



# Traumatic abdominal wall hernias: a single-center case series of surgical management

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## ABSTRACT

**Background** Traumatic abdominal wall hernias (TAWHs) are a rare clinical entity that can be difficult to diagnose and manage. There is no consensus on management of TAWH due to its low incidence and complex concomitant injury patterns. We hereby present the largest single-center case series in the USA to characterize associated injury patterns, identify optimal strategies for hernia management, and determine outcomes.

**Methods** Patients who presented with a TAWH from blunt trauma requiring operative management were retrospectively identified over a 14-year period. Demographic data, Injury Severity Score (ISS), associated injuries, type of repair, durability of repair, and complications were collected, and descriptive statistics were calculated.

**Results** Fifteen patients were identified. The average age was  $31 \pm 11$  years, ISS  $15 \pm 9$ , and body mass index  $33.4 \pm 7.1$  kg/m<sup>2</sup>. Mechanisms included falls (13%), motor vehicle collisions (60%), motorcycle accidents (20%), and pedestrian versus motor vehicle collisions (7%). The most commonly associated injuries included colonic injuries (53%), long bone fractures (47%), pelvic fractures (40%), and small bowel injuries (33%). Nineteen hernia repairs were performed: 6 underwent primary suture repair (32%) and 13 used mesh (68%). There were four recurrences. We could not find any significant relationship between contamination and mesh use or recurrence. There was one mortality related to sepsis.

**Discussion** TAWHs have an associated injury pattern involving fractures and abdominopelvic visceral injuries where a tailored approach is advisable. Without hollow viscous injuries and gross contamination, these hernias can be repaired safely with mesh in the acute setting. However, in patients with gross contamination or hemodynamic instability, the risk of recurrence with primary repair must be weighed against the risk of infection and prolonged surgery with mesh repair. In those cases, a delayed reconstruction in the elective setting may be optimal.

## BACKGROUND

Traumatic abdominal wall hernias (TAWHs) secondary to blunt traumas are a rather infrequent entity, defined by a disruption of the underlying musculature and fascia following either low-velocity or high-velocity blunt trauma without skin penetration or evidence of a hernia defect prior to the injury.<sup>1</sup> Evidence of abdominal wall injury is seen on CT scans in up to 9% of blunt trauma patients, yet fascial disruptions or true TAWHs are

rare injury pattern seen in less than 0.2% of patients following high-energy blunt trauma.<sup>2</sup> The first case of a TAWH was reported in 1906,<sup>3</sup> and while there has been an increase in sightings through the widespread use of CT scans, the published literature has been limited mostly to case reports and series due to their low incidence and unexpected nature.<sup>4</sup>

Treating physicians are required to merge their knowledge of the acute management of a trauma patient with elective non-traumatic hernia repair. Historically, surgeons advocated for urgent operative exploration when TAWHs were identified due to the concern for associated intra-abdominal injuries (33%–100%) and the high rate of perceived bowel incarceration (25%).<sup>5</sup> However, with image resolution improvements in modern CT scanners, the advent of non-operative management protocols for most solid organ injuries, and a new understanding of potential complications from abdominal surgery, the need for an urgent trauma laparotomy becomes less clear in the setting of an acute TAWH without obstruction or associated intraperitoneal organ injury. The optimal surgical management of these hernias is debatable, particularly in the presence of visceral injuries and contamination. Is it indicated to address the hernia during the initial operation or schedule a takeback? Should the defect have a primary suture repair or use mesh reinforcement?

The aim of this study is to present one of the largest single-center case series to characterize associated injury patterns, identify optimal strategies for hernia management, and determine outcomes.

## METHODS

This is a descriptive study from a single-center retrospective chart review of an urban level I trauma center in Chicago, IL, USA. A waiver of consent was approved by the Advocate Health Care Institutional Review Board (no. 6698) given the retrospective and de-identified nature of the study. The trauma registry was queried over a 14-year period between January 2004 and December 2017 using ICD 9th revision codes for abdominal hernia and CPT operative codes for patients who underwent traumatic hernia repair. Inclusion criteria were acute TAWHs diagnosed during admission from a blunt trauma mechanism requiring operative management. Exclusion criteria were penetrating trauma, age <18, and pregnant patients.

Patients were included if the TAWH was diagnosed on physical examination, intraoperatively, or

**Table 1** Demographics of study cohort

Patients	N=15	%
Age	31±11	
Sex		
Male	8	53
Female	7	47
Mechanism		
Fall	2	13
MVC (driver)	7	47
MVC (passenger)	2	13
Motorcycle	3	20
Pedestrian vs auto	1	7
Prolonged extrication	6	40
Presentation		
ISS	15±9	
RTS	12±1	
BMI (kg/m <sup>2</sup> )	33.4±7.1	
Peritonitic	5	33
Seatbelt sign	7	47
Mortality	1	7

BMI, body mass index; ISS, Injury Severity Score; MVC, motor vehicle collision; RTS, revised trauma score.

during imaging. For CT diagnosis, we chose to only include those with a complete disruption of the abdominal wall musculature, that is, with grade IV (complete abdominal wall muscle disruption) or grade V (complete abdominal wall disruption with herniation of abdominal contents) based on the system by Dennis *et al.*<sup>2</sup> The data collected included baseline demographics, presentation, radiologic studies, associated injuries, timing and method of repair, and outcomes. Hernias were repaired primarily if there was adequate tissue to obtain a tension-free closure. The use of mesh was left to surgeon preference based on the overall patient condition and the presence of contamination. For hernias where a tension-free repair could not be obtained with native tissue, mesh bridging was used which was anchored to the iliac crest.

Data are presented as mean±SD or percentage. This manuscript was written in accordance to the STROBE Guidelines for observational studies.<sup>6</sup>

## RESULTS

There were 16,957 patients admitted with blunt traumatic injuries during the selected period. Fifteen (0.1% of high-energy blunt trauma admissions) met inclusion criteria for our study cohort. There was a total of 19 repairs in the study population. The average age was 31±11 years, Injury Severity Score (ISS) 15±9, and body mass index (BMI) 33.4±7.1 kg/m<sup>2</sup> (table 1). Our cohort had full-thickness traumatic disruptions of their abdominal wall from falls (13%), motor vehicle collisions (MVCs) (60%), motorcycle accidents (20%), and pedestrian versus MVCs (7%). Of interest, seven patients (47%) had evidence of a seatbelt sign and five (33%) had peritonitis on presentation necessitating emergent operations. MVCs were the most common mechanism (60%) and there was only one death unrelated to the TAWH, which matches the overall low mortality rate reported in the literature.<sup>1 4 5 7–10</sup>

Table 2 summarizes the hernia characteristics with associated fractures or intraperitoneal injuries (table 2). Preoperative CT was performed in 93% of initial presentations. There were seven ventral and eight lumbar TAWHs. There were 3 grade IV and

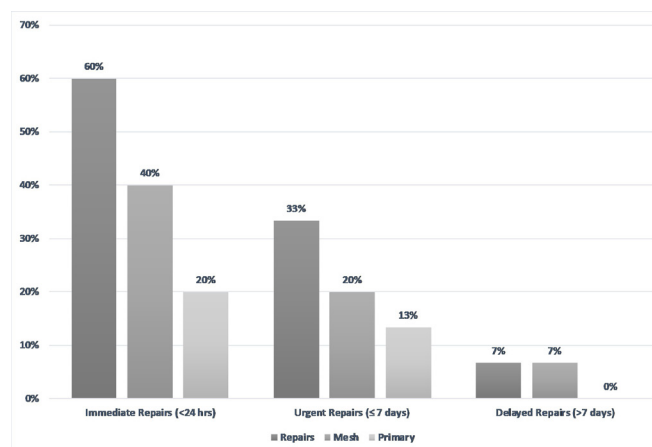
**Table 2** Characteristics of the traumatic abdominal wall hernias and associated injuries

	N=15	%
Hernia location		
Ventral	7	47
Lumbar	8	53
Abdominal wall injury grade		
IV	3	20
V	12	80
Associated intraperitoneal injuries	11	73
Pancreas	1	7
Liver	1	7
Spleen	3	13
Kidney	1	7
Mesentery	4	27
Hollow viscus	9	60
Small bowel	5	33
Colon	5	33
Sigmoid colon	5	33
Rectum	1	7
Associated fractures	12	80
Spine fracture	4	27
Rib fracture	4	27
Pelvic fracture	6	40
Long bone fracture	7	47

12 grade V abdominal wall injuries. Associated intraperitoneal injuries were found in 73% of patients with the most common being hollow viscus injuries (60%). Fractures were seen in 80% of our cohort with the most common being pelvis (40%) and long bones (47%).

Most patients (93%) were repaired in the acute setting, defined as <1 week from presentation (figure 1). The wound classifications were divided into clean (40%), clean-contaminated (20%), and contaminated (40%). Techniques included mesh underlay (63%), mesh bridge (11%), and primary suture repair (32%). The mesh bridge was used once only for a large ventral abdominal wall disruption associated with a Morel-Lavallée lesion where the fascia was unable to be re-approximated.

Mesh was implanted in 74% of cases. Permanent mesh was used in eight cases (five clean and one contaminated field). There

**Figure 1** Operative timing and repair method.

was one mesh infection in a clean case that required explantation and a delayed repair. Biologic mesh was elected for repair three times, with two contaminated cases. Phasix mesh (BARD; Davol) was used twice in a clean-contaminated and contaminated field. There were four recurrences in three patients; two patients were initially repaired primarily, and one patient recurred after mesh repair due to infection requiring explantation. This results in a primary recurrence rate of 33% for those who had a primary suture repair and 8% for mesh repair.

## DISCUSSION

The TAWH is formed by a combination of local tangential shearing forces and an acute rise in intra-abdominal pressure secondary to a blunt trauma.<sup>11</sup> They constitute a rare occurrence with a reported incidence of less than 1% of all blunt trauma admissions.<sup>2</sup> Diagnosis based on physical examination alone is difficult in the acute setting and delayed diagnosis is not uncommon with almost a quarter missed at initial presentation.<sup>11</sup> However, the widespread utilization of CT scans in the evaluation of a trauma patient have led to an increased number of diagnoses estimating up to 15,000 patients per year with more mild forms of blunt abdominal wall injuries. Despite the overall number, a single trauma center will have a relatively low incidence ranging from 0.1% to 1.5% of blunt injuries with no clear consensus or guidelines for management.<sup>2,10</sup>

Our findings support previous etiological considerations for obesity and seatbelt-related trauma as increased risk factors.<sup>11</sup> In total, 47% of our patients sustained visible trauma to their abdominal walls manifested as a seatbelt sign and their BMI place them firmly in the obese category, which is associated with inappropriate seatbelt use.<sup>11</sup>

One important question regarding the management of TAWHs is the need for a mandatory exploration on diagnosis. TAWHs are found in moderately to severely injured patients with previously reported median ISS ranging from 17 to 31 (and a mean of  $15 \pm 9$  in our own findings). Our cohort was selected based on operative management and we were unable to identify patients who were managed non-operatively. Associated intraperitoneal injuries were found in 73% of our cohort with the most common being hollow viscus injuries (60%), particularly colon (54%). Fractures were seen in 80% of our cohort with the most common being pelvis (40%) and long bones (47%). Most patients were repaired in the acute setting, with 60% undergoing immediate exploration, defined as <1 day from presentation (figure 1). This was related to a variety of reasons including the presence of peritonitis (33%) or concerning radiographic signs (60%). While we cannot comment on non-operative management from our data, surgical exploration is necessitated in the presence of peritonitis, hollow viscus perforation, or hemodynamic instability. Our data support that TAWHs have an associated pattern of injuries involving hollow viscus (specifically colon) as well as pelvic and long bone fractures.<sup>5,10-12</sup> Other reviews have evaluated non-operative management: a series by Coleman *et al*<sup>10</sup> reporting non-operative management rate of 56% and bowel injuries identified in 36%; while Netto *et al*<sup>5</sup> had a non-operative rate of 71% and bowel injuries identified in 35%. In their series, only two patients progressed to require operative repair with the remainder being asymptomatic and without complications during their follow-up.<sup>5</sup> Mandatory operative exploration for patients with TAWH without another clinical indication for exploration is not recommended.

A second issue is whether to repair the TAWH in an acute or delayed setting. Our study has a selection bias as all patients

underwent an operative repair on their index admission. Our data suggest that even in clean-contaminated or contaminated fields, it was safe to perform a hernia repair operation. This will be determined by clinical judgment of the overall patient condition. Unstable patients should follow standard trauma protocols for stabilization with or without surgical intervention and damage control operations may be the best option with the hernia repair deferred.<sup>1</sup> Any alternative indication to perform operative exploration should be prioritized over repairing the hernia defect itself. Simultaneous repair should be considered based on the patient's overall trauma burden and difficulty of hernia repair. Repairing a hernia during the index admission does carry increased risk for surgical site infection and recurrence as reflected in our data.<sup>1,10</sup> Stable patients with minimal abdominal trauma burden are the best candidates for a simultaneous repair. If the patient does not require operative exploration, has a low risk of incarceration, or necessitates a damage control laparotomy, a delayed repair is recommended. A series by Novitsky demonstrated that delayed laparoscopic repairs of traumatic flank hernias in 14 patients were feasible, safe, and durable with no recurrences during a mean follow-up of 35 months.<sup>7</sup> Of note, TAWHs occurred in our study population in two contrasting clinical presentations: either as lumbar (posterior defects: 53%) or anterior abdominal wall lesions (47%). While the injury mechanisms as well as therapeutic approaches are different, our cohort lacks enough power to make any useful clinical inferences from this. Larger studies will be required to perform meaningful subgroups analysis on these two distinct clinical entities.

The final concern is the use of mesh. Attempting primary closure of a defect with non-absorbable monofilament sutures is recommended for closing small defects. However, the data from elective primary repairs of incisional hernias have a recurrence rate of up to 40%, similar to our rate of 33%.<sup>13</sup> Contamination due to other injuries or overall patient condition may prohibit the use of a prosthetic in the acute setting, when a primary repair would suffice, accepting the higher recurrence rate. In some instances, absorbable or biologic meshes can be used when there is a concern for contamination in the setting of a large wall defect.<sup>1,14</sup> Alternatively, the hernia repair can be delayed altogether if the risk of incarceration or strangulation is low. A delayed repair can be performed after 6–8 weeks when the soft-tissue damage and edema have subsided, and a clean field is available. It is well documented that tension-free techniques with mesh reinforcement minimize hernia recurrence rates and therefore is recommended for all delayed TAWH repairs.<sup>1,13</sup>

## CONCLUSION

The genesis of TAWH is typically from a combination of shearing forces and intra-abdominal pressures damaging the abdominal all musculature and fascia while the skin remains intact. Risk factors include obesity and seatbelt placement. The operating surgeon should be cognizant of concomitant injury patterns, with pelvic visceral injuries and fractures seen most often. In patients without hollow viscous injuries and gross contamination, these hernias can be repaired safely with mesh in the acute setting. However, in patients with gross contamination or hemodynamic instability, the risk of recurrence with primary repair must be weighed against the risk of infection and prolonged surgery with mesh repair. In those cases, a delayed reconstruction in the elective setting may be optimal.

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