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Screws or Sutures? A Pediatric Cadaveric Study of Tibial Spine Fracture Repair Techniques

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Disclosures

- Dr. Sherman holds committee positions for AANA, AAOS, ACLSG, AOSSM, Biologic Association, ICRS, and ISAKOS. He is on the editorial board for the Arthroscopy Journal, Cur Rev Musc Med, and VJSM. He is a course chair of ISMF and the PFF Masters Course and a member of the AO Sports Medicine Taskforce. Dr. Sherman is a paid educational consultant for Arthrex, Depuy, Flexion, JRF, Kinamed, LifeNet, NewClip, and Smith & Nephew. He is a paid advisory board member for Bioventus, Icarus, Ostesys, Reparel, Sarcio, Sparta Medical, Vericel, and Vivorte. Dr. Sherman is on design teams and receives royalties from ConMed and DJO.Dr. Sherman holds stock options for Ostesys, Sarcio, Reparel, and Vivorte.

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Background

- Tibial spine fractures are common in the pediatric population due to the integrity of their subchondral epiphyseal bone.

- Two techniques predominate the tibial spine fracture repair: screw fixation and suture fixation.

- Most studies in porcine or adult human bone suggest suture fixation is superior to screw fixation, but these tissue types may be poor surrogates for pediatric bone.

- No prior study has evaluated fixation methods in human pediatric knees.

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Aims and Hypothesis

- This study aimed to quantify the biomechanical properties of two-screw and two-suture tibial spine fracture repair in pediatric knees.

- We hypothesized that these repair techniques would have statistically different failure loads when compared in pediatric tissue.

Methods

1. Age and laterality matched pediatric knee specimens were randomly assigned to either a two-screw or two-suture fixation.
2. An osteotome induced a standardized Meyers-Mckeever Type III tibial spine fracture.
3. Fractures were repaired with either screws or sutures.
4. Specimens were then mounted for biomechanical testing.
5. One-sample t-tests were used to assess differences between ultimate failure loads, cyclic stiffness, and cyclic elongation.

Screw Fixation:

1. For knees assigned to screw fixation, each fracture was reduced with two 1.25-mm K-wires drilled into the lateral and medial borders of the ACL-fracture construct and fracture bed at 45-degree angles.
2. Then, K-wires were over drilled using a 2.7-mm drill to a depth of 40mm.
3. Next, two 35 mm–length, 4 mm–diameter, partially threaded cannulated screws were placed over the K-wires and tightened to adequate purchase
4. Appropriate convergent screw trajectory and depth were assessed via anteroposterior, lateral, and axial fluoroscopy.

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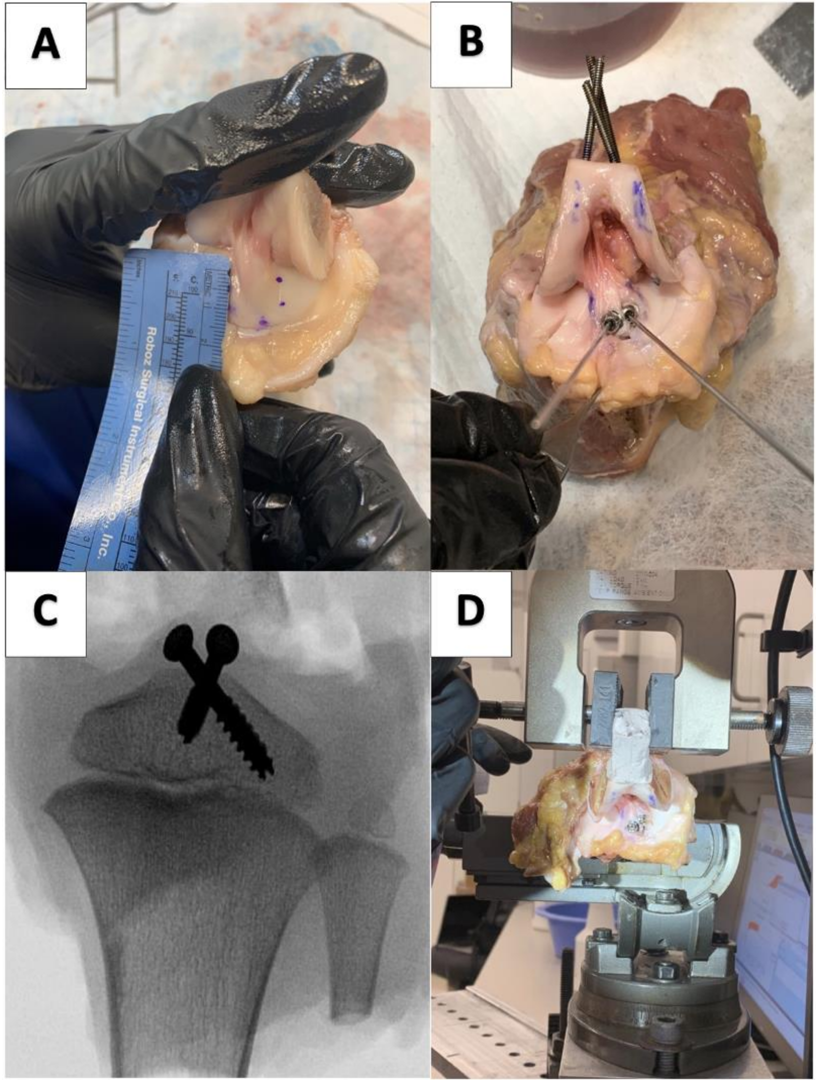
Screw Fixation:

- **(A)** Specimen with representative circumferential marks made at 2mm away from the ACL insertion.
- **(B)** Screws placed in a convergent trajectory through the medial and lateral aspects of the fracture fragment.
- **(C)** Anteroposterior fluoroscopy of the construct.
- **(D)** Screw repaired construct loaded into the Instron 5944 for biomechanical testing.

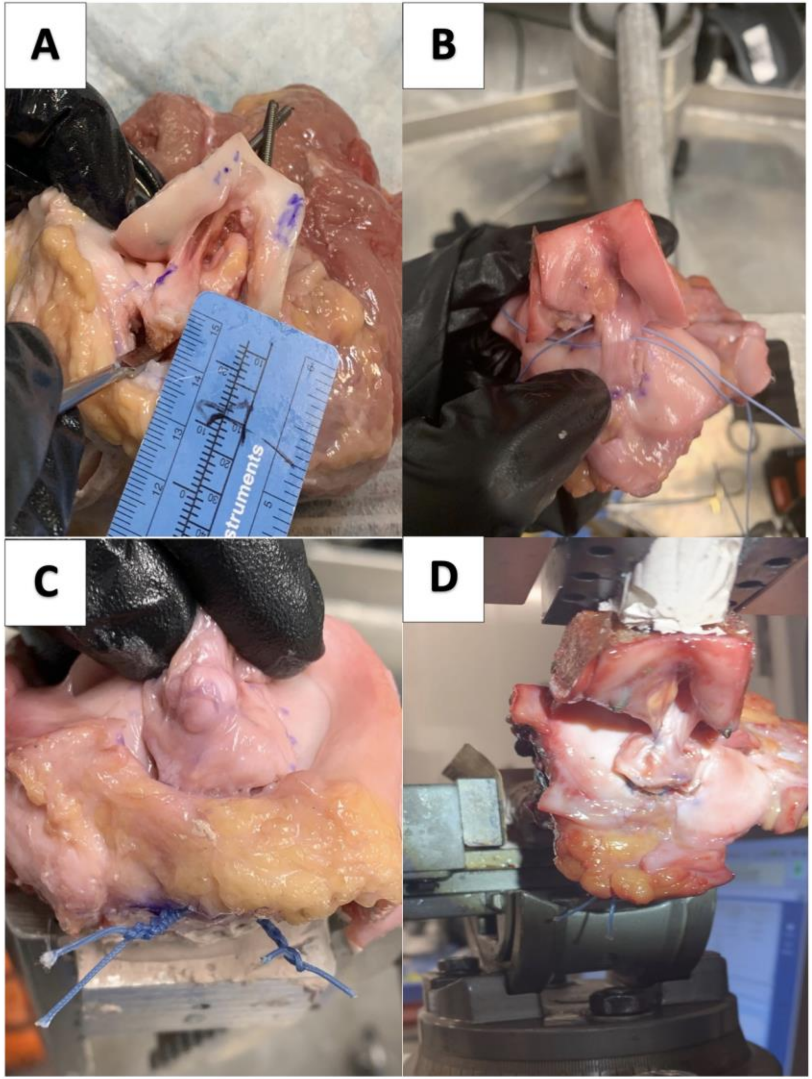


Suture Fixation:

1. For knees assigned to suture fixation, a tibial ACL guide and 2.4mm drill-tip guide wire were used to drill two medial-entry bony tunnels spaced 1cm apart and 1cm distal to the articular surface of the medial tibial plateau
2. Bony tunnels exited into both the medial and lateral base of the manually-reduced fracture fragment. Drill exit holes at the level of the ACL insertion into the fracture fragment were consistently 1cm apart and straddled the anteromedial ACL bundle.
3. Next, two No. 2 FiberWire sutures were passed through the base of the ACL with a curved needle. One suture was passed through the anterior one-third of the ACL, the other through the posterior one-third.
4. The sutures were then pulled through the bony tunnels with a suture passer and secured over the 1cm bony bridge with five alternating surgical knots.

Suture Fixation:

- **(A)** Elevation of the anterior portion of the fracture fragment with the standard osteotome.
- **(B)** Suture passing through the anterior and posterior thirds of the ACL.
- **(C)** Suture fixation and reduction of the fracture and ACL.
- **(D)** Suture repaired construct loaded on the Instron 5944 for biomechanical testing.



Biomechanical Loading Protocol

1. Specimens were potted in epoxy putty and mounted for biomechanical testing on an electromechanical load frame at approximately thirty degrees of flexion to simulate typical ACL loading conditions.

2. After loading, each testing construct was subjected to cyclic preconditioning, which consisted of 20 cycles of loading between 5 and 25N at a rate of 60 cycles per minute.

3. Next, a cyclic loading protocol was applied to each specimen. This included 500 cycles between 5 and 75N at a crosshead speed of 100mm per minute.

4. Upon the completion of cyclic loading, samples recovered for thirty minutes. Finally, a load-to-failure protocol was conducted at a rate of 0.5mm per second.

5. Biomechanical properties for each construct were recorded and compared by univariate analysis.

Results:

- A total of twelve age (range: 6 years - 10 years) and laterality-matched pediatric cadaveric knees were tested.

- The repair groups had identical mean (8.3 years) and median (8.5 years) ages and an identical number of samples of each laterality.

Biomechanical Property	Screws	Sutures	P-Value
Mean Ultimate Failure Load in Newtons (SD)	143.52 (41.97)	135.35 (43.17)	0.760
Mean Stiffness During Load to Failure Test in Newton-Millimeters (Sd)	21.79 (10.58)	13.83 (6.82)	0.076
Mean Elongation Over the Course of Cyclic Loading in Millimeters (SD)	5.02 (2.43)	8.46 (3.99)	0.069
Number of Specimens Surviving Cyclic Loading	5	5	<0.9

Conclusions:

- Screw and suture fixation of tibial spine fractures in pediatric bone are biomechanically comparable, contrasting with previous literature.
- This study is the first to evaluate different fixation methods in pediatric bone and demonstrates that failure loads are statistically and practically lower than adult cadaveric and porcine bone, such that inferences drawn from previous studies may be misleading.
- Further investigation should be conducted into repair constructs that are more biomechanically sound in pediatric bone.

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