Clinics in Surgery

Research Article
Published: 10 Sep, 2019

Retrospective Review on the Management of Blunt Aortic Injury at a Level I Trauma Community Hospital from 2003 to 2016

Delquis Mendoza, Mark Walker, Stanston Spence, Philip Ramsay, Katherine Kohler, Amy Wyrzykowski, Vernon Henderson, Walaya Methodius, James Poindexter, Marshall Lutske and Jonathan Nwiloh*

Department of General Surgery, Wellstar Atlanta Medical Center, USA

Abstract

Introduction: The management of blunt aortic injury has changed dramatically over the past three decades. An endovascular approach is now recommended whenever possible. Literature review shows that high volume centers tend to have shorter hospital LOS and fewer complications compared to low volume centers. However, there is no significant difference in mortality. We performed this retrospective study to take a snapshot of our experience on BAI management between the years of 2003 to 2016.

Methods: Trauma patients managed at our community hospital with blunt aortic injury over a 13-year period were reviewed. The patient sample was derived from the trauma registry. 53 patients who received specific treatment of the aortic injury underwent statistical analysis.

Results: For the 53 patients analyzed, their mean ISS was 30 and their mean hospital length of stay was 22 days. The average time to endovascular repair was 1.94 days with a range of 1 to 6 days. 32 out of the 53 patients underwent endovascular repair within 24 h of admission. Orthopedic injuries were the most common associated injuries followed by chest trauma. Close to 70% of the 53-patient cohort were discharged either to home or to an acute rehab facility. Two patients were declared brain dead; three died from cardiac arrest, and one patient died following withdrawal of care as requested by family. In-hospital mortality was 11.32%.

Conclusion: In reviewing our data, patients who did not survive following endovascular repair had severe closed head injuries and ongoing hemorrhage from multisystem organ injuries. It is possible these patients would not have survived even if they were treated at centers with much higher number of cases per year. Timing of endovascular repair could be another factor affecting mortality. Most of our patients had interventions within 24 h of admission. As we plan for the future, we will closely monitor grading of injuries and timing of endovascular repair.

OPEN ACCESS

Correspondence:
Delquis Mendoza, Department of General Surgery, Wellstar Atlanta Medical Center, USA,
E-mail: Delquis.caro@wellstar.org

Received Date: *25 Jul 2019*
Accepted Date*: 06 Sep 2019*
Published Date*: 01 Jan 2020*

Citation:
Mendoza D, Walker M, Spence S, Ramsay P, Kohler K, Wyrzykowski A, et al. Retrospective Review on the Management of Blunt Aortic Injury at a Level I Trauma Community Hospital from 2003 to 2016. Clin Surg. 2019; 4: 2568.

Introduction

The management of Blunt Aortic Injury (BAI) has changed dramatically over the past three decades. Innovations in imaging have provided a rapid and accurate diagnosis. CT of the chest with contrast has become a widely used tool in the diagnosis. Angiography, the historical gold standard, is reserved for equivocal CT results [1-2].

BAI management has shifted from open repair to a minimally invasive endovascular approach whenever possible. The previous notion of immediate repair due to a high risk of rupture has been replaced by delayed intervention with thanks to the implementation of rigorous blood pressure control. This decreases aortic wall stress and the risk of rupture [1].

Demetriades in a Scudder oration on trauma noted that we have crossed the Rubicon and will never go back to how we managed this injury in the past. Nevertheless, there are contraindications to keep in mind when evaluating patients for endovascular repair. Such contraindications include anaortic diameter less than 15 mm, injury in the mid aortic arch requiring coverage of the left common carotid artery, and left vertebral origin on the aortic arch with an uncollateralized posterior inferior communicating artery [3-4].

Review of the literature suggests that high volume centers tend to have shorter hospital length of stays and fewer systemic complications compared to low volume centers [4]. However, there is no significant difference in mortality in patients with BAI managed at low *vs.* high volume centers [5]. We performed this retrospective study to take a snapshot of our experience on BAI management between the years of 2003 to 2016. In doing so, we planned to identify areas of strength as well of areas of weakness to improve the overall care provided.

Methods

All trauma patients managed at our community hospital with a fully accredited surgical residency training program and a level 1 trauma designation with blunt aortic injury over a 13-year period were reviewed. The patient sample was derived from the trauma registry. The diagnosis codes of 441.00, 441.01, and 901.0 for ICD-9-CM were used to identify patients with aortic injuries. Each medical record was reviewed and only those patients with blunt aortic injury were selected for further analysis. Those patients who died in the emergency department or within the first 4 h of admission were excluded from analysis. Only patients who received specific treatment of the aortic injury were included. Demographic variables used included; age, sex, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), blood pressure, pulse, lactate, base deficit, coagulation parameters (PT, PTT, INR), ventilator days, intensive care unit length of stay, hospital length of stay and outcome. Complications were catalogued, graft sizes were recorded and the technical detail of covering the left subclavian with the graft or deploying the graft without covering the left subclavian was recorded. Left arm ischemia was specifically looked for in the hospital record. Associated injuries were recorded and the need for additional surgery prior to repair of the aortic injury was documented. Continuous variables were analyzed using the Student's t-test and categorical variables were analyzed using chi-square. Survivors and non-survivors were compared. Patients older than 65 were compared to those younger than 65. Logistic regression was used to determine outcome based on age, lactate, ISS, time to endovascular repair among other variables.

Results

The trauma registry was researched for patients documented to have suffered a blunt aortic injury. A total of 98 patients were found, but 25 subjects were excluded because hospital stay was less than 48 h or patients expired shortly after arriving to the trauma bay. Of the 73 patients remaining, complete data could be found for 53 patients. General demographic and disposition data for the 73 patients was available and cataloged in Table 1. Among the 73-patient's cohort, mean age was 41 with a range of 15 to 89; mean ISS was 30.15; mean GCS was 11 and hospital length of stay was about 21.76 days. Approximately, 71% of patients were discharged to either home or to an acute rehab facility. 30-day in-hospital mortality was found to be 12.32%. Four out of the 9 mortalities in this 73-patient group were due to severe traumatic brain injuries leading to brain death; four were due to cardiac arrest and one had severe abdominal trauma with complete necrosis of the entire small intestine, which prompted withdrawal of care per relatives.

The demographics for the 53-patient cohort are outlined in Table 2. These patients were used for regression analysis, student's T test, and chi square test. Their mean ISS was 30 and their mean hospital length of stay was 22 days. The average time to endovascular repair was 1.94 days with a range of 1 to 6 days. 32 out of the 53 patients underwent endovascular repair within 24 h of admission. This table also shows associated injuries. Orthopedic injuries were the most

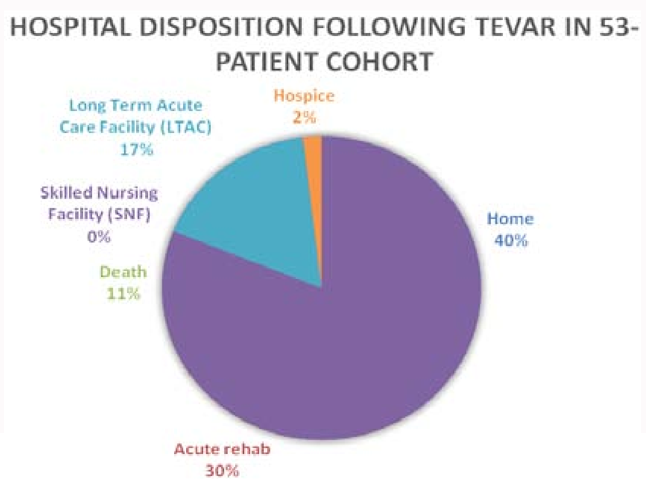

Chart 1: Hospital disposition following TEVAR in the 53-patient cohort.

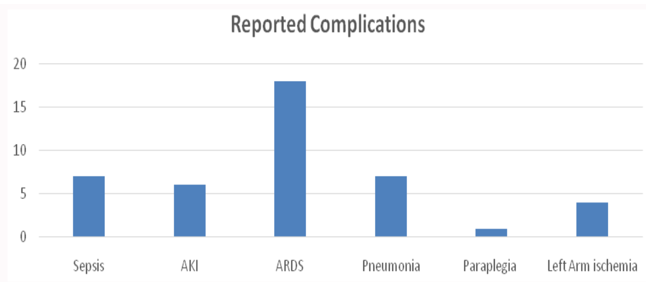

Chart 2: Reported complications in the 53-patient cohort.
AKI: Acute Kidney Injury; ARDS: Acute Respiratory Distress Syndrome

Table 1: General characteristics and disposition of the 73-patient cohort.

	73-patient group
Mean age Years (SD)	41.4 (19)
Race (%)	
White	22 (29.73)
Black	18(24.33)
Hispanic	3 (4.05)
Other	3 (4.05)
Unknown	28 (37.84)
ISS mean (SD)	30.15 (9.02)
GCS mean (SD)	11 (5.34)
ICU LOS Days mean (SD)	18.12 (14.06)
Hospital LOS Days mean (SD)	21.76 (14.19)
Hospital Disposition (%)	
Acute rehab	*26 (35.62)*
Home	*27 (36.99)*
Death	*9 (12.32)*
Skilled Nursing Facility (SNF)	*5 (6.85)*
Long Term Acute Care Facility (LTAC)	*4 (5.48)*
Another Hospital	*1 (1.37)*
Hospice	*1 (1.37)*
In Hospital Mortality (%)	*12.32*

LOS: Length of Stay; GCS: Glasgow Coma Scale; SD: Standard Deviation

Table 2: Epidemiologic and clinical characteristics of the 53-patient cohort.

	53-patient group
Mean age years (SD)	*41.98 (18.17)*
Race (%)	
White	*35 (64.81)*
Black	*15 (27.78)*
Unknown	*3 (5.56)*
ISS mean (SD)	*30.02(8.01)*
Associated Injuries:	
Rib fractures	*23/53*
Diaphragm injury	*7/53*
Spleen Injury	*12/53*
Liver Injury	*8/53*
Orthopedic injuries	*34/53*
Bowel Injuries	*8/53*
Vertebral Injuries	*16/53*
Pulmonary contusions	*19/53*
Pneumothorax/Hemothorax	*26/53*
GCS mean (SD)	*9.91 (5.76)*
Admission Pulse mean (SD)	*104.85 (21.56)*
Admission SBP mean (SD)	*122.47 (22.91)*
Admission DBP mean (SD)	*77.92 (19.57)*
Serum Lactate mean (SD)	*3.18 (2.19)*
ICU LOS Days mean (SD)	*18.30 (13.09)*
Hospital LOS Days mean (SD)	*21.86 (13.49)*
Time to endovascular repair mean (SD)	*1.94 (1.52)*
Left Subclavian Artery Coverage	*9*
Subclavian-Carotid bypass	*4*
Outcome (% survivors)	*47/53 (88.68)*
In-hospital Mortality	*11.32%*

LOS: Length of Stay; GCS: Glasgow Coma Scale; SD: Standard Deviation

common associated injuries followed by chest trauma. A total of 8 patients were reported to have bowel injuries and underwent bowel resection or primary repair. 9 patients had left subclavian artery covered after TEVAR. 4 of these 9 patients required a carotid artery to left subclavian artery bypass due to development of ischemic symptoms in the postoperative period. Close to 70% of the 53-patient cohort were discharged either to home or to an acute rehab facility (Chart 1). In this group, two patients were declared brain dead; three died from cardiac arrest, and one patient died following withdrawal of care as requested by family. In-hospital mortality was 11.32%.

The most common complication reported was ARDS (Chart 2), which comprised 34% of patients. There was one patient who developed paraplegia following endovascular repair, but this patient suffered cardiac arrest a few days after TEVAR. Therefore, full assessment of the paraplegia and potential functional recovery was not possible. Patients were stratified into those older or less than 65 years of age (Table 3). The average serum lactate, hospital length of stay, ICU length of stay, and GCS were similar between the two groups. ISS and admission pulse were lower in the older cohort.

Table 3: Stratification of the 53-patient cohort into patients older or younger than 65 years of age.

	Age >65 years old (n=7)	Age <65 years old (n=46)	p-value
Mean age years (SD)	72.14 (5.08)	37.39 (14.73)	0.0008
Race (%)			
White	7 (100)	28 (60.87)	-
Black	0 (0)	15 (32.61)	
Unknown	0 (0)	3 (6.52)	
ISS mean (SD)	26.57 (5.04)	30.50 (8.25)	0.2226
GCS mean (SD)	9.85 (5.94)	9.91 (5.73)	0.9398
Admission Pulse mean (SD)	94.14 (15.49)	106.48 (21.89)	0.1936
Admission SBP mean(SD)	129.14 (22.02)	121.46 (22.87)	0.4506
Admission DBP mean (SD)	80.57 (16.74)	77.52 (19.94)	0.7358
Serum Lactate mean (SD)	2.97 (2.72)	3.05 (2.09)	0.8550
ICU LOS Days mean (SD)	19 (11.28)	18.19 (14.02)	0.9842
Hospital LOS Days mean (SD)	20.86 (12.41)	22.02 (13.64)	0.3400
Time to endovascular repair days mean, (SD)	2.71 (1.90)	1.83 (1.42)	0.1474
Outcome (% survivors)	6/7=85.71	41/46=89.13	-

ICU: Intensive Care Unit; n: Sample Size; LOS: Length of Stay; GCS: Glasgow Coma Scale; SD: Standard Deviation

Time to endovascular repair was longer in the older group on average, 2.71 days vs. 1.83 days. In-hospital mortality was higher in the older group at 14.29% *vs.* 10.87%.

In Table 4, the survivor group was compared with the non-survivor group. On admission, the non-survivor group was noted to have a lower GCS, higher ISS and higher lactate levels. The mean time to endovascular repair was lower in the non-survivor group 1.5 days *vs.* 2.0 days in the survivor group. On average, more RBC units were transfused in the non-survivor, 24.57 units *vs.* 5.42 units in the survivor group and this difference was statistically significant. Overall, regression analysis and t-tests on our dataset showed that ISS and lactate level are predictive of survival. Similarly, the more RBC units transfused was correlated with increased mortality.

Discussion

Endovascular repair of blunt aortic injuries has become the preferred approach whenever feasible. It is associated with significant reduction in hospital mortality 7.2% from 23.5% for the open approach [6]. Endovascular repair is also associated with decreased rate of complications such as paraplegia or stroke when compared to the open technique [6,7]. Endovascular repair has its own set of complications such as stent migration, collapse, or leaks among others [8]. Open repair is left for patients who are not anatomically suitable for endovascular repair, such as those with ascending or transverse aortic arch injuries [9].

Furthermore, high volume centers, those with more than 20 endovascular cases per year, tend to have shorter hospital length of stays and fewer systemic complications compared to low volume centers. This is likely due to higher allocation of resources to the care of the acutely injured. Such resources are not only used to obtain the latest instruments or hybrid operating rooms, but they ensure the ongoing training of staff taking care of these patients. They also

Table 4: Comparison between survivors and non-survivors in the 53-patient cohort.

	Survivor (n=47)	Non-Survivor (n=6)	P-values
Mean age in years (SD)	*41.45 (17.88)*	*44.28 (17.65)*	0.310933
Race n (%)			
White	*31 (65.96)*	*5 (71.43)*	
Black	*13 (27.66)*	*1 (28.57)*	
Unknown	*3 (6.38)*	*0(0.0)*	
ISS mean (SD)	*29.00 (7.31)*	*40.00 (5.85)*	0.044878
GCS mean	*10.3*	*6.83*	0.54272
Admission Pulse mean (SD)	*104.78 (22.19)*	*105.33 (12.81)*	0.774314
Admission SBP mean (SD)	*123.17 (21.26)*	*117.00(31.41)*	0.281441
Admission DBP mean (SD)	*78.49 (18.56)*	*73.50 (24.65)*	0.7358
Serum Lactate mean (SD)	*2.52 (1.27)*	*7.20(3.03)*	0.000055
ICU LOS Days mean (SD)	*19.83(12.85)*	*6.33 (5.62)*	0.147695
Hospital LOS Days mean (SD)	*23.85 (12.77)*	*6.33 (5.62)*	0.140951
Time to endovascular repair Days mean (SD)			
	1–6	*1–3*	
Mean RBC Units Transfused			
	5.42	*24.57*	

RBC: Red Blood Cell; ICU: Intensive Care Unit; N: Sample Size; LOS: Length of Stay; GCS: Glasgow Coma Scale; SD: Standard Deviation

develop management protocols, which ultimately lead to better outcomes as compared to low volume centers [4-7].

In reviewing our data, patients who did not survive following endovascular repair had severe closed head injuries, that often led to brain death. The non-survivor group also had ongoing hemorrhage from multisystem organ injuries as is reflected by the higher number of red blood cells units transfused in this group. It is likely these patients would not have survived even if they were treated at centers with much higher number of cases per year.

Another possibility for increased mortality in our study group is timing of endovascular repair. In a prospective, observational multicenter study performed by Demetriades et al., [4-7] it was found that endovascular cases per year, tend to have shorter hospital length of stays and fewer systemic complications compared to low volume centers. This is likely due to higher allocation of resources to the care of the acutely injured. Such resources are not only used to obtain the latest instruments or hybrid operating rooms, but they ensure the ongoing training of staff taking care of these patients. They also develop management protocols, which ultimately lead to better outcomes as compared to low volume centers.

While delayed repair seems to be correlated with improved outcomes, early repair may not be the predictive factor for mortality in severely injured patients. In our study population, 32 out of 53 patients had their endovascular repair within 24 hours. It is possible many of these injuries were not deemed stable and suitable for delayed repair. For stable injuries, it has been shown that aggressive blood pressure control decreases risk of rupture of stable injuries from 12% to 1.5% [9]. At our institution, we have emphasized aggressive blood pressure and heart rate control for every patient with blunt aortic injury. We utilize beta blockade with esmolol initially. We aim for a systolic blood pressure less than 110 mmHg and heart rate less than 100 BPM. As we plan for the future, we will closely monitor grading of injuries and timing of endovascular repair.

Some of our prolonged length of stay is related to the initial pattern of injury. Severe closed head injury as reflected in the low initial GCS often requires steps to control cerebral edema with osmotic therapy, intracranial pressure monitoring and mechanical ventilatory support. All of this requires time to allow the brain to recover. In addition, ARDS and pulmonary complications contributed to the prolonged length of stay because of the need for mechanical ventilator support. We continue to utilize aggressive pulmonary toilet, multimodal pain control strategies, and lung protective mechanical support to help minimize complications related to chest trauma.

Literature review shows that in up to 35% of blunt thoracic aortic injuries, the left subclavian artery may need to be covered during stent placement [11-12]. Total coverage of the left subclavian artery without revascularization increases the prevalence of left arm ischemia [12]. A systematic review performed by Sepehripour et al., revealed that partial coverage of the left subclavian artery is better than complete coverage in terms of avoiding postoperative ischemic complications. In our review, coverage of the left subclavian artery was reported in 9 patients and carotid to subclavian bypass was performed in 4 patients due to ischemic symptoms. Moving forward, partial coverage of the left subclavian artery will be implemented to reduce that complication.

A total of 8 patients had bowel injuries that required open repair or resection. In 7 out of the 8 cases, laparotomy was performed prior to endovascular repair of the aortic injury, which is the ideal and recommended approach in the literature [10]. The other patient had a delayed presentation of the small bowel injury and had undergone a TEVAR at the time of exploratory laparotomy. This patient was discharged to an acute rehabilitation facility in stable condition.

As a retrospective study, there are always limitations regarding data collection, misclassification of data, selection bias and incomplete follow up. A prospective evaluation with more accurate reporting and larger sample size are needed to provide a more complete analysis.

Conclusion

This retrospective study of our hospital experience emphasizes beta-blockade, blood pressure control and endovascular repair as hallmarks of a standard approach to this injury. We have identified prolonged length of stay as a multi-factorial problem that will be addressed moving forward. This work provides a solid foundation for developing and implementing quality improvement protocols to decrease mortality and post-operative complications at our Level I trauma community hospital.

References

1. Fox N, Schwartz D, Salazar JH, Haut ER, Dahm P, Black JH, et al. Evaluation and management of blunt traumatic aortic injury: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2015;78(1):136-46.
2. Kolbeck KJ, Kaufman JA. Endovascular Stent Grafts in Urgent Blunt and Penetrating Thoracic Aortic Trauma. Semin Intervent Radiol. 2011;28(1):98-106.
3. Demetriades D. Blunt thoracic aortic injuries. Crossing the Rubicon. J Am Coll Surg. 2012;214(3):247-59.
4. Demetriades D, Velmahos GC, Scalea TM, Jurkovich GJ, Karmy-Jones R, Teixeira PG, et al. Operative Repair or Endovascular Stent Graft in Blunt Traumatic Thoracic Aortic Injuries: Results of an American Association for The Surgery of Trauma. Multicenter Study. J Trauma. 2008;64(3):561-70.
5. Iacobellis F, Ierardi AM, Mazzei MA, Magenta Biasina A, Carrafiello G, Nicola R, et al. Dual-Phase CT for the assessment of acute vascular injuries in high-energy blunt trauma: the imaging findings and management implications. Br J Radiol. 2016;89(1061):20150952.
6. Demetriades D, Velmahos GC, Scalea TM, Jurkovich GJ, Karmy-Jones R, Teixeira PG, et al Operative Repair or Endovascular Stent Graft in Blunt Traumatic Thoracic Aortic Injuries: Results of an American Association for The Surgery of Trauma Multicenter Study. J Trauma. 2008;64(3):561-70.
7. Fox N, Schwartz D, Salazar JH, Haut ER, Dahm P, Black JH, et al. Evaluation and management of blunt traumatic aortic injury: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2015;78(1):136-46.
8. Brenner M, Teeter W, Hadud M, Hoehn M, O'Connor J, Stein D, et al. Long-Term outcomes of thoracic endovascular aortic repair: A single institution's 11-year experience. AAST 2016 Plenary Paper. J Trauma Acute Care Surg. 2017;82(4):687-693.
9. Avery LE, Stahlfeld KR, Corcos AC, Scifres AM, Ziembicki JA, Varcelotti J, et al. Evolving role of endovascular techniques for traumatic vascular injury: A changing landscape? J Trauma Acute Care Surg. 2012;72(1):41-6.
10. Demetriades D, Velmahos GC, Scalea TM, Jurkovich GJ, Karmy-Jones R, Teixeira PG, et al. Blunt Traumatic Thoracic Aortic Injuries: Early or Delayed Repair-Results of an American Association for the Surgery of Trauma Prospective Study. J Trauma. 2009;66(4):967-73.
11. Branco BC, DuBose JJ, Zhan LX, Hughes JD, Goshima KR, Rhee P, et al. Trends and outcomes of endovascular therapy in the management of civilian vascular injuries. J Vasc Surg. 2014;60(5):297-1307.e1.
12. Miller LE. Potential Long-Term Complications of Endovascular Stent Grafting for Blunt Thoracic Aortic Injury. Review article. Scientific World J. 2012; 2012: 897489.
13. Sepehripour AH, Ahmed K, Vecht JA, Anagnostakou V, Suliman A, Ashrafian H, et al. Management of the Left Subclavian Artery during Endovascular Stent Grafting for Traumatic Aortic Injury -A systematic Review. Eur J Vasc Endovasc Surg. 2011;41(6):758-69.
14. Patel VI, Mukjppadhyay S, Ergul E. Impact of hospital volume and type on outcomes of open and endovascular repair of descending thoracic aneurysms in the United States Medicare population. J Vasc Surg. 2013;58(2):346-54.