underwent rigid IMN and 27 underwent flexible IMN. The average age in the rigid IMN group was 14.7 years versus 12.6 years in the flexible nail group ($P<0.001$). Patients treated with rigid IMN had a significantly decreased time to weightbearing, less time immobilized in a cast, and were less likely to undergo hardware removal. Rigid IMN treatment was associated with a significant radiographic difference in posterior slope. The mean decrease in posterior slope demonstrated by the rigid IMN group was $1.9° \pm 3.1°$. Six patients exhibited proximal tibial physeal arrest in the rigid IMN group while no patients in the flexible nail group displayed this finding ($P = 0.001$).

Conclusion: There was no significant difference in time to union or complications between the flexible and rigid IMN groups, although patients treated with rigid IMN benefited from decreased time to weightbearing, less time immobilized in a cast, and avoided future hardware removal. There was statistically significant increased incidence of physeal arrest in the rigid IMN group with a decrease in posterior slope.

Demographics			
Variable	**Rigid**	**Flexible**	**P-Value**
Total, n	28	27	--
Age at Surgery, yrs	14.7 ± 1.1	12.6 ± 1.4	<0.001*
Skeletal Age, yrs	14.0 ± 1.0	12.6 ± 1.2	<0.001*
Length of Surgery, min	122.3 ± 66.4	119.1 ± 77.8	0.871
Time to WB, mo	0.8 ± 0.9	2.3 ± 1.4	0.002*
Follow-Up, days	399.1 ± 616.8	271.9 ± 145.6	0.301
Union, days	114.6 ± 176.1	82.85 ± 39.1	0.805
Change in Posterior Slope, mm	1.9 ± 3.0	-0.06 ± 4.0	0.041*
Initial CPV	0.06 ± 0.02	0.06 ± 0.03	0.886
Final Coronal Alignment, deg†	-0.84 ± 1.4	-1.82 ± 3.4	0.160
Final Sagittal Alignment, deg††	-0.78 ± 1.8	0.0 ± 6.4	0.533
Open Injury, n	11	11	1.000†
Cast Use, n	6	17	0.005*†
Hardware Removal, n	8	22	<0.001*†
Complications, n	11	11	1.000†
Physeal Arrest, n	6	0	0.003*†

* Statistical significance ($p<0.05$)

† χ^2 test

†Varus alignment indicated by negative number

††Recurvatum

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