Management strategies and outcome of blunt traumatic abdominal wall defects: a single centre experience

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ABSTRACT

Introduction: Traumatic abdominal wall defects (TAWDs) following blunt trauma are uncommon injuries with an incidence reported less than 1%. Improved diagnostics and subsequent early detection of otherwise rare injuries raise more questions concerning their treatment. There is lack of consensus on treatment and timing of TAWD. The aim of this study was to analyse the management strategy and outcomes of these injuries in our level I trauma centre.
Methods: All trauma patients who presented with a TAWD at our trauma centre between 2007 and 2016 were retrospectively reviewed. Blunt abdominal wall injuries were classified, patient characteristics, concomitant injuries and treatment characteristics were recorded. In addition, telephone surveys were conducted to assess patient reported quality of life.
Results: In a period of nearly ten years 21 patients with a TAWD were treated in our hospital, approximately 0.17% of all admitted trauma patients. Seventeen patients were classified as polytrauma patient. Seventeen patients underwent surgical repair in whom 5 recurrences occurred. All of the recurrences were in patients treated without mesh repair (p = 0.03). The quality of life in terms of EQ-VAS was similar for patients treated with and without mesh repair and reasonable when compared to the reference population. Overall quality of life was lower compared to the reference population, mainly due to limitations in daily activities, mobility and pain.
Conclusion: Using mesh in the treatment of TAWD, in our hands, showed significantly less recurrences compared to primary closure. We therefore recommend the use of mesh in the repair of TAWDs, both in the acute as well as in the delayed setting when feasible.

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Introduction

Traumatic abdominal wall defects (TAWDs) are uncommon injuries following blunt abdominal trauma. The reported incidence in literature of these defects is less than 1%.[1–5] There is a bimodal distribution: either children following handle bar trauma or (mostly) young adults after high energy trauma.[6] Due to the sources in adults, these injuries are frequently accompanied by other injuries, such as intra-abdominal organ damage or pelvic and spine fractures. [2–6]

The first to describe a TAWD was Shelby in 1906 and at that time treatment consisted of primary repair.[7] Ever since the introduction of a more protocolled assessment of trauma patients and liberal use of computed tomography in the early stage of their management revealed a slight increase in diagnosing and reporting of TAWDs.[1,2,5,6,8] However, up to now the literature

on TAWDs still is scarce and most of the publications are small case series or case reports. So far there is no standardized treatment for TAWDs and little is known about long term outcomes of this injury type. Previous reports varied in treatment from conservative to surgical, without clear indications when to operate or not. Even timing of operation differed, varying from acute to delayed surgery after several months. Finally there are several surgical techniques described, with or without the use of mesh, event the position of a possible mesh is still a debate in TAWDs. Since we have had continuous expertise both in major trauma, and in hernia repair surgery, and exerted the same therapeutic principles throughout the years, we evaluated all TAWDs treated at our level I trauma centre and documented our management strategy and outcomes over the last years.

Patients & methods

Patients who were diagnosed with a TAWD at our level I trauma centre between 2007 and 2016 were retrospectively reviewed. A TAWD was defined as an abdominal wall disruption occurring after

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blunt abdominal trauma, involving the rectus or (one of) the oblique muscles, without evidence of a prior hernia at this site. [6] Defects were categorized based on the involved muscles. Defects in the rectus muscle(s) were defined as anterior abdominal; disruptions of the abdominal wall involving (one of) the oblique muscles were classified as flank. When both muscle groups were ruptured, defects were labelled as complex.

Inclusion and classification

All abdominal wall injuries were graded according to the system developed by Dennis et al [8]. A schematic overview of this classification system is provided in Table 1. Patients with a grade I or II defect were not included in our analysis since these defects are merely a skin lesion not representing a true abdominal wall defect.

Patients were included when a TAWD was diagnosed on physical examination, computed tomography (CT) scan or during surgery, either on first presentation to the Emergency Room, during admission or at outpatient follow-up. Patients who sustained penetrating trauma were excluded, as well as patients younger than 18 years old. Due to this design of the study, the local Medical Ethics Committee at the UMCU provided a waver concerning informed consent.

Parameters

Collected data included demographic and clinical patient characteristics, concomitant injuries including Injury Severity Scores (ISS), injury mechanisms, location and size of defects, timing and methods of detection and repair, postoperative complications and recurrence rates.

Surgical technique

Depending on the size of the defect, as well as the possible contamination, the choice whether or not to use a mesh was made during surgery by the individual surgeon. Small defects or when there was obvious contamination, were primarily repaired. When meshes were used they were all placed extraperitoneally retromuscularly augmenting the repair of the muscular defect in this way. If transmuscular fixation of the mesh could not be obtained, the mesh was fixated to surrounding bony structures such as the iliac crest or the superior ramus of the pubic bone, using anchors or sutures through drilled holes. After that, the disrupted muscles were approximated whenever possible and the anterior sheath was closed or reattached. Concerning the timing of repair, the following descriptions were used. Acute repair means that the TAWD was repaired at the (acute) index laparotomy after trauma. When the TAWD was reconstructed any time thereafter, but before hospital discharge, this was defined as the semi-acute posttraumatic period (planned). All patients who underwent delayed repair had their TAWDs repaired after their initial hospitalization (delayed).

Patient reported outcome measures (PROMs)

Telephone surveys were conducted to assess self-reported functional outcomes and quality of life. For this, a modified question tool was used, based on three validated questionnaires: EuroQol 5 Dimensions [9] (EQ-5D), Hernia-Related Quality-of-Life Survey [10] (HerQLes) and Carolinas Comfort Scale [11] (CCS) (see Appendix 1a-b). For the assessment of functional outcomes the five domains of the EQ-5D were evaluated. Per each domain a nominal reporting scale from no problems (score 1) to inability (score 4) was used. We have shown the means of these scores in a graphic and reported the percentage of patients having any problem within in each domain. To assess the quality of life in relation to the TAWD, and its repair, we used a combination of the HerQLes and CCS surveys with a nominal reporting scale as well, in which a score from 0 (not applicable/no complaints) to 3 or 5 (very severe complaints) was used, differing per question. The results of these questions are displayed separately.

Statistical analysis

All statistical analyses were conducted using IBM SPSS Statistics 22.0 (IBM Corporation, Armonk, NY, USA;). Continuous variables were reported in medians, including ranges. Discrete variables were displayed as proportions. Contingency tables were analysed using the Fisher exact test, since all cell counts were lower than ten. For comparisons between more than two independent groups, the Kruskal-Wallis one-way analysis of variance test was applied. P-values below 0.05 were considered statistically significant.

Results

From April 2007 to November 2016, 21 of over 12.000 admitted trauma patients (approximately 0,17%) were diagnosed with a TAWD in our trauma centre. The majority of these patients were male (14/21) with a median age of 44 years. Seventeen patients (17/21) were categorized as polytrauma with an injury severity score (ISS) greater than 15 and 10 patients (10/21) experienced concomitant abdominal injuries. Three patients (3/21) within our study population died. (Table 2)

The most common trauma mechanisms were motor vehicle accidents (MVA, 17 patients), crush injury or fall from height. Most defects were detected on CT-scan (17/21). In three out of the 4 patients in whom the defect was encountered during surgery pre-operative CT-imaging was negative for TAWD. There was one patient in whom the defect was discovered on physical examination direct at presentation.

No significant differences were seen in the baseline characteristics between patients in whom a mesh was used and in whom it was not.

Classification

The lower abdomen was the predominant site of defect occurrence, with 9/21 in the right and 7/21 in the left lower quadrant. Most of the defects were flank defects (14/21), in 2 patients both the rectus and oblique muscles were ruptured and therefore classified as complex defects. One patient had a bilateral avulsion of the whole abdominal wall musculature, which was also classified as complex. The majority of the patients had a complete abdominal wall disruption, corresponding to grade IV (n = 8) or V (n = 10) and one patient experienced a grade VI injury with evisceration. There was a significant difference in mesh use for patients who experienced a grade V abdominal wall defect.

Table 1
Classification of traumatic abdominal wall hernias as defined by Dennis et al.[8]

Grade	Definition
I	Subcutaneous tissue contusion
II	Abdominal wall muscle hematoma
III	Singe abdominal wall muscle disruption
IV	Complete abdominal wall muscle disruption
V	Complete abdominal wall muscle disruption with herniation of abdominal wall contents
VI	Complete abdominal wall disruption with evisceration

Table 2
Baseline characteristics.

Patient demographics	Total (N = 21)	Mesh* (N = 8)	No Mesh* (N = 9)	P-value
Age, years (range)	44 (24-70)	49 (31-70)	44 (24-66)	NS
Male gender, N (%)	14 (67)	6	6	NS
BMI, median: kg/m² (range)	25 (21-51)	25 (25-31)	23.7 (21-26)	NS
Trauma mechanism, N (%)				NS
Motor vehicle accident (MVA)	8 (38)	3	2	
Motor cycle accident (MCA)	5 (24)	1	3	
Bicycle crash	3 (14)	0	3	
Crush injury	4 (19)	3	1	
Fall from height	1 (5)	1	0	
ISS, median (range)	25 (9-59)	19.5 (8-59)	34 (10-48)	NS
Polytrauma (ISS > 15), N (%)	17 (81)	6	8	NS
Concomitant injuries, N (%)				NS
Bowel injury	8 (38)	3	3	
Liver injury	2 (10)	0	1	
Spleen injury	2 (10)	1	1	
Kidney injury	2 (10)	0	1	
Pelvic fracture	8 (38)	2	6	
Costal/sternum fracture	11 (52)	3	5	
Spinal fracture	9 (43)	3	4	
Peritoneal contamination, N (%)	3 ()	3	0	NS
Classification, N (%)				
Grade III	2 (10)	0	2	NS
Grade IV	8 (38)	1	5	NS
Grade V	10 (48)	6	2	***0.044***
Grade VI	1 (5)	1	0	NS
Mortality, N (%)	3 (14)	0	2	NS

BMI = body mass index.
ISS = injury severity score.
* In 4 out of 21 patients mesh use was not documented.

Associated injuries

As shown in Table 2, associated injuries were very common in this population, with only one patient identified having no other injuries. Ten patients (48%) had intra-abdominal injuries with the majority suffering bowel or mesentery injury (n = 8), other intra-abdominal injuries included liver, spleen, kidney or urogenital. Most common fractures accompanying the defect were costal or sternum fractures in 11 patients or bony spinal fractures (n = 9) and 8 patients suffered a pelvic fracture.

Treatment

Seventeen of the patients (17/21) underwent surgical repair of their TAWD, 14 of them had surgical repair during the initial hospital admission. Five of them had their defect repaired during the index laparotomy after trauma, only 4/21 patients were treated non-operatively (2 morbidly obese, 1 transfer and 1 severe neurotrauma). In twelve patients the defects have been repaired with mesh augmentation. In three of the nine patients in whom the defect had been primarily repaired this was due to obvious
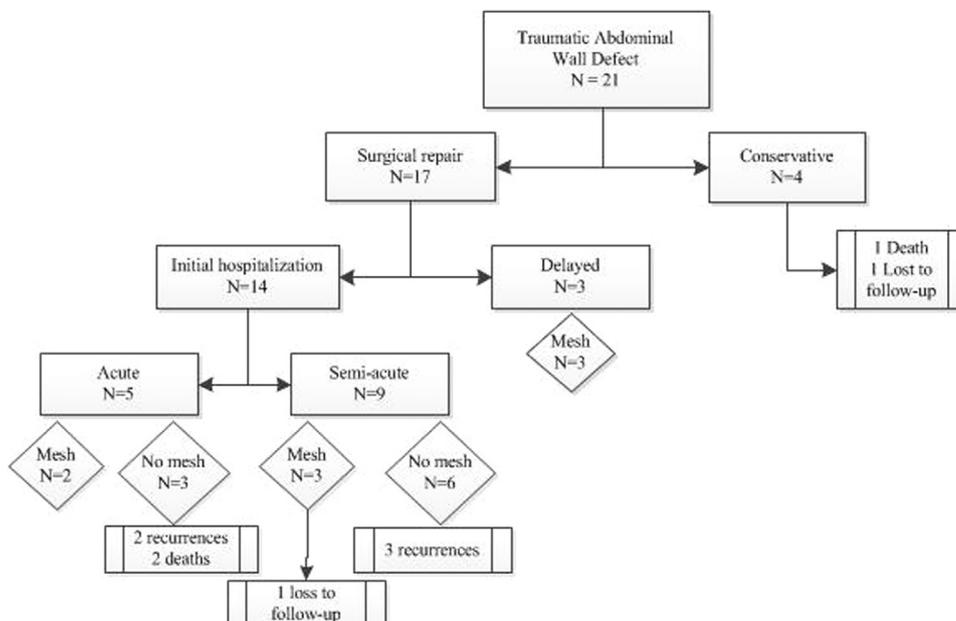

Fig. 1. Management strategy and outcome.

contamination, within the other six patients the defect seemed small enough to repair without a mesh. The management strategy as described above is summarized in Fig. 1.

Outcome

Three patients developed a superficial infection treated conservatively, one patient presented with a suprapubic seroma following defect repair (without mesh) and required secondary surgery. There was no significant difference in postoperative complications between patients after primary or delayed repair. There were two patients presenting at the outpatient clinic with low grade chronic infections after pelvic fixation and defect repair without mesh, both of them requiring surgical intervention to excise fistulas and remove plate and screws.

Median out-patient follow-up time was 17 months (ranging from 2 to 60 months). Three patients died and final follow up rate was 88%. (Table 3). Five patients experienced a recurrence after surgery (29%). All of the recurrences occurred in patients treated without mesh repair, either in the semi-acute or acute period. Of the five recurrences, one occurred in a patient who had no mesh repair due to contamination at his first surgery, the other four were repaired primary due to the small size of the defect. Two of these patients had their recurrence repair without mesh again and one developed a second recurrence, repaired with mesh this time. In one patient the recurrence was repaired with a mesh and had an uneventful course. Another two patients were treated conservatively since they experienced only moderate symptoms.

In the three patients treated conservatively none experienced complications nor underwent secondary surgical repair, one was lost to follow-up.

Patient reported outcome measures: quality of life

We were able to evaluate a total of 16 patients for the second part of the study, self-reported functional outcomes and quality of life. Median follow-up was 49 months (range 6-120) after recognition of the injury. Fourteen of these patients had surgical repair, seven with a mesh and seven without. Fifteen of the 16 patients reported any symptom concerning the (repair of the) abdominal wall in daily life, with 10 out of 14 after surgery complaining of a numb feeling near the surgical site.

Within all domains of the EQ-5D our study group showed more problems than the reference population (Graph 1 and Table 4). Eight of the patients (8/16) mentioned some problems in mobility, ten complained of pain or discomfort and up to twelve patients (12/16) encounter some amount of problems in usual daily activities. Thirteen patients complained of any problem within one of the domains. The latter is comparable to previous numbers for quality of life following trauma [18]. No significant differences in patients after surgical repair with and without mesh were observed in self-reported functional outcomes.

When evaluating quality of life specifically concerning the hernia or its repair, patients reported acceptable scores for pain
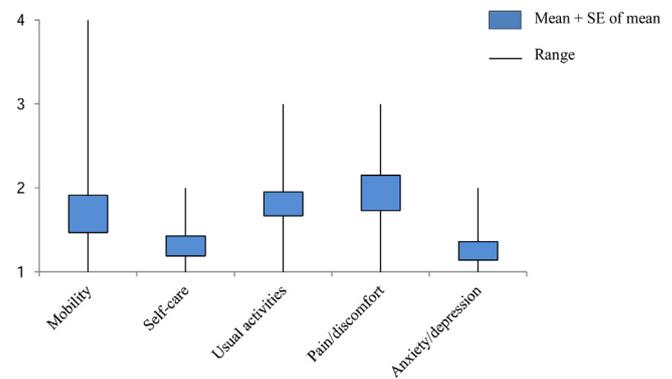
Graph 1. Results of the QoL questionnaire according to the domains of the EQ5D. *A nominal rating scale from 0-4 was used, with a low score indicating no problems and the higher the score the more problems within the domain.

during daily activities however scores for discomfort are worse (Graphs 2 and 3). Complaints regarding exercise were remarkably high, indicating that patients are seriously disabled on that behalf.

The mean EQ-VAS score, representing the respondent's self-rated health score, in our population was 75 out of 100 for patients who had a mesh repair, (Table 5).

Discussion

In a 9-year period a total of twenty-one patients with a traumatic abdominal wall defect due to the trauma were identified (incidence of <0.2%). Treatment depended on the situation, both with respect to timing of reconstruction and repair with or without mesh augmentation. The outcome when using a mesh resulted in significant lower recurrence rate than without mesh augmentation (p = 0.03). Long-term quality of life is decreased in these patients when compared to the healthy reference population. However, our patient population consists merely of polytrauma patients with a median ISS of 25, which makes the interpretation of long term functional outcome difficult to interpret since there are several injuries possibly leading to an impaired quality of life. Our secondary outcomes do correspond to previous investigation for quality of life in trauma patients. [18]

The low incidence found in the present study is comparable to previous studies. [1–4]. Dennis et al [8] report a higher incidence of 3.6% in all admitted blunt trauma patients, but included also grade I and II injuries. When excluding these low-grade injuries, otherwise described as subcutaneous tissue contusion or abdominal wall muscle hematoma, the incidence remains 0.66%, which still is higher than most of the reports. Comparable to our study, all other studies show motor vehicle accidents as most common trauma mechanism [1–5].

Due to the high impact of the trauma, most of the patients suffer concomitant injuries [2–4] with mostly intra-abdominal injury, small bowel or mesenteric. In our study population the most common additional injuries were sternum or costal fractures.

Table 3
Complications and recurrence rates

	Method of repair			Timing of repair		
	Mesh (n = 8)	No mesh (n = 9)	*p-value*	Acute (n = 14)	Delayed (n = 3)	*p-value*
Timing of repair, acute	5	9	0.08	-	-	-
LOS (range)	11 (6-19)	19 (9-60)	0.11	15 (7-60)	9 (6-10)	**0.05**
Complications	5	4	0.64	8	1	0.58
Recurrence	0	5	**0.03**	5	0	0.51
Follow-up (range) - *months*	13 (5-60)	20 (2-35)	0.80	13 (2-60)	23 (9-23)	0.76

Table 4
Reported problems according to the 5 dimensions of the EQ5D

	All patients N = 16	Mesh used N = 7	No mesh used[#]N = 9	Reference population[*]
Mobility, n (%)	8 (50)	4 (57,1)	4 (44,4)	11,5%
Self-care, n (%)	5 (31,3)	2 (28,6)	3 (33,3)	3,4%
Usual activities, n (%)	12 (75)	6 (85,7)	6 (66,7)	13,5%
Pain/discomfort, n (%)	10 (62,5)	5 (71,4)	5 (55,6)	34,2%
Anxiety/depression, n (%)	4 (25,0)	1 (14,3)	3 (33,3)	3,5%
Total of all domains, n (%)	13 (81,3)	6 (85,7)	7 (77,8)	88% [$]

Shown as the percentage of patients reporting any problem within the dimension, e.g. 57,1% of the patients after mesh repair experiences any problem with mobilization.
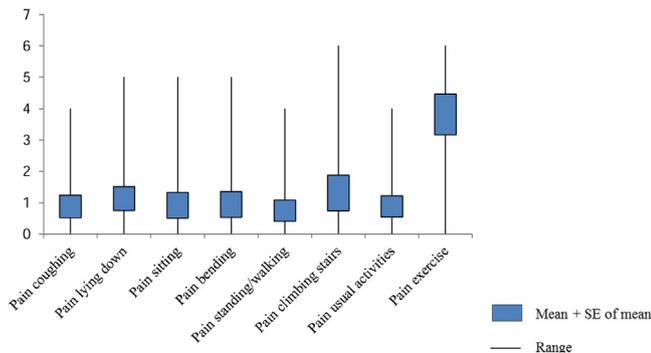[#] 7 patients after surgical repair without mesh, 2 patients treated conservatively.
[*] Reference 17, Janssen B. et al.
[$] Reference 18, Gunning et al.
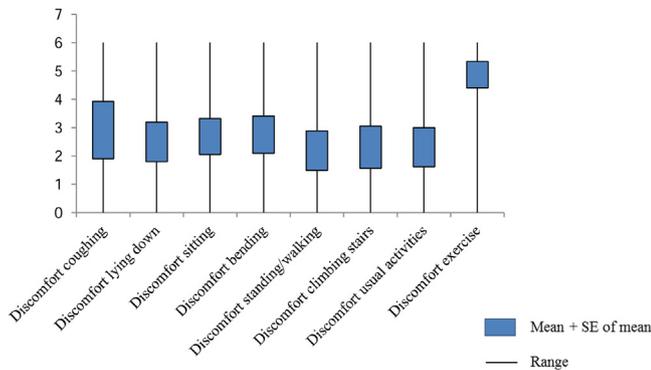
Graph 2. Quality of life questionnaires, hernia score - discomfort.

Graph 3. Quality of life questionnaires, hernia score – pain.

There have been no other studies reporting these diagnoses as concomitant injuries. We found an ISS > 15 (defined as polytrauma) in 17 patients, with a median ISS of 25. This shows that the population in our trauma centre exists mainly of polytrauma patients, with a notable higher ISS compared to other studies (range 17-31). [2,3,5] Recently, Gunning et al [18] have investigated the health related quality of life (HRQoL) in trauma patients. A total of 1870 patients were included, all following admission after trauma. They found that being severely injured was negatively associated with HRQoL. They reported 88% of all trauma patients with at least 1 problem in one of the domains of the EQ5D. This finding corresponds with our secondary outcomes, where 81% of our study population reported any problem within one of the domains of the EQ5D.

Management strategies vary very much in previous reports. Pardhan et al [1] and Honaker and colleagues [3] operated the majority of the defects, respectively 93% and 83% of the patients. This is comparable to our findings, since 81% of our patients underwent a surgical defect repair. Coleman et al [2] and Netto et al [5] have treated most of the TAWDs non-operatively (56% and 76,5%). It is likely that, similar to our study, there were specific reasons to apply non-operative treatment in these considerably sized TAWDs, such as morbid obesity or severe comorbidities or concomitant injuries, but this was not mentioned in their article. Based on our experience we would recommend all patients with a TAWD to be repaired with the use of a mesh. As with ventral hernia repair it is well known that the use of mesh has great advantages with the greatest being significantly less recurrences [12–15]. Possible contra-indications are obvious contamination related to concomitant abdominal injury. Previous reports have shown an increase in surgical site infection when mesh is used in contaminated fields [12,14–16]. Birindelli et al. [12] recommend avoiding the use of a synthetic mesh in cases with gross enteric spillage, they suggest primary repair in small defects or the use of a biologic mesh.

In our population, 29% of the patients developed a recurrence. All of whom were treated in the (semi-)acute period without a mesh. This is on average compared to most previous reports with recurrence ranging from 7.3-50% [1–5]. Most of the recurrences were seen in patients after primary repair, but recurrences were also reported in patients after biologic or synthetic mesh repair [2,5].

This present study is the largest for TAWDs in the Netherlands. For several reasons our management strategy has been consistent throughout the years resulting in a relatively homogenous treatment strategy to this patient population. In addition, a high follow-up rate of 90% was achieved, resulting in a large sample size for assessment of outcomes.

A limitation of this study is the lack of a specific diagnoses code for TAWDs in the Netherlands. The manually collected hernia database throughout the years was crosschecked with trauma registry in our hospital to minimize missing patients.

In conclusion, based on this analysis of our own group of patients, we continue our strategy to operate on these injuries at an early stage by using a mesh in a retromuscular position as

Table 5
Mean EQ-VAS score

	All patients N = 16	Mesh used N = 7	No mesh used N = 9[#]	Healthy population[*]
Mean EQ-VAS	70,6	75,7	65,7	82,0

The EQ VAS records the respondent's self-rated health score on a visual analogue scale from 0 (worst imaginable health state) to 100 (best imaginable health state).
[#] 7 patients after surgical repair without mesh, 2 patients treated conservatively.
[*] Reference 17, Janssen et al.

augmentation, since primarily repair resulted in more recurrences and none of our patients after mesh repair developed a recurrence. However, these severely injured patients are likely to have a decreased quality of life on the long term.

Transparency document

The Transparency document associated with this article can be found in the online version.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.injury.2019.06.028.

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