




## Article

# An Australian Approach to Managing Traumatic Abdominal Wall Hernias

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**Abstract:** Traumatic abdominal wall hernias (TAWH) occur in less than one percent of trauma presentations. In the absence of clinical guidelines, management is centre-specific and largely dependent on surgeon experience. This study describes the management of TAWH in a high volume Australian trauma centre. A single centre retrospective cohort study was performed. Adults with TAWH as a result of blunt trauma, between January 2016 and July 2020, were included. Primary outcomes were the mechanism of injury, presentation, timing of repair, and operative technique used. A total of 16 patients (63% male; median age 36 years; median Injury Severity Score [ISS] 19.5) were identified. In total, 75% were the result of a motor vehicle accident. A total of 13 patients (81%) underwent repair. Eight patients received repair during emergency exploration undertaken for concurrent injuries. Three patients had a delayed repair during index admission, and two patients had an elective repair. Primary tissue repair was performed in seven patients. Mesh repair was used in six. Patients were followed for a median of 55.5 days. One patient had a recurrence of hernia following primary repair. This local series demonstrates that traumatic abdominal wall hernias may be successfully repaired during index admission using tissue or mesh techniques.

**Keywords:** acute surgical unit; blunt trauma; abdominal wall hernia; traumatic abdominal wall hernia; mesh; hernia repair



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## 1. Introduction

Traumatic abdominal wall hernias (TAWH) are estimated to affect less than one percent of blunt trauma presentations [1–3]. Though well described, there is a paucity of guidelines regarding the management of this condition. TAWH are defined as abdominal wall disruption without skin compromise following blunt trauma [3]. Dennis et al. [3] proposed a severity grading system for TAWH based on the degree of musculature disruption and herniation of solid and hollow viscera. Seatbelt trauma in motor vehicle accidents (MVA) is the most common presentation of TAWH [1,4], presumably due to traumatic shearing forces upon the abdominal wall combined with an increase in intra-abdominal pressure in the context of sudden deceleration [5].

Traditionally, urgent surgical exploration was thought mandated due to the frequent association with concurrent intra-abdominal injuries [6,7]; however, with the advent of routine and readily available computed tomography (CT), conservative management and observation is becoming increasingly favoured [2,8]. When urgent exploration is undertaken, immediate repair is debatable, and is often dependent on patient factors and surgeon preference [1]. Alternatives to immediate repair include delayed repair (during index admission), elective repair (post discharge), or surveillance only in asymptomatic patients [2,9,10]. When repair is undertaken, the option to repair primarily or to use mesh is

also disputable and often based on tissue availability for a tension-free closure, and degree of contamination [1,2,11].

Our aim was to identify our local incidence of TAWH, as well as describe our local patterns of presentation, management, and outcomes in order to contribute to the existing literature surrounding these clinical questions.

## 2. Materials and Methods

This study was conducted through retrospective analysis of admissions from a single metropolitan level-one trauma centre, the Princess Alexandra Hospital (Brisbane, Australia), over a 4.5-year period (January 2016 to June 2020). Participants were identified using the Princess Alexandra Hospital Electronic Trauma Database using keywords and Abbreviated Injury Scale (AIS) codes. This prospective database captures all trauma-related admissions and is managed by a multidisciplinary trauma specialty service. Inclusion criteria were patients admitted with clinical or radiological diagnosis of TAWH. Those with diaphragmatic hernias, pre-existing hernias, or penetrating injury were excluded. Ethical clearance for this study was obtained from the Metro South Human Research Ethics Committee (LNR/2020/QMS/72703).

Chart reviews of patients' integrated Electronic Medical Record (iEMR) were performed to identify primary outcomes of interest. Demographic data, mechanism of injury, Injury Severity Score (ISS) [12], clinical examination on admission, operative reports, as well as discharge and follow-up details were retrieved. All CTs were reviewed to confirm the diagnosis and anatomical location of TAWH. We included only those with complete abdominal wall disruption with or without herniation, correlating to grade IV-V per Dennis et al. [3] classification. Due to the lack of standardised anatomical descriptions for TAWH, the following definitions were utilised. An anterior hernia was defined as a defect in the rectus muscle and its fascia. A lateral hernia was defined as a defect in the oblique muscles, including if they were disrupted from the iliac crest or costal margin. A lumbar hernia was defined as a defect in the lumbar space bounded anteriorly by the posterior border of the external oblique. Patients were stratified by mechanism of injury, including MVA, motorbike accident, and crush injury. Timing of repair was classified as "emergent" if repaired within 24 h, "delayed" if repaired after 24 h but during the same admission, and "elective" if repaired post discharge. Data are presented as median with range or percentage for all variables by subgroups of outcomes of interest.

## 3. Results

### 3.1. Patient Characteristics and Presentation

A total of 4900 trauma patients were admitted from January 2016 to June 2020. In total, 1035 patients were admitted following blunt abdominal trauma. A total of 16 patients met inclusion criteria, correlating to an incidence of 1:65 or 1.54% of those presenting following blunt abdominal trauma. Patient demographics are described in Table 1. MVA was the most common mechanism of injury (75%).

**Table 1.** Patient demographics of those with traumatic abdominal wall hernias.

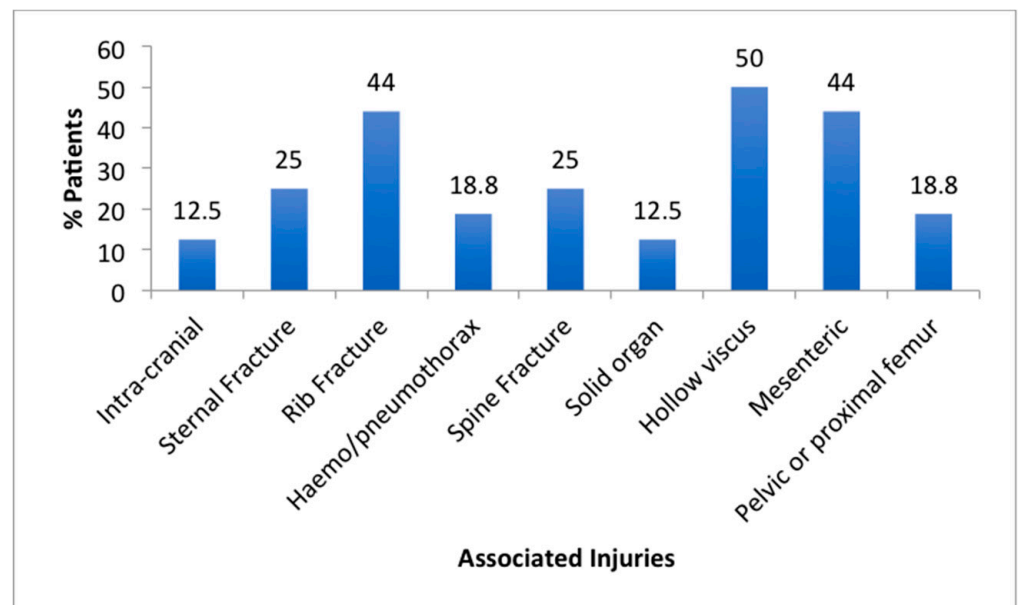
Patient Demographics	<i>n</i> = 16	Patients (%)
Age	Median 36 (Range 18–59) years	
Gender	Male	10/16 (62.5%)
	Female	6/16 (37.5%)
ISS	Median 19.5 (Range 5–34)	
Mechanism of Injury	Motor Vehicle (Car) Accident	12/16 (75%)
	Crush Injury	3/16 (18.8%)
	Motor Bike Accident	1/16 (6.3%)

**Table 1.** *Cont.*

Patient Demographics	<i>n</i> = 16	Patients (%)
Motor Vehicle Accident Group	Travelling >80 km/h	8/12 (66.7%)
	Multi-vehicle accident	8/12 (66.7%)
	Driver of vehicle	7/12 (58%)
Length of stay	Median 14.5 (Range 2–94) days	
Location of Hernia	Right lateral	6/16 (37.5%)
	Unilateral Anterior	3/16 (18.8%)
	Bilateral Anterior	3/16 (18.8%)
	Left Lateral	2/16 (12.5%)
	Bilateral Lateral	1/16 (6.3%)
	Left Lateral and Lumbar	1/16 (6.3%)
Abdominal signs on presentation	MVA group–seatbelt sign documented	12/12 (100%)
	Non-MVA group–abdominal contusion documented	3/4 (75%)
CT trauma series findings	Radiological evidence of TAWH	16/16 (100%)
	TAWH included in initial radiology report	14/16 (87.5%)

### 3.2. Pattern of Injury

Hollow viscus, mesenteric injury, and rib fracture were most frequently associated with TAWH (50%, 44%, and 44%, respectively) (Figure 1).

**Figure 1.** Injuries associated with traumatic abdominal wall hernia.

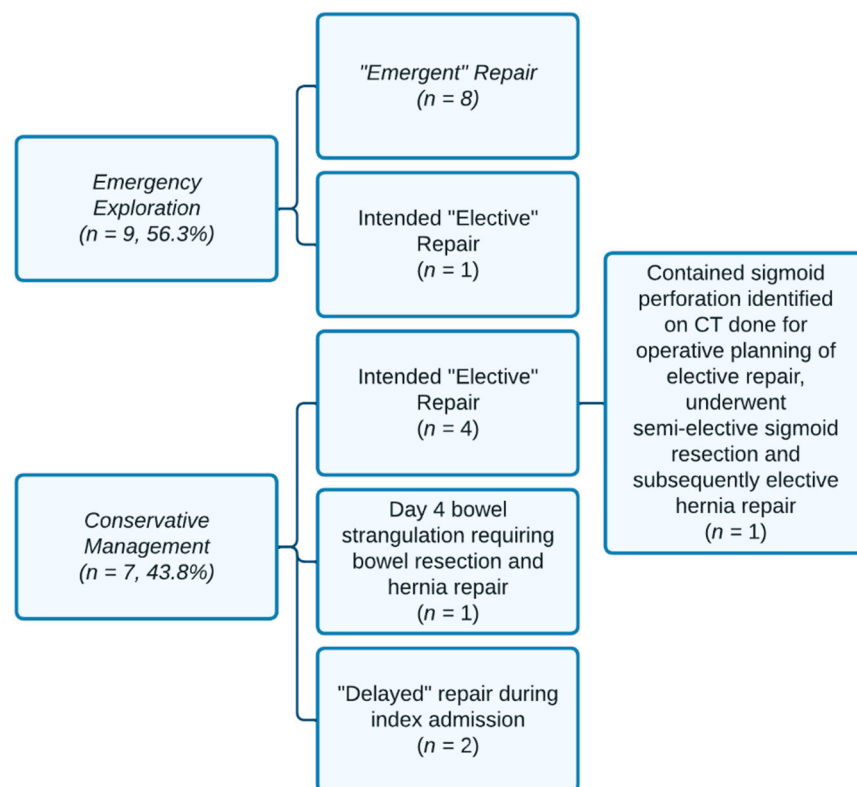
### 3.3. Urgent Surgical Exploration

Over half of the patients (nine patients) in this series underwent emergency exploration within 24 h of admission. Intra-operative findings and management at emergency exploration are detailed in Table 2.

**Table 2.** Intra-operative findings and management at emergency exploration for those with TAWH.

Emergency Exploration ( <i>n</i> = 9)	Type of Injuries Identified	Management
Intra-abdominal injury identified ( <i>n</i> = 7)	Small bowel ( <i>n</i> = 4)	Devascularisation due to bucket-handle mesenteric injury ( <i>n</i> = 3) Traumatic jejunal perforation ( <i>n</i> = 1)
		Small bowel resection and anastomosis, and primary repair of TAWH ( <i>n</i> = 4)
	Colonic ( <i>n</i> = 2)	Rectosigmoid seromuscular tear ( <i>n</i> = 1)
		Oversewing of rectosigmoid defect, and mesh repair of TAWH ( <i>n</i> = 1)
		Devascularisation due to bucket-handle injury of sigmoid mesentery ( <i>n</i> = 1)
		Hartmann's procedure, and primary repair of TAWH ( <i>n</i> = 1)
	Bladder ( <i>n</i> = 1)	Intraperitoneal bladder rupture ( <i>n</i> = 1)
		Primary bladder repair, TAWH not repaired ( <i>n</i> = 1)
No intra-abdominal injury identified ( <i>n</i> = 2)	None	Repair of TAWH at exploratory operation (Mesh repair <i>n</i> = 1; Primary repair <i>n</i> = 1)

"Emergent" hernia repair was performed during emergency exploration in eight cases. Only one patient who underwent emergency exploration did not have their hernia repaired and was referred for elective repair, which has not yet been undertaken (Figure 2).

**Figure 2.** Emergency exploration and timing of repair of traumatic abdominal wall hernias.

### 3.4. Conservative Management

A total of 43.8% patients were initially managed conservatively (Figure 2). Two patients had initial management of non-abdominal injuries and underwent "delayed" hernia repair during the index admission without adverse events. One patient developed strangulation of herniated small bowel without perforation on day four of admission, requiring laparotomy and small bowel resection. One patient from the group that was discharged with intent for elective repair was later identified to have a contained sigmoid perforation in the outpatient setting. They were clinically well and underwent semi-elective resection of the sigmoid colon, and subsequently elective hernia repair. The remaining three patients had

an uneventful admission and were referred for elective repair, of which one patient has had their operation (Figure 2). Overall, 13 patients (81.3%) underwent repair of their TAWH.

### 3.5. Approach to Repair

Primary repair using native tissue was the most common surgical technique employed at our centre (seven patients, 54%); six of these primary repairs were performed at the time of emergency exploration. Table 3 depicts the timeframe of primary versus mesh repair, also stratified by the presence of concurrent intra-abdominal injury (hollow viscus devascularization/perforation requiring resection/anastomosis) meeting the definition of a dirty/contaminated/clean-contaminated surgical wound.

**Table 3.** Timeframe of primary/mesh repair and presence of dirty/contaminated/clean-contaminated surgical wound.

Type of Repair			Patients
Primary ( <i>n</i> = 7, 54%)	Timing of repair	Emergent	6/7 (85.7%)
		Delayed	0/7 (0%)
		Elective	1/7 (14.3%)
	Surgical Wound Type	Dirty/Contaminated/Clean-contaminated	5/7 (71.4%)
		Clean	2/7 (28.6%)
Mesh ( <i>n</i> = 6, 46%) *	Timing of repair	Emergent	2/6 (33.3%)
		Delayed	3/6 (50%)
		Elective	1/6 (16.7%)
	Surgical Wound Type	Dirty/Contaminated/Clean-contaminated	1/6 (16.7%)
		Clean	5/6 (83.3%)

\* Vicryl (Ethicon US, LLC, New Jersey US) *n* = 3, BIO-A (W.L.Gore & Associates Inc, Delaware US) *n* = 1, Ventralex ST (BD, New Jersey US) *n* = 1, Unknown *n* = 1.

### 3.6. Follow-Up

The median length of stay was 14.5 days (range, 2–94). Patients who received repair at our centre were followed up for a median 55.5 days (range, 18–137 days). At the completion of the study period one patient (8.3%) who had undergone repair had clinical evidence of hernia recurrence. This patient had undergone an emergent primary repair at the time of their exploratory operation. Of the patients managed conservatively during their inpatient stay, two have undergone “elective” repair, one is awaiting repair, and two have been lost to follow-up.

## 4. Discussion

TAWH were first described in the literature over a century ago [13]; however, according to a recent systematic review, only 230 cases in retrospective studies have been reported cumulatively [5]. The largest series to date includes only 80 patients [10]. We observed a TAWH incidence of 1.54%, in keeping with the internationally quoted incidence of 0.17–1.5% [1,3,10].

Our demographic parameters are analogous to the existing literature that describes a median age of 38 years, median ISS 17–31, and a higher prevalence of TAWH in those wearing a seatbelt and involved in a high-speed or multi-vehicle MVA [1,2,8]. CT was sensitive and specific for TAWH; however was less effective in characterising associated bowel and mesenteric injury, as consistent with previous reports [14,15]. TAWH were frequently associated with significant intra-abdominal injuries in our cohort. Almost half (46.2%) sustained bowel or mesenteric injury, consistent with the previous literature describing incidence of this as high as 36–53% [1,8]. This affirms that a high level of

suspicion for associated intra-abdominal injuries must be maintained in those with TAWH, even in the setting of non-specific radiological findings. Whilst we do not undertake urgent surgical exploration routinely for the presence of TAWH alone, our view is that the threshold for exploration should be low in the setting of clinical concern.

In one case, initial trauma CT did not demonstrate any signs of hollow viscus injury, and as the patient was clinically well they were discharged from index admission for interval follow up. On outpatient review, the patient complained of persistent mild abdominal discomfort from the date of injury. A CT performed for operative planning (done 54 days from the date of injury), revealed locules of gas tracking from the sigmoid colon to the hernia. The patient was clinically well with normal c-reactive protein and white blood cell count on laboratory studies. They underwent semi-elective laparoscopic wedge resection of the sigmoid colon, which confirmed contained perforation. Though they subsequently had the hernia repaired with mesh (unspecified type) six weeks later, the mild abdominal discomfort had almost entirely resolved post sigmoid resection. This highlights that the differential for mild persistent abdominal pain in the setting of TAWH in the outpatient setting can include a contained traumatic perforation relating to the initial injury, and may not always relate to the hernia itself.

A total of 56.3% of our patients underwent urgent surgical exploration, comparable with recent studies that reported exploration rates of 44–68.4% [1,2,8]. Of those who were conservatively managed initially, one patient in our cohort later developed bowel strangulation relating to the hernia, necessitating operative management. Though bowel obstruction and incarceration relating to TAWH has been previously documented in case reports [6,7], larger reviews in the literature have described this as rare [2,8]. Netto et al. [2] found that 0% of their conservatively managed patients developed the need for urgent operative management, despite a considerably lower emergent hernia repair rate (21%). Their cohort included 81% inferior lumbar triangle (posterior) hernias, which they proposed might be less likely to become problematic [2]. However, overall, to date, there has been insufficient evidence for formal subgroup analysis to identify which TAWH are likely to become problematic, and the true incidence of obstruction or strangulation in association with TAWH is likely yet unknown.

The proportion of TAWH repaired acutely varies widely between centers. Though Netto et al. [2] and Coleman et al. [8] repaired only 21–29% of TAWH acutely; our center repaired 50% at the time of emergency exploration, more in keeping with Chow et al. [16] and Honaker et al. [1] (60–75%). In a recent systematic review, Karhof et al. [5] was not able to make a statistically significant conclusion on optimal timing of repair due to study heterogeneity [5]. Some individual studies have implied acute repair is associated with recurrence, and that this may be due to suboptimal tension-free techniques in the emergency setting where mesh use is restricted due to contamination, and primary repair is resorted to despite tissue oedema and haematoma [1,2,5]. Netto et al. [2] reported a 50% recurrence in those repaired acutely, and though Honaker et al. [1] reported recurrence of only 8.3% overall, all recurrences occurred in their acute repair group who underwent primary repair. In our study, of the eight patients who underwent repair at their emergency exploration, six had a primary repair, and one of those patients developed recurrence. Though our numbers for inclusion are small, it is our view that primary repair may have a higher chance for success in this setting, as the presence of a defect likely correlates with mechanism rather than any systemic predisposition to hernia. The use of primary repair concurrent to an exploratory operation when possible can be both successful and help counter the potential risk of complications relating to leaving the hernia alone. Ultimately, the risk of recurrence must be balanced against the potential risk of obstruction or strangulation in a TAWH that is conservatively managed.

We found that the approach of delayed or elective repair with mesh was still usually preferred in the absence of other indications for emergency surgical exploration. Honaker et al. [1] strongly advocated for elective mesh repair of TAWH, and described 0% recurrence in this group. The advantages of a delayed or elective repair are that the patient may be



medically optimised beyond the acute post-traumatic period, and there is less likely to be contamination restricting the use of mesh techniques. Relating to elective repair, the development of a hernia sac with chronicity may also help define muscular margins at an interval repair [2,4,9,10]. Whether a patient underwent delayed repair during admission or elective repair post discharge often depended on factors such as the severity of symptoms relating to their TAWH, or the presence of other injuries still requiring priority management and optimisation. We were unable to conclude if elective repair is necessary at all in the asymptomatic patient, as the follow-up for these patients in our cohort is incomplete; however, our approach is that large abdominal wall defects should be repaired to restore anatomical function and to avoid progression in size over time. Overall, primary repair was used rather than mesh repair in cases where there was evidence of associated intra-abdominal injury or other potential sources of infection. There was only one case in our cohort where mesh was used concurrent to bowel injury that required resection. This patient developed small bowel strangulation at the site of their left lateral hernia during admission. They underwent small bowel resection, and hernia repair with BIO-A mesh concurrently, as it was essential to bridge an immense fascial defect. Unfortunately, this patient had also sustained a significant degloving injury to the overlying subcutaneous tissues, extending circumferentially from midline at the anterior abdominal wall to the left flank and pre-sacral tissue. In the days following hernia repair, this immense soft tissue injury developed into necrotising fasciitis and the patient became critically unwell from septic shock. They were taken back to theatre on the fifth post-operative day for radical debridement of the infected tissues and removal of the adjacent infected mesh. Following multiple debridement procedures and physiological stabilisation, the patient underwent delayed closure of the hernia ten days after initial mesh repair, and received Vicryl mesh in the pre-peritoneal space. This case serves as an example of a common dilemma encountered in the management of TAWH in the acute setting when presented with a patient who has an intra-abdominal injury with potential for contamination, or other potential sources of infection, such as a large soft tissue wound, concurrent to a large defect that has inadequate tissue for primary repair. Biologic mesh may be a practical option in these circumstances, but they remain at risk for infection.

Our data reflects good early outcomes for TAWHs repaired in the emergency setting and, as such, we would advocate for repairing TAWH with either tissue or mesh techniques at the time of emergency operations if circumstances permit. In those who do not undergo an exploratory operation, “delayed” or “elective” mesh repair is reasonable. This series highlights some unique issues specific to the management of TAWH. The existing literature consists of limited size retrospective cohort studies, small case series, and case reports with uncertain generalisability. There are no published protocols on how TAWH may be ideally managed. As TAWHs are rare, our numbers for inclusion in this study were low, limiting the generalisability of the results also. Due to the retrospective nature of this report, it may be prone to misclassification bias and loss to follow-up. Though we have been able to report on the early outcomes for our cohort, more longitudinal follow up is required to assess long-term outcomes. Though further larger studies at the multi-institutional level are required in order to develop a protocol for management of these injuries, this study serves a local description of incidence and management approach.

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**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board Metro South Human Research Ethics Committee (LNR/2020/QMS/72703 5/1/2021).

**Informed Consent Statement:** Patient consent was waived as the study was compliant with the NHMRC guidance protocol on Ethical Considerations in Quality Assurance and Evaluation Activities 2014.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

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