CORTICES 2026 POSNA RESEARCH MEETING

2:00 – 5:00 PM

May 5th, 2026

Rosen Shingle Creek

Orlando, Florida

Introduction

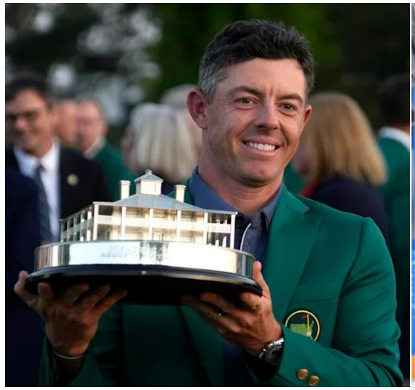
Presenters: Fernanda Canizares

Welcome

Introductions

What sport, team, athlete, or comeback story were you rooting for this past year?

Not a sports fan? Share an entertainment moment, show, artist, or your unique talent instead.



Housekeeping

- Agenda will go 2-5pm.
- 4 sessions, 2 breaks
- Short 5 min presentations followed by 5 min discussion
- Dinner later at Café Tu Tu Tango at 6:30pm.

Research Committee Update

Evidence Synthesis Before Retrospective Proposals:

- Clarifies the true knowledge gap before collecting data
- Reduces duplication and strengthens novelty
- Improves REDCap variables, definitions, outcomes, inclusion/exclusion criteria
- Creates publishable opportunities for trainees without new IRB/DUA burden

Not mandatory — but strongly encouraged

Map the evidence

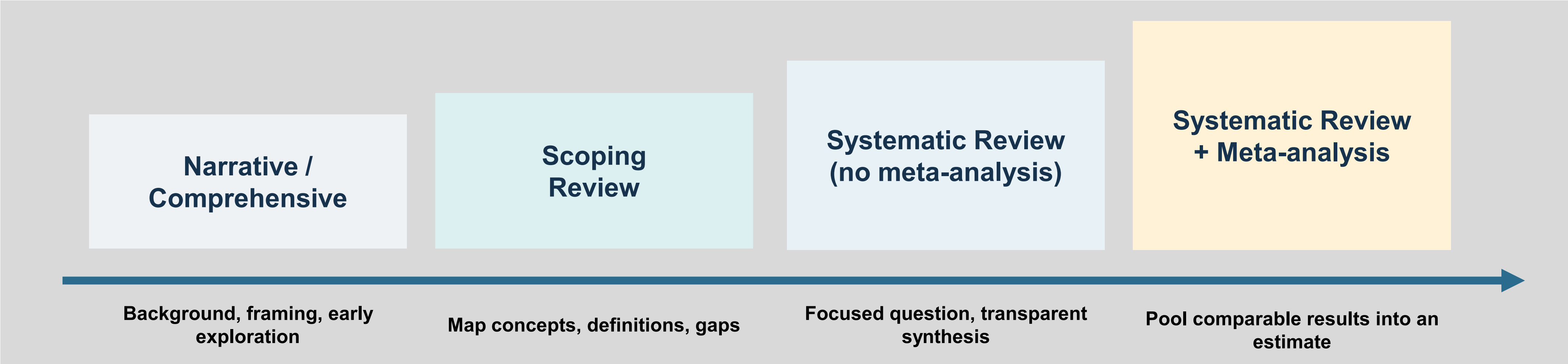
Define the gap

Build a better proposal

Stronger CORTICES study

Choosing the right evidence synthesis

- The question drives the method — and the evidence level depends on both the review and the underlying studies.
- A high-quality systematic review of weak studies remains limited by the underlying evidence.
- Scoping reviews are not “less useful.” They are the right tool when the literature is heterogeneous or immature.
- Submit an Expedited proposal to the RC using Research Study Proposal – CORTICES



Children's Hospital of Philadelphia®

CORTICES CHOP Projects
Floating Elbow + Traumatic Hip

Presenter(s): Alexander Arkader & Keith Baldwin

Floating Elbow 2- Electric Boogaloo

- No difference in outcomes for fixation of non displaced distal fractures in pediatric floating elbows versus casting
- Published JPOSNA 2025 vol 13
- Presenting this week at POSNA Fri May 8 2:37-2:41

Traumatic Hip Dislocation

- Alpha test completed
- Beta test 5 centers- CHOP, BCH, Mich, Seattle, Colorado
- Received Completed beta test data on 4/5 centers (waiting on Colorado
- 112 patients total from these 4 sites 85 with completed data sets

Goals

- All REDCAP fields designed to answer one of 7 questions
- Last of which is to formulate a classification which helps understand optimal treatment strategy for traumatic hip dislocations in children

7. CLINICAL QUESTION & SPECIFIC AIMS

Include PICOt components for aims: Population, Intervention, Comparison, Outcome, time

P	I	C	O
1. To determine the rate and risk factors for AVN and functional outcomes following post-dislocation AVN of the femoral head			
Pediatric Patients with Traumatic Hip Dislocations	Early vs Late reduction, Open versus closed reduction	AVN vs No AVN	AVN Rate, AVN Management, AVN resolution or progression, Upadhyay and Moulton grading of dislocation at final follow-up, Range of motion
2. To establish differences in reduction protocols/ incidence of femoral head fractures and other adverse events of reduction (OSH vs CORTICES hosp, and ED vs OR)			
Pediatric Patients with Traumatic Hip Dislocations	Reduction Location	OSH vs CORTICES hosp, and ED vs OR	Imaging modality, iatrogenic fractures, time taken for reduction, time to reduction, delay in care, other complications.
3. To establish post-reduction imaging protocols (MRI findings vs CT, what findings were present and addressed on MRI that would not have been found on CT)			
Pediatric Patients with Traumatic Hip Dislocations	Imaging Protocol	CT vs MRI vs Radiographs	Missed injuries, change in management, secondary procedures
4. To establish post-reduction rehabilitation protocols (bracing duration, immobilization strategy by age)			
Pediatric Patients with Traumatic Hip Dislocations	Rehabilitation Protocol	Immobilization type, length of immobilization, weight bearing restrictions	Time to return to activity, Time to fill weight bearing, Re-dislocation events, Time to development of recurrent instability
5. To determine factors influencing return to sport			
Pediatric Patients with Traumatic Hip Dislocations	Reduction and Rehabilitation Protocols	Re-dislocation events, Early radiographic arthritis, time for development of recurrent instability	Hip instability/re-dislocation/stiffness
6. To determine the risk factors for hip instability/re-dislocation/stiffness			
Pediatric Patients with Traumatic Hip Dislocations	Reduction and Rehabilitation Protocols	Re-dislocation events, Early radiographic arthritis, time for development of recurrent instability	Hip instability/re-dislocation/stiffness

Patients

- 84 patients
- 13.4 months avg follow up
- 80% male
- Avg age 12.1
- 94% posterior 4% anterior 2% central
- 57% mechanism sports (Football most common)
- 5% open reduction, 4% spontaneous reduction, 91% closed reduction

Data

- 69% present initially to an OSH, 31% to a CORTICES center
- 51% reduced by trainee or APP, 49% by attending
- 96% good/excellent 4% fair/poor
- 81% of reductions done in the ED 19% OR
- 5% nerve injury 2.5 % foot drop
- 2.4% rate of post reduction injury (femoral physeal fx)
- 4.7% rate of AVN (4/84, 3 of these had surgery

Good Prelim Data

- Issues
- Similar to previous studies, most have good outcomes
- Rate of fair/ poor outcomes is sub 5%
- As such we need a lot of centers to participate, and possibly consider extending dates
- Good news- The data set is robust and well understood by data collectors, there was not a ton of missing data.

Incidence of Adverse Clinical Outcomes of Femoral Neck Fractures in a Pediatric Population

Jill E. Larson, MD

Lurie Children's Hospital

Ann & Robert H. Lurie Children's Hospital of Chicago

Children's Hospital Colorado

C.S. MOTT CHILDREN'S HOSPITAL MICHIGAN MEDICINE

Children's Hospital LOS ANGELES

Cincinnati Children's

CORTICES

ADVANCING EVIDENCE-BASED ORTHOPEDIC CARE

Ann & Robert H. Lurie Children's Hospital of Chicago

Retrospective Study

Primary Aim: To determine the incidence and risk factors of adverse outcomes (AVN, non-union, repeat surgery, etc.) after treatment of femoral neck fracture in a pediatric population in the United States

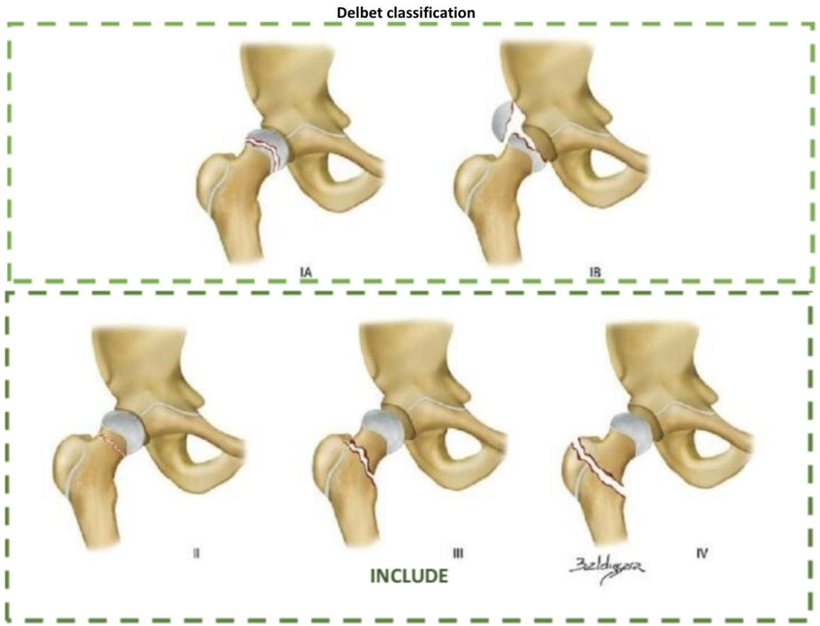
Secondary Aims:

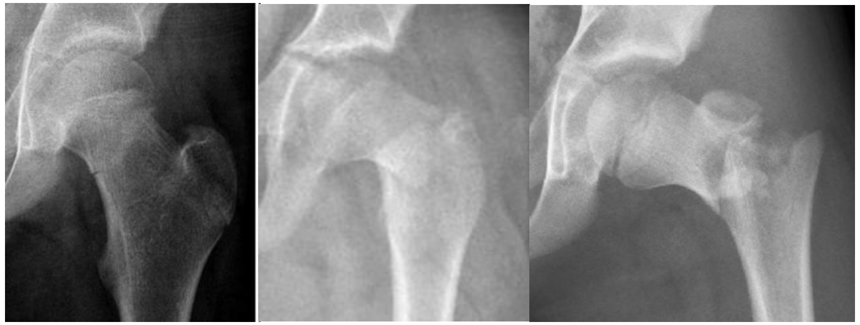
1) To identify the demographic and clinical factors associated with sustaining a femoral neck fracture in children treated at CORTICES institutions

2) To develop a multicenter retrospective database of femoral neck fractures treated by CORTICES members

Inclusion Criteria

- Patients with femoral neck fracture defined as **Delbet 1, 2, 3, and 4 fractures** including physeal fractures proximal to the lesser trochanter
- Fracture occurrence between 1/10/2010 and 5/30/2025
- Age **2 to 16 years** at date of injury presentation
- Presented at, transferred to, or followed up at a CORTICES-participating institution with initial injury imaging available
- This data represents beta testing in Chicago





Exclusion Criteria

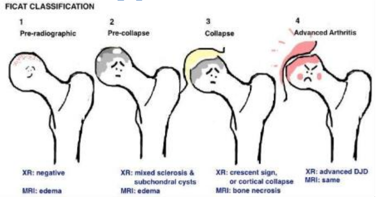
- Atraumatic physeal injuries: Slipped Capital femoral epiphysis (ICD-9 732.2 or ICD-10 code M93.0)
- Age >16 at time of surgery
- Lost to follow-up within 2 weeks of surgery
- No initial injury imaging available for radiographic classification

Adverse Outcomes – Definition

Modified Clavien-Dindo-Sink Complication Classification System	
Grade	Definition
I	A complication that does not result in deviation from routine follow-up in the postoperative period and has minimal clinical relevance and requires minimal treatment (e.g., antiemetics, antipyretics, analgesics, diuretics, electrolytes, antibiotics, and physiotherapy) or no treatment
II	A deviation from the normal postoperative course (including unplanned clinic/office visits) that requires outpatient treatment, either pharmacological or close monitoring as an outpatient, or results in prolonged initial inpatient hospital stay.
III a/b	A complication that is treatable but requires an unplanned hospital readmission (**IIIa**); or unplanned surgical, endoscopic, or interventional radiology procedure(s) **(IIIb)**
IV a	A complication that is life or limb-threatening, and/or requires ICU admission, a complication with potential for permanent disability but treatable, a complication that may require organ/joint resection/replacement. <u>No long-term disability</u>
IV b	A complication that is life or limb-threatening, and/or requires ICU admission, a complication that is not treatable, a complication that requires organ/joint resection/replacement or salvage surgery. <u>With long-term disability</u>
V	Death

Adverse Outcomes – Examples

- Grade 1 – complication requires no treatment, no deviation from post-op course
- Grade 2 – deviation from normal post-op course requiring outpatient treatment (pharm/close monitoring)
  - Superficial infection: resolved with observation or antibiotics / LLD < 2cm
- Grade 3 – treatable, but requires surgical, endoscopic, or interventional radiology procedures or unplanned hospital admission
  - Deep infection: required a return to the operating room and/or admission
  - Hardware related complications: This includes hardware prominence, broken hardware, loose hardware, or hardware penetrating the joint. Does NOT include planned hardware removal for surgeon/family preference.
- Grade 4 – life- or limb-threatening and/or requires ICU admission
- 4a – potential for long-term disability, but treatable (may require organ/joint resection/replacement).
  - Nonunion (lack of healing at >6 months and/or loss of mechanical integrity with respect to implanted hardware)
  - Malunion (vertical or femoral neck shortening of >15 mm)
  - **AVN with cortical drilling**
- 4b – not treatable or with long-term disability, requiring require organ/joint resection/replacement)
  - **AVN: as diagnosed on MRI or evidence of collapse on x-rays (according to the modified Ficat system with type 2b and greater defined as clinical failure)**
  - Subsequent major reconstructive surgery required (conversion to THA or proximal femur osteotomy)
- Grade 5 – Death



Imaging Findings

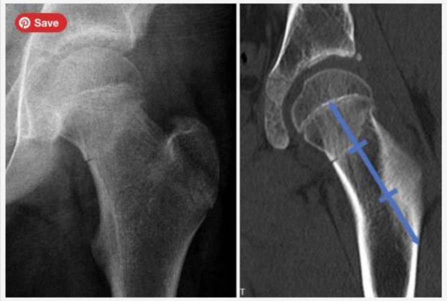
Record ID 1

Initials of the person filling out this form JL
* must provide value

Date of Image being evaluated 08-22-2021 Today M-D-Y

Fracture location: A line is drawn from the proximal femoral physis to the lateral cortex, parallel to the neck, and divided in thirds. The most proximal site of fracture line exiting the cortex determines the type. Type I includes the proximal third (Transcervical), Type II middle third (basicervical), and Type III when there is involvement of the trochanters (intertrochanteric). Examples:

Type I:



Type II:

Type III:

* must provide value

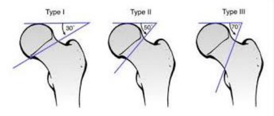
- ◉ Type I (proximal third) - subcapital and transcervical
- ○ Type II (middle third) - basicervical
- ○ Type III (distal third) - trochanteric involvement

Fracture Type
* must provide value

- ○ Incomplete
- ◉ Complete
- ○ Stress
- ○ impacted

reset

Pauwels Type



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- ○ Type I (< 30 deg)
- ◉ Type II (30-50 deg)
- ○ Type III (>50 deg)

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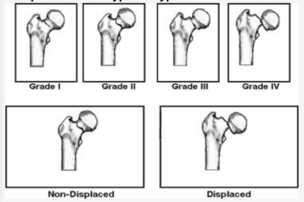
Displacement of Fracture (Modified Garden Classification)
o Non-displaced - Grade I /Grade II
o Displaced - Grade Type III / Type IV



- ○ Non-displaced
- ◉ Displaced

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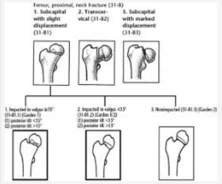
OTA Classification



- ○ B1.1 Subcapital - valgus impacted
- ○ B1.2 Subcapital - nondisplaced
- ○ B1.3 Subcapital - displaced
- ◉ B2.1 Transcervical fracture - simple
- ○ B2.2 Transcervical fracture - multifragmentary
- ○ B2.3 Transcervical fracture - shear fracture
- ○ B3.1 Basicervical fracture

reset

Proximal femoral physis
* must provide value

- ○ Open
- ◉ Closed

reset

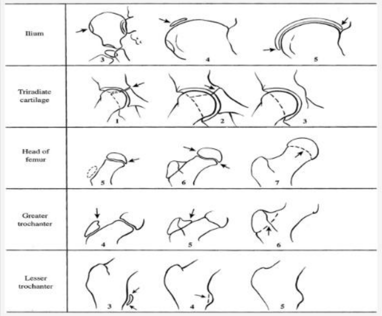
Triradiate cartilage
* must provide value

- ○ Open
- ◉ Closed

reset

Oxford score -

Total sum of all aphophyseal stages listed below



Fracture Description

incomplete (fracture line in only one cortex)
complete (fracture extends to both cortices),
stress (chronic symptoms, often seen on MRI only),
impacted (more common in individuals with fragile bone, no visible fracture line but the femoral neck height is diminished, hence "impacted"

Injury CT Scan available?
* must provide value

- ○ Yes
- ◉ No

reset

Injury MRI available?
* must provide value

- ○ Yes
- ◉ No

reset

Intra-operative imaging available?
* must provide value

- ◉ Yes
- ○ No

reset

Quality of reductionn
Excellent: < 2mm of displacement and < 5 degrees of angulation in any plane on any view
Good: 2-5 mm of displacement and/or 5-10 degrees of angulation in any plane on any view
Fair: >5-10 mm of displacement and/or >10-20 degrees of angulation in any plane on any view
Poor: >10 mm of displacement and/or >20 degrees of angulation or any varus

- ◉ Excellent
- ○ Good
- ○ Fair
- ○ Poor

reset

Comments on intra-op imaging

Expand

Ann & Robert H. Lurie Children's Hospital of Chicago

First post-op imaging available?
* must provide value

(•) Yes
( ) No

reset

Date imaging was performed 09-03-2021 Today M-D-Y

Quality of reduction

Excellent: < 2mm of displacement and < 5 degrees of angulation in any plane on any view
Good: 2-5 mm of displacement and/or 5-10 degrees of angulation in any plane on any view
Fair: >5-10 mm of displacement and/or >10-20 degrees of angulation in any plane on any view
Poor: >10 mm of displacement and/or >20 degrees of angulation or any varus

(•) Excellent
( ) Good
( ) Fair
( ) Poor

reset

Femoral Neck Length - Affected Side N/A
(measurement of tip of greater trochanter to femoral head center on an AP Pelvis radiograph)

Femoral Neck Length - Non-affected Side N/A
(measurement of tip of greater trochanter to femoral head center on an AP Pelvis radiograph)

Hardware stable from surgery?

(•) Yes
( ) No

reset

Comments on first post-op imaging

Expand

Was bone scan done?
* must provide value

( ) Yes
(•) No

reset

Adverse event imaging available?
XR/CT/MRI images that demonstrate progression or presence of AVN/malunion/non-union/hardware complication/etc.
* must provide value

( ) Yes
(•) No

reset

Time period of adverse outcome IMAGING since surgery date

( ) ≤ 3 mo
( ) ≤6 mo
( ) ≤12 mo
( ) ≤18 mo
( ) ≤24 mo

Final imaging available?
* must provide value

(•) Yes
( ) No

reset

Date final imaging was done 03-05-2023 Today M-D-Y

Quality of reduction

Excellent: < 2mm of displacement and < 5 degrees of angulation in any plane on any view
Good: 2-5 mm of displacement and/or 5-10 degrees of angulation in any plane on any view
Fair: >5-10 mm of displacement and/or >10-20 degrees of angulation in any plane on any view
Poor: >10 mm of displacement and/or >20 degrees of angulation or any varus

(•) Excellent
( ) Good
( ) Fair
( ) Poor

reset

Femoral Neck Length - Affected Side N/A

Femoral Neck Length - Non-Affected Side N/A

Is hardware in stable position compared to initial post-operative images?

[x] yes
[ ] no
[ ] removed

Adverse outcomes noted on final imaging

[ ] AVN
[ ] Malunion
[ ] Nonunion
[ ] Hardware complications (backing out, breakage, penetrating joint, etc.)
[ ] Fracture displacement post-op
[ ] Other
[x] None

Comments on final imaging

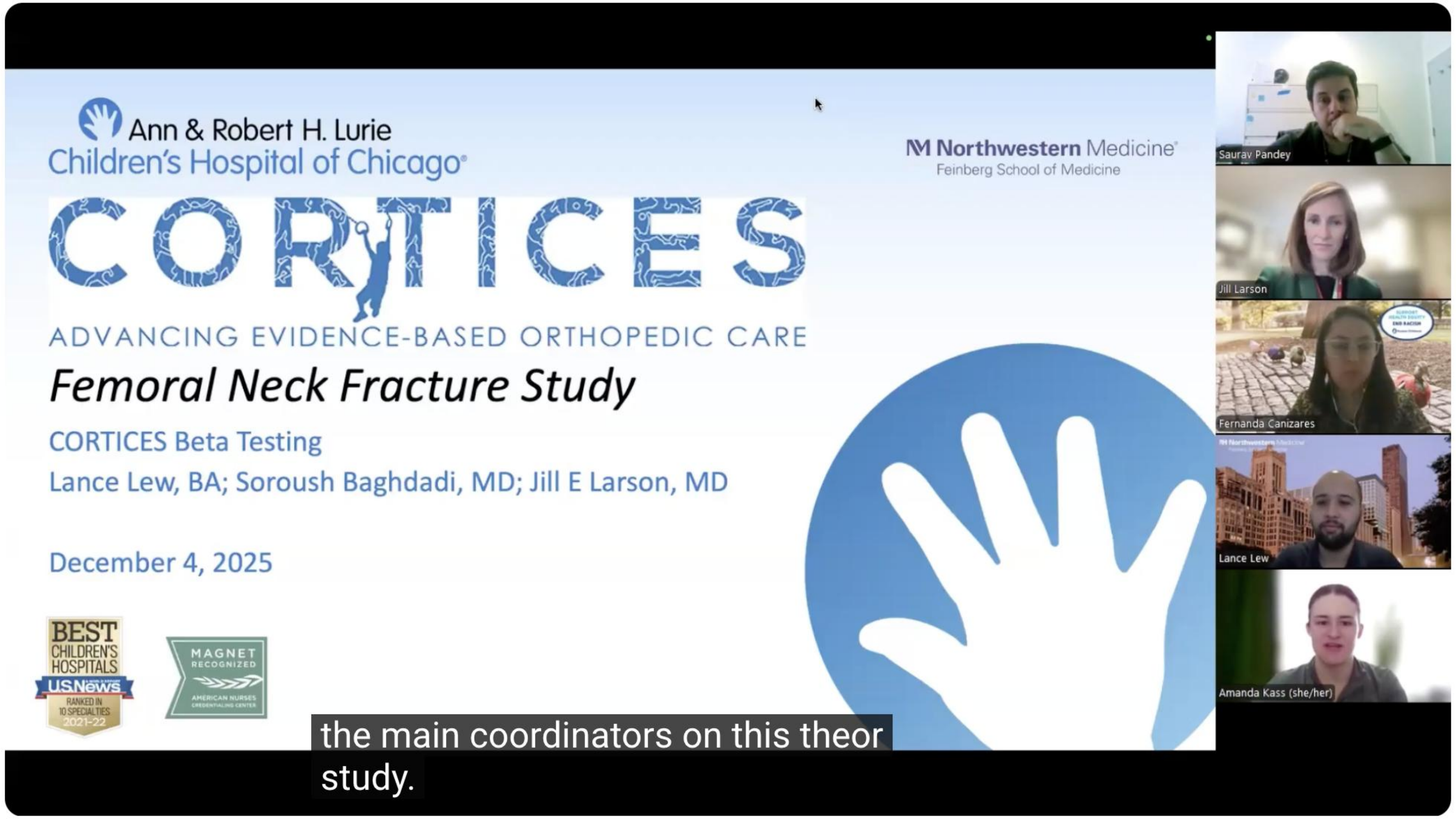
No AP Pelvis available so no femoral neck length comparison

Expand

Value of Beta Testing

- Address patient ID issues – (bilateral fem neck fx)
  - Solved with instance #1, instance #2
- Address reference image discrepancy
  - Solved with new image
- Identify Imaging obstacles (no Neck length comparison in hip images)
  - Greater troch above/below/at femoral head center

CORTICES Website



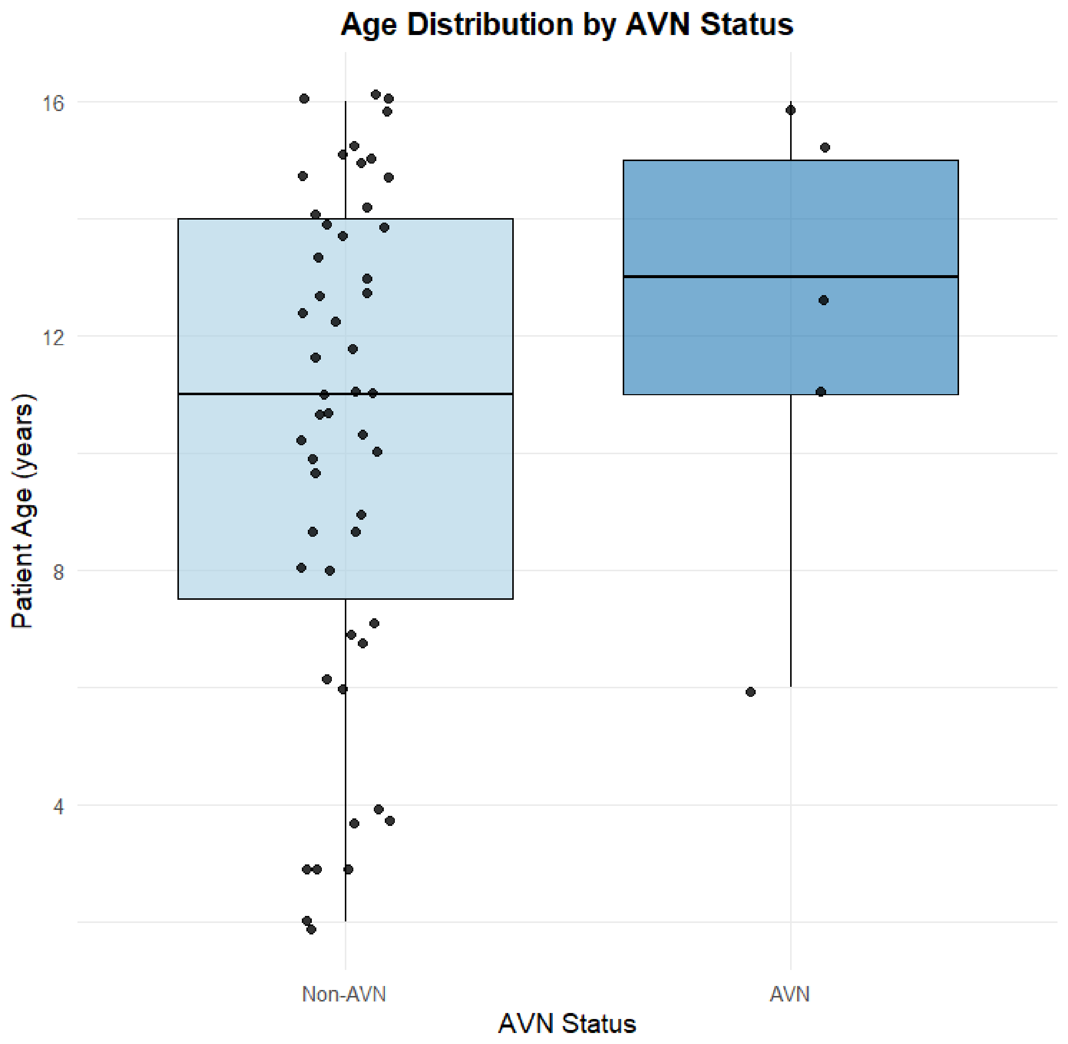
CORTICES: Femoral Neck Fractures (β-Launch)

Unlisted

Results

- 56 patients were identified at *Ann & Robert H. Lurie Children's Hospital of Chicago*
    - 38 male (67.9%)
    - Age distribution
        - 9 young child (2-6 years) - 16.9%
        - 23 older child (7-12 years) - 41.1%
        - 22 adolescent (13-16 years) - 39.3%
- A total of 5 patients had AVN (8.9%)
    - 1 case identified 6 months postoperatively
    - 3 cases identified ≥ 12-18 months post-operatively
    - 1 case identified ≥ 19 months post-operatively
- Incidence of adverse outcome was 46.4% (95% CI 33.0-60.3)

AVN and Adverse Outcomes

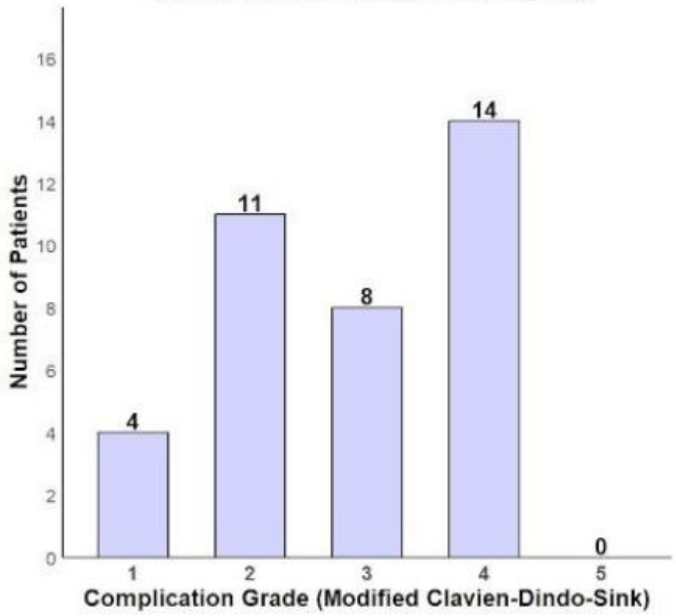


2.48 times odds of developing AVN in older patients (age ≥ 13)

(95% CI 0.26–32.2 p = 0.371)

Incidence of Postoperative Complications

Complication	Events (n/N)	Rate (95% CI)
Superficial infection	1/56	1.79% (0.05–9.55%)
Deep infection	0/56	0% (0–6.38%)
Avascular necrosis	5/56	8.93% (2.96–19.62%)
Nonunion	8/56	14.29% (6.38–26.22%)
Malunion	4/56	7.14% (1.98–17.29%)
Hardware complications	11/56	19.64% (10.23–32.43%)
Other complications	20/56	35.71% (23.36–49.64%)
Overall	26/56	46.43% (32.99–60.26%)



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Conclusion / Significance

- Almost **half of pediatric femoral neck fractures** treated at our institution had some type of **adverse outcome** post-operatively
  - Of the complications noted, approximately 60% required further intervention (modified Clavien-Dindo-Sink Grade III or IV)

Of the 5 patients who had AVN,

age $\geq$ 13 years was the most notable risk factor with odds ratio of 2.48

The majority of AVN cases presented >12 months from surgery suggesting the importance of long-term follow-up for this injury

Underpowered to detect associations between AVN and sex, BMI, abnormal bone quality, medical conditions, or delayed surgery

- Data provides foundation for a larger retrospective clinical and radiographic database study to be conducted by the **multi-center CORTICES study group**

References

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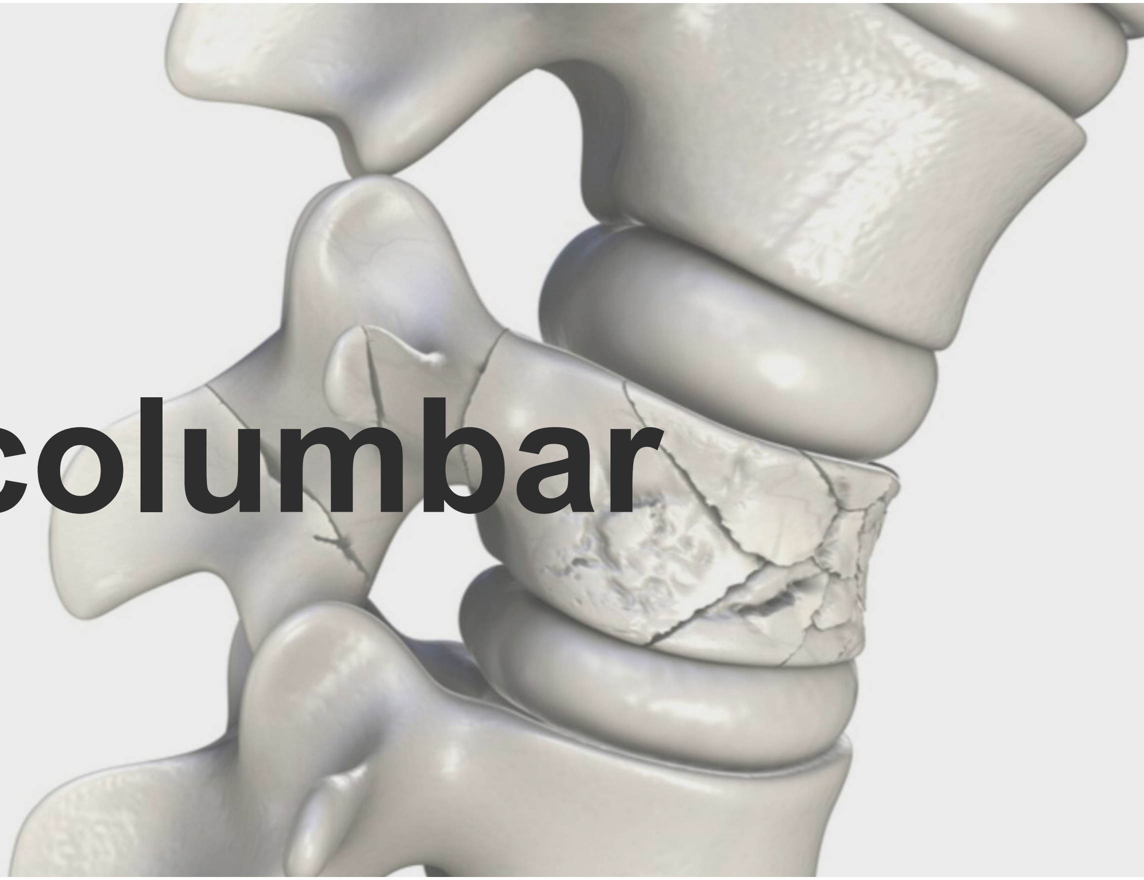


Pediatric Thoracolumbar Fractures

Presenter(s): Craig Birch

BACKGROUND

- **No pediatric-specific standard** of care for thoracolumbar spine trauma; most management **extrapolated from adult literature**
- Pediatric anatomy, growth potential, biomechanics differ from adults

Lack of consensus regarding:

Surgical Indications	Extent of Construct	Operative Approach	Specialty Based Variation

Goals

Greater Standardization	Consistency of Care	Improved Outcomes

STUDY AIMS

PRIMARY AIM

Characterize Injury & Treatment Patterns

Identify common fracture patterns & operative strategies in pediatric TL trauma across CORTICES

Hypothesis: *Burst type fractures with short-segment constructs (±2 levels) will be most common*

SECONDARY AIM #1

Evaluate Surgical Outcomes

Assess complication & reoperation rates following operative management

Hypothesis: *Overall low reoperation rates; implant-related issues will be most frequent indication for reoperation*

SECONDARY AIM #2

Assess Practice Variability

Examine regional, institutional, & surgeon-specific differences in management

Hypothesis: *Significant variability will exist across institutions and specialties (neuro vs. ortho vs. combined)*

INCLUSION & EXCLUSION

Inclusion

- Pediatric patients aged 0–18.99 years at presentation.
- Patient underwent spinal surgery for thoracolumbar (TL)* trauma at CORTICES institutions from Jan 2002 to June 2025.
- Patients treated by Orthopaedics, Neurosurgery, or a combined Orthopaedic/Neurosurgery procedure

**TL Vertebral Levels = T1 – L5*
*Any **thoracic** OR **lumbar** vertebral fractures which required surgery*

Exclusion

- Pre-existing non-traumatic spinal pathology or underlying bone disorders (with or without prior surgery)
- Fractures extending beyond the TL region (i.e., cervicothoracic, spinopelvic)
- Non-osseous or minor injuries (e.g., contusion, exclusive ligamentous injuries, isolated fractures of posterior elements)
- Questionable fractures without clear and/or incomplete radiologic documentation
- Fractures initially treated outside CORTICES institutions

SCREENING RESULTS: BCH

Identification

N = 106 Screened

(n = 53 did not meet inclusion criteria)†

Inclusion

N = 53 meet inclusion*

(n = 10 meet exclusion criteria)‡

Analysis

N = 43 meet inclusion and do *not* meet exclusion criteria**

†***Atraumatic* conditions not meeting inclusion: n = 47**

Pathologic conditions: **17**	Scoliosis/Kyphosis: **14**
Congenital Complexities: **13**	Atraumatic Spondylolysis: **3**

***Traumatic* conditions not meeting inclusion: n = 6**

Outside of defined TL zone: **5**	Not related to spine: **1**

‡**Conditions meeting exclusion: n = 10**

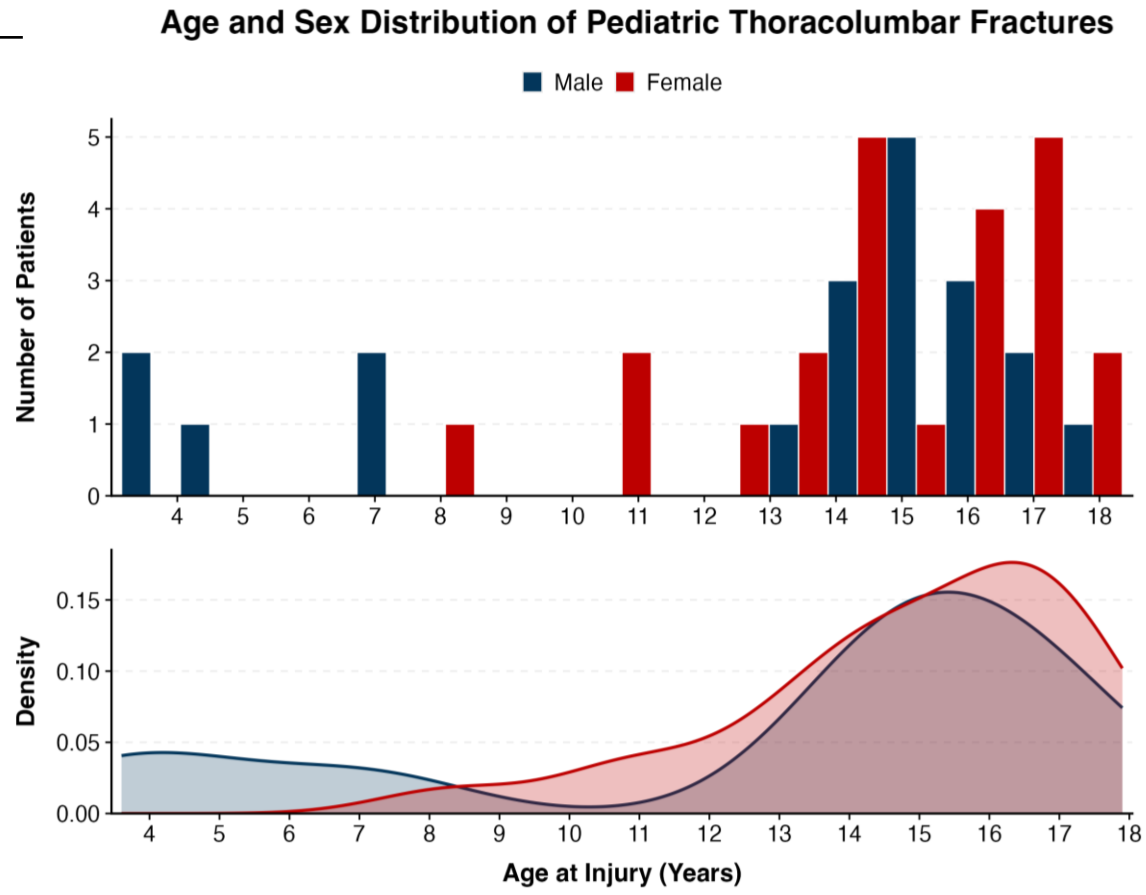
Pre-existing pathology/prior surgery: **4**	Outside CORTICES (initial management): **4**
Inadequate imaging: **1**	Decompression-only (neurologic indication): **1**

For REDCap data collection purposes:
*Include Study IDs for all patients that meet inclusion criteria
**Collect data on patients that meet *both* inclusion/exclusion criteria

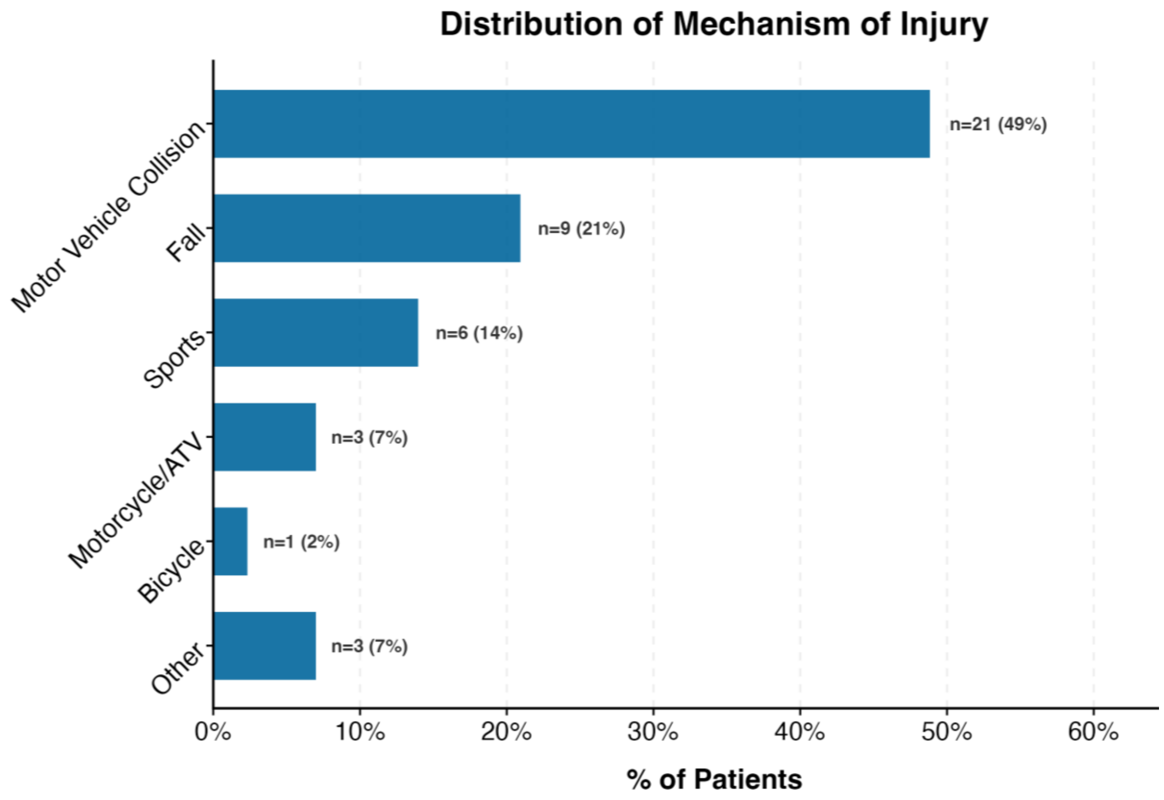
DEMOGRAPHICS

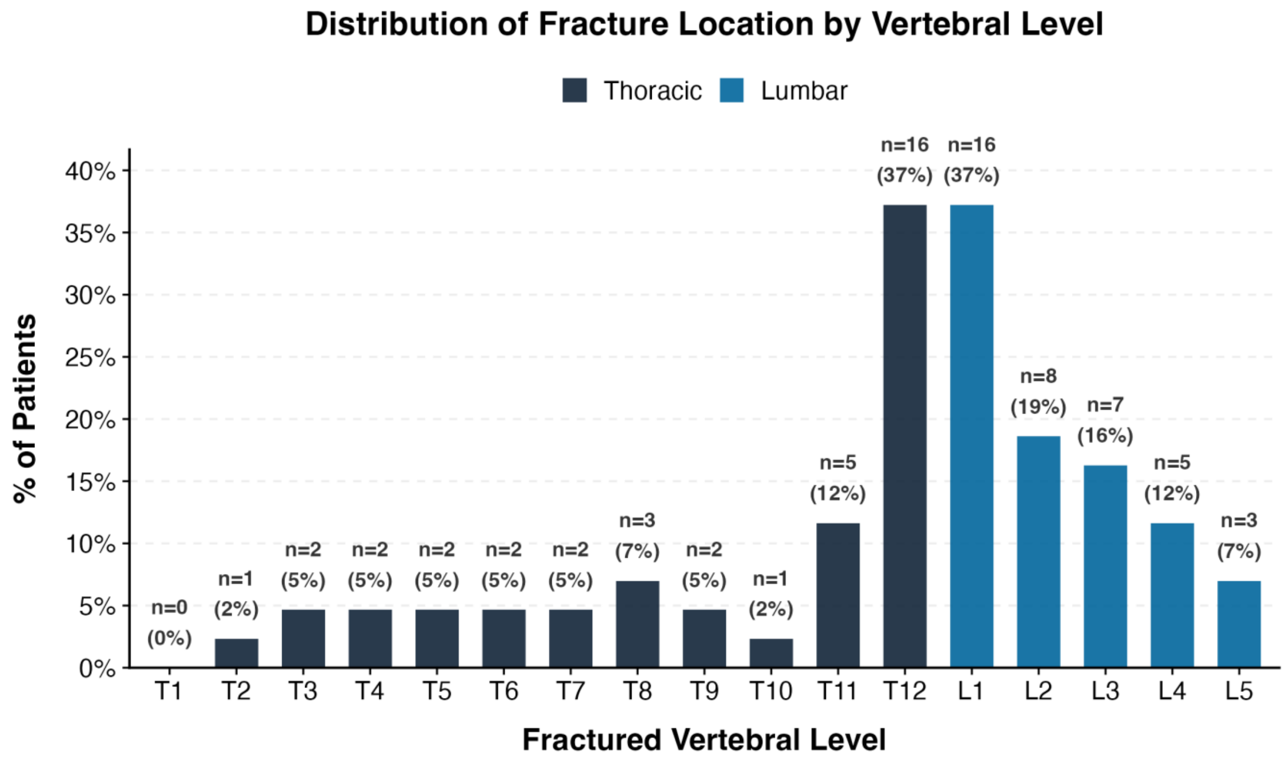
Characteristic	(N = 43)[1]
Age at injury (years)	15 (4, 18)
Sex	
Male	20 (47%)
Female	23 (53%)
Mechanism of injury	
Motor vehicle collision	21 (49%)
Carseat (n = 21)	0 (0%)
Motorcycle/ATV accident	3 (7%)
Bicycle accident	1 (2%)
Fall from height	9 (21%)
Sports-related injury	6 (14%)
Type of sport (n = 6)	
Football	1 (17%)
Hockey	3 (50%)
Skiing/Snowboarding	2 (33%)
Other	3 (7%)
Neurological deficit (n = 42)	19 (45%)

[1] *Continuous variables presented as median (min, max); categorical variables presented as frequency (%)*



FRACTURE DETAILS
(MOI & FRACTURED LEVELS)

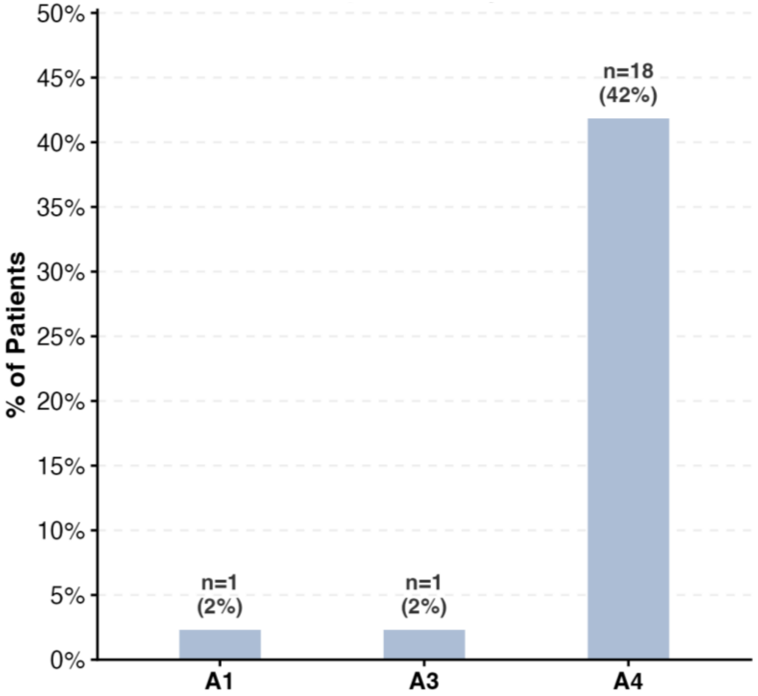




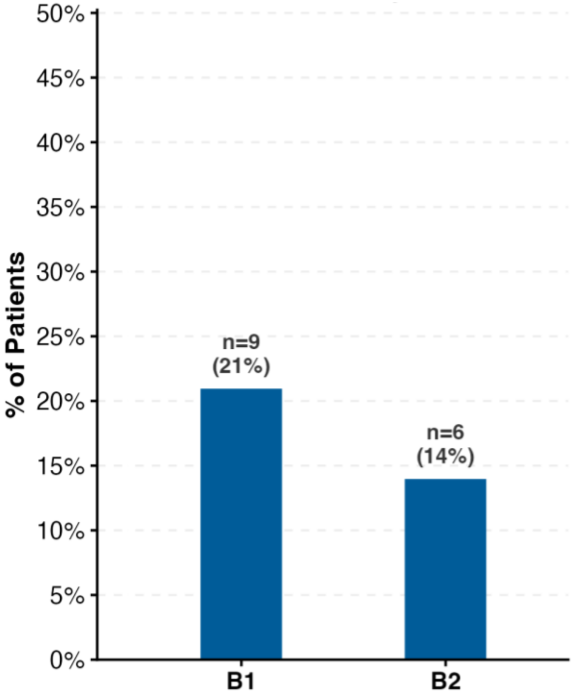
Patients may have multiple fractured vertebrae: percentages do not sum to 100%.

FRACTURE DETAILS
(AO SCORING OF PRIMARY FX & TLICS SUMMARY)

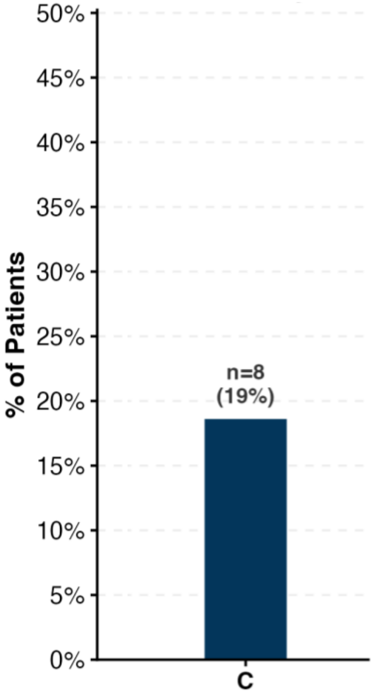
Compression Injuries
n = 20 (47%)



Distraction Injuries
n = 15 (35%)



Translation Injuries
n = 8 (19%)



Fracture Characteristics (N = 43)[1]	
# of Fx Levels	2 (1, 4)
Primary Fx Levels	
T1-T9	6 (14%)
T10-L2	27 (63%)
L3-L5	10 (23%)
(TLICS Breakdown (N = 43)[1]	
Median	7 (4, 9)
TLICS group	
≤ 4	6 (14%)
5-6	14 (33%)
≥ 7	23 (53%)

[1]Continuous variables presented as median (min, max)
Categorical variables presented as frequency (%)

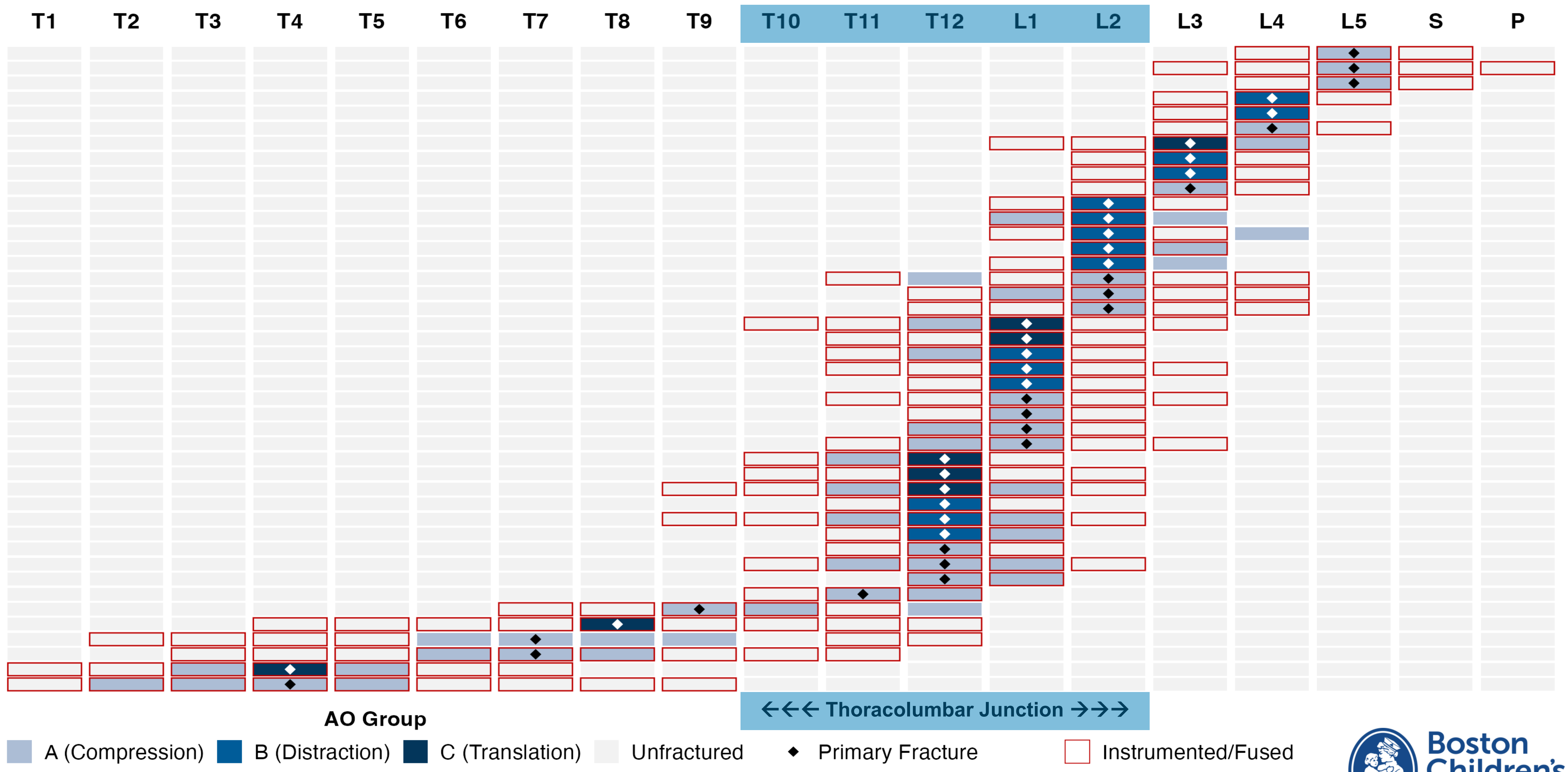
SURGICAL DETAILS

Characteristic	Frequency (%) (N = 43)[1]
Medical team	
Orthopaedics	22 (51%)
Combined orthopaedics and neurosurgery	21 (49%)
Open surgery	43 (100%)
Fusion or instrumentation	43 (100%)
Type of fusion or instrumentation	
Posterior spinal fusion	36 (84%)
Anterior spinal fusion	5 (12%)
Intrumentation without fusion	2 (5%)
Type of interbody fusion	
No interbody fusion	31 (72%)
Posterior lumbar interbody fusion	4 (9%)
Bone graft	
Autograft	26 (60%)
Allograft	36 (84%)
Other	1 (2%)

Characteristic	Frequency (%) (N = 43)[1]
Decompression	23 (53%)
Type of decompression (n = 22)	
Laminectomy	14 (64%)
Corpectomy	6 (27%)
Discectomy	9 (41%)
Other	2 (9%)
Navigation	2 (5%)
Type of navigation (n = 2)	
CT-based navigation	2 (100%)
Intraoperative imaging	
C-arm fluoroscopy (2D)	40 (93%)
O-arm CT spin	5 (12%)

[1]Continuous variables presented as median (min, max)
Categorical variables presented as frequency (%)

Fracture Pattern by AO Thoracolumbar Classification & Extent of Surgical Instrumentation or Fusion



Each row represents a patient and each column represents a vertebral level. S = sacrum. P = pelvis.

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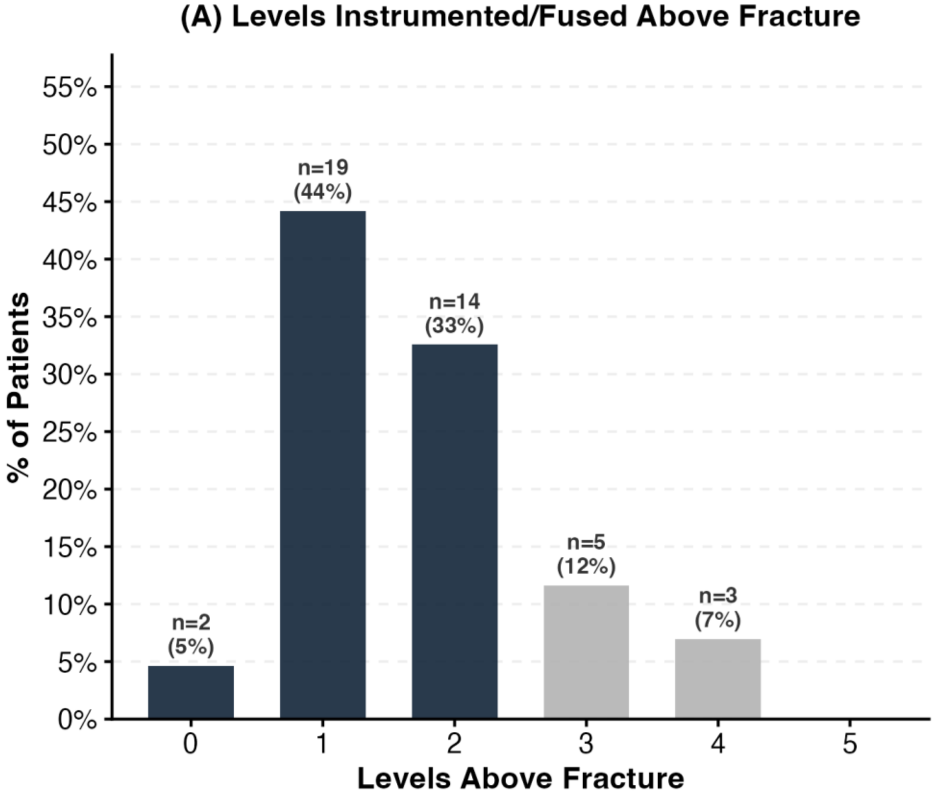
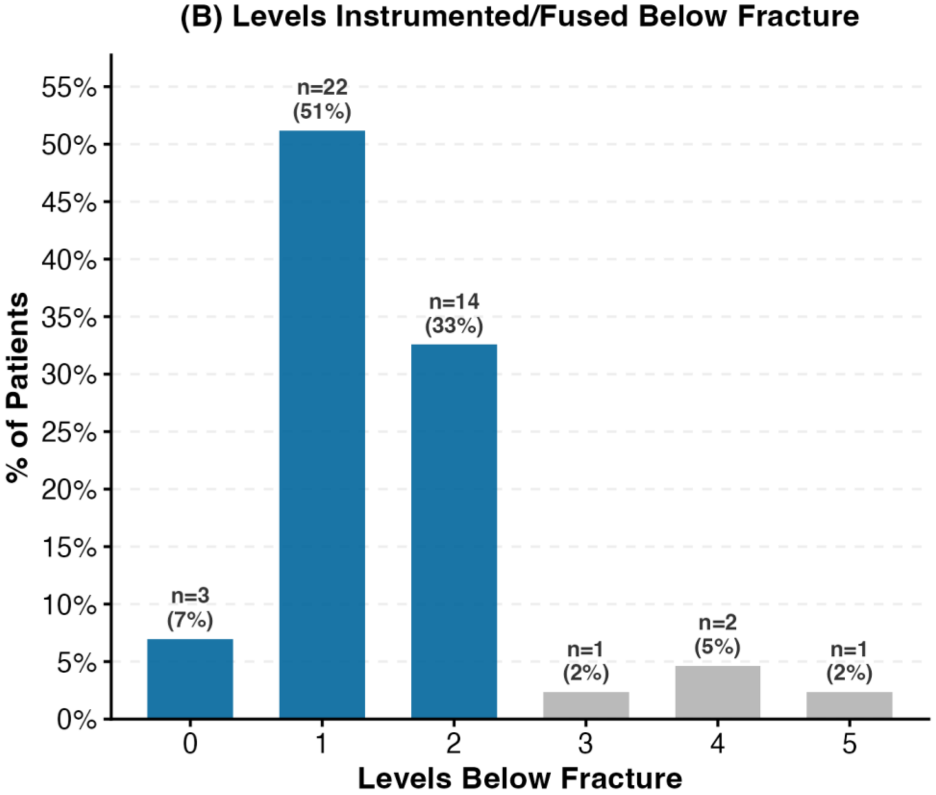
CONSTRUCT EXTENT
(Relative to Primary Fx Site)





Darker bars denote constructs within ≤2 levels of the primary fracture.
A value of 0 indicates that instrumented vertebra aligns with the fracture level (upper in Panel A, lower in Panel B).

INTRAOPERATIVE OUTCOMES

Intraoperative Outcome	(N = 43)[1]
Estimated blood loss (mL) (n = 42)	300 (25, 3,250)
Intraoperative transfusion (n = 41)	10 (24%)
No. of transfusions	2 (1, 5)
Dural injury (n = 42)	6 (14%)
Cause of injury (n = 6)	
Traumatic	5 (83%)
Iatrogenic	1 (17%)
Dural repair (n = 6)	4 (67%)
Management of dural repair (n = 4)	
Direct repair (primary suture)	1 (25%)
Augmented repair with patch	2 (50%)
Other	1 (25%)

[1]*Continuous variables presented as median (min, max)*

Categorical variables presented as frequency (%)

‡ *Indications for 3rd re-operation onwards for persistent infection (n = 1)*

POSTOPERATIVE OUTCOMES

Postoperative Outcome	(N = 43)[1]
ICU	21 (49%)
Length of ICU stay (days)	3 (0, 33)
Unexpected ED visit	2 (5%)
Reoperation ‡	14 (33%)
No. of reoperations (n = 14)	1 (1, 6)
1 reoperation	11 (79%)
2 reoperation	1 (7%)
3+ reoperations	2 (14%)
Indication for 1st reoperation (n = 14)	
Implant failure/revision	7 (50%)
Neurologic deterioration	2 (14%)
Other	4 (29%)
Infection	1 (7%)
Indication for 2nd reoperation (n = 3)	
Implant failure/revision	1 (33%)
Neurologic deterioration	1 (33%)
Other	1 (33%)

NEXT STEPS

α-Site Analysis
Preliminary manuscript preparation

Scoping Review
Parallel to BCH analysis (Collaboration w/ RADY)

β-Sites Collect
Target: Late July for completion

Fall Abstracts
POSNA/Spine conference submission w/ β-Site data

Full Launch
Late Fall rollout to all CORTICES institutions

Grade 3 Open Fractures

Presenter(s): Kristin Livingston

Collaborators: Ben Sheffer, Ben Heyworth, Collin May, David Spence, Ben Shore

Status of Grade 3 Open Fracture Study

- BCH retrospective completed, manuscript in process
- CORTICES Survey study completed and published in JPO
- CORTICES multicenter retrospective study
  - Goal: describe GA3 open fx tx, abx strategy, timing to fixation/wound coverage – factors associated with poor outcomes/infection/nonunion
  - Ready for Beta Site volunteers
  - Feedback on data collection plan (RedCap presented today)
  - Data Collection done by October CORTICES Meeting and Abstract for POSNA 2027

Inclusion/Exclusion

INCLUSION CRITERIA	
Is the participant between 0 and ≤18 years of age at presentation?	◯ Yes ◯ No (Patient considered to be no older than 18 years old at time of presentation)
Has the patient been diagnosed with a Gustilo-Anderson Grade III open fracture of a long bone?	◯ Yes ◯ No
Was the patient's Grade III open fracture treated between the time period of 01/01/2015 to 12/31/2025?	◯ Yes ◯ No

EXCLUSION CRITERIA	
Is the patient immunocompromised?	◯ Yes ◯ No (Conditions include known immunodeficiency, undergoing chemotherapy, taking chronic immunosuppressive medications, or otherwise having a condition that impairs the immune system)
Was the mechanism of injury a firearm-related incident (ballistic injury)?	◯ Yes ◯ No
Was the mechanism of injury a lawnmower-related incident?	◯ Yes ◯ No

Patients captured for future research project but will not undergo data collection here

Demographic Data

PATIENT & DEMOGRAPHIC DATA

Date of Birth
____

Age at time of injury (years)
____
(Auto-calculated)

Sex at birth
- ◯ Male
- ◯ Female

Ethnicity
- ◯ Hispanic or Latino
- ◯ Not Hispanic or Latino
- ◯ Unknown

Race (Check all that apply.)
- ☐ White
- ☐ Black or African American
- ☐ Native American or Alaskan Native
- ☐ Asian
- ☐ Hispanic or Latino
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Other
- ☐ Unknown

Specify other race
____

Height (cm)
____

Weight (kg)
____

BMI
____
(auto-calculated)

Does the patient have any serious comorbidities?
- ◯ Yes
- ◯ No

Specify comorbidity
____

Injury Characteristics

INJURY CHARACTERISTICS	
Date of injury	______________________
Mechanism of injury	◯ Motor vehicle collision ◯ Pedestrian struck by motor vehicle ◯ Bicycle or scooter ◯ E-bike or E-scooter ◯ Playground ◯ Trampoline ◯ Sport ◯ Fall not otherwise specified ◯ ATV/UTV ◯ Other
Patient's role in the motor vehicle collision	◯ Driver ◯ Passenger
For bicycle/E-bike or scooter/E-scooter injuries, was a motor vehicle involved?	◯ No, motor vehicle involved was not involved ◯ Yes, patient struck by motor vehicle while on bicycle/e-bike or scooter/e-scooter
Specify other injury mechanism	______________________
Gustilo-Anderson Grade III Fracture Subtype	◯ Type IIIa ◯ Type IIIb ◯ Type IIIc
Open fracture location	◯ Femur ◯ Tibia and/or fibula ◯ Clavicle ◯ Humerus ◯ Radius and/or ulna

Did the patient sustain other fractures (other than the open fracture)?	◯ Yes ◯ No
Specify other fractures	______________________
Injury severity score (ISS)	______________________
ISS Category	◯ Mild (1-8) ◯ Moderate (9-15) ◯ Severe (16-75) (leave blank if ISS unknown)
Polytrauma	◯ Yes ◯ No (Polytrauma: Multiple injuries across ≥2 body systems, often with high injury severity)
Non-orthopaedic injuries sustained	◯ Yes ◯ No
Non-orthopaedic surgery required	◯ Yes ◯ No
Type of non-orthopaedic surgery	☐ General/Trauma surgery ☐ Plastic surgery ☐ Urology ☐ Neurosurgery ☐ Dental ☐ Vascular surgery ☐ Oral & Maxillofacial Surgery (OMFS) ☐ Other
Specify other type of non-orthopaedic surgery	______________________
Head injury sustained?	◯ Yes ◯ No (Includes concussion or head bleed (including intracranial hemorrhage))

Long bone only

Hospital Course

HOSPITAL COURSE

Date of ED admission	____________________ (For subsequent calculated field)
Datetime of ED admission	____________________ (Please use military time (24 hour) for all timing calculated fields)
ED arrival mode	◯ Ambulance ◯ Medical flight ◯ Walk or private transport ◯ Transfer from outside hospital ◯ Unknown
Admitting service	◯ Orthopaedics ◯ Trauma ◯ General surgery ◯ Plastic surgery ◯ ICU ◯ Other
Specify other admitting service	____________________
Orthopedic surgery procedure start datetime (wheels in the OR)	____________________ (Please complete for index surgery)
Orthopedic surgery procedure end datetime (wheels out of OR)	____________________ (Please complete for index surgery)
Operative time (minutes)	____________________ (Auto-calculated)
Time from ED admission to OR (hours)	____________________ (Auto-calculated)
Hospital discharge datetime	____________________
Length of hospitalization (days)	____________________ (Auto-calculated)

Antibiotic Data

ANTIBIOTIC DATA

Datetime of first IV antibiotics administration
____

Time from ED admission to IV antibiotics (minutes)
____
(Auto-calculated)

Name(s) of first IV antibiotic(s) administered. Please select all antibiotics the patient received upon arrival to the ED.

- ☐ Ampicillin
- ☐ Ampicillin/Sulbactam (Unasyn)
- ☐ Cefazolin
- ☐ Cefepime
- ☐ Ceftriaxone
- ☐ Ciprofloxacin
- ☐ Clindamycin
- ☐ Fluconazole
- ☐ Gentamicin
- ☐ Linezolid
- ☐ Meropenem
- ☐ Metronidazole
- ☐ Penicillin
- ☐ Piperacillin/Tazobactam (Zosyn)
- ☐ Tobramycin
- ☐ Vancomycin
- ☐ Voriconazole
- ☐ Other
- ☐ Unknown

Specify other IV antibiotic administered
____

Other IV antibiotics administered in first 24 hours?

- ◯ Yes
- ◯ No

Check additional IV antibiotics administered in first 24 hours

- ☐ Ampicillin
- ☐ Ampicillin/Sulbactam (Unasyn)
- ☐ Cefazolin
- ☐ Cefepime
- ☐ Ceftriaxone
- ☐ Ciprofloxacin
- ☐ Clindamycin
- ☐ Fluconazole
- ☐ Gentamicin
- ☐ Linezolid
- ☐ Meropenem
- ☐ Metronidazole
- ☐ Penicillin
- ☐ Piperacillin/Tazobactam (Zosyn)
- ☐ Tobramycin
- ☐ Vancomycin
- ☐ Voriconazole
- ☐ Other
- ☐ Unknown

Specify other additional antibiotic administered in first 24 hours
____

Datetime of final IV antibiotic administration:
____

Duration of IV antibiotics course (days)
____
(Auto-calculated)

Oral antibiotics prescribed at discharge?

- ◯ Yes
- ◯ No

Specify oral antibiotic(s) prescribed

- ☐ Amoxicillin
- ☐ Augmentin
- ☐ Bactrim
- ☐ Cephalexin
- ☐ Ciprofloxacin
- ☐ Clindamycin
- ☐ Doxycycline
- ☐ Levofloxacin
- ☐ Rifampin
- ☐ Other
- ☐ Unknown

Specify other oral antibiotic prescribed
____

Date of first oral antibiotics administration
____

Date of final oral antibiotic administration
____

Duration of oral antibiotics course (days)
____
(Auto-calculated)

Surgical Data

SURGICAL DATA

Total number of orthopaedic surgical procedures performed during initial hospitalization for open fracture treatment
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5+

(Count every separate trip to the OR related to fracture treatment and/or wound management)

For subsequent surgery: This box is "Delayed Primary Closure"

Surgery #1 Details

Surgery 1: Date ______________________

Surgery 1: Procedure type
- ☐ Irrigation and debridement
- ☐ Internal fixation (ORIF, IM nail, plate, K-wire, etc.)
- ☐ External fixation (ex-fix, etc.)
- ☐ Fasciotomy
- ☐ Amputation
- ☐ Other

Surgery 1: Procedure type - other ______________________

Surgery 1: Procedure specialty
- ☐ Orthopaedics
- ☐ Plastic surgery
- ☐ Other

Surgery 1: Specify other specialties ______________________

Surgery 1: Wound management
- ☐ Primary closure (at index surgery)
- ☐ Local or rotational flap
- ☐ Free flap
- ☐ Skin graft (split thickness, full thickness, synthetics)
- ☐ Wound vac
- ☐ Not closed/wound care (e.g. wet-to-dry dressings) and/or left to close by secondary intention
- ☐ Antibiotic bead or powder
- ☐ Other

Surgery 1: Wound management - other ______________________

Wound/Skin Closure Details

Wound/Skin Closure Details	
Was definitive wound closure or coverage achieved?	◯ Yes ◯ No
Total number of surgical procedures to achieve skin closure or definitive coverage	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5+ ◯ N/A (ex: secondary intention)
Date of surgical procedure where definitive coverage/skin closure achieved	____________________
Time from injury to skin closure (days)	____________________ (Auto-calculated)
If wound was not closed, date of final wound management surgery	____________________
Time from injury to final wound management surgery (days)	____________________ (Auto-calculated)

Fracture Fixation Timing

Fracture Fixation Details	
Date of surgical procedure where definitive fracture fixation was performed	___________________________
Time from injury to definitive fracture fixation (days)	___________________________ (Auto-calculated)

Complications

CLINICAL FOLLOW-UP	
Date of last recorded orthopaedic follow-up	________________
Total length of follow-up (days)	________________ (Auto-calculated)
Full return to activity/clinical recovery by final recorded follow-up?	○ Yes ○ No ○ Unknown (lost to follow-up)
Date of radiographic fracture union	________________ (Defined as progressive bridging callus across at least 3 of 4 cortices on radiographs.)
Time from injury to radiographic union (days)	________________ (Auto-calculated)

POSTOPERATIVE COMPLICATIONS	
Did the patient develop a complication?	○ Yes ○ No
Specify complication(s)	☐ Unexpected return to ED ☐ Need for additional surgery (UPROR) ☐ Infection ☐ Wound/surgical site complications (non-infectious) ☐ Delayed union or nonunion (time to union >180 days) ☐ Acute compartment syndrome ☐ Amputation or loss of limb ☐ Neurological deficit ☐ Vascular injury ☐ DVT or PE ☐ Sepsis ☐ Death ☐ Other
Describe other complication:	________________

Specify additional surgical procedure	☐ Irrigation & debridement ☐ Hardware removal ☐ Revision fixation ☐ Soft tissue coverage (local flap, free flap, skin graft) ☐ Fasciotomy ☐ Antibiotic bead placement ☐ Other (Occuring after initial hospitalization discharge)
Specify other additional surgical procedure	________________
Type of postoperative infection	○ Superficial (requiring local wound management and/or oral antibiotics) ○ Deep (requiring surgical wound management and/or IV antibiotics)
Infection requiring antibiotic treatment?	○ Intravenous (IV) ○ Oral (PO) ○ None
Infection requiring surgical washout?	○ Yes ○ No
Clavien-Dindo-Sink (CDS) Complication Classification	○ Grade I: Any deviation from normal postop course (ex: nausea/fever/pain medications, physiotherapy, electrolytes) ○ Grade II: Pharmacological treatment (ex: antibiotics, blood transfusion, IV iron, total parenteral nutrition) ○ Grade III: Surgical, endoscopic, or radiologic intervention (ex: surgical washout, hardware removal, CT scan) ○ Grade IV: Life-threatening complication requiring intensive care management (ex: dialysis, single organ dysfunction, multi organ dysfunction) ○ Grade V: Death (If the patient has multiple complications, please record the most severe)

Calcaneal Fracture

Presenter(s): Collin May

Updates

- Presented Single site data at EPOS
  - Review Feedback
  - Potential future directions/ **main question**
- Received feedback from committee and resubmitted protocol with edits
- Reworked Primary Aims with statistics team
- Redcap has been created for study

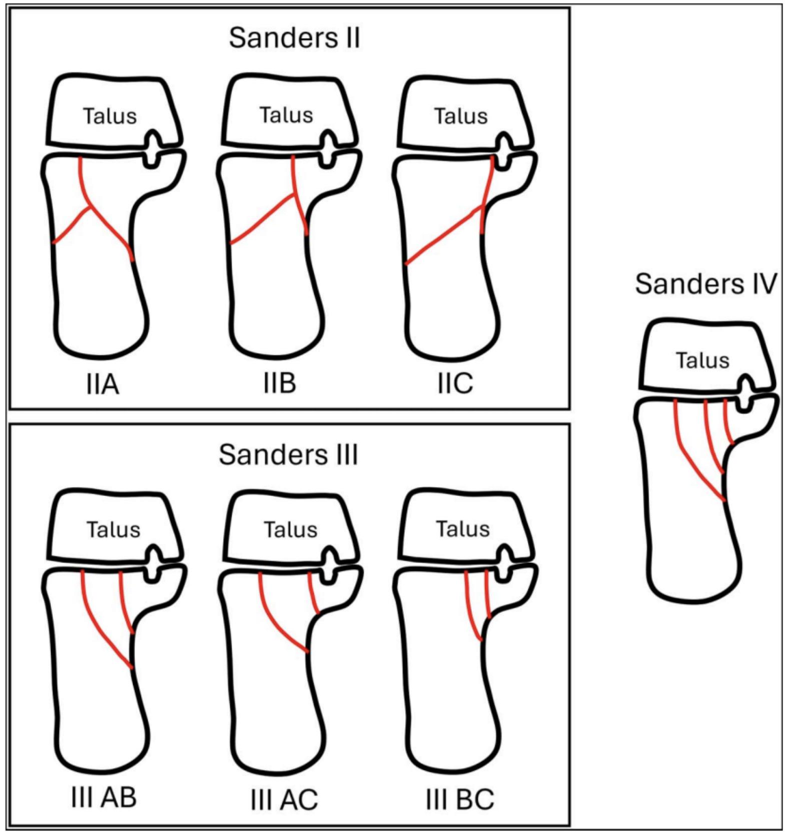
BCH Study – What did we learn?

- **Study design:** Retrospective case series, 2003–2024
- **Inclusion:** Age 0–17, **Intraarticular calcaneal fracture**, ≥6 months follow-up
- **Exclusion:** Pathologic fractures, isolated anterior process/tuberosity, open fractures
- **Primary outcomes:** Time to full weight-bearing; time to return to sport/activities
- **Secondary Outcomes:** Demographics, mechanism, Bohlér’s and Gissane’s angles, surgical details, complications

BCH Study – What did we learn?

- **Cohort:** 38 fractures in 35 patients, **mean age 12 years**
- **Sex:** 74% male (26/35)
- **Mechanism of injury:**
  - – Ski/snowboard: 40% (15/38)
  - – Fall >10 ft: 34% (13/38)
  - – Fall <10 ft: 16% (6/38)
  - – Other/MVC: 11% (4/38)

BCH Study – What did we learn?



Who Got Surgery?

Independent predictors of surgery (MVR):

- **Age**: each additional year ↑ surgical odds by **64%** (OR 1.64)
- **Sanders class**: each increment ↑ odds ~**4×** (OR 3.9, p=0.002)

BCH Study – What did we learn?

Return to full weight-bearing:

- Mean 2.4 months overall
- No Difference between operative and non-operative groups

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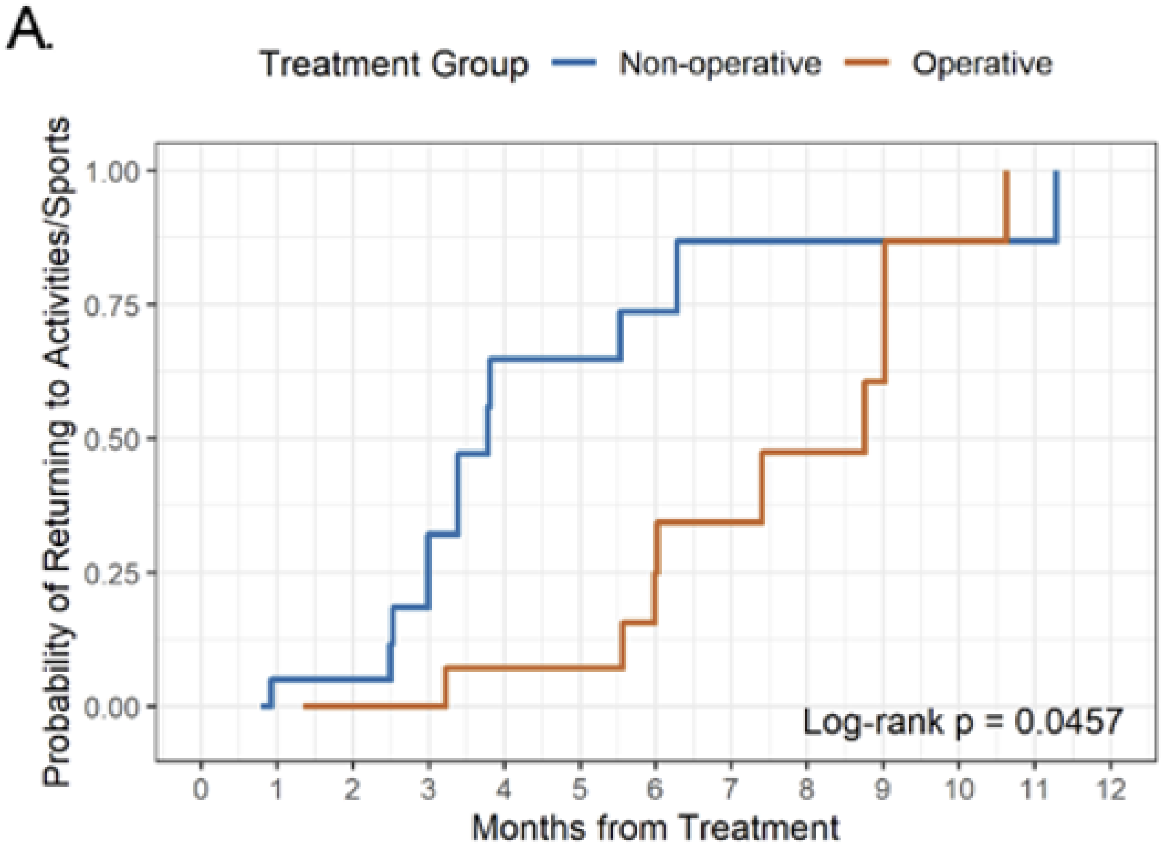
BCH Study – What did we learn?

Return to sport/activities:

- Operative: median 13 months vs. non-operative: median 8 months (p=0.04)
- Difference likely reflects indication bias and fracture severity



Transition to Multi-Center Study
Core Questions

- What drives operative vs. non-operative decision making?
  - Can we better define surgical indications?
  - Are we overtreating (or under-treating) children based on adult outcomes/literature?
- What are the early/mid/long term outcomes of operative vs. non-operative management?
  - Complications? Return to WB/sports?
  - Remodeling potential (EPOS critique)
- Open vs. Percutaneous approaches?
- *Future Direction*: Can we develop a better pediatric-specific injury classification than existing ones geared towards adults?

Multi-center Protocol Review Committee Feedback

Consider including extra-articular fractures

- We feel this would be outside the scope of the study as these represent fundamentally different injury patterns with distinct treatment considerations.

Trauma Scores Calculations

- Calculated scores will be collected from site specific trauma registries
- Are trauma registries that collect scores available at other sites?

Including tongue-type and polytrauma fractures

Protocol Updates - Aims

Primary:

Determine patient/injury characteristics associated with likelihood of operation

- Incidence of surgery

Secondary

1. Determine patient/injury/treatment characteristics predictive of outcome
   - Op vs. Non-op. Consider propensity score adjustment
2. Assess sensitivity of the Sanders and Essex-Lopresti classification systems in distinguishing calcaneus fractures in pediatric populations across various patient and injury subgroups
3. Compare outcomes associated with open vs. percutaneous operative techniques

REDCap Overview

Demographics

Record ID	______________________
Sex	◯ Male ◯ Female ◯ Unknown ◯ Other
DOB	______________________
Race	◯ Asian or South Asian ◯ American Indian, Alaska Native, Indigenous, or First Nations ◯ Black, African American/Canadian, or African ◯ Hispanic, Latino/a, Latinx, or Spanish Origin ◯ Middle Eastern ◯ Native Hawaiian or Other Pacific Islander ◯ White ◯ Other ◯ Prefers not to answer ◯ Missing/Not Recorded
Ethnicity	◯ Hispanic or Latino ◯ Non Hispanic or Latino ◯ Other/Prefer not to answer
Height (cm)	______________________
Weight (kg)	______________________
Comorbidities	◯ Yes ◯ No
If yes, specify	☐ diabetes ☐ osteoporosis ☐ arthritis ☐ hypothyroidism ☐ smoking ☐ Autoimmune conditions ☐ neoplasia ☐ conditions requiring chronic steroids ☐ on immunosuppressant medications ☐ other
If other, specify	______________________

Presentation

Record ID	______________________
Date of injury	______________________
Date of presentation	______________________
Where did the patient present?	◯ ED ◯ Orthopedic Clinic
Age at presentation	______________________
Laterality	◯ Right ◯ Left
Mechanism of injury	◯ fall from less than 10ft ◯ fall from height greater than 10 ft ◯ skiing ◯ motor vehicle accident ◯ other ◯ unknown/not recorded
If other, specify	______________________
Is this a Polytrauma fracture?	◯ Yes ◯ No
If yes, what other fractures did they have?	______________________
Is this a multi-trauma/multi-fracture injury?	◯ Yes ◯ No
If yes, is this bilateral intraarticular calcaneal fx?	◯ Yes ◯ No
Other lower extremity fractures on same side?	☐ Tibia ☐ fibula ☐ talus ☐ cuboid ☐ digits ☐ cuneiforms ☐ other ☐ none ☐ navicular

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Overall alignment	◯ Non-displaced ◯ Displaced
If displaced:	◯ Mild ◯ Severe
Comminuted?	◯ Yes ◯ No
Level of activity prior to injury	◯ Very active (on a sport team) ◯ Active (recreational activities) ◯ Low activity level (notes denoting low activity levels) ◯ unknown
Full trauma burden	______________________
Injury severity score	______________________
Pediatric trauma score calculated from https://www.mdcalc.com/calc/10404/trauma-score-injury-severity-score-triss	______________________

Scores to be collected from trauma registries

Pre-treatment imaging

Record ID	____________________
Pre-treatment images available	◯ Yes ◯ No
Date of image	____________________
Modality	☐ XR ☐ CT ☐ MRI
Physes	◯ open ◯ closed ◯ unknown
Joint involvement	☐ Subtalar ☐ Calcaneocuboid ☐ Calcaneonavicular
Bohler's angle	____________________
Gissane angle	____________________
Sanders classification (CT) o I: Non-displaced posterior facet o II: One fx line through the posterior facet o III: Two fx lines through posterior facet o IV: 4 or more fragments of the posterior facet	◯ I ◯ II ◯ III ◯ IV
Essex-Lopresti classification	◯ Depressed ◯ Tongue-Type ◯ Unknown

Post-treatment Imaging

Record ID	____________________
Is post-treatment imaging available?	◯ Yes ◯ No
If no, is there comments in notes about image	◯ Yes ◯ No
date of image/description	____________________
If yes, specify	____________________
Modality	☐ XR ☐ CT ☐ MRI
Is there evidence of hardware issues:	◯ Yes ◯ No
If yes:	☐ hardware failure ☐ collapse ☐ hardware loosening ☐ other
If other, specify	____________________
Bohler's angle	____________________
Gissane angle	____________________
evidence of arthritis	◯ Yes ◯ No

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Initial Surgery

Record ID

Did the patient get surgery?

Surgery performed

Date of surgery

If other, specify

Surgical method

Operative time (min)

tourniquet time (min)

Implant type

If other, specify

Graft?

graft type

Bone augment?

Bone augment type

☐ other

Post-treatment Events

Were antibiotics given? ◯ Yes ◯ No

Type of antibiotics ______________________________

Length (days) of antibiotics ______________________________

Secondary event type ☐ pain ☐ decreased mobility ☐ wound complication ☐ Hardware issue ☐ other

If other, specify ______________________________

Reason for planned return to OR ______________________________

:linic

tion

n
:vent
plint off
ing
lifted
orts
op follow up
urn to OR
p

tic arthritis

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Subsequent Surgery

Record ID	__________________________________
Did the patient get surgery?	◯ Yes ◯ No
Date of surgery	__________________________________
Attending	__________________________________
Is the surgery a revision of initial surgery	◯ Yes ◯ No
Surgery performed	☐ ORIF ☐ K-Wire ☐ CRPP ☐ other
Operative time (min)	__________________________________
Tourniquet time (if available)	__________________________________
Implant type	☐ AO calcaneus plate ☐ Small fragment ☐ Limited contact dynamic compression plate (LCDCP) ☐ 1/3rd Tubular ☐ Single screw ☐ Fragment specific plate ☐ mini frag plates ☐ cannulated screw (headed/headless) ☐ K-wires ☐ other/unknown
Graft?	◯ Yes ◯ No
graft type	◯ auto ◯ allo
Bone augment?	◯ Yes ◯ No
Bone augment type	☐ cerament ☐ montage ☐ other
If no, surgery performed	__________________________________

Core Questions

- What drives operative vs. non-operative decision making?
  - Can we better define surgical indications?
  - Are we overtreating (or under-treating) children based on adult outcomes/literature?
- What are the early/mid/long term outcomes of operative vs. non-operative management?
  - Complications? Return to WB/sports?
  - Remodeling potential (EPOS critique)
- Open vs. Percutaneous approaches?
- *Future Direction*: Can we develop a better pediatric-specific injury classification than existing ones geared towards adults?

Action Items

- We will finalize BCH cohort and input into CORTICES REDCap database
- Refine the REDCap variables – suggestions?
- Identify 4-5 Beta Testing sites for REDCap validation and pilot data entry - Volunteers?
- Sub-study proposal:
  - Classification development with Delphi process
  - What radiographic parameters matter in assessing pedi calc fx

BREAK (~10 MINUTES)

Membership & Bylaw Discussions

Presenter(s): Benajmin Shore, Allan Beebe, Jennifer Laine

Welcome New Members

Newly Onboarded Sites:

- Jessica Burns-Phoenix Children’s
- Arianna Trionfo-Nemours Delaware
- Anna Rambo-Nemours Florida

Welcome New Members

Existing Sites:

- Romie Gibley – Lurie Children’s

Potential Future Additions From Existing Sites?:

- Liz Hubbard – Scottish Rite
- Denver Kraft – CHOA
- Breann Tisano – Vanderbilt

MEMBERSHIP Resignation/Changes

- Josh Murphy – CHOA
- Brando Ramo – Scottish Rite
- Jill Larson – Lurie → Colorado?
- Mark Miller – WUSTL
- Megan Johnson – Scottish Rite

Tibia Nail
POSNA Presentation Preview & CORTICES Discussion

Presenter(s): Mark Miller

Antegrade rigid intramedullary nailing of tibial diaphyseal fractures in adolescents with open proximal tibial physis: Does a deformity occur?

Mark Miller MD, Joshua Marino BS, Maria F. Canizares MD MPH, Shanika De Silva PhD, Zachary Meyer MD, Julia Sanders MD, Benjamin J. Shore MD MPH FRCSC

CORTICES Study Group: cortices@childrens.harvard.edu

Disclosures

Benjamin Shore is POSNA Board Member, and a consultant for OrthoPediatrics.

All other authors have no disclosures

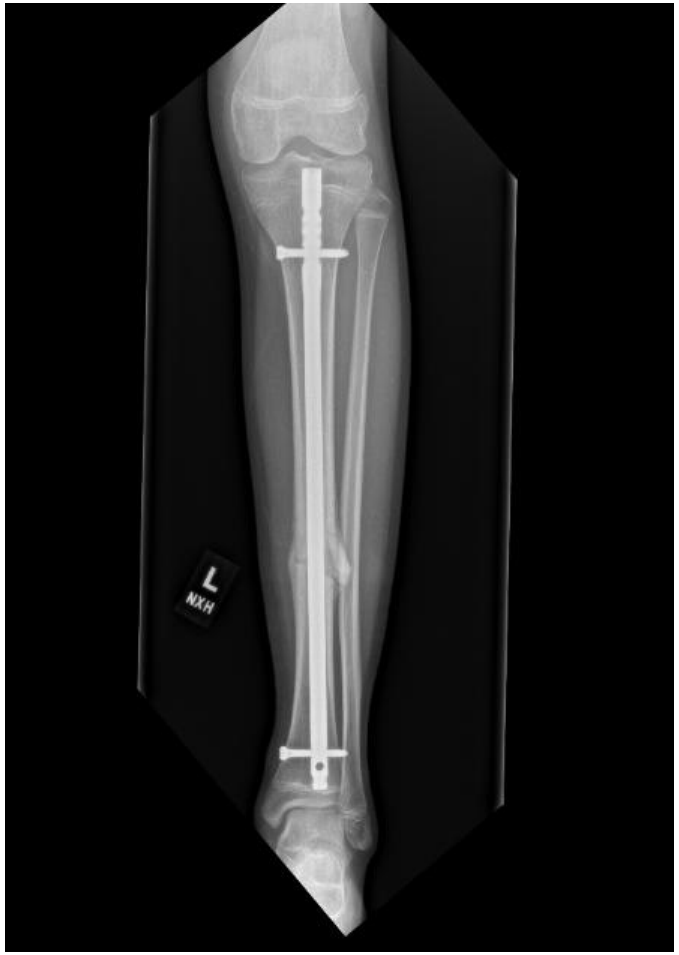
Background

Antegrade rigid intramedullary nailing (RIMN) is standard technique for the treatment of tibial shaft fractures.

RIMN = stable, load-sharing fixation

Increased stability of fracture

Earlier mobilization



Background

Concern for proximal tibial growth disturbance

Physeal violation = relative contraindication

Main feared deformity: sagittal recurvatum

Early series showed no clear growth arrest

Elastic Intramedullary Nailing Versus Open Reduction Internal Fixation of Pediatric Tibial Shaft Fractures

Andrew T. Pennock, MD,† Tracey P. Bastrom, MA,† and Vidyadhar V. Upasani, MD*†*

While multiple long bones are amenable to rigid intramedullary nailing, a contraindication to this technique in the tibia is a patient with open physes with substantial growth remaining.

J Child Orthop (2007) 1:281–286
DOI 10.1007/s11832-007-0056-y

ORIGINAL CLINICAL ARTICLE

Titanium elastic nails for pediatric tibial shaft fractures

Wudbhav N. Sankar · Kristofer J. Jones · B. David Horn · Lawrence Wells

Reamed locked intramedullary nails pose unnecessary risk to the proximal tibial growth plate, and have limited indications in those children with open physes.

ELSEVIER
Injury
Volume 34, Issue 10, October 2003, Pages 781-785

Intramedullary nailing of tibial diaphyseal fractures in adolescents with open physes

C.M Court-Brown, T Byrnes, G McLaughlin

36 patients, RIMN ages 12-16yrs with open physes. No radiological evidence of tibial shortening or partial growth arrest

Purpose

Quantify proximal tibial iatrogenic deformity at skeletal maturity in adolescents with diaphyseal tibial shaft fractures treated with RIMN through an open proximal tibial physis

Hypothesis:

RIMN fixation through open proximal tibia physis in adolescents will not cause significant proximal tibial deformity (>5° change – MPTA or PPTA)

Methods

Retrospective chart review from 2010-2025

6 CORTICES centers

ICD codes for diaphyseal tibial fractures

Treated with a Rigid Intramedullary Nail

INCLUSION CRITERIA

- Patients 18 years or under
- Proximal Tibial Physis open

EXCLUSION CRITERIA

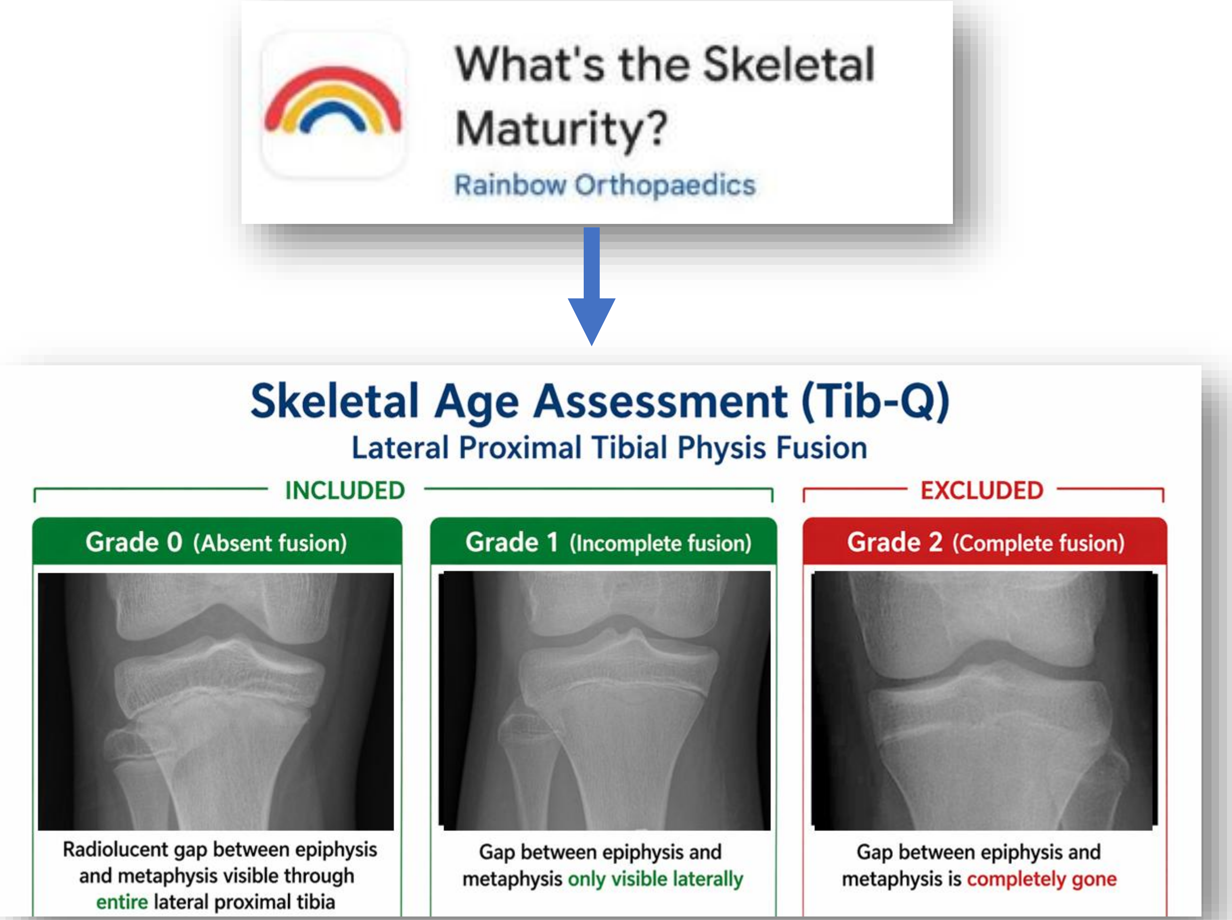
- Missing postop imaging
- Flexible rods, growing rods, retrograde rush rods and rods that are hooked

Methods

Physeal status determined by the lateral fusion of the proximal tibia physis (TIB-Q) using the Modified Fels Knee System.

AP and Lat xrays measured:

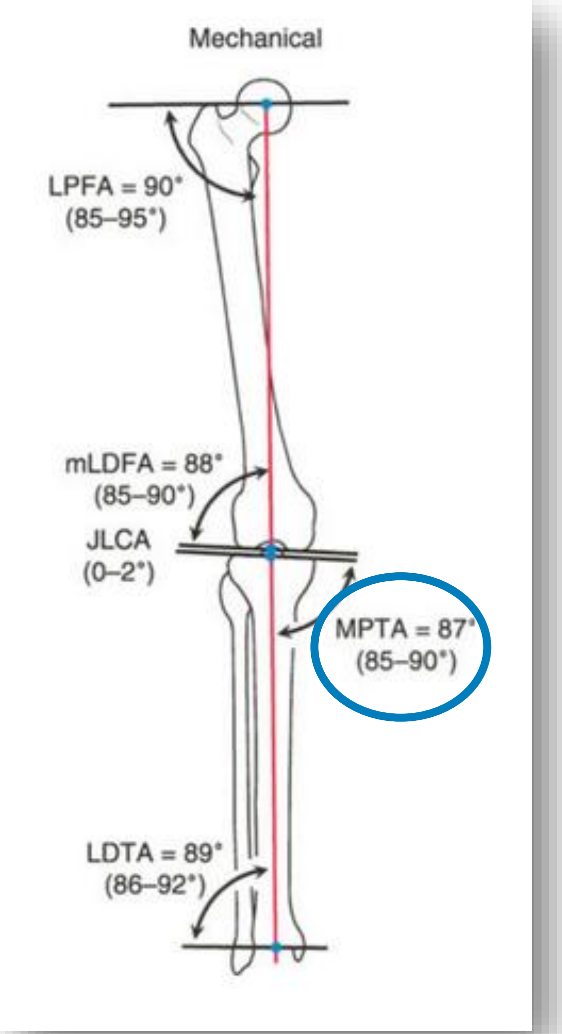
- Postoperatively to skeletal maturity
- if skeletal maturity is not reached, atleast 12 months postop

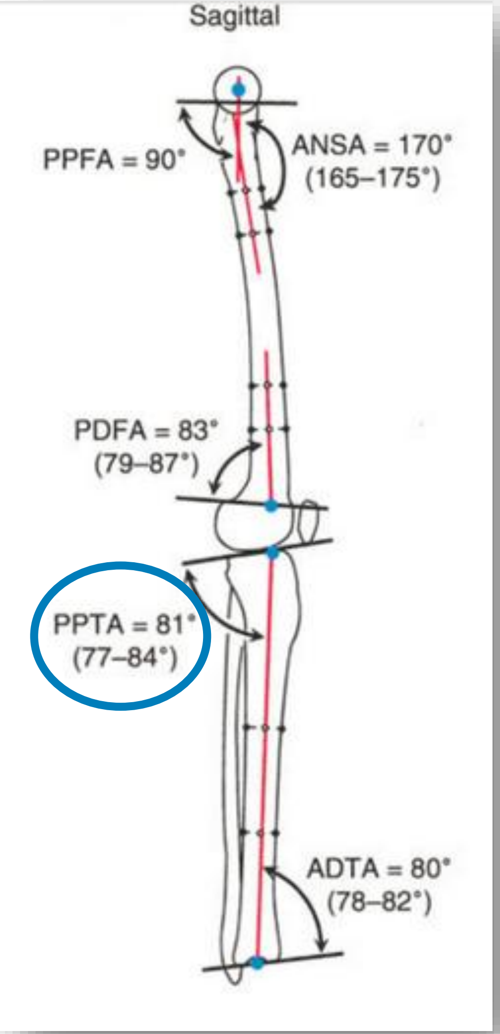


Outcomes

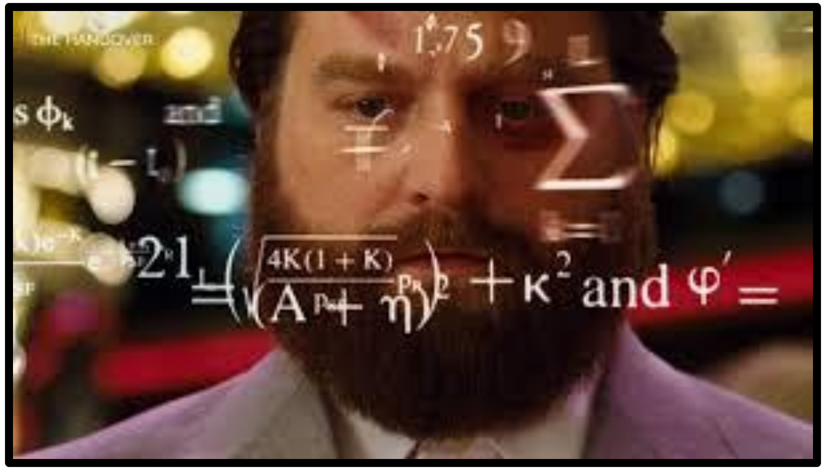
Proximal tibia deformity measured:

- Coronal: mechanical Medial Proximal Tibia Angle **(mMPTA)**
- Sagittal: mechanical Posterior Proximal Tibia Angle **(mPPTA).**





Statistical Analysis



Primary outcome → longitudinal change in mMPTA or PPTA

Paired angle comparisons → Wilcoxon signed-rank test

Statistical approach → Two one-sided equivalence testing

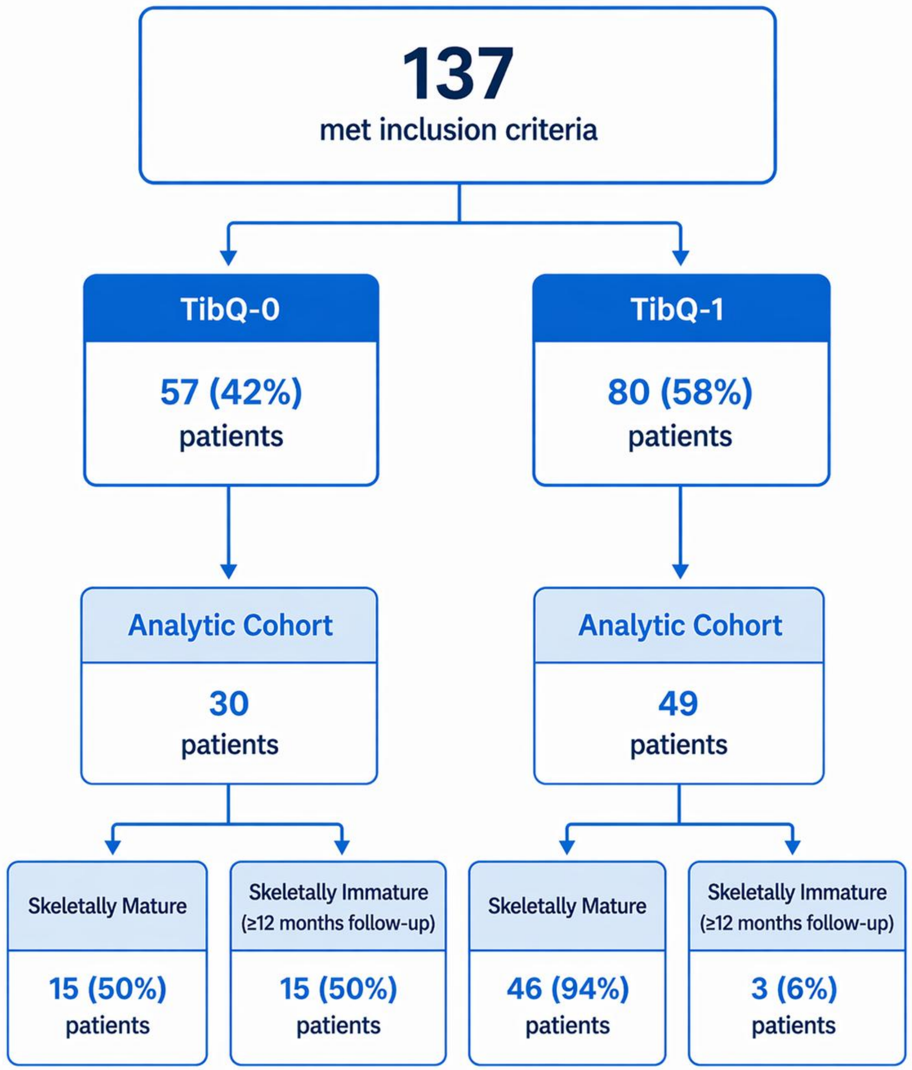
Clinical equivalence margin → ±5°

Equivalence met when the 90% CI remained fully within the margin

Results

57 TibQ0 (physis open)
- 30 reached skeletal maturity/12 mo FU
- Median Age 14y. Range (10-16y)
- 73% Male, 53% White
- MOI: 57% Sports

80 TibQ1 (physis partially open)
- 49 reached skeletal maturity/12 mo FU
- Median Age 15yr. Range (12-16y)
- 88% Male, 76% White
- MOI: 45% Sports



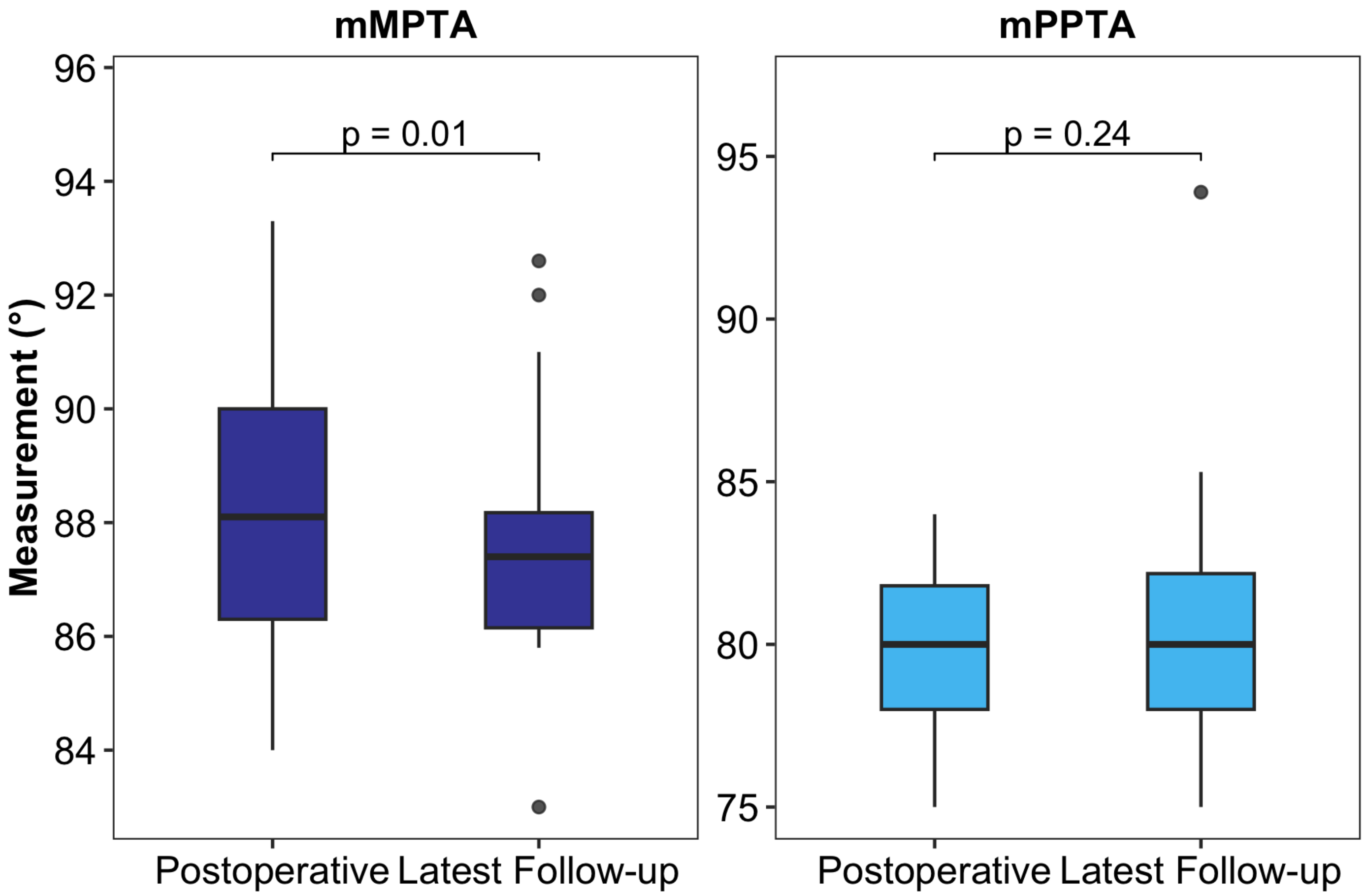
Surgical Characteristics

Characteristics	TibQ0 Physis open (N=30)	(TibQ1 Physis partially open N=49)
Surgical technique (n=28)		
Open reduction	11 (39%)	25 (52%)
Closed reduction	17 (61%)	23 (48%)
Nail technique (n=28)		
Suprapatellar	14 (50%)	9 (19%)
Infrapatellar	11 (39%)	21 (44%)
Extraarticular lateral	1 (4%)	9 (19%)
Other	2 (7%)	9 (19%)
Nail diameter (mm) (n=29)	8.5 (8.5, 9.0)	8.5 (8.5, 9.0)
Nail length (cm) (n=28)	34.0 (31.9, 36.0)	34.0 (31.9, 36.0)
Nail location		
Above physis	19 (63%)	14 (30%)
At physis	4 (13%)	22 (47%)
Below physis	7 (23%)	11 (23%)
Screws cross physis (n=19)	1 (5%)	1 (7%)

TibQ0 Physis open (N=30)

Median mMPTA decreased: 88.1° to 87.4°(p=0.01)

Median PPTA remained stable at 80.0° over follow-up (p=0.24)



Equivalence Testing

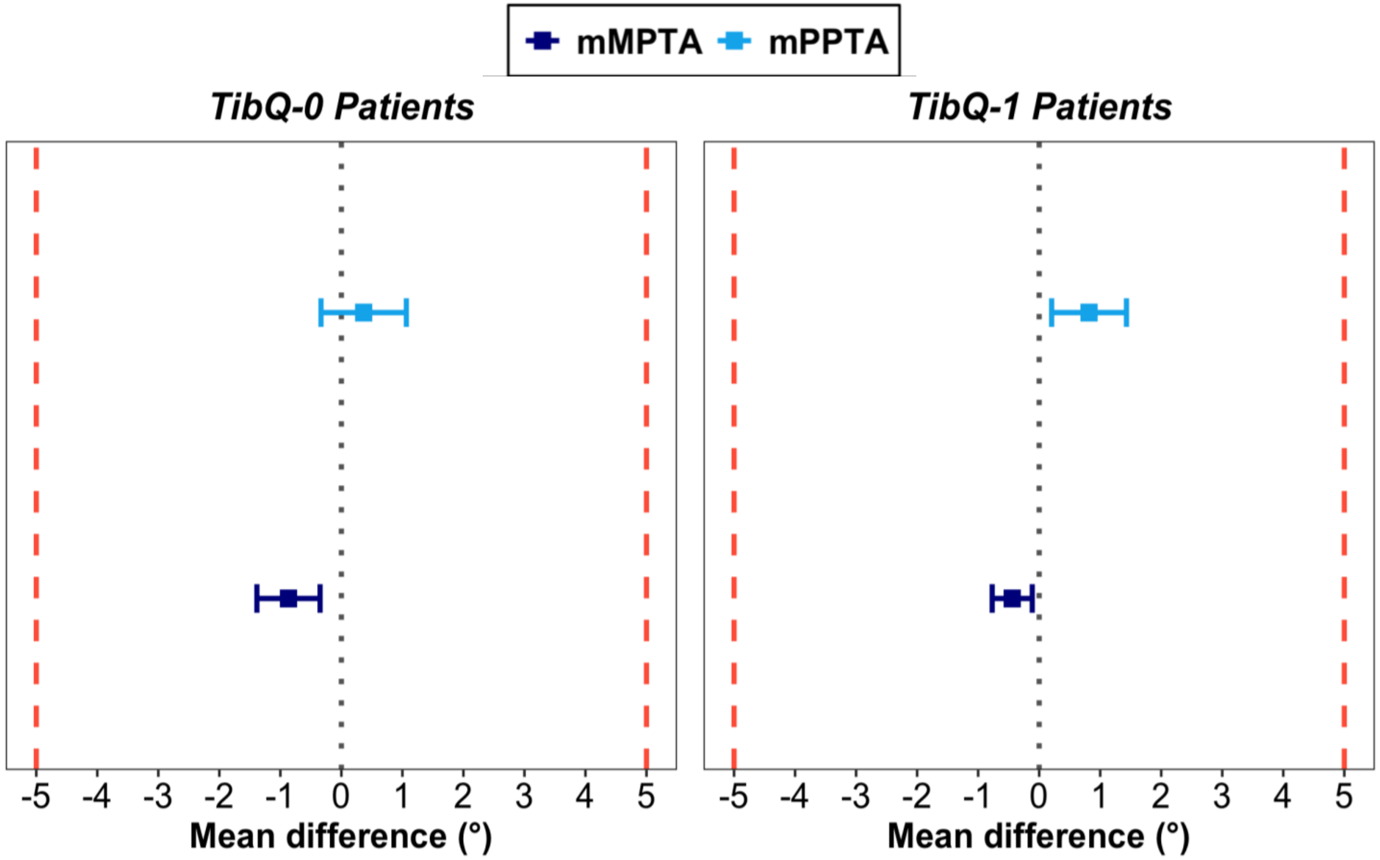
@ group level: △ in proximal tibial alignment = small & within the ±5° equivalence margin.

TibQ0 Physis open (N=30):

- None exceeded it for PPTA.

TibQ1 Physis open (N=49):

- 2 cases exceeded > 5° threshold for PPTA
- But still within range of normal for PPTA



Limitations

Small sample size, followed to skeletal maturity but late deformity could be missed

Selection bias & inconsistent F/u due to retrospective design

No correlation between function and small angular changes

Discussion

Preliminary multicenter results = clinically meaningful deformity was uncommon

Most patients remained within the **±5°** equivalence threshold

Conclusion

- Findings are promising, but preliminary
- Future research is needed with larger cohorts with prospective follow-up to skeletal maturity to confirm strength of the results and guide future practice.

Predictors and Complications of Delayed Femoral Shaft Fractures in Pediatric Patients

Presenter(s): Ishaan Swarup

Femur Fracture Fixation

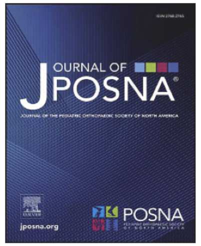
- Early fixation improves outcomes in adults
  - Lower rates of complications
  - Improved functional outcomes
  - Shorter hospital stays
  - Lower healthcare costs
- Benefits of early fixation in pediatric patients is debatable
  - Some studies support fixation <18hrs to reduce pulmonary and immobilization-related complications
  - Other studies have shown that early fixation does not significantly affect complication or mortality outcomes

Previous Study

Contents lists available at ScienceDirect

Journal of the Pediatric Orthopaedic Society of North America

journal homepage: www.jposna.com



Original Research

Predictors and Complications of Delayed Femoral Shaft Fracture Fixation in Pediatric Patients

Syed Ali, MD[1]; Alex Youn, AB[2]; Benjamin Black, BS[3]; Dennis Black, PhD[3]; Aaron Jensen, MD[1]; Ishaan Swarup, MD[1,*]

[1] *Department of Orthopaedic Surgery, University of California San Francisco, San Francisco, CA, USA*
[2] *School of Medicine, University of California San Francisco, San Francisco, CA, USA*
[3] *Department of Epidemiology and Biostatistics, University of California San Francisco, San Francisco, CA, USA*

Results and Limitations

- Predictors of Delayed Fixation
  - ISS scores > 15 ($p < 0.01$)
  - Worse GCS scores ($p < 0.01$)
  - Older age (10-16 years; $p = 0.02$)
  - Higher number of days on a ventilator ($p < 0.01$)
- Delayed fixation associated with longer LOS (p = 0.02) and complications (p < 0.01)
- Limitations: Unable to target isolated femoral shaft fractures, selection bias

CORTICES Study

- **Primary Aim**: To identify the optimal timing of definitive fixation in pediatric patients aged 6-16 years presenting with isolated closed femoral shaft fractures across CORTICES centers.
- **Secondary Aim**: To identify patient, injury, and center-level factors associated with delayed fixation (defined as ≥ optimal threshold identified in primary aim) in pediatric patients aged 6-16 years presenting with isolated closed femoral shaft fractures across CORTICES centers.

Inclusion/Exclusion

- Inclusion
  - (1) Patients aged 6 through 16 years, presenting with (2) unilateral and bilateral closed isolated fractures of the femoral shaft who (3) underwent closed or open reduction and internal fixation of the femur from January 2015 to December 2025
- Exclusion
  - (1) Patients who sustained an open femur fracture, (2) patients with other non-orthopaedic procedures performed during admission, and (3) polytrauma patients, defined as two or more organ system involvement, including also other orthopaedic injuries (e.g., pelvic fracture, floating knee)

Sample Size and Data Dictionary

- 800 patients needed to accomplish aims 1 and 2
- Data dictionary
  - Demographics
  - Clinical Data
  - Complications
    - 30 Day
    - 90 Day
    - 1 year

Next Steps

- Currently working on data entry guide and alpha testing
- Beta testing: Michigan, Colorado
  - Need a few other volunteers
- Grant application
  - POSNA Registry Grant

Lisfranc Fracture

Retrospective Study Design & Protocol Updates

CORTICES PI: Jaime Denning MD
CORTICES Co-Investigators: Megan Johnson MD, Keith Baldwin MD, Benjamin Shore MD
BCH Coordinator: Fernanda Canizares MD MPH, Saurav Pandey (CRC)
BCH Statistician: Shanika De Silva PhD

Specific Aims

Primary Aim

- To compare clinical and radiographic outcomes between operatively and non-operatively managed pediatric Lisfranc injuries.

Hypothesis

- Operative and non-operative management will yield similar clinical outcomes, whereas operative management will be associated with improved radiographic alignment and fewer late complications compared to non-operative management in pediatric Lisfranc injuries.

Primary Aim

<u>Primary outcome</u>

- Unplanned return to OR (**reoperation** in operative patients or **conversion to surgery** in non-operative patients)

<u>Secondary outcomes</u>

- Timing of return to sport/activity and time to weight bearing;
- Complications (infection, CRPS, cast complications, compartment syndrome, nonunion, malunion, loss of fixation)
- Need for supervised PT
- Radiographic outcomes at follow-up (residual displacement, arthritic changes, and deformity)

Secondary Aims/Hypotheses/Outcomes

Secondary Aim 1

- To evaluate the association between skeletal maturity and clinical and radiographic outcomes in pediatric Lisfranc injuries.

Hypothesis

- Patients with open physes/immature feet will have worse clinical and radiographic outcomes compared with those with closed physes/mature feet.

Secondary Aims/Hypotheses/Outcomes

Outcome

- Unplanned return to OR (**reoperation** in operative patients or **conversion to surgery** in non-operative patients)

Additional outcomes

- Timing of return to sport/activity and time to weight bearing;
- Complications (infection, CRPS, cast complications, compartment syndrome, nonunion, malunion, loss of fixation)
- Need for supervised PT
- Radiographic outcomes at follow-up (residual displacement, arthritic changes, and deformity)

Secondary Aims/Hypotheses/Outcomes

Secondary Aim 2

- To identify pre-treatment radiographic displacement measurements and/or advanced imaging markers of instability associated with failure of non-operative management in pediatric Lisfranc injuries, and to identify potential thresholds beyond which non-operative management is associated with failure.

Hypothesis

- Greater displacement (e.g., 1st–2nd metatarsal distance, medial cuneiform–2nd metatarsal distance, and disrupted alignment lines) will be associated with higher rates of late displacement/malunion, conversion to surgery, delayed return to sport, and radiographic arthritis/deformity.

Secondary Aims/Hypotheses/Outcomes

Outcome

- Non-operative treatment failure, defined as conversion to surgery, late displacement, or malunion

Additional outcomes

- Persistent symptoms and activity restrictions at final follow-up
- Time to weight bearing
- Radiographic outcomes (residual displacement, arthritic changes, and deformity) using the recorded measurements and classifications (Hardcastle/Myerson; Nunley & Vertullo) and MRI findings when available.

Tertiary Aim

<u>Tertiary Aim</u> (If xrays can be uploaded in REDCap)

- To develop a classification system of pediatric Lisfranc injuries based on the patterns of injury observed in this population accounting for skeletal maturity.

Design Methods

- Retrospective
- Inclusion:
  - Age 0-18, Lisfranc injury based on imaging (XR, CT, MRI), can include other associated foot fractures, open or closed injuries
  - Non-operative or operative treatment (any fixation method)
  - Treated at CORTICES institution b/w 1/1/10 – 6/30/25
  - At least 6 month f/u
- Exclusion:
  - Patients with known neuromuscular/syndromic conditions or metabolic bone diseases that may independently affect midfoot
  - Less than 6 months of follow-up

Description of Study Treatments or Exposures/Predictors

- Patients 18 years of age or younger with either open or closed physes with Lisfranc Injury (tarsometatarsal level injury) treated either nonoperatively or operatively

Definition of 1° & 2° Outcomes/Endpoints

Primary Outcome: The primary clinical endpoint will be unplanned return to the operating room (reoperation in operative patients or conversion to surgery in non-operative patients)

Secondary Outcomes:

- Return to activity at final follow-up, categorized by degree of activity restriction
- Adverse radiographic outcome at final follow-up (residual displacement, arthritic changes, or deformity on weightbearing radiographs)
- Occurrence of any clinically significant complication (infection, nonunion, malunion, loss of fixation, CRPS, cast complication, compartment syndrome, or reoperation)
- Time to weightbearing
- Non-operative failure (conversion to surgery, late displacement, or malunion)
- Persistent symptoms at final follow-up
- Supervised therapy utilization.

Data Collection

Data Collection Methods, Assessments, Interventions and Schedule (what assessments performed, how often)

Medical records will be reviewed to obtain patient demographic, injury, treatment and follow-up characteristics including age, sex, BMI, menarche status, method of injury, fracture type, treatment method, injury and follow-up physeal status, and radiographic measurements within three months of injury and at most recent radiograph at least 6-months postoperative.

*Appendix (data dictionary) has comprehensive variable list.

Study Timeline

- **Study Timeline**
- Protocol development: ~2 months – Feb-March 2026
- Research Committee Approval-1 month - April 2026
- Database creation: ~1 month -May 2026
- Beta testing period: ~3 months -June July August 2026
- Presentation Annual Meeting-Sept 2026
- POSNA 2027 submission- Oct 2026
- Data entry ~6 months Sept-Feb 2027
- Data Cleaning ~1 month -March 2027
- Data Analysis ~1.5 months -April 2027
- Writing: ~3- months May-July 2027

Data Analysis Plan

Epidemiology of Lisfranc Injuries

- Cohort demographics, injury mechanisms, presentation patterns, and pre-treatment imaging findings will be summarized **descriptively**.
- Continuous variables will be presented as means and standard deviations or medians and interquartile ranges, based on the distribution of the data.
- *Categorical variables* will be presented as *frequencies and percentages*.

Data Analysis Plan

Primary aim

- Clinical and radiographic outcomes will first be compared between operative and non-operative treatment groups using **univariate analyses**.
- Continuous variables will be compared using t-tests or Wilcoxon rank sum tests, based on distributional assessments, while
- *Categorical* variables will be compared using *Fisher's exact tests or chi-squared tests*, as appropriate.
- To evaluate the **independent association between treatment type and the primary outcome**, unplanned return to the OR, **multivariable logistic regression** will be conducted

Data Analysis Plan

Secondary Aim 1

- Clinical and radiographic outcomes will be assessed between skeletally mature and skeletally immature feet using the same univariate comparisons described in the primary aim.
- **Multivariable logistic regression** will similarly be used to **assess the independent association between skeletal maturity and the primary outcome**, unplanned return to OR
- To evaluate whether <u>skeletal maturity modifies the effect of treatment type</u> (operative vs. non-operative), an interaction term between skeletal maturity and treatment type will be included in the multivariable model

Data Analysis Plan

Secondary Aim 2

- The **association between pre-treatment radiographic displacement measurements and failure of non-operative treatment** will be assessed among patients initially managed non-operatively using **multivariable logistic regression** models.
- To identify displacement thresholds associated with non-operative failure, receiver operating characteristic (ROC) curve analysis will be performed for the continuous displacement measurements. The area under the curve (AUC) will be reported as a measure of discriminative ability, and optimal thresholds will be identified using the Youden index.

Statistical Power and Sample Sizes

- Total sample of 205 patients is required (82 in the operative cohort and 123 in the non-operative cohort) to detect this difference with adequate statistical power.

- Assuming a 20% rate of incomplete data, the **total sample size increases to 257 patients (103 operative and 154 non-operative)** to maintain 80% power for detecting a 10 percentage point difference in reoperation rates.

Statistical Power and Sample Sizes

- Total sample of 205 patients is required (82 in the operative cohort and 123 in the non-operative cohort) to detect this difference with adequate statistical power.

- Assuming a 20% rate of incomplete data, the **total sample size increases to 257 patients (103 operative and 154 non-operative)** to maintain 80% power for detecting a 10 percentage point difference in reoperation rates.

Update/To Do

- Protocol/Data Dictionary ✅
  - Will email to everyone who is interested in this study
  - Most updated Protocol
  - Most updated Data Dictionary
- Feedback from Research Committee & Members (this meeting)
- IRB
- REDCap
  - Once done, TSRH/CCHMC/CHOP/Boston? will pilot ~5 patients each, then open it up

Lisfranc Survey Update

- Survey on practice variation ✅
  - Lisfranc Case Survey
- Pilot with 10 patients to look at inter-rater reliability
  - Shanika De Silva (statistician) provided data analysis (lumped cases and case-by-case data)
  - Abstract submitted to POSNA (based on summary cases) ✅
    - Abstract (not selected for presentation)
  - Manuscript in process (goal submission by end of summer)
    - Meghana to help this summer!

Appendix

Appendix
Variables List

1. Eligibility (Screening)
- Age at injury (0–18 years)
- Lisfranc injury confirmed by imaging (XR/CT/MRI)
- Exclusion conditions (neuromuscular, syndromic, metabolic bone disease

2. Demographics
- Date of birth
- Sex (Male/Female)
- Race
- BMI
- Mechanism of injury
  - MVA
  - High-energy fall
  - Low-energy fall
  - AVP
  - Sports: If yes → sport category (list)
  - Other

3. Presentation & Timing
- Date of injury
- Date of first medical presentation
- Setting of presentation (ED, ortho, sports med, etc.)

4. Injury Characteristics

4A. Radiographic Classification
- Displaced vs Non-displaced
- Hardcastle/Myerson classification
- Nunley & Vertullo stage
- Injury pattern:
  - Ligamentous
  - Bony
  - Combined
- MRI performed? (Y/N)
  - If yes: Partial vs Complete tear

4B. Skeletal Maturity
- Physeal status at base of 1st MT (Open/Closed)
- Calcaneal apophysis stage (0–5)

(Maturity will be dichotomized later into Immature vs Mature)

4C. Radiographic Measurements (Pre-treatment, at latest follow-u
- 1–2MT distance (cm)
- MC–2MT distance (cm)
- 2nd MT alignment line (Y/N)
- 3rd MT alignment line (Y/N)
- 4th MT alignment line (Y/N)
- Dorsal TMT line intact (Y/N)
- Plantar TMT line intact (Y/N)

5. Treatment (Operative vs Non-operative)

If Operative:
- Date of surgery
- Arthrodesis vs Internal fixation
- Primary fixation category:
  - Screws
  - Pins/K-wires
  - Plate
  - Suture-button
  - Hybrid
- Time to surgery (calculated)

If Non-operative:
- Date of treatment
- Immobilization type:
  - Cast
  - Boot
  - Splint
  - Post-op shoe

Conversion to surgery (Y/N)

6. Acute Severity
- Compartment syndrome (Y/N)
- Neurovascular deficit at presentatio

7. Outcomes

Clinical Outcomes
- Date of final follow-up
- Return to activity at final follow-up:
  - Full return without restrictions
  - Return with minor modification
  - Return with medical restriction
  - Limited due to symptoms
  - No return
  - Unknown/Missing
- Time to weight bearing (date)
- Symptoms at final follow-up:
  - Mild
  - Moderate
  - Severe
- Physical therapy referral (Y/N)
- Reoperation (Y/N)
  - If yes → reason (short list)
- Readmission (Y/N)
  - If yes → date and reason

Complications
- Infection (acute/chronic)
- Nonunion (>6 months)
- Malunion (radiographic displacement)
- Loss of fixation
- CRPS/RSD
- Cast complication
- Other (free text)

Radiographic Outcomes (Final Follow-Up)
- Residual displacement present? (Y/N)
- Arthritis present? (Y/N)
- Deformity present? (Y/N)

MSKI Validation

Presenter(s): Jonathan Schoenecker

CORTICES STUDY GROUP UPDATE · 5 MAY 2026

The Discordant Dyad

A continuous CRP / Platelet ratio for severity across the pediatric MSKI spectrum

Riley S. Gilbertson · Sam Kavarana · Albert Cordoves · August Kim · Courtney E. Baker

Keith D. Baldwin (CHOP) · Jonathan G. Schoenecker (Vanderbilt)

DERIVATION	VALIDATION
n = 376	n = 2,076
Vanderbilt 2011-2022	*CORTICES 2010-2016*

The pivot point isn't diagnosis — it's severity

TASK 3 — How sick is this child, and how sick will they become?

From the chapter:

"Diagnostic tools like the Kocher criteria cannot differentiate severity — yet severity determines trajectory, treatment intensity, and risk of death."

— MSKI Infection Chapter, Lovell & Winter 9e

CRP is our strongest single marker — but it can't tell containment from consumption on its own.

WHAT'S MISSING

A single bedside number that integrates

inflammatory burden × platelet capacity

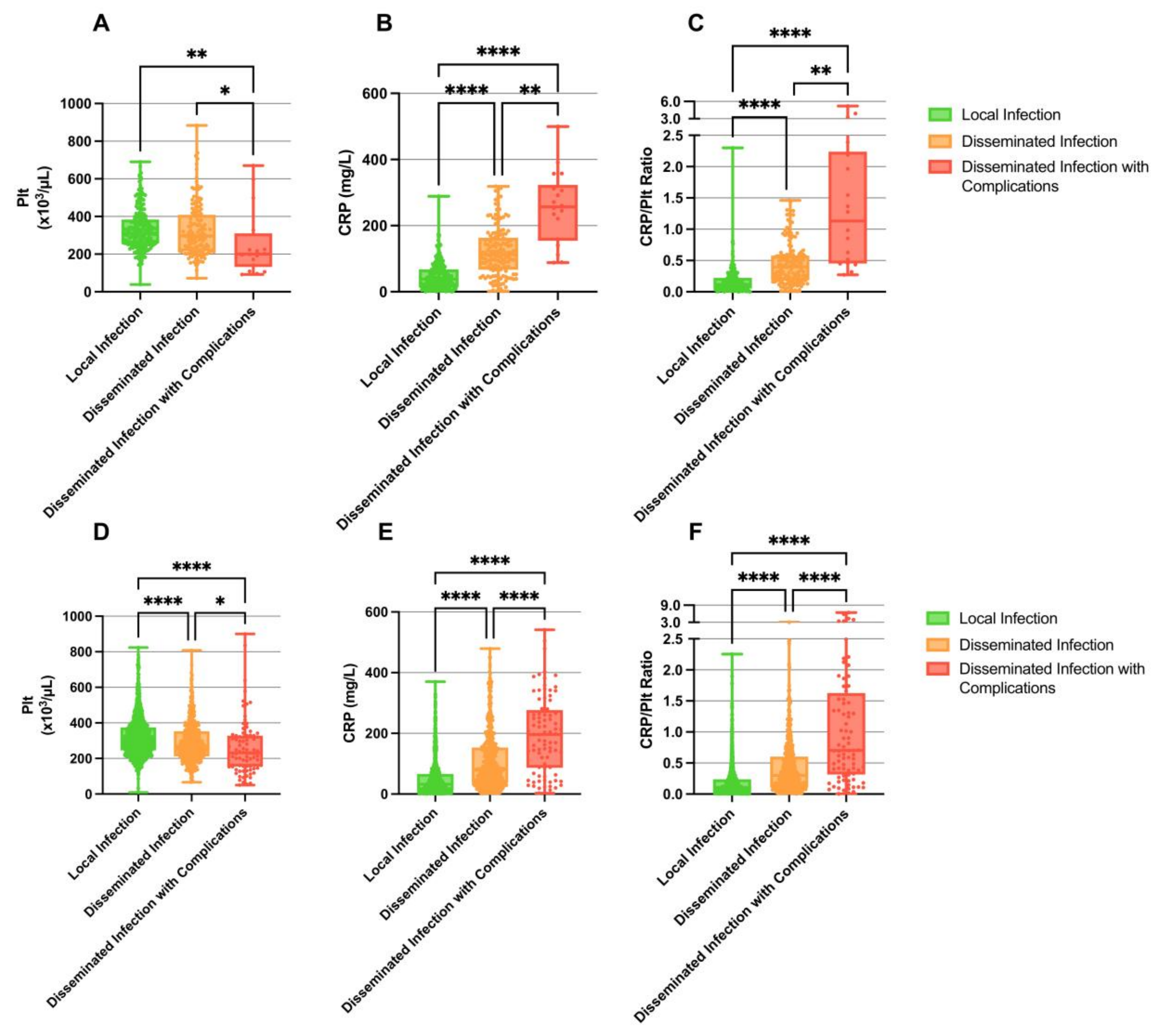
CRP	WBC / NLR	Platelets
rises with injury	*host response*	*rise OR fall*

The discordant dyad.

When CRP keeps rising while platelets fall, the host has stopped containing — and started consuming. The chapter establishes the biology; today we read it as a single number.

Stepwise across the severity spectrum — in BOTH cohorts

Top row: Vanderbilt (n=376) · Bottom row: CORTICES (n=2,076) · Platelets ↓ · CRP ↑ · Ratio ↑



DERIVATION

Vanderbilt (n = 376)

Local

median ratio 0.12

Disseminated

median ratio 0.40

Diss + Complications

median ratio 1.13

VALIDATION

CORTICES (n = 2,076)

Local

median ratio 0.09

Disseminated

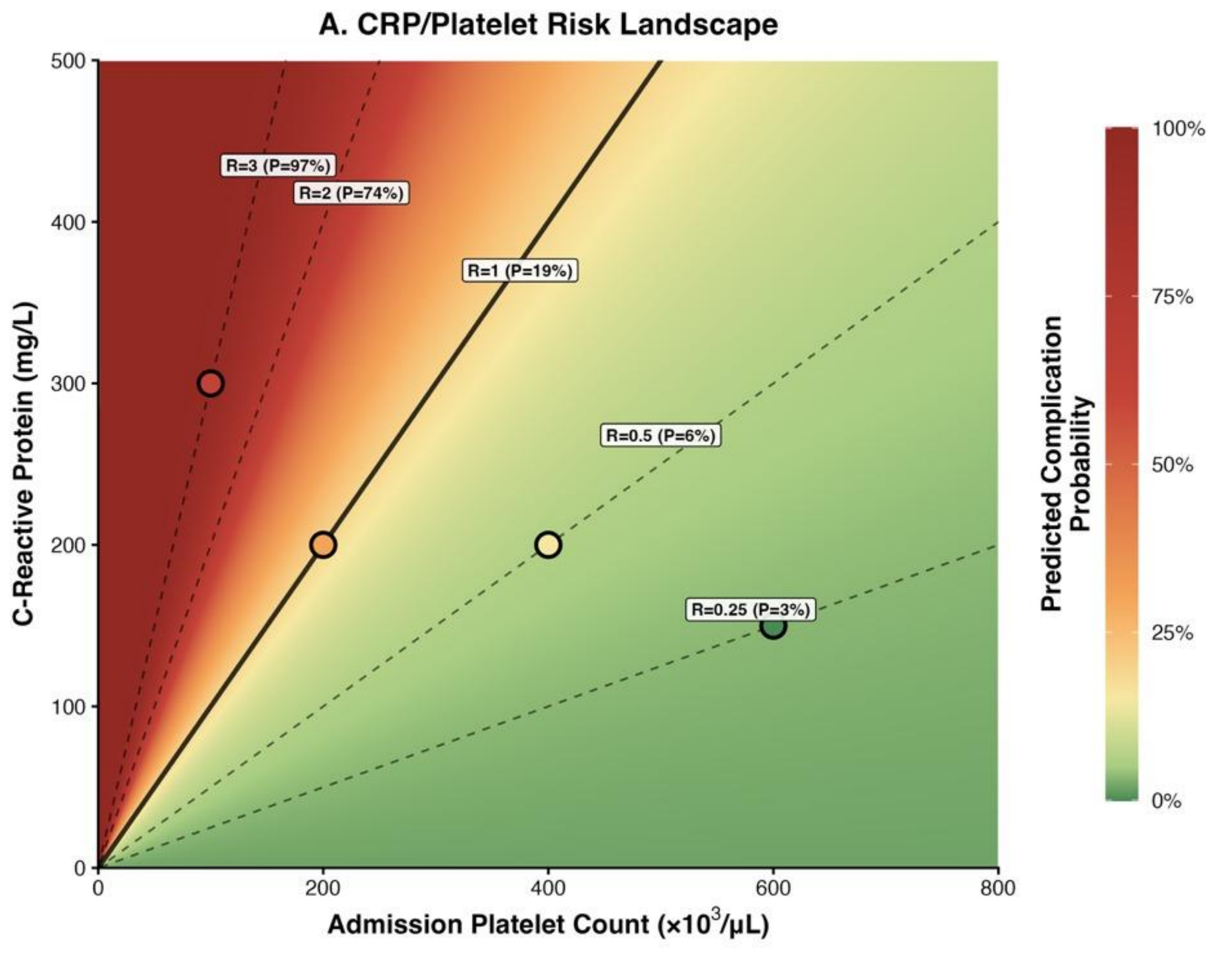
median ratio 0.30

Diss + Complications

median ratio 0.70

When CRP exceeds platelets — the discordant dyad

Ratio = 1.0 · the line where inflammatory burden numerically exceeds platelet capacity



THE LINE

Ratio ≥ 1.0

P(complication) ≈ 19 %

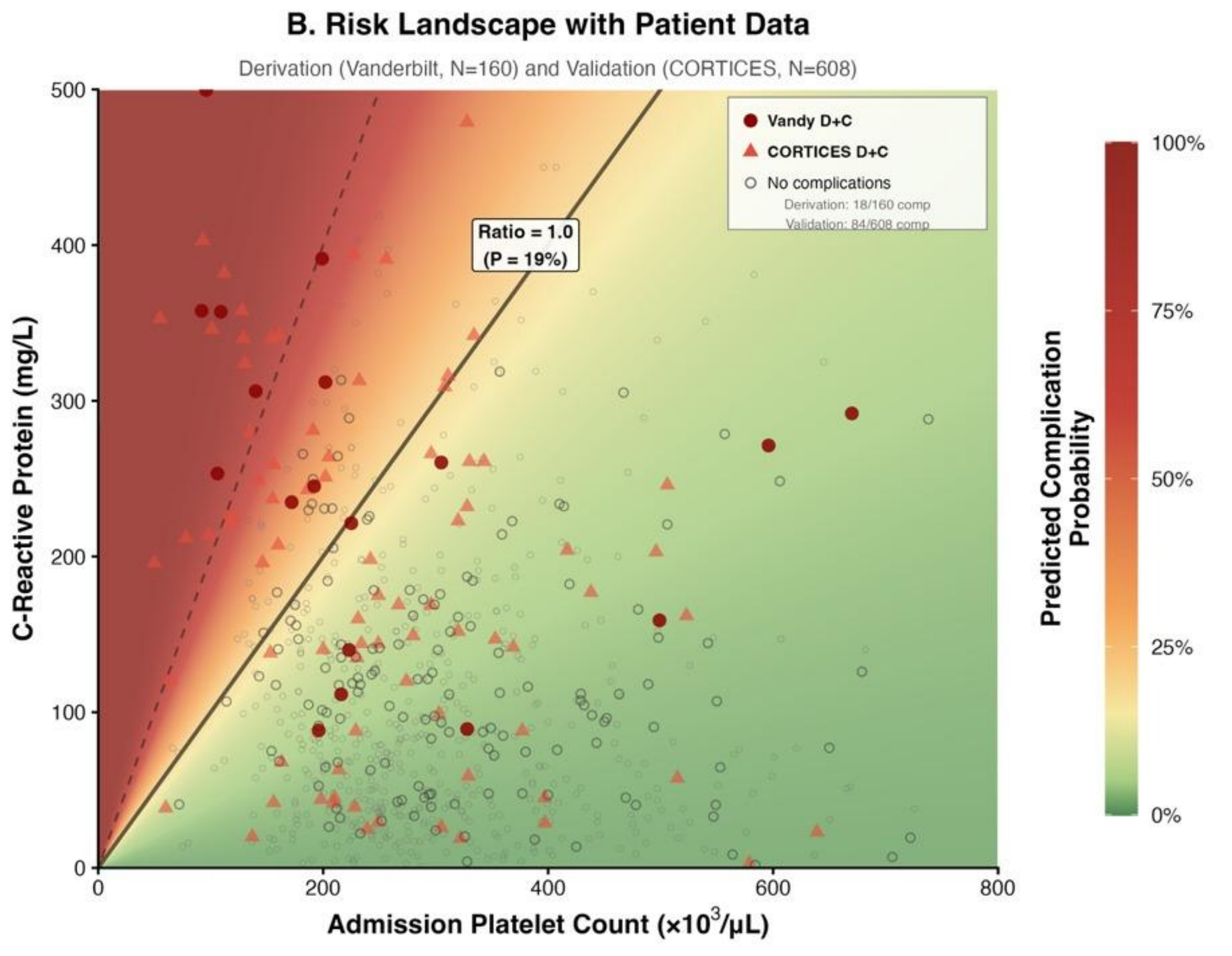
(derivation; 14% in CORTICES validation)

ISO-RATIO RISK

R = 0.25	P = 3 %
R = 0.50	P = 6 %
R = 1.0	P = 19 %
R = 2.0	P = 74 %
R = 3.0	P = 97 %

CORTICES patients land where the model predicts

Vanderbilt-derived risk landscape · with disseminated MSKI patients overlaid



DISCRIMINATION HOLDS

AUC = 0.71

external validation (n = 608 disseminated)

→ 0.816 in derivation

REFIT IS REMARKABLY SIMILAR

Derivation:

`logit(P) = −3.96 + 2.51·R`

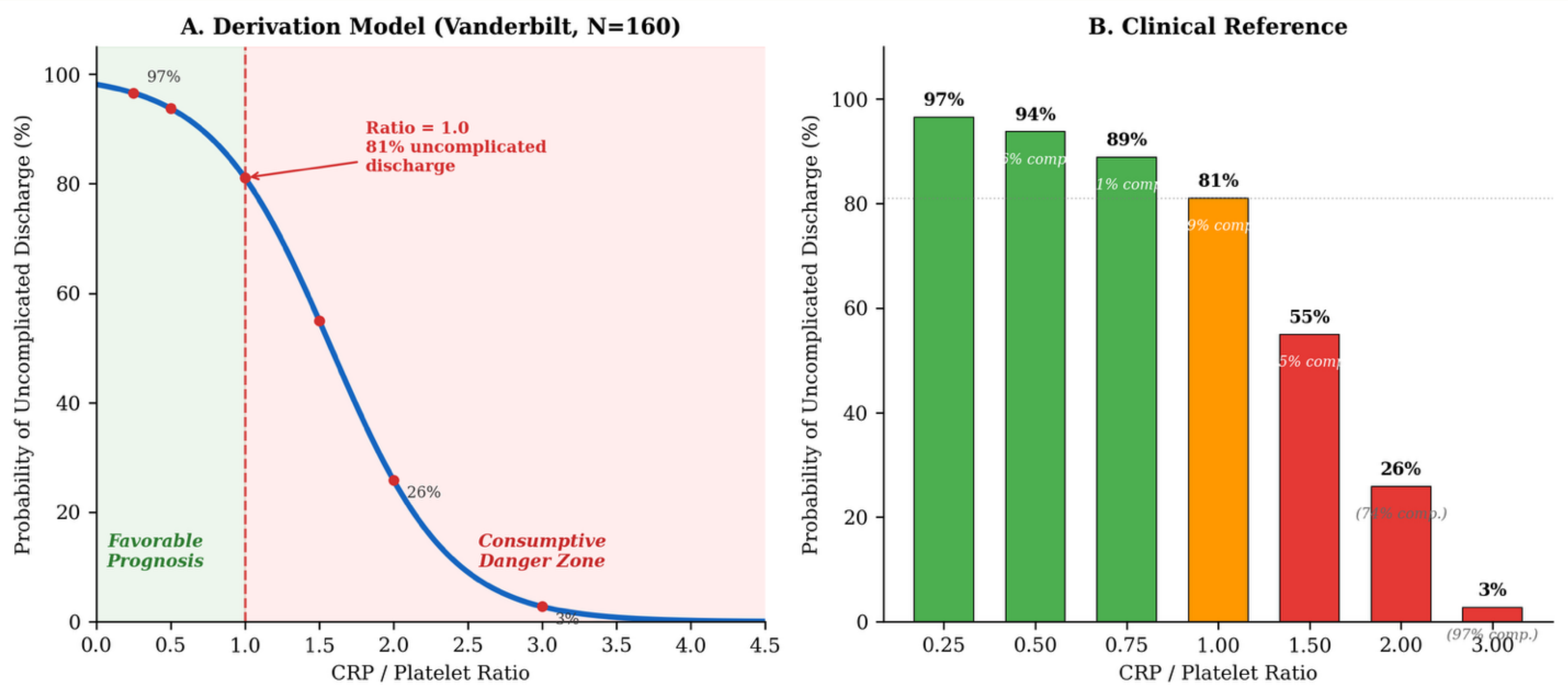
CORTICES refit:

`logit(P) = −2.69 + 1.25·R`

Same shape. Shallower slope = multicenter heterogeneity, not model failure.

From a number to a decision — bedside-actionable risk

Continuous ratio → probability of uncomplicated discharge



AT R ≥ 1.0

PPV ≈ 50 %

NPV ≈ 95 %

LR+ ≈ 3.0

BEDSIDE PEARL

If CRP (mg/L) ≥ platelet count (×10³/µL), the child is in the consumptive zone.

- Critical Pathway candidate
- Repeat labs in 12-24 h
- Lower threshold for return to OR

WHERE THIS GOES — AND WHAT WE'RE ASKING CORTICES

Two papers, one immunothrombotic story

SISTER PAPER · IN REVIEW

AVN after septic arthritis

- 4 binary markers (CRP, Plt, WBC, ESR)
- Outcome: hip / shoulder AVN
- Risk heatmap, 16-cell stratification
- Anchored in end-arterial anatomy

THIS PAPER · READY TO DRAFT

Continuous CRP/Plt ratio severity

- Single continuous biomarker
- Outcome: complications across spectrum
- Vanderbilt derivation + CORTICES validation
- Immunothrombosis as the unifying mechanism

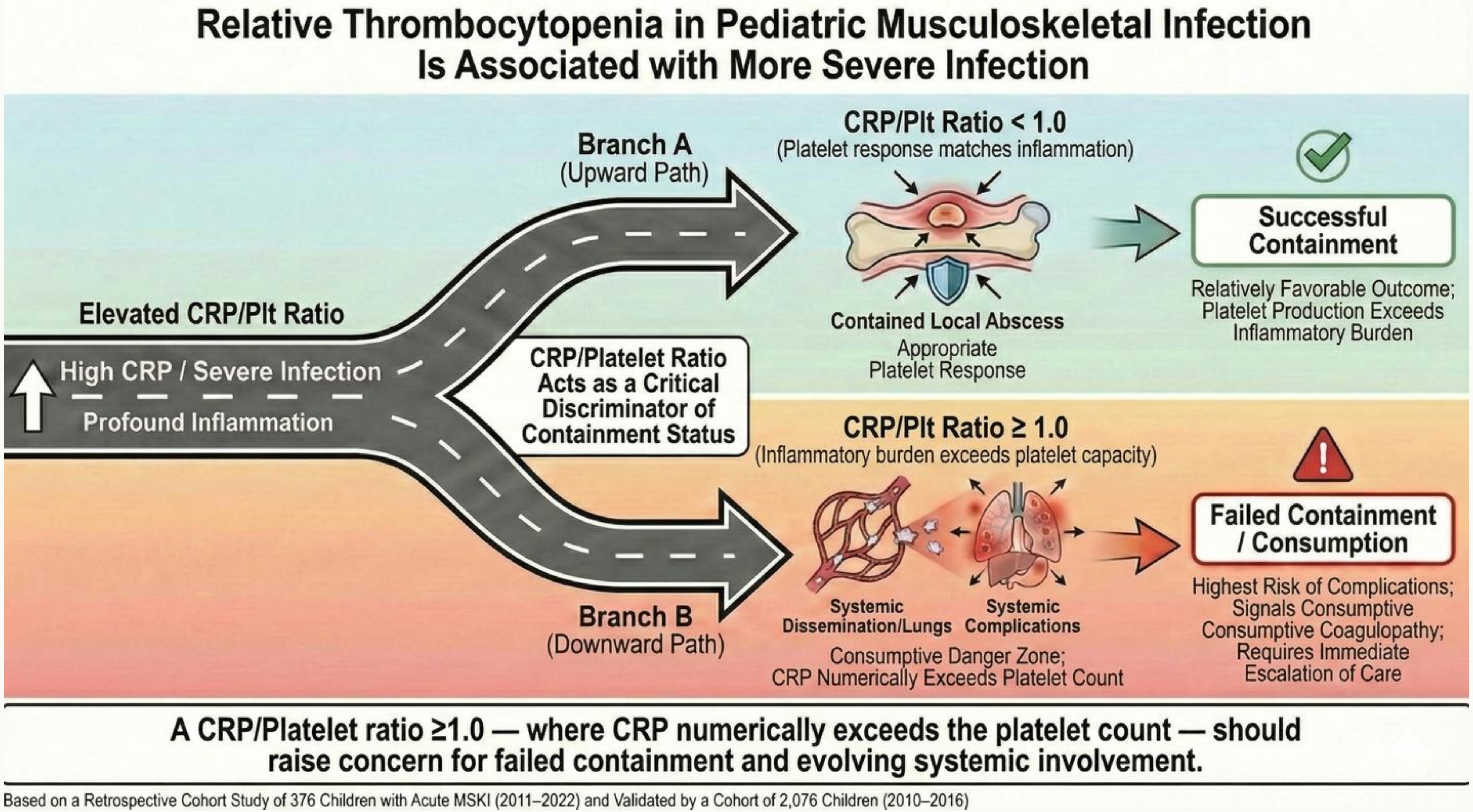
OUR ASK OF CORTICES TODAY

1. Endorse joint submission strategy. 2. Confirm authorship roster. 3. Flag any site-specific data caveats before lockdown.

Acknowledgments: Keith Baldwin (CHOP) — proposed the continuous ratio framing, Feb 2026

Two roads from one biology — containment or consumption

The ratio operationalizes the immunothrombotic continuum from chapter and bench



CLIOH

CLINICAL INTUITION ORDINAL HIERARCHY

CLIOH

Six statistics, one hierarchy

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

Six statistics, one hierarchy

1 **Pairwise comparison**

The voting mechanism

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

Six statistics, one hierarchy

1 **Pairwise comparison**

The voting mechanism

2 **Bradley-Terry win rate**

Converting votes to ranking

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

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3 **Majority % per pair**
How unified is each head-to-head

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

Six statistics, one hierarchy

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4 **Kendall's W**

Do all surgeons agree on the ranking

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

Six statistics, one hierarchy

1 — **Pairwise comparison**

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Do all surgeons agree on the ranking

5 — **Spearman r**

How closely does each surgeon track the group

Each statistic answers a specific question. Together, they tell you whether the consensus is real.

Six statistics, one hierarchy

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How unified is each head-to-head

4 **Kendall's W**
Do all surgeons agree on the ranking

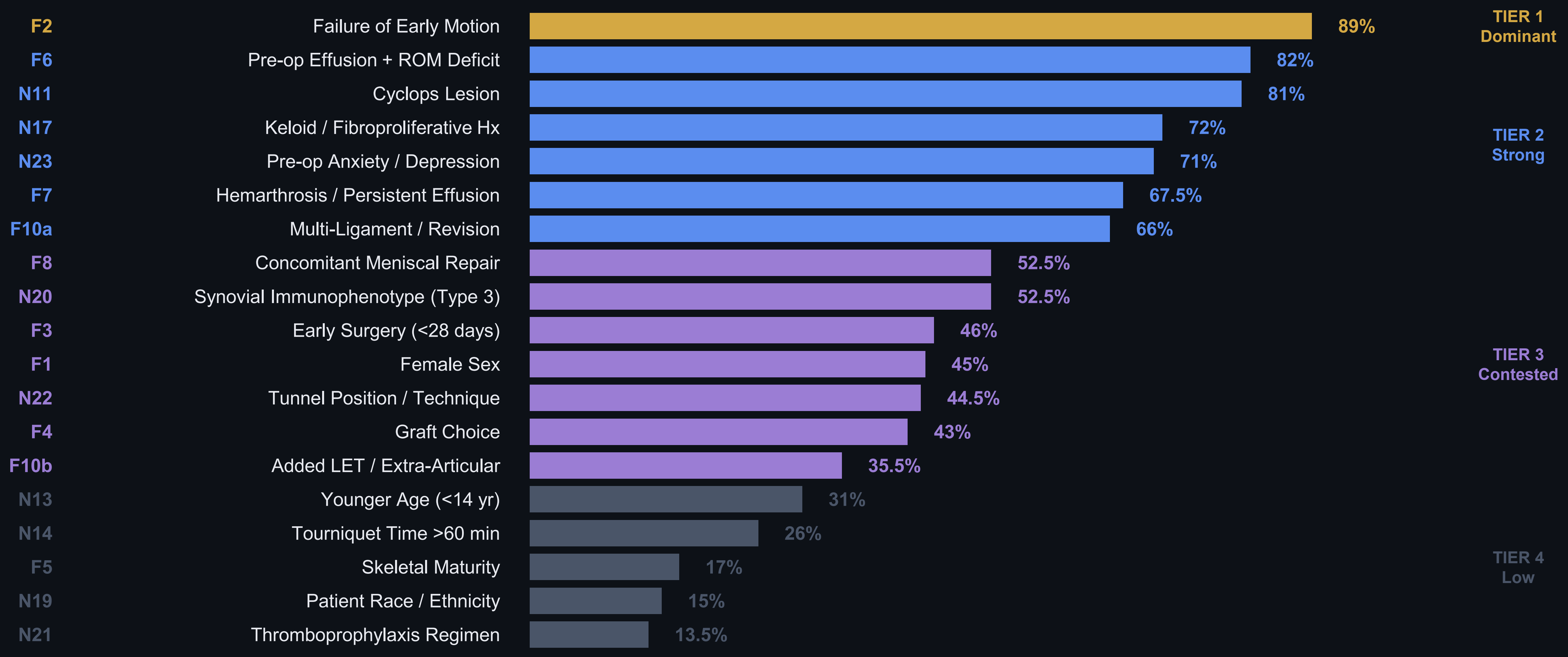
5 **Spearman r**
How closely does each surgeon track the group

6 **Tier boundaries**
Where we draw the lines

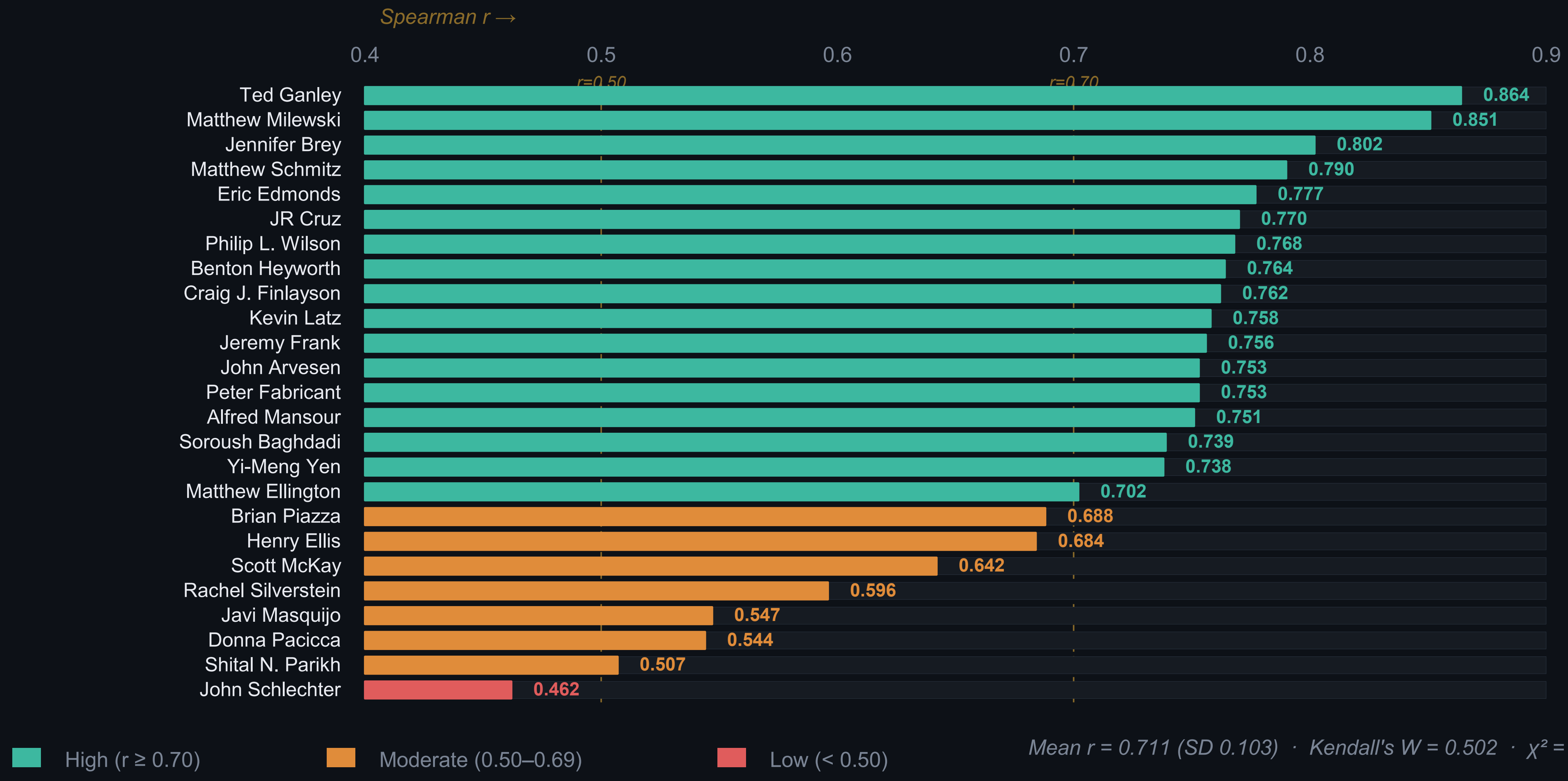
Each statistic answers a specific question. Together, they tell you whether the consensus is real.

THE RANKING

SCORE Clinical-Intuition Ordinal Hierarchy of Arthrofibrosis Risk After ACL Reconstruction



Panel Alignment — Every Surgeon, Every Coordinate



Mean r = 0.711 (SD 0.103) · Kendall's W = 0.502 · $\chi^2 = 225.7$, $p < 0.001$

CONCORDANCE MATRIX

Where Experts and Evidence Agree — and Where They Don't

	EVIDENCE CLEAR	EVIDENCE SPARSE
EXPERTS AGREE (≥70%)	**Q1 — CONFIRMED** **35** Expert consensus matches literature	**Q2 — NOVEL EBI** **85** Expert intuition overrides or exceeds evidence — the CLIOH signal
EXPERTS SPLIT (<70%)	**Q3 — LIT RESOLVES** **13** Literature is clear but experts split — education targets	**Q4 — RESEARCH GAP** **38** Both experts and literature uncertain — highest-value research questions

INDIVIDUAL VS. PANEL

Benton Heyworth vs Panel Consensus

Boston Children's Hospital · 15 yrs · r = 0.77 n = 25 · CORTICES network

Fibrosis biology before the calendar — the hemarthrosis signal leads, surgical timing trails.

HEYWORTH · IOH

1	F7	Hemarthrosis / Persistent Effusion	100.0%
2	F2	Failure of Early Motion	87.5%
3	F6	Pre-op Effusion + ROM Deficit	87.5%
4	N11	Cyclops Lesion	87.5%
5	N17	Keloid / Fibroproliferative Hx	87.5%
6	F10a	Multi-Ligament / Revision	75.0%
7	F10b	Added LET / Extra-Articular	62.5%
8	N20	Synovial Immunophenotype	62.5%
9	F8	Concomitant Meniscal Repair	50.0%
10	N13	Younger Age (<14 yr)	50.0%
11	N22	Tunnel Position / Technique	50.0%
12	N23	Pre-op Anxiety / Depression	50.0%
13	F4	Graft Choice	25.0%
14	N14	Tourniquet Time >60 min	25.0%
15	F1	Female Sex	12.5%
16	F5	Skeletal Maturity	12.5%
17	N19	Patient Race / Ethnicity	12.5%
18	N21	Thromboprophylaxis Regimen	12.5%
19	F3	Early Surgery (<28 days)	0.0%

PANEL · CONSENSUS

1	F2	Failure of Early Motion	89.0%
2	F6	Pre-op Effusion + ROM Deficit	82.0%
3	N11	Cyclops Lesion	81.0%
4	N17	Keloid / Fibroproliferative Hx	72.0%
5	N23	Pre-op Anxiety / Depression	71.0%
6	F7	Hemarthrosis / Persistent Effusion	67.5%
7	F10a	Multi-Ligament / Revision	66.0%
8	F8	Concomitant Meniscal Repair	52.5%
9	N20	Synovial Immunophenotype	52.5%
10	F3	Early Surgery (<28 days)	46.0%
11	F1	Female Sex	45.0%
12	N22	Tunnel Position / Technique	44.5%
13	F4	Graft Choice	43.0%
14	F10b	Added LET / Extra-Articular	35.5%
15	N13	Younger Age (<14 yr)	31.0%
16	N14	Tourniquet Time >60 min	26.0%
17	F5	Skeletal Maturity	17.0%
18	N19	Patient Race / Ethnicity	15.0%
19	N21	Thromboprophylaxis Regimen	13.5%

KEY DIVERGENCES

F10b **Added LET / Extra-Articular** — Heyworth #7 · Panel #14 (gap 7 ↑)
F7 **Hemarthrosis / Persistent Effusion** — Heyworth #1 · Panel #6 (gap 5 ↑)
F3 **Early Surgery (<28 days)** — Heyworth #19 · Panel #10 (gap 9 ↓)
N23 **Pre-op Anxiety / Depression** — Heyworth #12 · Panel #5 (gap 7 ↓)

SURGEON VS. SURGEON

Eric Edmonds vs Henry Ellis

Rady Children's San Diego · 18 yrs   TSRH / UT Southwestern · 14 yrs

r (Edmonds, Ellis) = 0.35   vs panel: Edmonds 0.78 · Ellis 0.68 · n = 76 pairs each

Same question, opposite axes — procedural complexity (Edmonds) meets patient-intrinsic biology (Ellis).

EDMONDS · IOH

1	F10a	Multi-Ligament / Revision	100.0%
2	N23	Pre-op Anxiety / Depression	100.0%
3	F2	Failure of Early Motion	87.5%
4	F6	Pre-op Effusion + ROM Deficit	87.5%
5	F7	Hemarthrosis / Persistent Effusion	75.0%
6	N17	Keloid / Fibroproliferative Hx	75.0%
7	N20	Synovial Immunophenotype	75.0%
8	F3	Early Surgery (<28 days)	62.5%
9	N11	Cyclops Lesion	62.5%
10	N14	Tourniquet Time >60 min	62.5%
11	F4	Graft Choice	37.5%
12	F8	Concomitant Meniscal Repair	25.0%
13	F10b	Added LET / Extra-Articular	25.0%
14	N13	Younger Age (<14 yr)	25.0%
15	N22	Tunnel Position / Technique	25.0%
16	F5	Skeletal Maturity	12.5%
17	N21	Thromboprophylaxis Regimen	12.5%
18	F1	Female Sex	0.0%
19	N19	Patient Race / Ethnicity	0.0%

ELLIS · IOH

1	F1	Female Sex	100.0%
2	F6	Pre-op Effusion + ROM Deficit	100.0%
3	N23	Pre-op Anxiety / Depression	100.0%
4	N17	Keloid / Fibroproliferative Hx	87.5%
5	F2	Failure of Early Motion	75.0%
6	F8	Concomitant Meniscal Repair	75.0%
7	F3	Early Surgery (<28 days)	62.5%
8	F5	Skeletal Maturity	62.5%
9	F7	Hemarthrosis / Persistent Effusion	62.5%
10	N11	Cyclops Lesion	50.0%
11	F4	Graft Choice	37.5%
12	F10a	Multi-Ligament / Revision	37.5%
13	N20	Synovial Immunophenotype	25.0%
14	N21	Thromboprophylaxis Regimen	25.0%
15	N22	Tunnel Position / Technique	25.0%
16	F10b	Added LET / Extra-Articular	12.5%
17	N19	Patient Race / Ethnicity	12.5%
18	N13	Younger Age (<14 yr)	0.0%
19	N14	Tourniquet Time >60 min	0.0%

KEY DIVERGENCES · WHERE THEY PART WAYS

EDMONDS F10a **Multi-Ligament / Revision** — Edmonds #1 · Ellis #12 **(gap 11)**
EDMONDS N14 **Tourniquet Time >60 min** — Edmonds #10 · Ellis #19 **(gap 9)**
ELLIS F1 **Female Sex** — Ellis #1 · Edmonds #18 **(gap 17)**
ELLIS F5 **Skeletal Maturity** — Ellis #8 · Edmonds #16 **(gap 8)**

INDIVIDUAL RANKING COMPARISON

Henry Ellis vs Ben Johnson

TSRH / UT Southwestern · 14 yrs · r = 0.68 Scottish Rite for Children · non-operating · r = 0.32

Same practice, different roles — the surgeon and the PA he works alongside

#	ID	FACTOR	WIN %
#1	F1	Female Sex	100.0%
#2	F6	Pre-op Effusion + ROM	100.0%
#3	N23	Anxiety / Depression	100.0%
#4	N17	Keloid / Fibroprolif Hx	87.5%
#5	F2	Failure of Early Motion	75.0%
#6	F8	Meniscal Repair	75.0%
#7	F3	Early Surgery (<28d)	62.5%
#8	F5	Skeletal Maturity	62.5%
#9	F7	Hemarthrosis / Effusion	62.5%
#10	N11	Cyclops Lesion	50.0%
#11	F4	Graft Choice	37.5%
#12	F10a	Multi-Lig / Revision	37.5%
#13	N20	Synovial Type 3	25.0%
#14	N21	Thromboprophylaxis	25.0%
#15	N22	Tunnel Position	25.0%
#16	F10b	Added LET	12.5%
#17	N19	Race / Ethnicity	12.5%
#18	N13	Younger Age (<14)	0.0%
#19	N14	Tourniquet >60 min	0.0%

#	ID	FACTOR	WIN %
#1	F2	Failure of Early Motion	100.0%
#2	F8	Meniscal Repair	87.5%
#3	N22	Tunnel Position	87.5%
#4	F7	Hemarthrosis / Effusion	83.3%
#5	N21	Thromboprophylaxis	75.0%
#6	F1	Female Sex	71.4%
#7	F3	Early Surgery (<28d)	71.4%
#8	F6	Pre-op Effusion + ROM	71.4%
#9	N11	Cyclops Lesion	62.5%
#10	F4	Graft Choice	50.0%
#11	F10b	Added LET	50.0%
#12	N17	Keloid / Fibroprolif Hx	40.0%
#13	N13	Younger Age (<14)	37.5%
#14	N23	Anxiety / Depression	25.0%
#15	N19	Race / Ethnicity	14.3%
#16	N20	Synovial Type 3	14.3%
#17	N14	Tourniquet >60 min	12.5%
#18	F5	Skeletal Maturity	0.0%
#19	F10a	Multi-Lig / Revision	0.0%

KEY DIVERGENCES

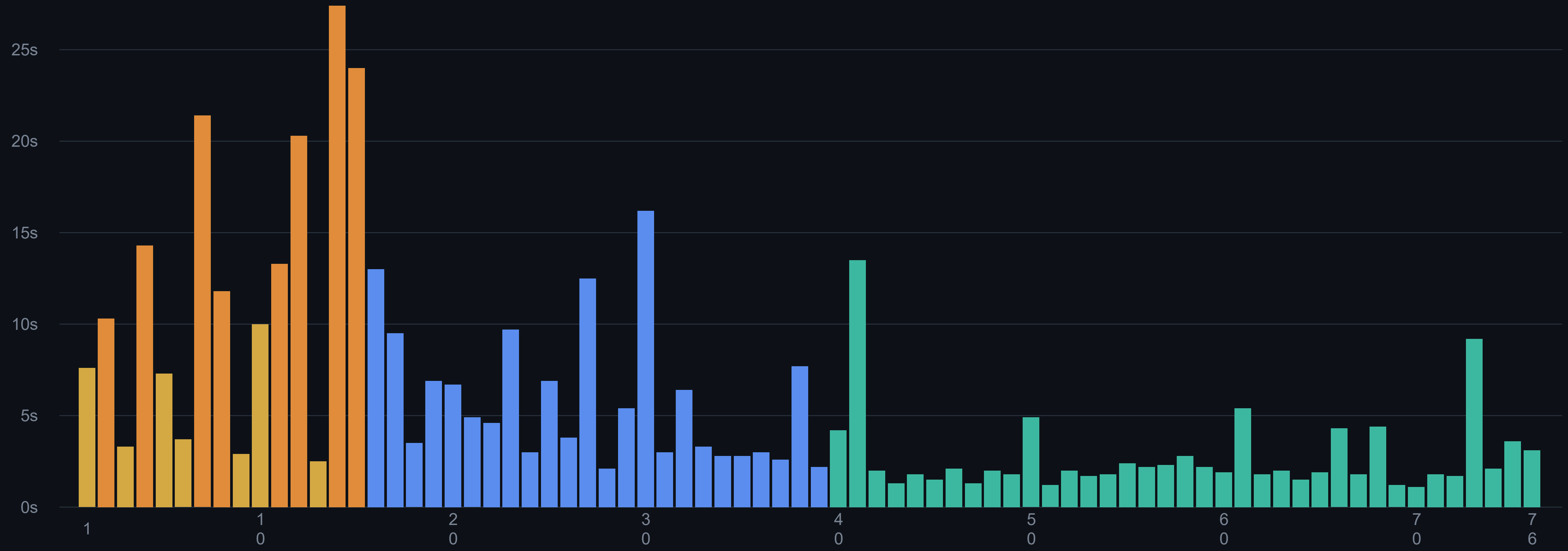
N22 **Tunnel Position** — Ellis #15 · Johnson #3 (gap 12)

N23 **Anxiety / Depression** — Ellis #3 · Johnson #14 (gap 11)

F5 **Skeletal Maturity** — Ellis #8 · Johnson #18 (gap 10)

Ben Johnson is shown outside the n=25 primary roster (non-operating panelist, included at his request for transparency). His alignment (r = 0.32) empirically validates the Tier 1 credential gate.

76 Pairs in Order: Building, Then Running, the Hierarchy



Building Phase (Pairs 1–15)

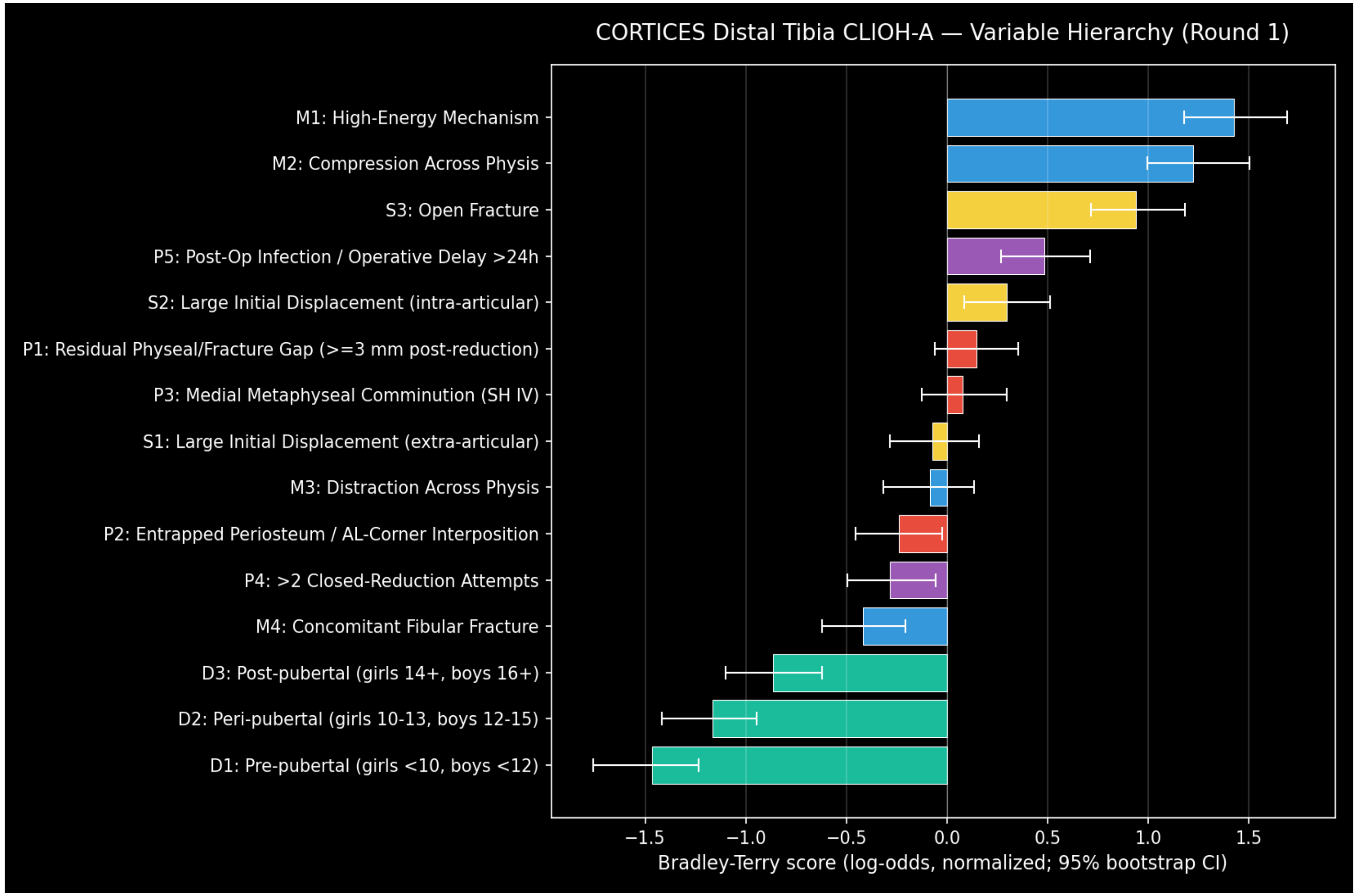
Mean 11.4s · 3 of 4 slowest pairs. Deep engagement with novel matchups — constructing the hierarchy.

Running Phase (Pairs 40–76)

Mean 2.5s · Highly consistent. Pattern recognition resolving from internalized hierarchy. No fatigue signal.

The 2026 CLIOH-A Pairwise — N = 25

Bradley-Terry rank with bootstrap 95% CI · Kendall's W = 0.334, p < 0.001 · 2,550 pairwise comparisons



rank_chart.png · Run 3 canonical · sex-aware skeletal-maturity wording locked

Top 3 — all impaction-axis

1. M1 High-Energy Mechanism 80.2%
2. M2 Compression Across Physis 76.5%
3. S3 Open Fracture 71.0%

Equipoise band (CIs straddle 0)

P1 · P3 · S1 · M3

P2 Periosteum at 44.3% · just below zero

→ Round 2 ATRD targets

Bottom 3 — demographic brackets

13. D3 Post-pubertal 30.5%
14. D2 Peri-pubertal 24.6%
15. **D1 Pre-pubertal 19.2% (BT –1.47, dead last)**

Divergence Map — Spearman + Agreement Heatmap

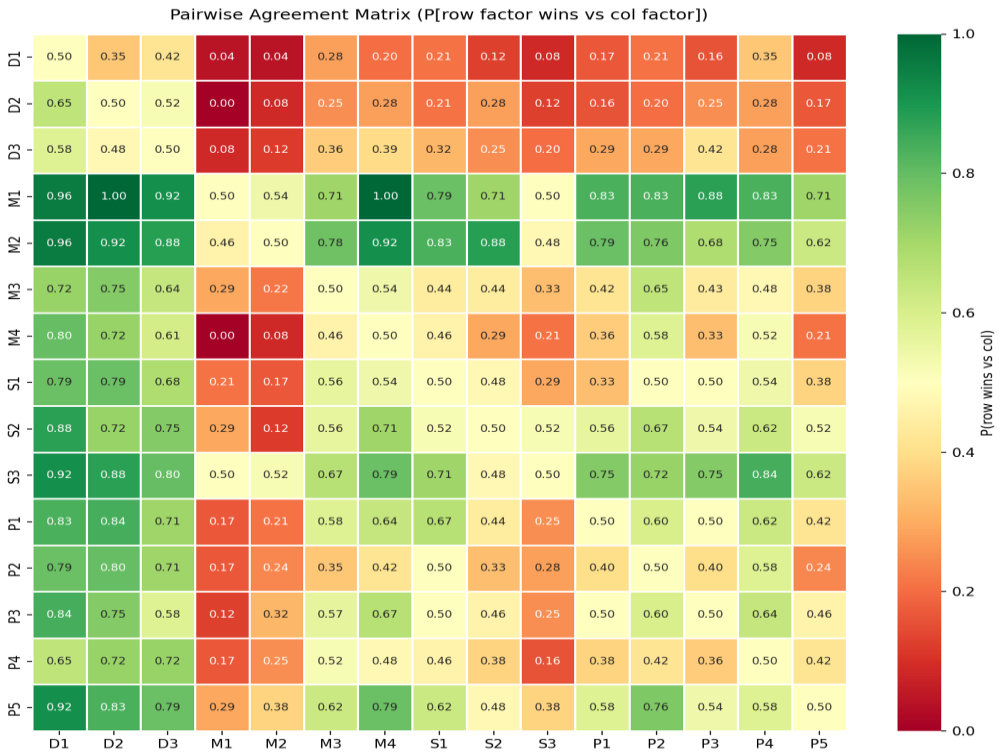
Per-respondent alignment to group consensus · 15×15 pairwise agreement

Spearman r per respondent vs group BT score

#	Surgeon	Institution	Spearman r
1	Walter Truong	*U Minnesota*	+0.865
2	Jonas Owen	*CHLA*	+0.828
3	Jessica Burns	*Phoenix*	+0.809
4	Allan Beebe ✦	*Nationwide*	+0.729
5	Jon Schoenecker	*Vanderbilt*	+0.704
6	Ben Shore	*BCH*	+0.694
7	Salil Upasani	*Rady SD*	+0.687
8	Craig Louer	*Vanderbilt*	+0.667
9	Ishaan Swarup	*UCSF*	+0.652
10	Matt Stepanovich	*U Michigan*	+0.644
11	Zachary Meyer	*WashU / SLCH*	+0.619
12	Ying Li	*U Michigan*	+0.591
13	Anonymous	*Vanderbilt*	+0.561
14	Anna Rambo	*Nemours-Jax*	+0.554
15	Arianna Trionfo	*Nemours*	+0.537
16	Anthony Riccio	*TSRH*	+0.514
17	Collin May *	*BCH*	+0.509
18	Nate Lempert	*Vanderbilt*	+0.501
19	Wendy Ramalingam *	*Cincinnati*	+0.458
20	Todd Blumberg	*Seattle*	+0.405
21	Jaime Denning ✦	*Cincinnati*	+0.395
22	Julia Sanders	*Children's Colorado*	+0.379
23	Emmalynn Sigrist	*U Minnesota*	+0.334
24	Ben Heyworth ✦	*BCH*	+0.301
25	Dell McLaughlin	*Emory / CHOA*	+0.207

** partial response (May 40 / Ramalingam 95 of 105)*   *✦ cross-method-flagged voice (2025 ballot)*

15×15 Pairwise agreement matrix

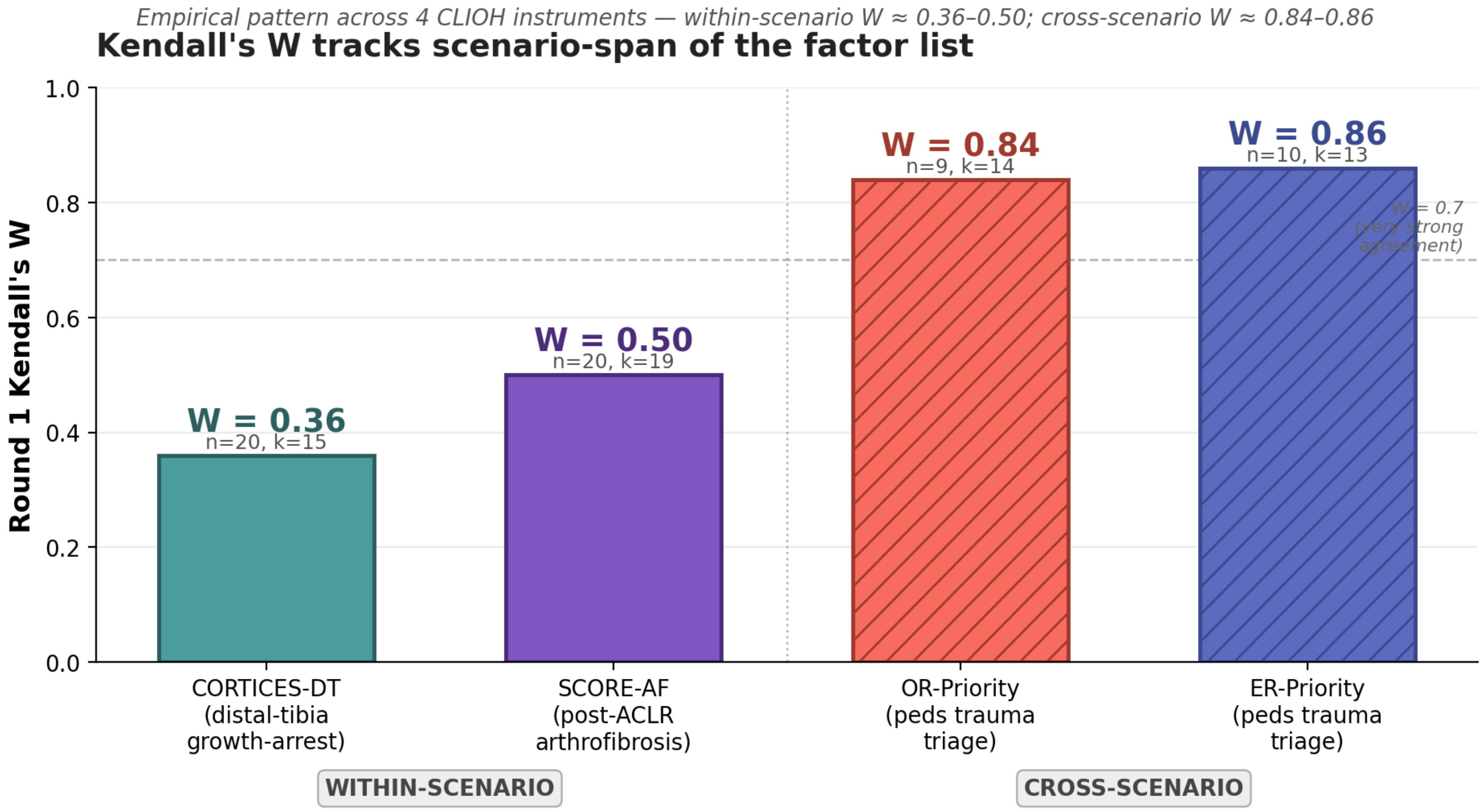


Disagreement clusters: D1/D2/D3 columns + P1/P2/S1 equipoise band

Cross-method archetypes: Beebe ✦ reversal · Heyworth ✦ persistent tail · Denning ✦ stable divergence · McLaughlin pure-pairwise (R2 ATRD primary)

Kendall's W tracks scenario-span

Empirical pattern across the 4 CLIOH instruments — within-scenario vs cross-scenario

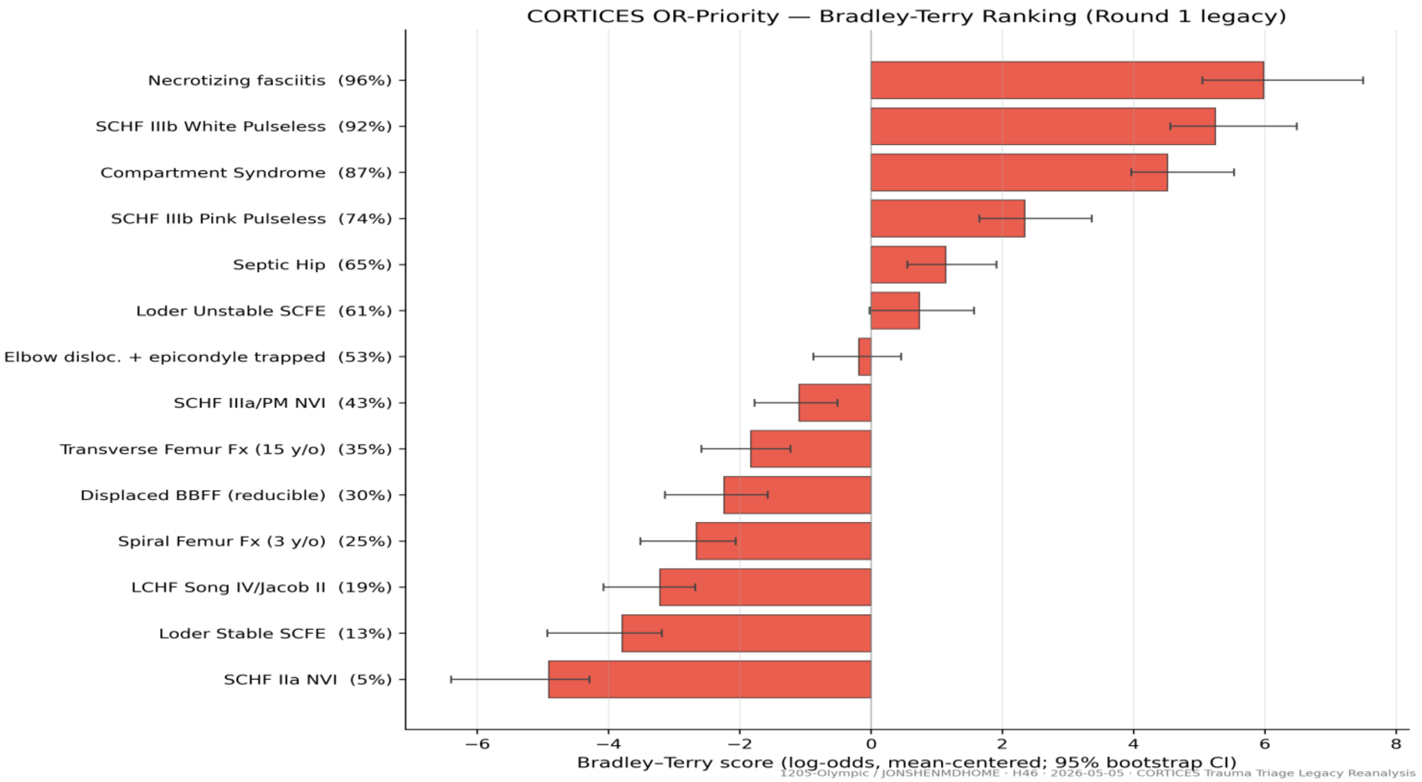


Within-scenario instruments force finer discrimination → mathematically lower W. The DT panel is doing the harder work.

OR-Priority — Legacy Bradley-Terry Ranking

n = 9 raters · 747 pairs · 2024 cohort

Necrotizing fasciitis tops OR (96% wins, BT +5.98 [+5.05, +7.50]) · SCHF (IIa) NVI dead last (5%, BT −4.91)

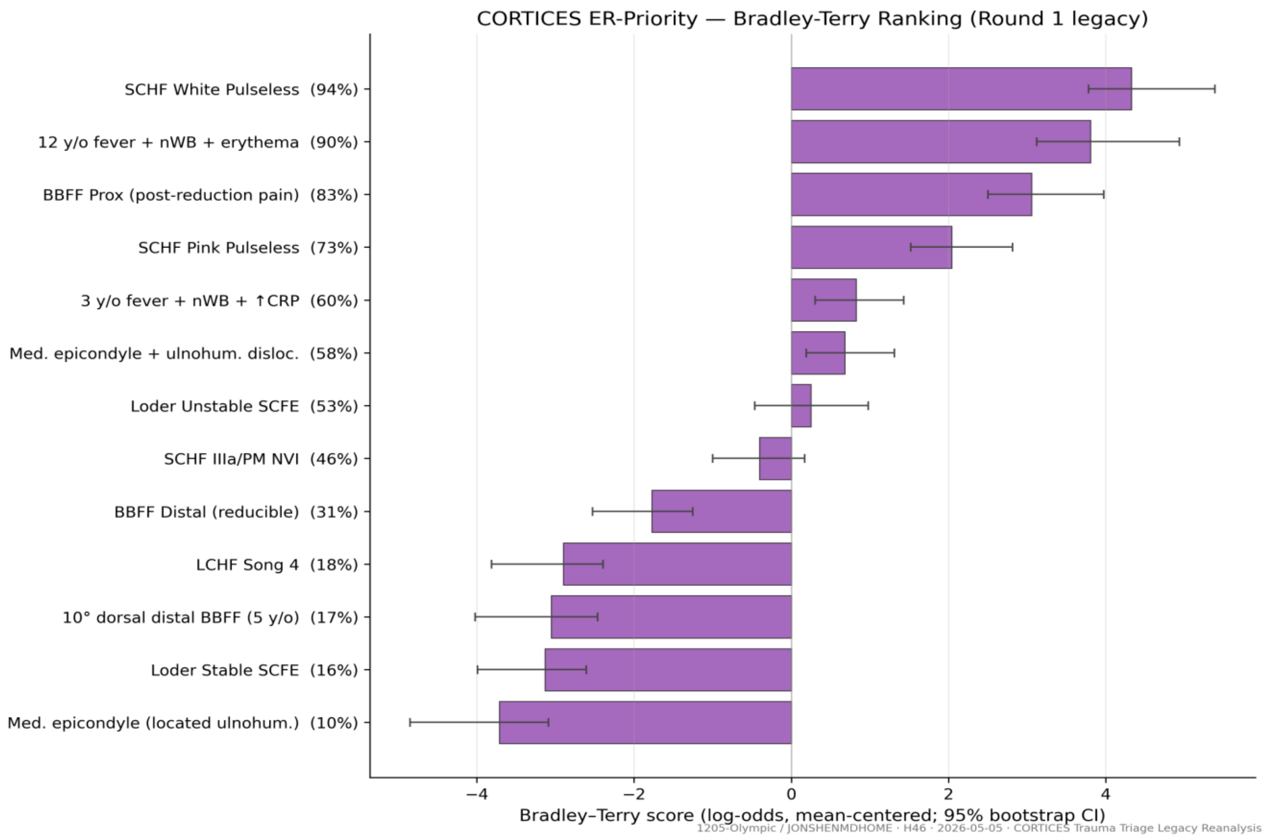


Legacy CORTICES Trauma Triage 2024 · OR-Priority R1 n=9 / 747 pairs · Verbatim factor labels per _VARIABLE_LIST_OR_PRIORITY.md

ER-Priority — Legacy Bradley-Terry Ranking

n = 10 raters · 780 pairs · 2024 cohort

White-Pulseless SCHF tops ER (94%, BT +4.33) · necrotizing-fasciitis-equivalent #2 · Loder Stable SCFE + medial-epicondyle scenario at bottom



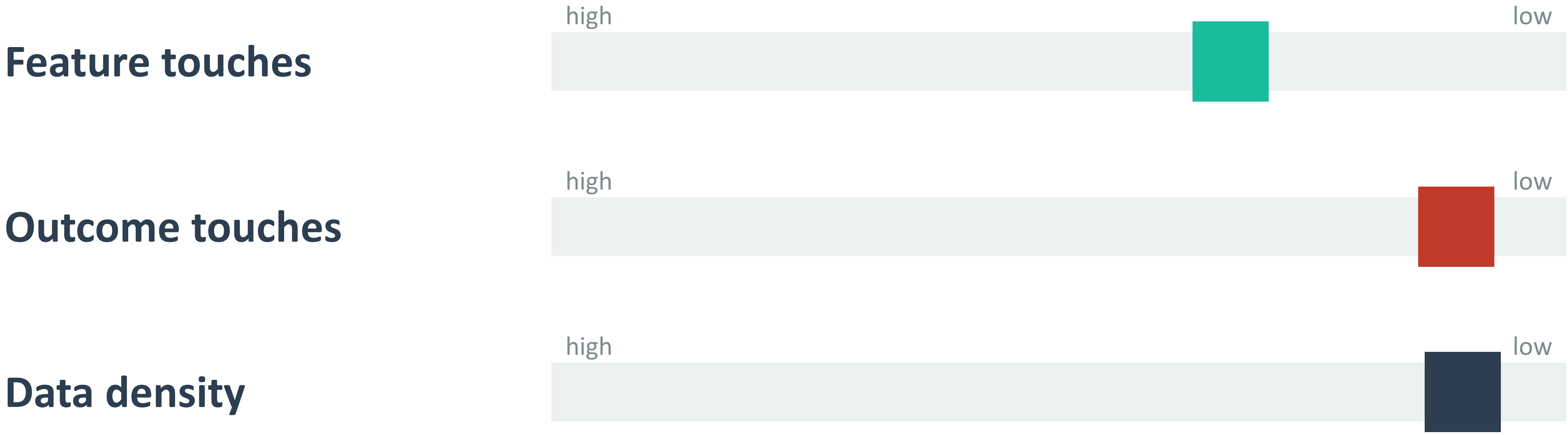
ER Factor 11 carries verbatim source-text "located ulnohumeral fracture" — H39 OQ-D typographic clarification (likely "locked" or "loose") still pending. Ranking unaffected.

Legacy CORTICES Trauma Triage 2024 · ER-Priority R1 n=10 / 780 pairs · Verbatim factor labels per _VARIABLE_LIST_ER_PRIORITY.md (n=13)

Distal Tibial Bar

Working framework · Three axes · Four instruments mapped

Three axes — emerging working hypothesis



What to See First ER

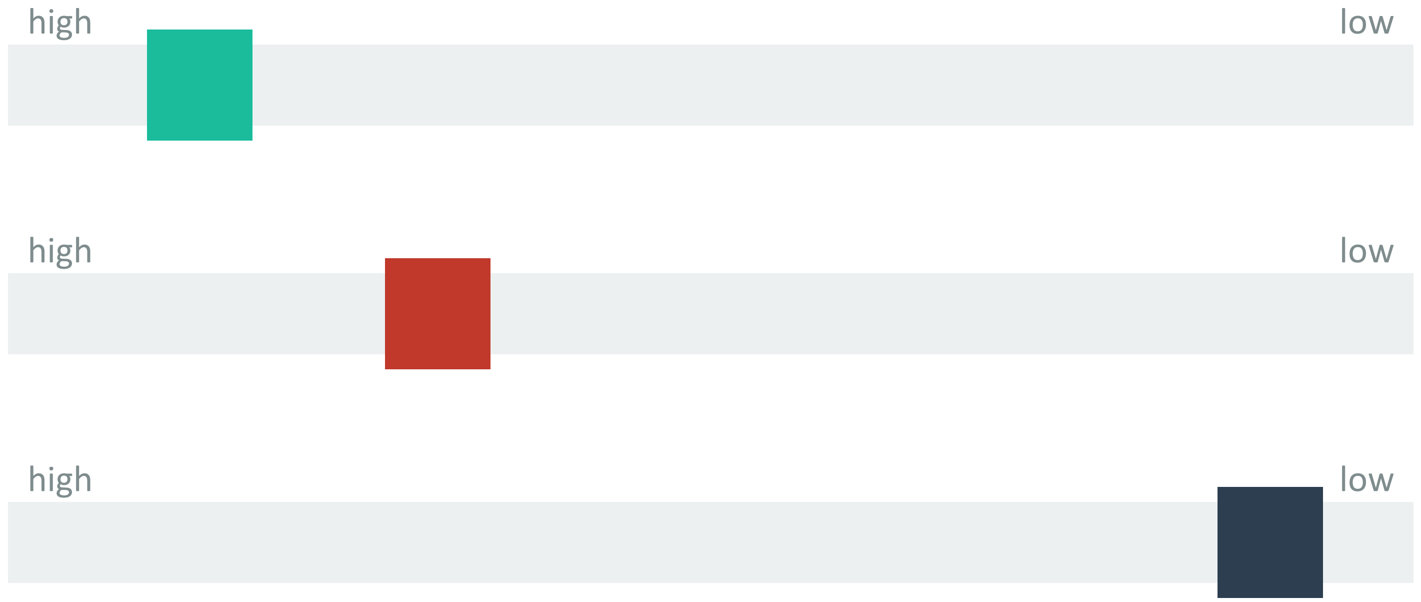
Working framework · Three axes · Four instruments mapped

Three axes — emerging working hypothesis

Feature touches

Outcome touches

Data density



What to Take to the OR First

Working framework · Three axes · Four instruments mapped

Three axes — emerging working hypothesis

Feature touches

Outcome touches

Data density

CLIOH

CLINICAL INTUITION ORDINAL HIERARCHY

BREAK (~5 MINUTES)

Napkin Ideas (~10 Minutes)

Presenter(s): Open Floor

Additional Discussions (~10 Minutes)

Presenter(s): Open Floor

Merch Surprise

Presenter(s): Benjamin Shore

Closing Remarks & Annual Meeting 2026 Preview

Presenter(s): Benjamin Shore, David Spence, Benjamin Sheffer

CORTICES 2026: Memphis Awaits!

September 18-19

David Spence

Chief of Orthopedic Surgery, Le Bonheur Children's Hospital

Division Directer, Pediatrics, Campbell Clinic

Ben Sheffer

Director of Orthopedic Trauma, Le Bonheur Children's Hospital

Campbell Clinic

Key Highlights

Memphis: Where History Meets the Future

- A Legacy of Culture: Immerse yourselves in the birthplace of blues and rock 'n' roll.
- Cutting-Edge Research: Discover the advancements happening at Campbell Clinic, Le Bonheur Children's Hospital, St. Jude Children’s Research Hospital, and Univ. of Memphis, and University of Tennessee Health Science Center
- Unmatched Energy: Feel the pulse of a city constantly reinventing itself.

Memphis offers a unique blend of rich cultural heritage and forward-thinking innovation.

Key Strengths

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  Savor incredible local cuisine and Southern flavors.

- **Iconic Excursions**

  Explore legendary sites like Graceland and the National Civil Rights Museum.

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  Experience the soulful sounds of Beale Street.

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Just down I-40 from Jon Schoenecker!

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Children's Hospital Colorado

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UCSF Benioff

SCOTTISH RITE FOR CHILDREN
children's MEDICAL CENTER

Ann & Robert H. Lurie Children's Hospital of Chicago

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C.S. MOTT CHILDREN'S HOSPITAL
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NATIONWIDE CHILDREN'S
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BJC HealthCare

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