International Surgery Journal
Weller J et al. Int Surg J. 2021 Mar;8(3):784-788
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20210906

Original Research Article

Trends and outcomes in the management of vascular trauma: institutional experience at a level 1 trauma center

Justin Weller[1]*, Madison Bowles[2]

[1]Department of Vascular Surgery, Gold Coast University Hospital, Queensland, Australia
[2]Department of Surgery, Logan Hospital, Queensland, Australia

Received: 03 February 2021
Accepted: 11 February 2021

***Correspondence:**
Dr. Justin Weller,
E-mail: weller.justinj@gmail.com

ABSTRACT

Background: Vascular trauma remains a complex area for clinicians and its management is constantly evolving. The increasing use of endovascular modalities and non-operative management has led to significant changes in the treatment of vascular trauma. The aim of this study was to identify the current management and outcomes of vascular trauma at a Level 1 trauma centre in Queensland, Australia and compare this with the current literature.
Methods: All individuals who presented to GCUH with vascular injuries between January 2014 and December 2019 were identified from the GCUH trauma database. A descriptive analysis was performed on this cohort.
Results: 213 patients were identified in our cohort; 51 were managed non-operatively, 121 were managed with open surgery, 37 were managed endovascularly and 4 had a combination of open and endovascular intervention.
Conclusions: The proportion of vascular injuries managed with endovascular interventions or non-operatively has increased within the study period. This study shows that the trends of management for vascular trauma in Australia are consistent with recent international literature.

Keywords: Vascular trauma, Intervention, Endovascular, Mortality

INTRODUCTION

Vascular trauma is a constantly evolving field that continues to challenge modern clinicians. It can be defined as any injury to either a named arterial or venous vessel that results from trauma.[1] The most recent Australian study at high volume centre found that vascular trauma accounted for 3.2% of all trauma admissions and was increasing over time.[2] Furthermore, the literature suggests that the mortality rate of vascular trauma lies between 18 and 26%.[3-5] Given that this is dramatically higher than the mortality for overall trauma reported in Australia it is clear that vascular trauma and its treatment are a crucial aspect of trauma management at any institution.[6] Traditionally, vascular injuries were managed with open procedures, which included primary repair, venous/synthetic grafts and temporising intravascular shunts.[7] While these remain an important aspect of the treatment of vascular injury, there have been significant developments as medical technology has advanced. The advent of endovascular surgery has changed this dynamic significantly. Despite first being used for elective procedures in the 1970s, its first recorded use in trauma in the US was in 1997.[8] The expanded availability and institutional experience with endovascular techniques has led to its increasing use over the last two decades. One 2014 US study showed that there was an overall increase of 0.4 to 13.2% in the use of endovascular procedures for vascular trauma between 2002 and 2010, while Richmond et al showed an increase from 0 to 32% from 2005 to 2013.[9-11] This has also been reflected in anatomical area specific studies.[12,13] For example, Weinberg et al showed that the use of endovascular repair in cervicothoracic injury is an emerging field.[12] A 2008 US study examining thoracic

aortic trauma demonstrated an increase from 0 to 67% in the use of endovascular intervention between 1997-2007, while endovascular repair in the extremities is also being increasingly used.[11,13] However, while the changing nature of treatment of vascular trauma has been studied in other countries, it has not been examined in an Australian population.

A literature review revealed only two studies examined the epidemiology of vascular trauma in Australia over the last 20 years. Both of these studies were undertaken at the same institution, the Royal Perth hospital (RPH), with the most recent data taken from 2010.

There have been no studies which have examined management of vascular trauma in an Australian population. This clearly shows that there is a lack of current evidence on the epidemiology, trends and outcomes of vascular trauma management in Australia. This study was designed as a sub analysis of a larger study of vascular trauma undertaken by the same authors. It examined data from the Gold Coast university hospital (GCUH), a level 1 trauma centre in Queensland, Australia. It was first opened in 2013 and designated a level I trauma centre in 2019. Similar to RPH, GCUH is a major referral centre for a wide variety of both regional and urban institutions. While GCUH does have paediatric medicine and surgical teams, it is not a dedicated children's hospital. Paediatric trauma is primarily received by the nearby children's hospital.

The research questions for this study were: What are the current trends in management of vascular trauma at a Level 1 Trauma Centre? How do the current trends in vascular trauma compare with the established literature?

METHODS

This study was approved by the GCUH human research and ethics committee, reference number 61769. All individuals who presented to GCUH with a vascular injury from January 2014 to December 2019 were identified from the GCUH prospective trauma database. A vascular injury was defined as any injury occurring to a named vessel that was diagnosed either intra-operatively or by imaging. This database is collated by dedicated research assistants from the patient's time of arrival to eventual hospital discharge. Pre-hospital data was assimilated from a number of sources, including paramedics, police reports and patient assessment. Additional data collection was undertaken by 2 independent researchers for any missing data points. This information was accessed from the GCUH electronic medical record (EMR). Both the trauma database and the EMR were accessed retrospectively for this study. The individuals identified from the database also included patients who initially presented to peripheral hospitals but were transferred to GCUH for ongoing management. The inclusion criteria were patients aged 14 years and older who presented to GCUH with vascular injuries within this time period. Fourteen was chosen for a number of reasons. Fourteen is the age agreed to at GCUH for the changeover between adult and paediatric surgical management. Furthermore, paediatric vascular trauma is rare and its management has a number of complicating factors.[14] In addition, GCUH, as stated above, is not a dedicated children's hospital and most paediatric trauma patients are diverted to the nearby children's hospital. For all these reasons, paediatric vascular trauma was not included.

Patients with solely intracranial vascular injuries were excluded, which is consistent with previous literature.[4,15] It is commonly acknowledged that neurotrauma has different management strategies.[16,17] If patients presented with intracranial vascular injuries and other vascular injuries, they were included for their extracranial injuries only. Patients were also excluded if they died pre-hospital, either at the scene of incident or in-transit. This was defined as patients who still had cardiac output either on arrival or at some time during their hospital stay. Therefore, patients who arrived at hospital with cardiopulmonary resuscitation (CPR) occurring who never had spontaneous return of circulation were excluded. However, if CPR occurred pre-hospital or was occurring on arrival and spontaneous return of circulation occurred (i.e., CPR was ceased and the patient was alive), the patient was included. Injuries were classified using the abbreviated injury score (AIS 2008 prior to 2015 and AIS 2015 for the subsequent years). The five major vascular injury groups as defined by the AIS code, namely neck, thorax, abdomen, upper and lower limbs, were analysed. Demographic information gathered included age, gender, mechanism of injury, involvement of drugs and alcohol and injury severity as determined by the injury severity score (ISS). The primary outcome was determining the type of vascular intervention. Mode of vascular intervention was determined as non-operative, endovascular, open and both endovascular and open. Secondary outcomes were mortality and amputations.

If patient data required for this project was not included in the prospective trauma database, the information was taken from the Gold coast health service (GCHS) electronic medical record. The trauma database and GCHS electronic records currently classify gender as male, female or unspecified. All patients in our cohort were male or female. The use of drugs or alcohol was determined by whether they had been consumed by the patient within 12 hours of the injury. Those patients involved in incidents where another person was under the influence of drugs or alcohol but themselves had not consumed either, were documented as 'not contributing to injury'. Drugs were defined as recreational drugs as well as deliberate or accidental overdoses of prescription medications. Mortality was defined by whether the patient died within 30 days of injury in the same hospital admission. Any patients who were discharged and subsequently died within 30 days were documented as 'no' for mortality.

Statistical analysis was performed using the statistical package for the social sciences (SPSS) program. SPSS is a statistical software application available for use on home computers. The patient data was not uploaded onto any online server and was kept secure at all times. The software was used to undertake a descriptive analysis of the cohort as well as a multivariate statistical analysis of the variables listed above. A p value of less than 0.05 was deemed statistically significant. A confidence interval of 95% was also used on all calculations of statistical significance.

RESULTS

During the six-year study period, from January 2014 to December 2019, there were a total of 5454 trauma admissions at GCUH, as documented in the prospective trauma database. There were 234 patients who fit the initial inclusion criteria for vascular trauma. After removal of those patients who fulfilled the exclusion criteria, there were 213 patients with vascular trauma during the study period.

The demographics of the cohort can be found in Table 1.

Table 1: Demographics of the cohort.

Demographic	Period						
	2014	2015	2016	2017	2018	2019	Total
Gender (%male)	74	82	95	90	79	86	83.6
Age (mean)	43	41	36	47	48	54	44.5
Mechanism of injury (% blunt)	69	67	70	70	69	66	68.5
Alcohol (% involved)	26	18	8	17	17	28	19
Drugs (% involved)	10	15	2.7	83	17	17	13
Rural/Interhospital transfer	14	21	19	10	26	24	19
Injury severity score	17.8	19.0	20.8	17.8	20.6	14.9	18.7
Hospital length of stay (days)	16	14	12	20	16.0	9.3	14.7
ICU length of stay (days)	2.1	1.6	1.2	1.8	3.7	4.0	2.4

Vascular surgical intervention was divided into 'non-operative, 'open', 'endovascular', or 'endovascular and open'. While some patients required multiple interventions, the number of total interventions is not represented in the data, as seen in Table 2. Overall, 162 of the patients required vascular intervention, while 51 required no intervention. The breakdown for the interventions was 121 patients required open procedures (56.8%), 37 required endovascular procedures (17.3%) and 4 required both open and endovascular procedures (1.9%) (Table 2).

The Use of endovascular procedures increased substantially throughout the study period. Only 9% of vascular trauma cases included endovascular management in 2014, compared with 24.1% in 2019. Use of non-operative management also appears to have increased, with 19.6% of cases in 2014 and 27.6% in 2019.

The secondary outcomes of mortality and amputations can be seen in Table 3.

The breakdown of intervention by anatomical group can be seen in Table 4.

Table 2: Primary outcome-mode of intervention.

Intervention	N (%)
Non-operative	51 (30)
Open	121 (56.8)
Endovascular	37 (17.3)
Open and endovascular	4 (1.9)

Table 3: Secondary outcomes.

Outcome	Mortality	Amputation
Non-operative	7	1
Open	6	8
Endovascular	3	0
Open and endovascular	2	1

Table 4: Mode of intervention by anatomical group.

Anatomical area	Neck	Thorax	Abdomen	Upper limb	Lower limb
Non-operative	32	2	11	3	3
Open	14	7	28	47	26
Endo-vascular	0	4	27	2	4
Open and endovascular	0	2	2	0	1

DISCUSSION

The management of vascular trauma is complex, and this is reflected in our study. Like all trauma, the approach to management of vascular injuries is determined by a number of factors, including patient disposition, clinical signs, radiological findings, associated injuries and concomitant operations.

A 2014 study from Jacks et al examining the US national trauma data bank, found that over the period from 2002 to 2010, the use of endovascular intervention increased from 1.0 to 10.8%.[18] Our study found that overall, 17.4% of our cohort underwent endovascular procedures and 56.8% underwent open procedures. A small percentage also underwent combined open and endovascular procedures. This figure shows a dramatic increase from that in the Jacks et al study, which likely reflects the trend in Australia for the increased use of endovascular surgery in trauma. There did appear to be a slight increasing trend over the study time period in our cohort. As the use of endovascular approaches in vascular trauma patients has not been studied previously in an Australian population there is no data for comparison. The difference between the Australian and US data likely reflects the ongoing increased use of endovascular therapy, however, it is also likely affected by the fact the US trauma data bank includes data from institutions which are without access to endovascular intervention, whereas GCUH has endovascular facilities available at all times. GCUH is also a major referral centre, so cases which cannot be managed at facilities without endovascular facilities may be transferred to this facility.

An important consideration when examining the increasing use of endovascular interventions for trauma is whether their increased use has led to any changes in overall outcomes. Desai et al found in their study that overall endovascular intervention for trauma had good long-term technical success, limited by centre experience and availability of facilities.[19] They argue that endovascular intervention adequately achieves the goals of haemorrhage control, particularly in areas when definitive repair would otherwise be difficult. They conclude that while it is a viable option in many patients, those with multiple injuries are likely better served with an open approach. In other institutions, injuries otherwise suitable for endovascular intervention may be treated non-operatively or with open procedures.

Over the past few decades, there has been a major shift from operative to selective non-operative management of traumatic injuries.[20] This approach was developed in paediatric trauma and was initially adopted in adults for management of solid organ injuries. This approach has increasingly been utilised for vascular trauma. Studies from Wahlgren and Stawicki et al highlight the potential utilisation of non-operative management in various types of vascular injuries.[20,21] Non-operative management includes appropriate resuscitation, thorough and repeated assessment, relevant investigations and imaging, as well as involvement by appropriate specialties. Our study findings have reflected this trend of non-operative approach to vascular injury, increasing from 19% of injuries in 2014 to 28% of injuries in 2019 being managed non-operatively.

Mortality was highest in the non-operative group. It is difficult to make an accurate comparison of outcomes between interventions in our cohort, as the method of intervention relies on the specific injury, associated injuries, patient stability and other procedures. However, it is clear that patients who died prior to intervention or where intervention was deemed futile would be included in the 'non-operative' group. While this was a small percentage, this does overestimate somewhat the use of non-operative management at GCUH. A more in-depth analysis of non-operative management of vascular trauma would be a possible area for future research.

As mentioned previously, the treatment of vascular trauma is also an evolving field. There has been increasing evidence internationally of the management and outcomes of endovascular intervention in anatomical specific studies. Alderazi et al demonstrate the significant impact of vascular injuries in the neck, with high mortality and significant morbidity secondary to stroke, both haemorrhagic and ischaemic.[22] Our findings are consistent with this, with a mortality rate of 17.8%. Neck trauma also had the highest rate of non-operative management, which likely reflects vertebral artery injuries often being managed non-operatively, as well as often non-survivable injuries to the cervical vasculature and other associated injuries.[22,23]

Thoracic vascular injuries are often devastating, with an extremely high mortality rate reported in the literature.[24] Thoracic aortic trauma has been suggested as the 2nd most common cause of death in trauma, behind only intracranial injury. It is also an area which has shown increasing use of endovascular therapies. Thoracic vascular trauma is well studied internationally, particularly aortic trauma. Xenos et al found decreased mortality in the endovascular group of their meta-analysis of open vs endovascular.[25] Much like the international literature, our study found that thoracic vascular injury had significant mortality. It further demonstrated that endovascular intervention was a viable therapeutic option in such injuries.

There were some limitations to this study. The most significant is the study is retrospective although the data was gathered prospectively. Furthermore, the sample size was small. The complications and associated injuries were also not analysed in this study, which should be addressed in further research.

CONCLUSION

Our experience with vascular trauma at the GCUH level one trauma centre shows that the management of vascular trauma is a complex, evolving field. The proportion of injuries managed through endovascular and non-operative methods has increased over the study period,

which is consistent with the international literature. This study adds to the body of research on this topic in an Australian population and it provides clear areas where further research can be undertaken. These areas include analysing complications and associated injuries as well as an in-depth analysis of the factors affecting treatment choice.

ACKNOWLEDGEMENTS

Authors would like to thank gold coast university hospital trauma service, gold coast university hospital department of vascular surgery

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Rohrer M. Vascular Trauma. Society for Vascular Surgery. https://vascular.org/patient-resources/vascular-conditions/vascular-trauma. 2020. Accessed March 10, 2020.
2. Friend J, Rao S, Sieunarine K, Woodroof P. Vascular trauma in Western Australia: a comparison of two study periods over 15 years: Vascular trauma in Western Australia. ANZ J Surg. 2016;86:173-8.
3. Perkins ZB, De'Ath HD, Aylwin C, Brohi K, Walsh M, Tai NRM. Epidemiology and Outcome of Vascular Trauma at a British Major Trauma Centre. Eur J Vascular Endovascular Surg. 2012;44:203-9.
4. Loh SA, Rockman CB, Chung C, BS. Existing trauma and critical care scoring systems underestimate mortality among vascular trauma patients. Journal of Vascular Surgery. 2011;53:359-66.
5. Sugrue M, Caldwell EM, Damours SK, Crozier JA, Deane SA. Vascular injury in Australia. Surg Clin North Am. 2002;82(1):211-19.
6. DiMaggio C, Ayoung-Chee P, Shinseki M. Traumatic injury in the United States: In-patient epidemiology 2000-2011. Injury. 2016;47:1393-403.
7. Oliver JC, Gill H, Nicol AJ, Edu S, Navsaria PH. Temporary vascular shunting in vascular trauma: A 10-year review from a civilian trauma centre. South Afr J Surg. 2013;51:6-10.
8. Jacks R, Degiannis E. Endovascular Therapy and Controversies in The Management of Vascular Trauma. Scandinavian J Surg. 2014;103:149-55.
9. Starnes BW, Arthurs ZM. Endovascular Management of Vascular Trauma. Sage J. 2006;18(2).
10. Branco BC, DuBose JJ, Zhan, Luke X. Trends and outcomes of endovascular therapy in the management of civilian vascular injuries. J Vascular Surg. 2014;60:1297-307.
11. Richmond B, Judhan R, Sherrill W. Trends and Outcomes in the Operative Management of Traumatic Vascular Injuries: A Comparison of Open versus Endovascular Approaches. Am surgeon. 2017;83:495-501.
12. Weinberg JA, Moore AH, Magnotti LJ, Teague RJ, Ward TA, Wasmund JB, et al. Contemporary management of civilian penetrating cervicothoracic arterial injuries. J Trauma Acute Care Surg. 2016;81:302-6.
13. Xenos ES, Minion DJ, Davenport DL, Hamdallah O, Abedi NN, Sorial EE, et al. Endovascular versus open repair for descending thoracic aortic rupture: Institutional experience and meta-analaysis. Eur J Cardiothoracic Surg. 2009;35:282-6.
14. Barmparas G, Inaba K, Talving P, David JS, Lam L, Plurad D, et al. Pediatric vs adult vascular trauma: an National Trauma Databank review. J Pediatr Surg. 2010;45:1404-12.
15. Gupta R, Rao S, Sieunarine K. An epidemiological view of vascular trauma in Western Australia: A 5-year study. ANZ J Surg. 2001;71:461-6.
16. Ecklund JM, Moores LE. Neurotrauma Management for the Severely Injured Polytrauma Patient. 1st 2016 ed. Cham: Springer. 2017.
17. Kobata H. Department of Neurosurgery, Osaka Mishima Emergency Critical Care Center. Diagnosis and Treatment of Traumatic Cerebrovascular Injury: Pitfalls in the Management of Neurotrauma. Neurologia medico-chirurgica. 2017;57:410-7.
18. Jacks R, Degiannis E. Endovascular Therapy and Controversies in The Management of Vascular Trauma. Scandinavian J Surg. 2014;103:149-55.
19. Desai SS, DuBOse JJ, Parham CS, Charlton-Ouw KM, Vlaes J, et al. Outcomes after endovascular repair of arterial trauma. J Vascular Surg. 2014;60:1309-14.
20. Stawicki SPA. Trends in nonoperative management of traumatic injuries-A synopsis. Int J Cri Illness Injury Sci. 2017;7:38-57.
21. Wahlgren CM, Riddez L. Penetrating Vascular Trauma of the Upper and Lower Limbs. Current Trauma Rep. 2016;2:11-20.
22. Alderazi YJ, Cruz GM, Kass-hout T, Prestigiacoma CJ, Duffis EJ, Gandhi CD. Endovascular therapy for cerebrovascular injuries after head and neck trauma. Sage J. 2015;17:258-69.
23. Karaolanis G, Maltezos K, Bakoyiannis C, Georgopoulos S. Contemporary strategies in the management of civilian neck Zone II vascular trauma. Frontiers Surg. 2017.
24. Irace L, Laurito A, Venosi S, Irace FG, Malay A, Gossetti B. Mid and lon term results of endovascular treatment in thoracic aorta blunt trauma. Sci World J. 2012;12.
25. Xenos ES, Abedi NN, Davenport DL, Minion DJ, Hamdallah O, Sorial EE, et al. Meta-analysis of endovascular vs open repair for traumatic descending thoracic aortic rupture. J Vascular Surg. 2008;48:1343-51.

Cite this article as: Weller J, Bowles M. Trends and outcomes in the management of vascular trauma: institutional experience at a level 1 trauma center. Int Surg J 2021;8:784-8.