Medical Student Research

Moderator: Scott H. Kurtzman, MD, FACS, Assistant Dean for Graduate Medical Education & Designated Institutional Official, Frank H. Netter MD School of Medicine at Quinnipiac University

Judge: Kathleen LaVorgna, MD, FACS, Chair of Surgery, Nuvance Health - Norwalk Hospital

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Optimizing Surgical Ergonomics and Assessing Surgeon Musculoskeletal Pain: A Quality Improvement Study with the Da Vinci Surgical System

Nora Singh, BA, John G. Angeles, BS, MA, Leland J. Soto, MD.
Griffin Hospital, Derby CT; Frank H. Netter M.D. School of Medicine at Quinnipiac University.

Introduction: The widespread adoption of the da Vinci Surgical System for minimally invasive surgeries has transformed surgical practice. However, its seated position poses ergonomic challenges not encountered previously during traditional open or laparoscopic surgery. This study aims to explore the extent of musculoskeletal (MSK) issues related to robotic surgery, identify specific ergonomic shortcomings of the da Vinci XI system's process to optimize position at the console, and evaluate whether ergonomic interventions can mitigate these problems. We hypothesize that implementing ergonomic guidelines can significantly reduce MSK pain and discomfort among surgeons.

Methods: A multi-phase study was designed and has begun with a preliminary survey adapted from an existing survey instrument reported by Patel et al. (2023) in the Journal of Robotic Surgery. This survey was distributed to surgeons utilizing the da Vinci XI system across various surgical specialties including general, bariatric, colorectal, and thoracic surgery. The preliminary survey collects qualitative data on surgeons' experiences with MSK pain and discomfort, focusing on specific ergonomic challenges encountered while using the da Vinci Surgical System. This data is crucial for identifying the most problematic aspects of surgeon MSK pain, which will guide targeted ergonomic interventions to improve surgeon comfort and reduce the risk of long-term MSK issues.

Results: Preliminary survey data was collected from 7 surgeons, aged 35 to 65 years, with BMIs between 27 to 30, and 1 to 20 years of robotic surgery experience. All surgeons that took the survey reported experiencing some level of MSK pain after surgery. The most frequently reported MSK issues among these surgeons included discomfort in the shoulders (71.4%), cervical spine (57.1%), and lumbar spine (57.1%). They identified ergonomics of the robot (85.7%), prolonged procedure durations (57.1%), and the volume of cases (28.5%) as primary contributors to their discomfort. Many noted that the ergonomic challenges of the robotic interface exacerbated their symptoms, with MSK pain lasting on average 2 to 3 hours post-surgery. These findings underscore the need for targeted ergonomic interventions to improve surgeon comfort and reduce MSK pain.

Conclusions: To address the pressing issue of MSK pain and discomfort among robotic surgeons, a controlled experimental design was developed and is underway. This study will address the ergonomic challenges identified in the preliminary survey by performing an ergonomic assessment of surgeons' positions at the console during robotic surgeries. We will implement targeted ergonomic interventions, including adjustments to console and chair positioning, to optimize surgeon posture and reduce MSK discomfort. Surgeons' discomfort levels will be evaluated before and after the interventions to determine the effectiveness of these adjustments in mitigating the identified ergonomic issues. This approach aims to enhance surgeon comfort and reduce the risk of long-term MSK problems associated with the da Vinci XI system.

Diagnostic and Therapeutic Challenges of the Adductor-Dominant Sports Hernia

Ekrem Ayhan BS, Nicholas Wells BS, John Bonadies MD, FACS
Frank H. Netter M.D. School of Medicine

Introduction: Sports hernias are a common condition that greatly impact the function and quality of life for both athletes and non-athletes. While common, the anatomy and pathophysiology of sports hernias are poorly understood, making effective diagnosis and treatment challenging. Standardized categorization into distinct types may optimize the definition and treatment. The goal of this work was to propose a novel categorization system for sports hernias to aid clinicians in identifying and treating patients at risk of poor outcomes.

Methods: Review of a prospective sports hernia registry from 2013-2024 was performed. Sports hernias were categorized into three types based on clinical presentation and MRI findings: adductor-dominant (AD), posterior wall deficient (PW), and combined adductor and posterior wall deficient (CAPW). Demographics and outcomes were analyzed in IBM SPSS 29 using multivariate logistic regression and compared across each type. The primary outcome measure was complete resolution of symptoms. Secondary outcome measures included time to diagnosis, rate of surgical treatment, and rate of positive MRI.

Results: 368 patients were included, with 327 (88.9%) males, a mean age of 43 ± 16, and mean BMI of 27.72 ± 5.53. 101 (27.4%) patients were athletes, defined as ≥2 days of weekly participation in organized sport. Non-athlete status, older age, and prior history of inguinal hernia were significantly associated with AD type ($P < 0.05$). AD type had the longest time to diagnosis and lowest odds of exhibiting positive sports hernia findings on MRI compared to PW type (OR: 0.536, 95% CI [0.290, 0.991], $P = 0.047$). AD type had the highest rate of unresolved symptoms after treatment (67.1%). Across all types, surgical treatment, specifically robotic or laparoscopic mesh reinforcement of the inguinal floor, had significantly greater odds of achieving complete resolution compared to nonoperative treatment (OR: 6.792, 95% CI [3.825, 12.059], $P < 0.001$). Patients with AD type had significantly lower odds of undergoing surgery compared to PW type (OR: 0.189, 95% CI [0.099, 0.362], $P < 0.001$).

Conclusions: These findings highlight the potential value of the standardized categorization of sports hernias based on clinical presentation and MRI findings. Surgical treatment with mesh reinforcement of the inguinal floor should be considered the gold-standard treatment for all sports hernia injuries. Of the proposed types, AD is associated with delayed diagnosis, lowest rate of surgical treatment, and ongoing symptoms even after surgery. The low rate of surgery for the AD type suggests a gap in current treatment approaches. The proposed categorization system can help guide shared decision making and identify patients at risk of poor outcomes.

Table 1. Patient Characteristics by Sports Hernia Type

	Posterior Wall Deficient (n = 138)	Adductor Dominant (n = 82)	Combined (n = 148)
Male (n)	120 (87%)	73 (89%)	129 (87.2%)
Age (years)	42 ± 15	50 ± 16	40 ± 15
Athlete (n)	49 (35.5%)	13 (16%)	38 (25.7%)
Time to Diagnosis (months)	12.0 ± 22.0	18.3 ± 31.4	12.2 ± 15.8
Surgical Treatment (n)	91 (66.4%)	22 (28.2%)	102 (69.9%)
Full Resolution (n)	73 (52.9%)	27 (32.9%)	68 (45.9%)

Evaluating Two Decades of Traumatic Amputations Treated in US Emergency Departments: A Multicenter Epidemiological Analysis from NEISS 2003-2022

Sam Boroumand BS, Ismail Ajjawi BS, Nancy Park BS, Viola Stögner MD, Lioba Huelsboemer MD, Karen Bach MD, Martin Kauke-Navarro MD, Siba Haykal MD, PhD, Bohdan Pomahac MD, David Colen MD

Introduction: Traumatic amputations pose a considerable source of morbidity as a significant cause of limb loss in the United States. The purpose of this study is to provide new insights and understanding into the epidemiology of traumatic amputations in the U.S. by analyzing the largest national multicenter sample of pediatric, adult, and geriatric patients to date.

Method(s): The National Electronic Injury and Surveillance System (NEISS) database was queried from 2003 to 2022 to extract patients with an "Amputation" diagnosis. Patients were subsequently divided into three comparison age groups of pediatric (0-17), adult (18-64), and geriatric (65+). Variables including race, sex, affected body part, commercial products involved in amputation, incident location, and ED treatment disposition were assessed between the three patient populations utilizing two-proportion z-tests with Bonferroni correction.

Results: In total 14,734 patients with traumatic amputations were identified with 5,011 patients classified as pediatric, 7,741 patients classified as adult, and 1,982 classified as geriatric. Adults had a significantly greater frequency of upper extremity amputations than pediatric patients especially of the finger (93.1% vs 91.2%; $p<0.001$), with geriatric patients incurring an even higher frequency than adults (94.9% vs 93.1%; $p=0.003$). Relative to adults, pediatric patients had the highest frequency of lower extremity injuries especially involving the toe (7.9% vs 5.2%, $p<0.001$). The most common cause of amputation in pediatric patients relative to adults were doors (48.5% vs 7.2%, $p<0.001$), while in adults and geriatric patients it was bench/table saws with geriatric patients incurring a significantly higher frequency (33.9% vs 19.6%, $p<0.001$). Pediatric patients were more likely to be treated and released from the ED relative to adults (79.4% vs 71.5%, $p<0.001$) while geriatric patients were more likely to be admitted/hospitalized (23.6% vs 21.1%, $p<0.01$). Across all age groups, the majority of traumatic amputations occurred at home and males incurred a significantly greater frequency of amputations (>63%, $p<0.001$) relative to females.

Conclusions: This study provides a critical overview of the incidence, outcomes, and mechanisms surrounding traumatic amputations in the US, especially providing valuable insight of these trends in the more vulnerable pediatric and geriatric patient demographics. Ultimately, these findings can be leveraged to not only inform targeted preventative measures for traumatic amputations but also provide surgeons invaluable qualitative context for the most frequent types/mechanisms of amputations they will be treating.

Blunt Traumatic Hemobilia, Hemorrhagic Shock and Considerations for the Trauma Surgeon: A Case Report

Ivy Huynh, BS, Patra Childress MD, Lindsey Wilburn MD, Krishan Patel MD, Michael Nicoara DO, Heath Walden MD, Simon Eiref MD, Patrick Zimmerman DO

Introduction: Hemobilia is a rare but significant cause of upper gastrointestinal bleeding, typically resulting from iatrogenic or penetrating trauma. Although cirrhosis, due to coagulopathy and portal hypertension, increases the risk, hemobilia following blunt trauma is uncommon and often overlooked in initial differential diagnoses. In cirrhotic patients, more common bleeding sources like variceal hemorrhage can complicate the diagnostic process, making hemobilia challenging to identify and manage. This case explores the diagnostic and management complexities in such a scenario and discusses the role of conservative management in a high-risk patient.

Case Presentation: A 45-year-old male with a history of alcohol abuse and decompensated cirrhosis presented following a 16-foot fall from a ladder. He sustained multiple facial fractures and bilateral distal radial fractures. Upon admission, he developed hemorrhagic shock, as evidenced by hypotension, tachycardia, hematochezia, and hematemesis, raising concern for gastrointestinal (GI) or visceral bleeding. Massive transfusion protocol (MTP) was implemented, with hemodynamic improvement achieved through ongoing transfusion and resuscitation. Eventual CT angiography revealed active arterial extravasation into the gallbladder lumen, indicative of hemobilia (Figure 1). Further evaluation via esophagogastroduodenoscopy (EGD) identified grade 1 esophageal varices in the middle and lower third of the esophagus without stigmata of recent or active hemorrhage and portal hypertensive gastropathy without active bleeding. Repeat CT angiography revealed persistence of the initial findings without new or worsening hemorrhage. With hemodynamic stabilization and the absence of ongoing hemorrhage, conservative management was continued with close monitoring and supportive, nonoperative, care.

Figure 1: CT angiogram showing active arterial extravasation into the gallbladder lumen, consistent with hemobilia.

Over several days, his condition gradually improved with resuscitative transfusion and nonoperative management. Interventional Radiology (IR) cystic artery angioembolization was considered, but deferred due to the risk of precipitating cholecystitis, which could have necessitated operative intervention. Daily laboratory results showed steady improvement in hemoglobin levels and coagulation status, confirming successful hemostasis. He remained stable without recurrent GI bleeding or liver failure. On hospital day 11, he underwent successful orthopedic surgery for bilateral distal radial fractures and was discharged in stable condition on day 12.

Discussion: In trauma patients with cirrhosis, maintaining a broad differential diagnosis is essential, as uncommon conditions like hemobilia can easily be overlooked. The spontaneous resolution observed in this case challenges the reliance on invasive interventions, suggesting that nonoperative management may be an effective option in carefully selected cases, particularly in patients with significant comorbidities where surgical risks are heightened.

Conclusion: This case highlights the importance of considering hemobilia as an uncommon, but possible source of visceral hemorrhagic shock in a cirrhotic trauma patient. The successful nonoperative management underscores the value of balanced resuscitation, normalization of coagulopathy, and supportive care as a primary resuscitative strategy. This approach minimized the need for invasive interventions, demonstrating the potential for nonoperative management in similar high-risk scenarios.

Successful Treatment of a Biliary Stricture After Liver Transplantation Using the Rendezvous Technique.

Nora Singh, BA, Vaibhav Mehendiratta, MD, Elizabeth Richardson, MD, Daniel Collins, MD, Oscar K. Serrano, MD, MBA. Hartford Hospital Transplant Program, Hartford Hospital, Hartford, CT; University of Connecticut School of Medicine.

Introduction: Biliary strictures (BS) are a common complication following liver transplantation (LT), often requiring intervention to restore bile flow and prevent liver injury. The management of BS following LT has traditionally involved surgical interventions like a Roux-en-Y hepaticojejunostomy (RYHJ). However, recent advances in endoscopic techniques provide a less-invasive alternative with promising outcomes. These developments suggest a shift toward more refined, endoscopic approaches that could improve patient recovery and reduce the need for invasive procedures.

Methods and Results: This case report describes a 27-year-old female who had a LT for acetaminophen overdose. Her LT went well, and she recovered uneventfully. She presented 6 months post-transplant with jaundice, nausea, and vomiting. An endoscopic retrograde cholangiopancreatography (ERCP) revealed a severe BS that could not be traversed. Initial attempts to manage the stricture, including a biliary sphincterotomy, were unsuccessful and complicated by bile duct injury and leak, bleeding, post-ERCP pancreatitis, and cholangitis. Subsequent management included percutaneous transhepatic cholangiography (PTC) with stent placement, which was also unsuccessful in resolving the obstruction. Over the following months, the patient underwent multiple ERCPs and PTCs, all failing to traverse the stricture. Finally, a rendezvous procedure was performed (Figure 1), employing a combination of endoscopic and percutaneous techniques to access and traverse the BS. This dual approach allowed for precise navigation of the stricture and successful advancement of the guidewire and placement of a stent. The patient experienced significant clinical improvement and has remained stable.

Conclusion: At one-year follow-up, the patient remains stricture-free, demonstrating that complex post-transplant biliary complications can be effectively managed with advanced endoscopic techniques. This case highlights the potential clinical value of endoscopic procedures in the treatment of significant surgical complications, particularly in young, otherwise healthy patients. The success of the rendezvous procedure in this case contributes to the growing body of evidence supporting endoscopic management as a viable and less invasive alternative to surgery that minimizes risk and recovery time in the treatment of post-liver transplant biliary strictures.

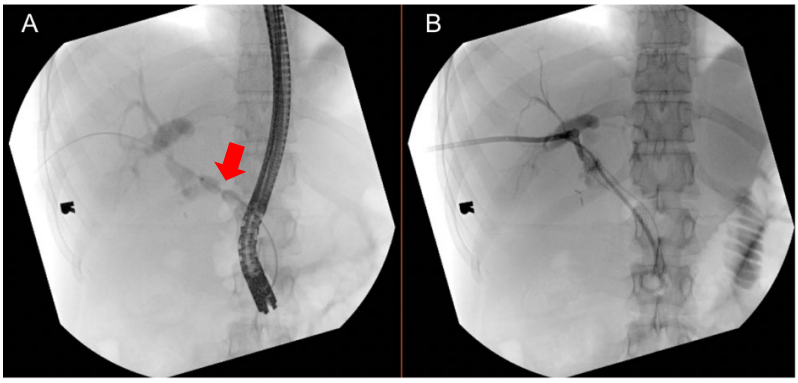

Figure 1A. Rendezvous procedure (arrow marks the stricture). B. Stent placed across biliary stricture.

Characterizing the Epidemiology of Traumatic Ear Injuries: A 20 Year Analysis of Emergency Department Visits in the US

Sam Boroumand BS, Beatrice Katsnelson BA, SeungJu Jackie Oh MD, Katelyn Lewis MD, Lioba Huelsboemer MD, Viola A. Stögner MD, Martin Kauke-Navarro MD, Siba Haykal MD, PhD, Bohdan Pomahac MD

Introduction: Given its unique anatomy, the ear is one of the most technically difficult areas to reconstruct following traumatic injury. Ultimately, the success of the reconstruction is dependent on the extent of the defect, mechanism of injury, as well as many other patient derived factors. Utilizing the largest national multicenter sample of geriatric, adult, and pediatric patients to date, this study seeks to provide a critical overview of the epidemiology of traumatic ear injuries.

Method(s): From the years 2003-2022, the National Electronic Injury and Surveillance System (NEISS) database was searched to identify patients with related traumatic injury diagnosis codes for the ear including lacerations, contusions, punctures, hematomas, burns, avulsions, and amputations. The patient population was separated into three age groups of geriatric (65+), adult (18-64), and pediatric (2-17). Variables including race, sex, incident location of traumatic ear injury, commercial products involved in traumatic ear injury, and emergency department disposition were compared between the three groups utilizing two-proportion z-tests with Bonferroni correction.

Results: 25,285 patients who sustained ear injuries were identified from the NEISS database. The top five types of ear injuries were laceration, contusion, puncture, hematoma, and burn. Geriatric patients experienced a significantly higher frequency of ear lacerations (82.5% vs 68.6%, $p<0.001$) relative to non-geriatric adults, while children had a significantly greater frequency of hematomas (3.7% vs 2.8%, $p=0.001$), and contusions (18.0% vs 16.0%, $p=0.006$). The top five products involved for ear injuries were tables, first aid equipment, bed/bedframe, jewelry, and chairs. Geriatric adults had a significantly higher frequency of ear injuries from bed frames relative to non-geriatric adults (20.0% vs 3.2%, $p<0.001$) and were over five times more likely to be admitted to the hospital from ear injuries.

Conclusions: This study provides new understandings and insights into the outcomes, trends, and mechanisms surrounding traumatic ear injuries in the U.S- with an additional granular focus on the more vulnerable geriatric and pediatric populations. Apart from providing plastic surgeons an informative context for the most frequent mechanisms/types of ear injuries they will be treating, the findings of this study can also be utilized to inform targeted prevention measures for traumatic ear injuries across different age demographics.

Endoscopic Ultrasound-Guided Pancreaticogastrostomy for a Pancreaticojejunostomy Stricture after Whipple Pancreaticoduodenectomy.

Nora Singh, BA, Vaibhav Mehendiratta, MD, Oscar K. Serrano, MD, MBA
Hartford Healthcare Cancer Institute, Hartford Hospital, Hartford, CT; University of Connecticut School of Medicine.

Introduction: An uncommon complication from a Whipple pancreaticoduodenectomy is the development of a stricture at the pancreaticojejunostomy (PJ). These type of complications have historically been corrected through invasive surgical revision or total pancreatectomy, both of which carry the potential for high morbidity, an extended recovery period and could have severe implications on the patient's quality of life. The advent of endoscopic procedures that may successfully recanalize pancreatic flow to treat these complex strictures has shown great promise in avoiding complex surgery.

Methods and Results: We present the management of a 42-year-old woman who underwent a Whipple procedure for acinar cell transformation and initially recovered well. Two years post-surgery, she developed pancreatitis due to a stricture at the PJ. Given the high risks associated with further surgery, the medical team opted for an endoscopic approach, specifically an endoscopic pancreaticogastrostomy. During this procedure, a fistula was created between the stomach and the pancreatic duct (Figure 1). This enabled for direct drainage of pancreatic juices into the stomach, bypassing the obstructed PJ. Furthermore, this enables for serial dilation of the PJ to restore antegrade flow. The procedure was completed successfully, and the endoscopic approach alleviated the patient's symptoms from further pancreatitis episodes but also avoided extensive recovery time and the risks associated with major surgery.
Conclusion: This case highlights the potential of advanced endoscopic techniques in managing complex post-surgical complications, particularly in patients who have undergone extensive procedures like a Whipple pancreaticoduodenectomy. By providing a less invasive approach, the endoscopic pancreaticogastrostomy demonstrated excellent outcomes while sparing the patient from an extended recovery and long-term complications of revisional surgery, while preserving her quality of life. This case further reinforces the emerging evidence that endoscopic interventions are a promising alternative to surgical treatment in managing pancreatic duct strictures.

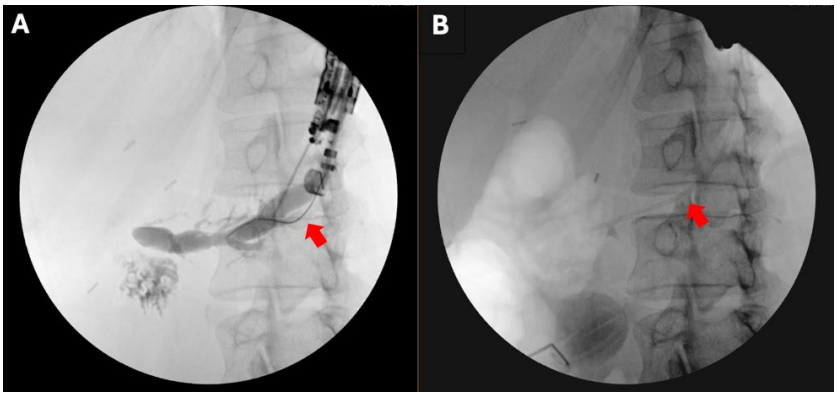

Figure 1A. Guidewire placed through the gastric wall into the pancreatic duct. B. Stent placed across the pancreaticogastrostomy.

Mechanical Device Failure in Robotic and Laparoscopic Surgery: A State-of-the-art Review

Ayaka Tsutsumi, MD, Fabrizio Darby, BS, Shaan Bhandarkar, BS, Eric B Schneider, PhD, Alexandria Brackett MA, MLIS, Vanita Ahuja, MD, MPH, MBA

Introduction: Despite the rise in robotic and laparoscopic surgeries and device manufacturing, there is a dearth of literature amalgamating reports of mechanical failure in these devices. The aim of this review is to highlight cases of device malfunction to guide advancements in robotic and laparoscopic procedures.

Method(s): Based upon systematic assessment of relevant articles found in Web of Science, Scopus and Embase published from January 1, 1974, to March 15, 2024, a state-of-the-art review was conducted. Search terms such as robotic or laparoscopic surgery, and medical device malfunction, failure, or misfire were utilized. Applicable controlled vocabulary was also searched in Embase. Only cohort, cross-sectional, case-control, or randomized controlled studies were included.

Results: We retrieved 454 articles, 54 of which were included for review. We decided to focus on 17 articles that utilized data from the Manufacturer and User Facility Device Experience (MAUDE). Reported cases of mechanical failure varied across specialties, with more reported failures in robotic surgery (12 failures) as compared to laparoscopic procedures (6 failures). Additionally, broken instrumentation gradually became a leading cause of device failure between 2000 and 2013 representing 14.7% of cases. Electrical arching (10.5%), operation errors, such as instruments not being recognized by system (10.1%), system errors (5.0%), and video/imaging problems (2.6%) represented the other most common causes of device failure, with 47.9% of issues being attributed to some other malfunction (faulty wiring, etc.).

Conclusion(s): Robotic and laparoscopic devices have improved in safety. However, further studies as well as requiring mandatory reporting of device failures could elucidate potential risks with these instruments.

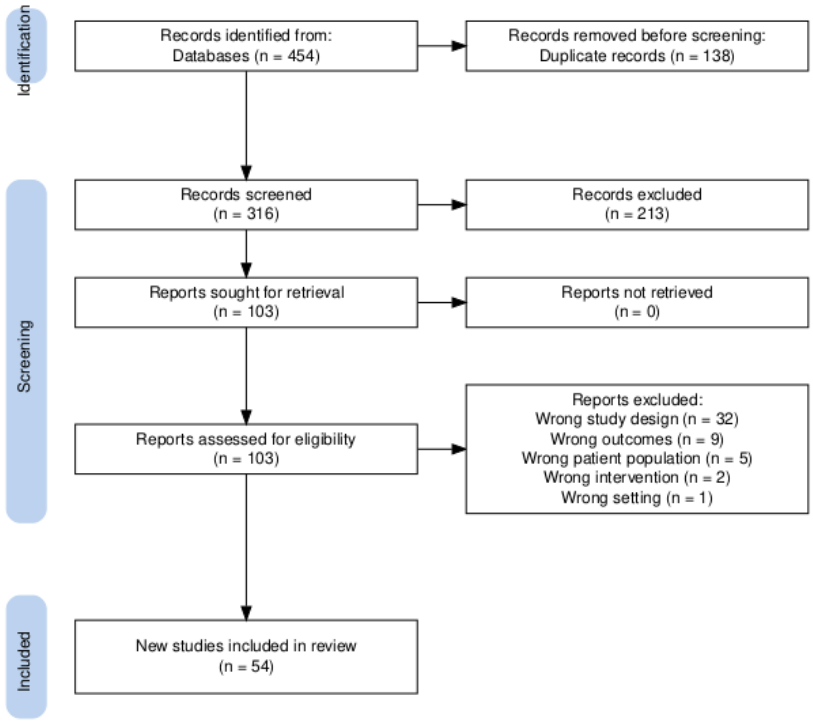

Figure 1. PRISMA figure showing screening process and article identification

Innovative Solutions In Reconstructive Surgery: A Series of Complex Back Closures Using Kerecis Omega-3 (SurgiBind)

Alexandra Savage, BS, Marina A. Carro, BS, Phillip H. Smit, BS, Nora Singh, BA, Mark M. Melendez, MD, MBA.
Division of Plastic and Reconstructive Surgery, St. Vincent's Medical Center, Hartford Healthcare.

Introduction: Postoperative complications, particularly wound dehiscence and infection, pose significant risks in spinal surgery. The presence of posterior hardware, revision surgery, advanced age, obesity, suboptimal nutrition, and prolonged wound dependency challenge current wound management techniques. The pursuit of effective solutions in reconstructive surgery has led to investigations into novel biomaterials. Kerecis Omega-3 SurgiBind, also known as Fish Skin Graft (FSG), has been described in complex wound management and exhibits promise as a biologic material for reinforcing soft tissue. The purpose of our study is to analyze the use of FSG as a potential intervention to reduce wound complications and promote healing in a series of complex posterior spinal revisions with wound dehiscence and infection.

Methods: We assessed patients undergoing cervical and lumbar revisions for spinal wound dehiscence by a single primary plastic surgeon from November 2021 to November 2023. All patients were treated with irrigation, debridement, musculofascial flap mobilization, and closure over drains with the application of FSG superficial to the fascia and deep to the dermal layers. Evaluation encompassed patient demographics, co-morbidities, intraoperative and postoperative findings, and patient outcomes.

Results: Six patients underwent wound washout, debridement, complex closure involving tissue and muscle rearrangement with advancement, and incisional wound VAC placement. KerecisOmega-3 SurgiBind (FSG) fenestrated was used as an onlay. All FSG's were attached with multiple interrupted absorbable monofilament sutures circumferentially about the graft. Four cases required coverage of posterior hardware. The median age was 59 (range 51-73), with 50% female patients. The average time between initial surgery and revision was 4.2 weeks. Wound sizes ranged from 5cm x 1cm to 15cm x 5.5cm. Every case was complicated by at least three co-morbidities, of which 83% of patients had hypertension and 67% had an autoimmune disease. One case experienced postoperative seroma development, while the remaining five recovered without complications. One particularly challenging case in our series was a 62-year-old female who underwent a transformational lumbar inter-body fusion with posterior hardware four months before wound dehiscence, necessitating revision closure. Four weeks following the revision wound closure, she presented to the ER. A second revision wound closure was performed immediately, consisting of I&D, complex flap closure, multiple drains, and a negative pressure system. FSG was used during the second revision, after which the wound healed.

Conclusion: Revision of dehisced and infected spinal wounds, particularly with hardware, is a challenging task. In this case series, the use of FSG as an adjunct was effective in promoting wound healing. These cases demonstrate an innovative approach to addressing challenges in intricate back closures. This study encourages further exploration into potential benefits, such as health system cost savings and integrating Kerecis Omega-3 in complex back closure procedures.