

Abstract | Abdominal/Laparoscopy

Beyond Ordinal Grades: A Continuous Image-based Adhesion Burden Index

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Introductions: Postsurgical adhesions develop after abdominal operations and are a leading cause of small bowel obstruction, yet no effective prophylaxis exists. Therapeutic development depends on reliable preclinical models, but adhesion burden is scored with clinical ordinal scales that have high inter-observer variability and compress a biological continuum obscuring treatment effects. We hypothesized that adhesion burden is inherently continuous and an area-based index would resolve quantitative differences hidden within grades.

Methods: Specimens from a murine abdominal adhesion model were photographed (93 specimens, 277 images, 1-9 images per specimen). Three blinded observers assigned each specimen a consensus score 0-5. Another blinded observer traced four regions per image: 1. Surgical field, 2. Direct adhesions, 3. Tethering zones (viscera tented, fused, or displaced towards the wall), and 4. Abdominal wall interface. Masks were processed in Python to compute 2 area fractions, a visible (C_v) and tethering (C_t) contribution. The Adhesion Burden Index (ABI) is the area-based sum of C_v and C_t scaled 0-100. Computation was deterministic; region tracing was the only source of variability.

Results: ABI increased across lower clinical grades and was associated with clinical score (Spearman $\rho=0.52$, $p<0.001$; Figure). Within clinical grades, images spanned a continuous range of ABI that widened at higher grades. ABI did not separate Grades 4 and 5.

Conclusion: A deterministic index from intraoperative photographs recovered a continuous gradient of adhesion burden, offering a more sensitive endpoint. Requiring only standard photographs and deterministic computation, the approach can be readily shared and extended to other pathologies scored by visual appearance.

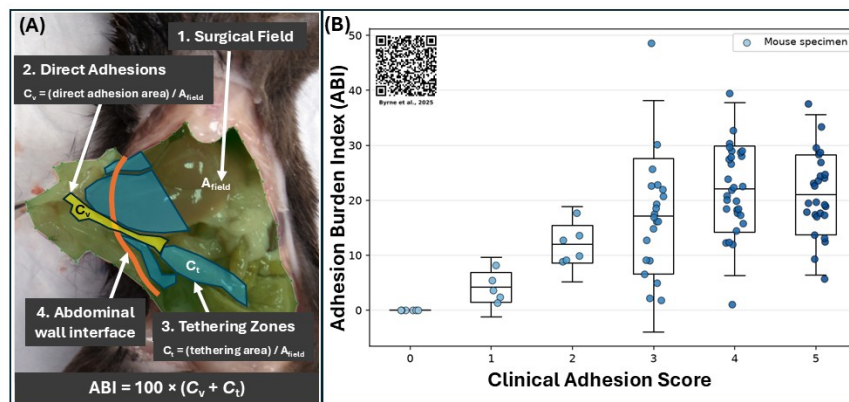


Figure. Image-based quantification of intra-abdominal adhesions and association with clinical severity.
(A) Annotation scheme on a representative intraoperative image. The exposed surgical field (A_{field} , green) normalizes two compartments: direct adhesions (yellow), $C_v = \text{direct adhesion area} / A_{\text{field}}$, and tethering zones (blue), $C_t = \text{tethering area} / A_{\text{field}}$. Orange trace, abdominal wall interface. $ABI = 100 \times (C_v + C_t)$ gives one area-normalized burden score per animal. (B) average ABI versus clinical adhesion score (0–5) [Byrne et al., 2025], one point per mouse ($n = 93$). Boxes represent mean and 1 SD; whiskers 2 SD. ABI rose with score (Spearman $\rho = 0.52$, $p < 0.001$).

Abstract | Pediatric Surgery

CoQ10 Depletion Contributes to Oxidative Stress in Necrotizing Enterocolitis Despite Preserved NAD and FAD Levels in Enteroids

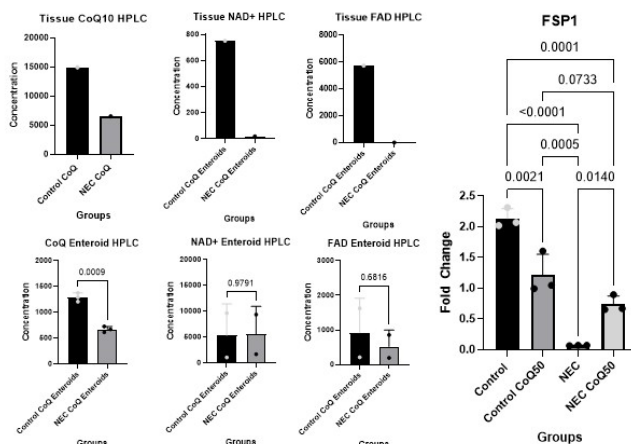
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Introductions: Necrotizing enterocolitis (NEC) is an intestinal disease of infants characterized by mitochondrial dysfunction and oxidative stress. Coenzyme Q10 (CoQ10) is a component of the mitochondrial electron transport chain and antioxidant. The FSP1-CoQ10 pathway maintains redox homeostasis by reducing CoQ10 to ubiquinol, suppressing lipid peroxidation and ferroptosis. Disruption of this pathway may contribute to disease pathogenesis. We investigated the metabolic profiles of human NEC tissue and a NEC intestinal enteroid model and evaluated the effect of CoQ10 supplementation on oxidative stress.

Methods: NEC and non-NEC tissues were analyzed for CoQ10, nicotinamide adenine dinucleotide (NAD), and flavin adenine dinucleotide (FAD). Enteroids were exposed to lipopolysaccharide and hypoxia to induce experimental NEC. CoQ10 was supplemented before and after injury. Metabolic cofactors were quantified, and reactive oxygen species (ROS) were assessed using fluorescent assays. FSP1 expression was assessed by PCR.

Results: NEC tissue demonstrated depletion of CoQ10, NAD, and FAD compared with control ($P < 0.05$). In contrast, NEC enteroids exhibited CoQ10 depletion ($P = 0.0009$) without changes in NAD or FAD. FSP1 expression was decreased in NEC tissue ($P = 0.026$), but increased following CoQ10 supplementation in NEC enteroids ($P = 0.014$) when compared to controls.

Conclusion: CoQ10 is depleted in both NEC tissue and experimental NEC enteroids, suggesting impaired mitochondrial antioxidant defenses contribute to disease pathogenesis. CoQ10 supplementation attenuates oxidative stress by increasing FSP1 expression when compared to control. These findings suggest that restoration of CoQ10-dependent antioxidant pathways may represent an approach to reducing oxidative damage in NEC.



Abstract | Pediatric Surgery

Upregulated NADPH Oxidase Activity as a Driver of Oxidative Stress in Necrotizing Enterocolitis

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Introductions: Necrotizing enterocolitis (NEC) is an acute inflammatory bacterial necrosis of the intestinal tract that predominantly affects premature infants. Its hallmark features include impaired intestinal barrier function, a hyperinflammatory response, epithelial injury, and oxidative stress. The oxidative burden in NEC is thought to be driven by NADPH oxidases (NOX), a family of enzymes activated by pro-inflammatory stimuli to produce reactive oxygen species (ROS). Although the pathophysiology of NEC remains incompletely understood, ROS may sustain the hyperinflammatory state and drive disease progression. Using human NEC tissue and human intestinal enteroids subjected to NEC-like injury, we investigated NOX expression and ROS production.

Methods: Intestinal tissue from premature infants who underwent surgical resection for NEC was compared with non-NEC control tissue. Expression of NOX isoforms (NOX1, NOX2, and NOX4) was quantified using real-time quantitative PCR (RT-qPCR). To model NEC in vitro, human intestinal enteroids were subjected to an established induction protocol consisting of lipopolysaccharide (LPS) exposure and hypoxia. NOX isoform expression in enteroids was similarly assessed by RT-qPCR, and intracellular superoxide generation was measured using a fluorescence-based ROS detection assay.

Results: Compared with non-NEC controls, NEC tissue showed significant upregulation of all three NOX isoforms: NOX1 ($p<0.0001$), NOX2 ($p=0.0148$), and NOX4 ($p=0.0011$), which is consistent with NADPH oxidase-driven oxidative stress in the NEC disease state. Enteroids subjected to LPS and hypoxia demonstrated significantly elevated intracellular superoxide levels ($p=0.0092$) on assay, confirming oxidative stress induction. However, equivalent upregulation of NOX1, NOX2, or NOX4 on RT-qPCR was not detected. This discrepancy suggests that while intestinal epithelial cells are independently capable of generating a significant oxidative response under NEC-like conditions, the epithelial-only enteroid system does not reproduce the full NOX gene expression profile seen in human NEC tissue. The absence of immune, stromal, and endothelial cell populations within enteroid cultures likely accounts for this discrepancy, particularly for NOX2, which is predominantly expressed by infiltrating phagocytes.

Conclusion: Significant upregulation of NOX1, NOX2, and NOX4 in human NEC tissue identifies NADPH oxidases as contributors to oxidative injury and intestinal inflammation in NEC. Human intestinal enteroids subjected to NEC-like injury reproduce epithelial-derived oxidative stress, as shown by elevated superoxide production. However, the enteroid model does not reproduce the NOX transcriptional changes seen in human NEC tissue, emphasizing a limitation of epithelial-only organoid systems. These results suggest that NOX upregulation in NEC depends on multicellular inflammatory signaling that current enteroid models lack. Future studies incorporating immune-competent enteroids or co-culture systems are warranted to better define NEC pathogenesis and explore NOX-related therapeutic interventions.

Abstract | Trauma/Burn/Critical Care

EARLIER THAN YOU THINK: SAFETY OF ULTRA-EARLY WEIGHT-BASED ENOXAPARIN IN BLUNT SOLID ORGAN INJURY

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Introductions: Venous thromboembolism prophylaxis(VTEp) in blunt solid organ injury(BSOI) patients requires precision to avoid bleeding complications, with previous studies emphasizing the safety of initiation at 48-72h post-injury. Our study evaluates the safety of ultra-early(<24h) initiation of a weight-based enoxaparin scheme in patients with BSOI.

Methods: Our institutional trauma registry was queried for patients with BSOI from July 2023 to December 2024 who received at least 48hrs of enoxaparin VTEp. All patients were initiated on 0.5mg/kg enoxaparin dosing on a twice-daily schedule, with anti-Xa levels monitored for dosing adjustment. Patients were stratified by timing of VTEp initiation, organ injury grade and initial Xa level.

Results: 147 patients were included, of which 68(46.3%) received ultra-early VTEp. No significant differences in age, injured organ, or Injury Severity Score (ISS) were seen between the ultra-early and >24h cohorts. Patients receiving ultra-early VTEp had no significant increase in post-prophylaxis blood transfusion needs, or unplanned intervention for bleeding. No significant difference in rate of high-grade injuries existed between the ultra-early and >24h cohorts (63.2%vs.70.9%, $p=0.324$). Overall, 5 patients(3.40%) required an unplanned procedure for bleeding after VTEp initiation due to progression of their BSOI. Though 4 patients were initially managed using angiographic examination and embolization, all 5 ultimately required operative intervention. Xa level was not associated with significant differences in VTE, need for transfusion or unplanned intervention for bleeding.

Conclusion: In patients with BSOI, initiation of weight-based enoxaparin within 24 hours of admission appears safe. Despite this ultra-early initiation, no significant increase in blood requirements or procedural intervention for bleeding was observed.

Abstract | Trauma/Burn/Critical Care

The Efficacy and Surgical Technique of Self-Drilling Bone Anchor Augmentation for Abdominal Flank Hernias in Trauma Patients

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Introductions: Traumatic abdominal flank hernias (TAFH) are rare injuries characterized by lateral abdominal wall avulsion from the iliac crest and loss of reliable fascial fixation points. Conventional mesh fixation can be challenging in this setting and may predispose to repair failure. This study describes a bone anchor mesh fixation technique and reports short-term outcomes following repair of TAFH.

Methods: We performed a retrospective case series of five patients with TAFH treated at a single Level I trauma center between 2022 and 2025. Demographics, injury characteristics, operative details, and short-term outcomes were reviewed. All patients underwent open repair utilizing self-drilling orthopedic bone anchors for mesh fixation to the ilium beneath the mesh fixation column.

Results: All five patients sustained high-energy blunt trauma resulting in complete or near-complete avulsion of the lateral abdominal wall from the iliac crest. Bone anchors were placed approximately 1 cm apart along the iliac crest or iliac fossa to secure biologic or synthetic mesh in an underlay configuration. No intraoperative complications occurred. One patient developed a postoperative intra-abdominal abscess related to contamination, managed successfully with drainage and antibiotics. No wound dehiscence or early hernia recurrence occurred during available follow-up. Median hospital length of stay was 9 days (range, 3–14 days).

Conclusion: Bone anchor mesh fixation provides a feasible approach for TAFH repair when conventional fascial fixation is not possible. This technique leverages rigid osseous fixation points to achieve stable mesh placement in anatomically challenging defects. Larger studies with longer follow-up are needed to evaluate durability and recurrence outcomes.

Table 1. Patient characteristics, operative details, and outcomes

Age/Sex	Injury context	Hernia location / defect	Mesh / fixation	Outcome / complication
26-year-old female	Multiple injuries in a motor vehicle collision	Left TAFH with a 6.5 x 8 cm defect and colon herniation	Biologic mesh (16 x 20 cm) secured to the ilium with bone anchors and transabdominal sutures in an underlay fashion	Recovered without complication
43-year-old female	Polytrauma, including cerebrovascular injury and orthopedic fractures	Right TAFH with complete avulsion of the internal oblique and transversus abdominis; 10 x 5 cm defect	Vicryl mesh secured to the ilium using three Arthrex bone anchors	Recovered without complication
45-year-old male	Rib fractures and pneumothorax	Left TAFH measuring 10 x 5 cm with shredded musculature	Prolene mesh secured using three ilium bone anchors in an underlay fashion	Readmitted on day 6 for intra-abdominal abscess requiring percutaneous drainage
40-year-old male	Polytrauma; repair after bowel resection	Left TAFH with external oblique, internal oblique, and transversus abdominis avulsed from the iliac crest	Parietex mesh secured to the ilium using bone anchors	Recovered without complication
48-year-old male	Presented with left posterolateral TAFH	Left posterolateral TAFH measuring 15 x 6 cm containing colon and mesentery; abdominal wall completely detached from iliac crest	Prolene mesh anchored inferiorly to the ilium with bone anchors and superiorly to fascia	Recovered without complication

Abstract | Trauma/Burn/Critical Care

Center-Type Variation in Pediatric Blunt Renal Trauma Management

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Introductions: Organ preservation is the cornerstone of pediatric blunt renal injury management; however, treatment is highly variable across institutions. Children with blunt renal trauma may be managed at adult or combined centers despite their distinct pediatric physiology. We aim to evaluate the management of pediatric blunt renal trauma across center types.

Methods: We conducted a retrospective review of the National Trauma Data Bank from 2017-2023 of patients less than 18 years old with blunt renal injuries. Cohorts were defined by center type and renal Organ Injury Scale (OIS) (I-III vs IV-V). Injury Severity Score (ISS), initial shock index (SI), procedural renal intervention, concomitant solid organ injuries, and mortality data were collected.

Results: We identified 9,842 pediatric patients with blunt renal injuries. Patients presenting to adult centers were older and more likely to undergo renal intervention or blood product transfusion despite having the lowest mean SI (all $p < 0.01$). Patients with low-grade injuries were more likely to undergo any renal intervention at adult centers ($p < 0.01$). On multivariable analysis, presentation to an adult or combined center was an independent predictor of renal intervention (OR 2.27, 95% CI 1.46-3.55, $p < 0.01$ and OR 1.79, 95% CI 1.17-2.73, $p < 0.01$). Age group and presence of concomitant solid organ injury were not independently associated with renal intervention.

Conclusion: Adult and combined centers demonstrated higher rates of renal intervention compared to pediatric centers despite lower injury grades, supporting the influence of institutional practice patterns on the management of pediatric renal trauma.