Trends in the Evaluation and Treatment of Tibial Spine Fractures: Perspectives from SAOTI and SEOP Members

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ABSTRACT

Background: Tibial spine fractures are rare injuries in the pediatric population, leading to ongoing debate regarding the most appropriate diagnostic algorithms and treatment strategies. This study analyzed the practices and preferences of pediatric orthopedic surgeons affiliated with the Argentine Society of Pediatric Orthopedics and Traumatology (SAOTI) and the Spanish Society of Pediatric Orthopedics (SEOP) in managing these fractures. **Materials and Methods:** A cross-sectional online survey consisting of 21 questions was distributed to SAOTI and SEOP members in April 2024. Data were collected on demographics, years of experience, case volume, evaluation methods, decision-making processes, and fixation techniques. **Results:** A total of 112 completed responses were obtained (response rate: 28%). Preoperative evaluation was primarily based on radiographs and advanced imaging (99.1% of respondents). The majority of surgeons (58.9%) preferred an arthroscopic approach, with 48.2% using a combination of fixation methods. Surgeons with more than 10 years of experience were more likely to favor surgical treatment for type II fractures. Although nearly 80% of respondents recommended formal postoperative rehabilitation, fewer than one-third routinely used functional testing to determine return-to-sport readiness. **Conclusions:** The survey revealed diverse practices and preferences in the evaluation and treatment of tibial spine fractures. These findings highlight the need for further research and standardization to optimize the management of these uncommon injuries.

Keywords: Adolescents; screw fixation; suture fixation; survey; tibial eminence fracture; tibial spine.
Level of Evidence: V, expert opinion

Tendencias en la evaluación y el tratamiento de fracturas de la espina tibial: perspectivas de los miembros de la SAOTI y la SEOP

RESUMEN

Introducción: Las fracturas de la espina tibial son lesiones poco frecuentes en la población pediátrica, lo que ha generado debate sobre los algoritmos diagnósticos y las estrategias terapéuticas más apropiadas. En este estudio, se analizaron las prácticas y preferencias de los cirujanos ortopédicos pediátricos afiliados a la Sociedad Argentina de Ortopedia y Traumatología Infantil (SAOTI) y a la Sociedad Española de Ortopedia Pediátrica (SEOP) en el tratamiento de estas fracturas. **Materiales y Métodos:** Se realizó una encuesta transversal en línea, con 21 preguntas, distribuida a los miembros de la SAOTI y la SEOP en abril de 2024. Se recopiló información sobre demografía, experiencia, volumen de casos tratados, evaluación, toma de decisiones y métodos de fijación. **Resultados:** Se obtuvieron 112 respuestas completadas (tasa de respuesta del 28%). El 99,1% de los encuestados prefirió radiografías e imágenes avanzadas para la evaluación preoperatoria. La mayoría (58,9%) optó por un enfoque artroscópico y una combinación de métodos de fijación (48,2%). Los cirujanos con más de 10 años de experiencia preferían más el tratamiento quirúrgico de las fracturas tipo II. Aunque casi el 80% indica rehabilitación formal posoperatoria, menos de un tercio emplea pruebas funcionales para decidir el retorno al deporte. **Conclusiones:** La encuesta mostró prácticas y preferencias variadas en la evaluación y el tratamiento de las fracturas de la espina tibial. Estos hallazgos destacan que se necesita más investigación y estandarización para optimizar el manejo de estas lesiones poco frecuentes.

Palabras clave: Adolescentes; fijación con tornillos; fijación con suturas; encuesta: fractura de la eminencia tibial; espina tibial.
Nivel de Evidencia: V, opinión de expertos

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INTRODUCTION

Tibial spine fractures account for 2% to 5% of pediatric knee injuries, with most cases occurring in patients aged 8 to 14 years.[1,2] The classic mechanisms of injury include forced knee flexion with simultaneous external rotation of the tibia or knee hyperextension with a valgus or rotational force. Because the anterior cruciate ligament (ACL) inserts into the tibial spine, these fractures are often referred to as ACL-equivalent injuries.[3,4] The mechanisms are similar to those of ACL injuries in adults, where excessive traction forces lead to intrasubstance ligamentous injury. However, in children, avulsion fractures occur more easily because the strength of the tibial plateau, which is not yet fully ossified, is lower than that of the ACL.

Tibial spine fractures are uncommon injuries, meaning that few surgeons gain significant experience in their treatment. This lack of exposure presents challenges in assessment, treatment planning, and surgical execution, potentially affecting both surgeon confidence and the ability to manage these fractures optimally. Consequently, there is ongoing debate regarding the most appropriate diagnostic and therapeutic approaches. To better understand this matter, our study aimed to evaluate the management strategies and preferences of pediatric orthopedic surgeons affiliated with two professional societies: the *Sociedad Argentina de Ortopedia y Traumatología Infantil* (SAOTI) and the *Sociedad Española de Ortopedia Pediátrica* (SEOP).

MATERIALS AND METHODS

Sampling and Survey Administration

Ethics committee approval was not required, as the study did not involve human subjects. A cross-sectional survey was developed using Google Forms, consisting of 21 questions, and was distributed via email to active members of SAOTI and SEOP. Prior to distribution, the questionnaire was pilot-tested on an independent group of three experienced orthopedic surgeons to ensure it adequately covered current management practices and that individual questions aligned with the study's objectives. The survey was officially distributed in April 2024, with three follow-up reminders sent to improve the response rate. The questionnaire collected information on surgeon demographics, years of experience, volume of cases treated annually, evaluation methods, decision-making processes, and surgical approaches and fixation techniques

Data Entry and Analysis

Responses were entered into a database using Google Forms and subsequently exported to the statistical software R-Medic.[5] Continuous variables were tested for normality and are reported as mean (± standard deviation). Categorical variables are presented as counts and percentages. Associations between geographic location, experience, annual case volume, and practice preferences were analyzed. For continuous variables, either Student's t-test or the Mann-Whitney U test was applied, depending on the normality of the data distribution. A 95% confidence interval was used, with statistical significance set at $p < 0.05$.

RESULTS

A total of 112 completed surveys were collected from both societies, yielding a response rate of 28%. All respondents were specialists (with 87.5% having more than 5 years of experience) (Table 1).

Advanced imaging and radiographs were preferred by 99.1% of participants for preoperative evaluation. The majority of surgeons (58.9%) favored an arthroscopic approach, and 48.2% reported using a combination of different fixation methods (Table 2).

Subgroup analysis revealed that SEOP-affiliated surgeons showed a greater preference for arthroscopic treatment (p 0.03). While more than half of respondents (58.1%) considered surgical treatment ideal for displaced type II fractures (according to the Meyers and McKeever classification[3]) without associated injuries, this preference was significantly higher among surgeons with more than 10 years of experience (p 0.01) (Table 3). No significant differences were found regarding fixation method preferences based on respondent demographics, experience, or annual case volume. Although nearly 80% of respondents use formal postoperative rehabilitation, less than one-third routinely perform functional testing to determine readiness for return to sport.

Table 1. Demographic data of participants

Variable		n (%)
Country	Argentina	67 (60%)
	Spain	45 (40%)
Type of hospital practice	Public	28 (25%)
	Private	21 (19%)
	Both	63 (56%)
Post-residency training	Pediatric orthopedics	86 (77%)
	Pediatric orthopedics and sports medicine	21 (19%)
	None	5 (4%)
Years of practice as a specialist	<5	14 (12,5%)
	5-10	23 (20,5%)
	10-15	20 (18%)
	>15	55 (49%)
Percentage of practice involving pediatric and adolescent patients (≤18 years).	<25	14 (12,5%)
	25-50	8 (7%)
	50-75	20 (18%)
	>75	70 (62,5%)
Percentage of practice that involves sports medicine	<25	55 (49%)
	25-50	36 (32%)
	50-75	20 (18%)
	>75	1 (1%)
Number of tibial spine fractures treated annually	Rarely (<1)	39 (35%)
	1-3	48 (43%)
	4-6	14 (12,5%)
	7-9	8 (7%)
	>10	2 (2%)
Number of tibial spine fractures treated in their entire career.	<5	28 (25%)
	5-10	40 (36%)
	10-15	30 (27%)
	26-50	12 (10%)
	>50	2 (2%)

DISCUSSION

The results of this study provide an overview of the current practices and preferences of pediatric orthopedic surgeons in Argentina and Spain regarding the management of tibial spine fractures. All respondents were specialists, and 90% had more than 5 years of experience. However, a relatively low percentage (19%) had formal training in sports medicine and arthroscopy.

Table 2. Preference for evaluation and treatment among respondents*

Variable		n (%)
In the evaluation of a displaced fracture (Meyers and McKeever type II or III), what images do you use for surgical planning?	Radiographs only	1 (1%)
	Radiographs and CT	50 (45%)
	Radiographs and MRI	20 (18%)
	Radiographs, CT and MRI	41 (36%)
In your usual practice: what is the time delay for imaging tests needed to decide on treatment?	Same day	29 (26%)
	Less than one week	62 (55%)
	1-3 weeks	20 (18%)
	>3 weeks	1 (1%)
What is your preferred reduction technique?	Arthroscopy	66 (59%)
	Open (*mini-open*)	46 (41%)
In your service, do you have a specialist in pediatric knee or arthroscopy?	Yes	80 (71%)
	No	32 (29%)
What is your preferred method of internal fixation?	High-strength sutures	30 (27%)
	Cannulated metal screws	20 (18%)
	Bioabsorbable screws	6 (5%)
	Harpoons	2 (2%)
	Combination of the above	54 (48%)
Immobilization after reduction and internal fixation	No	2 (2%)
	Yes, <2 weeks	15 (14%)
	Yes, 2 weeks	43 (38%)
	Yes, 4 weeks	46 (41%)
	Yes, 6 weeks	6 (5%)
Weight-bearing of the operated limb after reduction and internal fixation	Partial weight-bearing from day 1	22 (20%)
	No weight-bearing for 2 weeks	30 (27%)
	No weight-bearing for 3 weeks	17 (15%)
	No weight-bearing for 4 weeks	33 (29%)
	No weight-bearing for 6 weeks	10 (9%)

(Continúa.)

Table 2. *(Cont.)*

Rehabilitation (physical therapy) after surgical treatment	Optional	24 (21%)
	Routine	88 (79%)
How do you decide on the return to sport in a patient who practices sports professionally?	Upon fracture healing, after regaining range of motion and at least 85% of contralateral limb strength and complete rehabilitation (regardless of time since surgery).	85 (76%)
	Upon fracture healing, and after completing 10-15 rehabilitation sessions (approximately 3 months)	20 (18%)
	Upon fracture healing (approximately 4-6 weeks)	7 (6%)
Do you routinely use functional tests (strength, coordination, balance, *hop tests*, etc.) to decide on the return to sport?	No	76 (68%)
	Yes	36 (32%)
In your experience, what is the most frequent complication requiring revision surgery?	Residual instability	49 (44%)
	Arthrofibrosis	38 (34%)
	Persistent pain	12 (11%)
	Malunion	9 (8%)
	Infection	4 (3%)
In an 11-year-old patient with a nondisplaced fracture (type I) with no associated injuries, how would you manage immobilization time for conservative treatment?	Immobilization for 4 weeks	70 (62%)
	Immobilization for 6 weeks	30 (27%)
	Immobilization for 2 weeks	12 (11%)
How would you treat an 11-year-old male patient with a displaced Meyers and McKeever type II fracture (intact posterior hinge) with no associated injuries?	Conservative treatment without attempted reduction	5 (4%)
	Conservative treatment with arthrocentesis and attempted closed reduction.	42 (38%)
	Surgical treatment with fixation, sparing the physis	59 (53%)
	Surgical treatment with transphyseal fixation	6 (5%)

*Values are expressed in whole numbers and percentages. CT = computed tomography; MRI = magnetic resonance imaging.

Table 3. Treatment preferences according to demographic location, experience, and annual volume

Variable		Country			Experience in years of practice			Annual case volume		
		Argentina (n= 67)	Spain (n= 45)	p	<10 (n= 37)	≥11 (n= 75)	p	< 3 (n=87)	>3 (n=25)	p
Approach	Open (*mini-open*)	33 (49%)	13 (29%)	**0.03***	14 (38%)	32 (43%)	0.63*	33 (38%)	13 (52%)	0.21*
	Arthroscopic	34 (51%)	32 (71%)		23 (62%)	43 (57%)		54 (62%)	12 (48%)	
Fixation method	High-strength sutures	19 (28%)	11 (24%)	0.82**	13 (35%)	17 (23%)	0.30**	23 (26%)	7 (28%)	0.67**
	Harpoons	0	2 (4%)		0	2 (2%)		2 (2%)	0 (0%)	
	Cannulated metal screws	13 (19%)	7 (16%)		6 (16%)	14 (20%)		15 (17%)	5 (20%)	
	Bioabsorbable screws	3 (4%)	3 (7%)		2 (5%)	4 (5%)		5 (6%)	1 (4%)	
	Combination	32 48%)	22 (49%)		16 (43%)	38 (50%)		42 (48%)	12 (48%)	
Treatment for type II, 11-year-old male	Conservative	32 48%)	22 (49%)	0.23*	22 (59%)	25 (33%)	**0.01***	40 (46%)	7 (28%)	0.11*
	Surgical	25 (37%)	22 (49%)		15 (41%)	50 (67%)		47 (54%)	18 (72%)	
	Conservative - No reduction	4 (6%)	1 (2%)	0.59**	1 (2%)	4 (5%)	0.09**	4(4%)	1 (4%)	0.08**
	Conservative - Arthrocentesis and closed reduction	21 (31%)	21 (47%)		21 (57%)	21 (28%)		36 (41%)	6 (24%)	
	Surgical – Physis-sparing fixation	40 (60%)	19 (42%)		11 (30%)	48 (64%)		42 (48%)	17 (68%)	
	Surgical - Transphy-seal fixation	2 (3%)	4 (9%)		4 (11%)	2 (3%)		5 (6%)	1 (4%)	
Preferred imaging in displaced fractures	Radiographs only	0	1 (2%)	0.03**	0	1 (1%)	0.32**	1 (1%)	0 (0%)	**0.06****
	Radiographs and CT	26 (39%)	24 (53%)		20 (54%)	30 (40%)		43 (49%)	7 (28%)	
	Radiographs and MRI	11 (16%)	9 (20%)		5 (14%)	15 (20%)		14 (16%)	6 (24%)	
	Radiographs, CT and MRI	30 (45%)	11 (24%)		12 (32%)	29 (39%)		29 (33%)	12 (48%)	

* t test (two independent samples); ** Mann-Whitney test. CT = computed tomography; MRI = magnetic resonance imaging.

A notable finding was the high preference for radiographs and advanced imaging in preoperative evaluation. This reflects the importance placed on thorough and accurate injury assessment before determining a treatment plan. Given the mechanism of injury, tibial spine fractures are often associated with meniscal, chondral, and ACL injuries.[6-8] For this reason, MRI is considered mandatory in the preoperative evaluation of these patients. Strikingly, 44% of respondents (39% of SAOTI members and 53% of SEOP members) considered radiographs and computed tomography (CT) necessary for surgical decision-making. However, while these modalities provide valuable information on fragment displacement and comminution, they do not adequately assess interposed structures (intermeniscal ligament, medial meniscus, etc.), associated injuries, or cartilaginous fragments, common in younger children.

Regarding surgical approaches, most surgeons preferred an arthroscopic approach with a combination of fixation methods. This trend suggests a shift toward less invasive techniques and a more individualized approach tailored to each fracture's characteristics. The arthroscopic technique is favored due to its advantages, includ-

ing better intra-articular visualization, removal of interposed structures (intermeniscal ligament, meniscus, etc.), treatment of concomitant meniscal and chondral injuries with minimal morbidity, and improved ACL tensioning.

A systematic review by the Tibial Spine Research Interest Group[9] found no significant differences in rates of nonunion, arthrofibrosis, loss of range of motion, laxity, or secondary ACL injury between different fixation methods. However, some studies report a reoperation rate nearly three times higher with screw fixation.[10,11] 52% of respondents preferred immobilization for 2 weeks or less, while 46% opted for 4 weeks or more. The majority did not allow weight-bearing on the affected limb for 2 to 6 weeks. Previous studies[12,13] suggest that prolonged immobilization increases the risk of arthrofibrosis and delays return to sports. Patel et al.[12] reported that immobilization for more than 4 weeks increases the risk of arthrofibrosis 12-fold. Therefore, every effort should be made to achieve optimal reduction and stable fixation, allowing for early rehabilitation, which promotes faster recovery and reduces secondary complications.

Tibial spine fractures are typically managed conservatively when undisplaced and surgically when completely displaced. However, the optimal treatment for displaced but posteriorly hinged (type II) fractures remains controversial. In our study, 58.1% of respondents favored surgical treatment for these fractures. No significant differences were observed in treatment preferences based on demographics, clinical experience, or annual case volume, suggesting a general consensus among pediatric orthopedic surgeons across different backgrounds. A recent multicenter study[14] analyzed 164 patients with type II fractures treated with both surgical and non-surgical approaches. The study found that while complication rates, reoperation rates, and total range of motion were similar, the non-surgical group had higher ACL laxity, a higher incidence of recurrent fractures and ACL injuries requiring surgery (4.9% vs. 0%; $p = 0.01$). Conversely, the surgical group had a higher rate of arthrofibrosis (8.9% vs. 0%; $p = 0.047$).

The widespread use of formal postoperative rehabilitation among respondents underscores the importance of active recovery strategies. However, the low frequency of functional testing to assess return to sport raises concerns about whether current rehabilitation protocols optimize long-term functional outcomes. This highlights potential areas for future research and protocol refinement.

This study has limitations that should be considered. The survey was distributed only to SAOTI and SEOP members, potentially introducing selection bias by excluding other pediatric orthopedic surgeons with different perspectives. This limits the ability to extrapolate our findings internationally or to other surgeon populations. Secondly, responses are based on self-reported practices, which may be subject to recall bias or response bias. Surgeons might report practices they perceive as more acceptable or ideal, affecting the accuracy of the data collected. Thirdly, although the survey included 21 questions, it may not have addressed all relevant aspects of tibial spine fracture management. Important variables, such as complication management, that could influence the clinical practices and treatment decisions of pediatric orthopaedic surgeons could have been omitted. Finally, while statistical analyses were conducted to explore associations among variables, the sample size may not have been large enough to detect significant differences in some comparisons, potentially limiting the robustness of certain findings.

This study highlights the variability in clinical practices regarding tibial spine fractures among pediatric orthopedic surgeons. While common trends emerged—such as the widespread use of advanced imaging and preference for less invasive surgical approaches—there were also areas of variability in clinical practice. These findings emphasize the need for continued research and interdisciplinary collaboration to refine therapeutic strategies for these injuries, ultimately improving long-term outcomes for pediatric patients.

Conflict of interest: The authors declare no conflicts of interest.

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