Periosteal Incarceration Versus Interposition Adipose Grafting in Physeal Fractures: A Laprine Model

Eric W. Edmonds, MD1,2, Joshua D. Doan, MEng3, Diana A. Glaser, PhD3, Christine Lynn Farnsworth, MS1.
1Division of Orthopedics, Rady Children’s Hospital, San Diego, CA, USA, 2Department of Orthopaedic Surgery, University of California, San Diego, San Diego, CA, USA, 3Orthopedic Biomechanics Research Center, Rady Children’s Hospital, San Diego, CA, USA.

Disclosures:
E.W. Edmonds: 2; Arthrex, Inc.. 5; Inion. J.D. Doan: None. D.A. Glaser: 4; mako, Mankind, Alphatec, NuVasive. 5; EOS Imaging, Growing Spine Foundation, KCI, K2M, Naval Medical Center San Diego. C.L. Farnsworth: None.

Introduction:
Physeal fractures risk arrest of growth,1 particularly with the incarceration of adjacent periosteum.2-4 Surgical interposition of adipose tissue has been proposed as a methodology to prevent the formation of physeal bars,5 but new evidence suggests that adipose will respond differently than periosteal tissue in the setting of acute fractures.6,7

Methods:
Eleven 10-week-old male rabbits (2kg) were used in this IACUC supervised study. Physeal fractures were created on the right proximal tibia utilizing a lateral approach; and a sham surgical approach was performed on the left leg (Sham Group, n=11). Fractures received one of the following treatments before cast placement: a flap of local periosteum interposed into the fracture (Periosteum Group, n=4, 1 euthanized early), post-patellar tendon adipose (Fat Group, n=5) and fracture only (Fracture Only, n=1). Radiographic Analysis: PA and lateral radiographs taken pre-op, post-op, 10 days (upon cast removal) and 6 weeks post-op were compared between groups by means of tibial medial-lateral side difference (TMLSD) (mm), femoral-tibial angle (°) and tibia plateau angle (°) measurements. Pre-op to 6 weeks post-op x-ray measurements were compared between surgical groups and postop to 10 days post-op measurements were compared; repeated measures ANOVAs were used. Radiographs were also reviewed for presence of physeal bars. MicroCT Analysis: micro CT was taken of each proximal tibia, growth plates reconstructed, and physeal area calculated. Fractured physeal areas (fracture only, periosteum and fat) were normalized to the contralateral side area (sham) in the same animal.

Results:
There were no significant differences between periosteum and fat groups when comparing age, weight, surgical duration and weight increase over 6 weeks. Radiographic Results: After 6 weeks, physeal bars were seen in Fracture Only (1/1 = 100%), Periosteum (4/4 = 100%), and Fat Groups (3/5 = 60%). The periosteum group showed a significant increase in the TMLSD between immediately post-op and 10 days later (p=0.028), showing a possible growth plate effect already present after 10 days that was not seen in the other two groups. The change in TMLSD between pre-operative and 6 week post-op was not different between the three surgical groups (p=0.161). Valgus alignment (femoral-tibial angle) increased slightly following sham surgery at both 10 days and 6 weeks and appears to be a natural result of growth in this animal model and was not affected by either surgical group. The tibial plateau angle remained consistent in the sham group, but decreased without significance in the 3 surgical groups.

MicroCT Results: The µCT findings demonstrated that the Fracture Only normalized physis area was 0.51 (FIGURE); whereas, every physis in the fat group was over 0.90 (mean of 0.99±0.06), and only half of the periosteum group was over 0.90 (mean of 0.81±0.24). Periosteum and fat groups were not significantly different (p=0.137).
Discussion:

There is some evidence that fat interposition may prevent, or at least delay, the onset of bars across a fractured physis. Retrospective clinical studies suggest that intervention on distal tibia fractures with interposed periosteum may not be completely benign. Therefore, the possible benefit of adipose interposition versus simple removal of incarcerated periosteum may need to be explored further.

Significance:

Adipose interposition grafting does not appear to fully protect from bar formation in the setting of physeal fracture, but it does appear to have less risk than incarcerated periosteum. The question of whether surgery to remove the periosteum and then interpose adipose tissue will require further study.

Acknowledgments:

This study was funded by a grant from the Pediatric Orthopaedic Society of North America and from support of the Children’s Specialists of San Diego. The authors thank Tracey Bastrom, MA for statistical analyses, Joseph Carreau, MD for surgical assistance and histology processing, Krishna Cidambi, MD for surgical assistance, Esther Cory, MA for assistance with microCT acquisition and Andrew T. Pennock, MD for discussions regarding clinical cases.

References:


ORS 2014 Annual Meeting
Poster No: 0644