**Research topic: Evaluation of Subclavian, Thoracic Aorta and Innominate Artery Injuries in Blunt Trauma Mechanisms: A Systematic Review of Case Reports and Case Series**

**Nebiyou Seyoum, MD1**

**Segni Kejela, MD1\***

**1** Addis Ababa University, College of Health Sciences, Tikur Anbessa Specialized Hospital, Department of surgery

**\***corresponding author

**Contactinformation**

**Segnikejela:email:segnikejo@gmail.com**

**Phonenumber:+251917083212**

**NebiyouSeyoum:phonenumber:+251911702525**

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**Abstract**

**Background:** Blunt thoracic arterial injuries are one of the rare causes for presentation at trauma centers. Most of the literature is in the form of case reports and case series with no significantly consolidated data available.

**Methodology:** A systematic review of English language case reports and case series from 2000 to 2019 was carried out using Pubmed and Google Scholar search engines.

**Results:** The mean age was 35.9, 36.4 and 44.3 years for thoracic aorta, innominate and subclavian artery injuries respectively. 89.7% of innominate artery injury patients were males. Motor vehicle related injuries contributed to 50.9% thoracic aortic injuries. Blood pressure/pulse deficit was recorded in 34.8% and 20,7% of patients with subclavian and innominate artery injuries respectively and chest pain; and hemodynamic instability was found in 23.5% and 20.5% of aortic injury patients respectively. Clavicular fracture was the most common associated finding, in Subclavian artery injury patients at 42%. Computed tomography was performed in 21.7%, 47.1%, 27.6% of patients with subclavian artery, aortic and innominate artery injuries respectively. Endovascular intervention was performed in 44.1% of patients with Subclavian artery injury.

**Conclusion:** Injury to the subclavian artery is relatively common among the older population. Blood pressure or pulse discrepancy could point to either Subclavian or Innominate artery injury. Endovascular intervention can be considered in all patients but has to be individualized based on patient and facility factors.

**Keyword**: Psuedoaneurysm, Transection, Dissection, Endovascular, Hybrid, Cerebrovascular accident**Evaluation of Subclavian, Thoracic Aorta and Innominate Artery Injuries in Blunt Trauma Mechanisms: A Systematic Review of Case Reports and Case Series**

**Introduction**

Trauma is the most common cause of mortality in children and adults under 44 years.[1] Blunt trauma is the leading mechanism in most civilian trauma centers.[2,3] Furthermore, motor vehicle accidents are the principal cause of blunt trauma accounting for 1.3 million annual deaths, 20-50 million non fatal injuries and 29% of all trauma cases.[4,5] The overall incidence of vascular trauma is 5% with larger fraction contributed by penetrating trauma mechanisms.[6,7] In fact, trauma centers report only 5% of vascular trauma is caused by blunt mechanisms.[8] However, this might actually be an underestimation as many blunt trauma patients with major vascular injury may not survive long enough to reach to a healthcare facility. The findings of postmortem examinations of prehospital trauma deaths support this notion placing blunt major vascular trauma as the second most common cause of death following head injury. [9,10]

The paucity of blunt vascular injuries in trauma centers is reflected up on the literatures as most relevant publications are case reports and case series.[11]

This review is intended to integrate the experiences of centers around the world through analysis of case reports and case series on this issue and hopefully fill the knowledge gap in the epidemiologic changes, investigative modality advancements and innovations on managements.

**Methods**

**Data source and search strategy:**

PubMed and Google Scholar were utilized to search for publication between January 2000 and September 2019 posing no language restrictions to the authors. The following key statements were utilized to initiate the search process, “case report/case series, subclavian artery injury”, “case report/case series, thoracic aorta injury” and “case report/case series, innominate artery injury”.

**Inclusion criteria**

All case reports and case series on subclavian, thoracic aorta and innominate artery injuries from blunt mechanism with no missing segment of the publication and published in English language were included.

Only publications from January 2000 to September 2019 are included.

**Exclusion criteria**

Exclusion criteria include any blunt vascular injuries not involving the subclavian, thoracic aorta and innominate arteries.

All reports of vascular injury with penetrating mechanisms of trauma were excluded.

Publications with a primary publication in a language other than English were excluded.

**Data extrication and handling**

From each patient report, the following information were retrieved: year of reported case, age at presentations, sex, mechanism of injury, general complaint/clinical presentations, associated injuries, specific vertebral injury, intracranial injury, associated vascular injuries in addition to the injured vessels under study, chest wall injuries, pulmonary injuries, facial injuries, limb injuries, abdominal injuries, specific type of vascular injury for the main thoracic arterial injuries under question, diagnostic modality utilized, treatment provided, type of open surgical treatment provided and outcome with specific complications pertaining to the vascular injury and mortality. No effort has been made to communicate authors for missing data from the publications.

**Data synthesis and analysis**

Generated data were entered into SPSS version 23 in the categories mentioned above and accuracy of data was evaluated and ascertained.

After data entry and cleanup was complete, data analysis was done using the same software, SPSS version 23.

**Results**

**Subclavian artery injury**

A total of 46 patients with Subclavian artery injuries have been reviewed. (Table 1) The mean age is 44.33±21.11 years and 73.8% are male. Motor vehicle collision was 32.6% of patients. Motor vehicle related injuries were reported in 13(65%) of patients younger than 45 years of age. Patients older than 45 years of age presented with falling down accident in 36.4% of the reported cases. Female patients have been reported to present after falling down accident in half of the cases with subclavian artery injuries.

Regarding the clinical manifestations, hemodynamic instability was recorded in 21.7% of the patients as a main clinical presenting sign/symptom and polytrauma was reported in 10(21.7%) of the patients. The most common clinical manifestations of motor vehicle related subclavian artery injuries are blood pressure/pulse deficit, 9(45%) and hemodynamic instability 7(35%). Patients presenting with subclavian artery injury after falling down accidents reported progressive supraclavicular swelling in 5(63.5%) cases. 3 of 5 patients’ presenting with sports related injury presented with blood pressure/pulse deficit.

Concerning associated injuries, clavicular fracture was reported in 24 (52.2%). 62.5% of patients with subclavian artery injury with Clavicular fracture are 45 years of age or older. 4(8.7%) of the patients had reported traumatic brachial plexopathy and 10(21.7%) of the patients presented with polytrauma. 15(32.6%) of reviewed patients had pneumothorax, hemothorax or both at presentation. (Table 2)

Regarding diagnostic modalities utilized, 44 cases reported either one or more imaging utilization. Conventional/digital subtracted angiography was utilized in 13(28.3%) of the reported cases with doppler ultrasonography, contrast CT and CT angiography used in 3(6.5%), 10(21.7%) and 12(26.1%) cases respectively. One patient had chest x-ray as the sole imaging modality for diagnosis. A combination of CT angiography and conventional angiography with Doppler ultrasonography was done in 2(4.3%) patients.

The type of vascular injuries diagnosed using imaging modalities or with intra-operative findings has been reported in all 46 patients in this review. Pseudoaneurysm and dissection were reported in 20(43.5%) and 8(17.4%) of the cases respectively. Rupture, laceration and compression occurred in (4)15.2%, 6(13%), (3)6.5% of cases respectively. One patient presented with spasm of the subclavian artery.

Treatment modalities were specified in all 46 cases reported with open surgical repair done in 21(45.7%); endovascular and hybrid procedures were performed in 17(37%) and 5(10.9%) respectively. 3 patients underwent conservative/medical therapy. From the open surgical repair group 11(57%) underwent graft repair. The graft repair patients underwent prosthetic interposition graft, prosthetic carotid-subclavian bypass and prosthetic carotid-axillary bypass graft 3(27.3%), 2(18.1%), 2(18.1%) respectively. 3(27.3%) patients underwent saphenous bypass graft. 8(42.1% of open repair) patients had direct repair with end to end anastomosis, simple suture and ligation was done in 2(25%) patients, and one patient underwent patch repair.

Outcome and complications were reported in 45 of 46 cases with 73.9% of patients reported to have experienced total resolution, 6(13%) of the cases reported had upper limb complications of which 4 were confirmed brachial plexopathy at presentation rather than vascular injury related complication. Repeat intervention was needed in 2(4.3%) patients and 2(4.3%) patients died. Furthermore, 1 patient was diagnosed with cerebrovascular accident related to the subclavian artery injury.

**Thoracic Aorta injury**

A total of 34 aortic injury patients’ data were retrieved from the literature between 2000 and 2019. (Table 3) The mean age of patients with aortic injuries is 35.9±18.9 years, and 26(76.5%) of the reported cases were male. 23(67.6%) of cases presented after motor vehicle collisions and 28(82.4%) had injuries related to motor vehicles (including pedestrian motor vehicle accident and motor cycle injuries). Hemodynamic instability (hypotension) and chest pain were the chief clinical features in 7(20.6%) and 8(23.5%) of cases reported. Polytrauma was reported in 17(50%) of the patients. 21(84%) of patients with age less than 45 years had motor vehicle related injury compared to 7(77.7.%) in group of patients with age 45 years or more. Female patients had motor vehicle accident 87.5% of the cases compared to 80.7% in male patients.

Rib fracture was the most common associated chest wall injury presenting in 9(26.9%) of the cases alone and in 3(8.8%) and 1(2.9%) cases with sternum and clavicle fractures respectively. Hemopneumothorax alone was reported in 5(14.7%) patients, and with lung contusion in 3(8.8%) patients. 5(14.7%) patients had ab associated innominate artery injury. 13(38.2%) patients had associated traumatic brain injury. (Table 4)

The most common imaging modalities utilized werecontrast CT scan and CT angiography in 16(47.1%) and 7(20.6%) respectively, and conventional/digital subtracted angiography in 10(29.4%) of reports. The most common site of injury was the isthmus and descending aorta, making up18(52.9%) of reported cases. Aortic arch and ascending aorta were injured in 13(38.2%) and 3(8.8%) patients respectively. Pseudoanuerysm was reported among 18(52.9%) of the patients either using imaging modality or intraoperative findings. Rupture was diagnosed in 11(32.4%) and dissection with or without thrombosis in 5(14.7%).

Regarding treatment, 13(38.2%) underwent open surgical repair with endovascular repair performed in 15(44.1%) and hybrid method in 6(17.6%). In the open repair group 10 of 13, 76.9%, patients underwent repair using prosthetic graft and 3(23.1%) underwent patch repair. The majority of open procedures, 7(53.8%) were performed under complete cardiopulmonary bypass with deep hypothermic arrest and centrifugal pump (3, 23.1%). 2 patients underwent simple clamp and stitch procedure with no bypass

For outcome and complications in aortic injury patients, 76.5% of patients had complete resolution with 2 deaths out of the 34 patients reported. 3(9%) patients had chronic cerebral sequelae with 2 of the 3 cases caused by traumatic brain injury.

**Innominate artery injury**

A total of 29 patients’ data were retrieved from reports from 2000 to 2019. (Table 5)The mean age of patients with Innominate artery injury was 36.4±12.8 years and 26(89.7%) are male. Motor vehicle collision contributed to 19(65.5%) of Innominate artery injury patients, with motor vehicle associated injury of 79.3%. Regarding clinical presentations for patients presenting with Innominate artery injury, chest pain and blood pressure/pulse deficit were reported in 7(24.1%) and 6(20.7%) of patients respectively. Polytrauma was reported among 8(27.6%) of patients.

Rib fracture alone was reported in 9(31%) patients, and with sternum fracture in 4(13.8%) patients. Lung contusion was reported in 3(10.3%) of patients, and in another 3(10.3%) patients along with hemopneumothorax. 8(27.6%) of cases reported facial injuries. Extremity injury was reported in 8 of 29, 27.6% , and6(20.7%) had a seatbelt sign.(Table 6)

Regarding diagnostic imaging and treatment modalities, Angiography(conventional/digital subtracted) was utilized in 18(62.1%) of patients. Contrast CT scan and CT angiography was performed in 8(27.6%) and 3(10.3%) patients respectively. Pseudoaneurysm was reported using imaging modalities or intraoperative findings in 58.6% of the reported cases, while 24.1% of cases had dissection with or without intravascular thrombosis, and rupture was present in 13.8% In one case, the type of innominate injury was not further specified. 24(82.8%) of patients underwent open surgical repair. 3 patients were treated with endovascular technique and 1 patient with hybrid method. 21 of 24(87.5%) patients treated with open repair underwent graft repair and one patient was treated with direct suture repair. Two cases did not specify the method of open repair used. From patients in graft repair group, 10(47.6%) had a ascending aorta to Innominate artery bypass graft while 3(14.3%) patients had Aorto-right common carotid and right subclavian bifurcated bypassgraft. Interposition graft was done in 4(19%) patients, and Ascending aorta to common carotid artery bypass, Innominate to axillary artery bypass graft and Ascending aorta to subclavian artery bypass procedures were done in one patient each.

Regarding Outcome and complications of patients with Innominate Artery injury, 69% of the patients had complete resolution and were symptom free on follow-up. 10.3% of the patients had a cerebrovascular accident pertaining to the arterial injuries, and one patient required a repeat intervention.

**Discussion**

**Subclavian artery injury**

Subclavian artery injury was more common in males, corresponding with a report of Sturm and colleagues in 1984 with 80%(12 out of 15 patients) male patients. [108] The mean age for this review was relatively older compared to older report of 26.2 in Sturm*et al,* but relatively younger than a case series published in 2001 from cases treated before 1998, which reported a mean age of 57 years. [107,108]

Motor vehicle related injuries were reported in almost half of cases as a mechanism of trauma which was low compared to other studies reviewed.[107,108,109] Motor vehicle related injuries were found to be more common among male than female in this review corresponding to a significantly higher motor vehicle related fatalities among males than females. [110] A point worth mentioning is the high proportion of falling down related Subclavian artery injury in older patients which has never been reported in reviewed publications

With respect to clinical presenting signs and symptoms, the most common were blood pressure/pulse deficit and hemodynamic instability. This is certainly not an outlier when discussing blunt Subclavian artery injuries, Katras *et al* reported 7 out of 15 patients with hypotension (unstable hemodynamic status) and diminished/absent pulse among 7 of the 15 patients evaluated. [107] Patients with Subclavian artery injury after a fall had a less dramatic, but more progressive presentation of progressive supraclavicular swelling pointing towards a more vigilant follow up in these cases.

Clavicular fracture was the most common associated fracture in patients with Subclavian artery injuries with more than half of patients presenting with this fracture. This finding has been replicated by multiple publications reviewed. [107-109]

Concerning imaging modalities, conventional/digital subtracted angiography was the most utilized technique followed by CT angiography and standard contrast CT scan. There is a decrement in the utilization of conventional angiography compared to older studies. This is evidenced by Sturm *et al* where 14 of 15 patients underwent conventional diagnostic angiography before operative management was done. In addition, Costa and Robbs reported that all 11 patients for whom operative management was provided conventional angiography were performed. [108,109] Investigative modalities found that most vascular lesion was pseudoaneurysm. This was lower in Katras *et al,* where only 2 of 7 patients had Pseudoaneurysm of the Subclavian artery. [108]

Endovascular and hybrid methods of treatment in combination have contributed to 48% of the management for Subclavian artery injury, which certainly have shown a significant shift from the previous reports in the end of the past century where all of the three reports, Strum *et al,* Katras *et al,* and Costa and Robbs, reported only open repair in all the patients in each study. [107-109] Open repair group underwent more graft repair than primary/direct suture, which was similar to Costa and Robbs’ report [109]

Regarding the outcome of the patients, 6 of 46 patients in this review reported to have upper limb complication either by vascular or non vascular causes. This outcome was significantly lower compared to 7 out of 15 patients with limb complications in Costa and Robbs. [109] This may be explained by more significant mechanism of trauma by the later, better operative techniques and the advent of endovascular and hybrid techniques.

**Thoracic Aorta injury**

More than three fourth of the patients with blunt thoracic aortic injury were male with motor vehicle related injuries being the most common mechanism. This corresponds to a larger study from Germany where 77.5% of the patients with blunt thoracic aorta injury were male, and high speed motor vehicle accidents caused 78% of the blunt thoracic aortic injuries. [111]

Common clinical manifestations in this review were chest pain and hemodynamic instability (hypotension). Hemodynamic instability in German study was higher compared to this review with 35.6-70.1% depending on the vascular lesions. [111] Polytrauma was reported in this review in half of patients and cervical and thoracic vertebral injuries in significant number. This is a significant proportion of patients even though no prior data is there for the purpose of comparison.

Rib fracture is the most common chest wall trauma associated with blunt thoracic aorta injury. There is additionally, a significantly high rate of associated traumatic brain injury.Autopsy report by Burkhart*et al* showed higher rates of rib fracture and Traumatic brain injury 69% and 68%, compared to this review at 26.9% and 38.2% respectively . [112] This might be because theautopsy cases havean expectedhigher severity of injury compared to the patients in this group. On top of that close to half of the patients had one or more pulmonary injuries. This high occurrence is still lower than autopsy reports of patients with thoracic aorta injuries.[112]

Innominate artery injury was most commonly associated with aortic injury, and although prior studies linking aortic and innominate artery injury are not available, it could be regarded as logical as similar trauma mechanisms and anatomic proximity makes both vessels vulnerable simultaneously.

Regarding investigative modalities, CT scan was the diagnostic modality of choice in close to half of the patients. This was in line with the recommendation from Mirvis *et al,*  which showed that sensitivity and specificity of greater than 90% concluding that CT scan is a reasonable alternative for traumatic aortic injury diagnosis and this certainly has been the case in almost half of the patients involved in the review. [113] In fact an additional a fifth of patients underwent CT angiography further decreasing the need for conventional/Digital subtracted angiography.

Most patients had injury either at the isthmus or descending aorta at 52.9%. This is slightly lower than other studies . For instance, Williams *et al* reported 65% in isthmus and descending aorta. [114] Regarding the type of vascular lesion, pseudoaneurysm was the most common vascular lesion in this review. This is similar to findings in the literature; including Starnes *et al,* where pseudoaneurysm was reported among 71% of theblunt aortic injury patients. [115]

Concerning the treatment modalities, Endovascular repair was the most common modality in thoracic aorta repair. In fact with addition of hybrid method, close to two third of patients have undergone aminimally invasive corrective procedure with either total endovascular or hybrid techniques. This data is similar to the findings of Gombert *et al,* in which62.8% of patients underwent an endovascular procedure. But compared to what Gombert and colleagues have reported, this review could not find patients who underwent conservative management with no surgical intervention. [111]Graft repair was the most common method of open repair.

Outcome and complications review showed a 6% mortality rate which was significantly lower than large reports like Gombert *et al,* in which 40.8% total mortality was reported. [111] This level of staggering difference may be attributed to the fact that case reports and case series may focus on alive patients and success stories rather than mortalities.

**Innominate artery injury**

The mean age of Thoracic aorta and Innominate artery injury patients is quite similar. The high male predominance, 89.7% has been replicated in the older review done by Hirose and Gill which showed a male predominance of 86.3%. Motor vehicle related injuries was the mechanism of injury in more than 80% of the patients with this study, similar to the 88.9% reported by Hirose and Gill. Chest pain and blood pressure/pulse discrepancy were the two dominant manifestations occurring in almost half of the patients. Hirose and Gill reported 20 of 132 patients, 15.15% with reported blood pressure/pulse deficit. Chest pain hasn’t been evaluated in the later review. [90]

On the subject of associated injuries, this review found rib fracture in almost half of reported cases, polytrauma in one fourth of the reports, and a significant number,41.4%, had at least one pulmonary injury. Hirose and Gill reported significantly lower rate of rib fractures, 16 of 132 cases (12.1%). Similarly only 28 of 132 patients were reported as having a pulmonary complication which is also significantly lower than the value in this review. The reason for these discrepancies is unknown. The rate of head injury, at 13.8% in this review was comparable to the report from Hirose and Gill, where 15 of 132 patients(11.4%) reviewed had a traumatic brain injury. [90] Seal belt sign status was reported in 8 patients of which 6 had a seatbelt sign, which can be a sign of a sudden deceleration injury which might have caused the Innominate artery injuries.

Even though 62% of patients in this review underwent diagnostic angiography, this invasive modality seems to be decreasing, as Hirose and Gill reported all cases reviewed with reported imaging modality underwent diagnostic conventional angiography, which made the authors conclude angiography as the gold standard modality. This shows a slow and yet steady improvement in utilization of noninvasive diagnostic modalities, CT with contrast and CT angiography. This review found pseudoaneurysm in more than half of the cases. This correlates well with similar review’s findings on Thoracic aorta and Subclavian artery injury lesions. [90]

Coming to the management of innominate artery injury, when one compares it with sortic and Subclavian artery repairs in this review; the most common repair was open repair. Hirose and Gill didn’t report any endovascular procedure in the case reports reviewed prior to 2003. Although the progress may be comparatively slower more and more surgeons are utilizing endovascular interventions in recent years. [90] Complications with cerebrovascular accidents have occurred in 10% of the patients. In this review, all complications occurred in open surgical repair group. This could be because of selection bias, as more stable patients may have been managed with endovascular techniques compared the ones’ undergoing open repair.

**Conclusion**

In Subclavian artery injuries, Clavicular fracture can point to arterial injuries especially in older patients. Blood pressure/pulse deficit was the best clinical triggers. Also investigations using any of the three methods, CT with contrast, CT angiography and conventional angiography, can be done with no preference of one over the other. Open repair is still the most predominant modality of treatment with increasing use of endovascular techniques.

Blunt thoracic aortic injuries are common among high speed deceleration injuries. Chest pain in a patient with a significant trauma mechanism is a good entry point for investigation especially when associated with head trauma or polytrauma. CT scan can be the first and even the modality of choice of investigation. Endovascular procedure could be considered regardless of the type of vascular lesion.

Innominate artery injury is a predominantly motor vehicle related injury. Chest pain and blood pressure/pulse deficit are the most common clinical features. Suspected Innominate artery injuries may need conventional/digital subtracted angiography and the threshold for it should be lower. Still open surgical management is the procedure of choice and until further experience is attained there can be no recommendation in changing this time tested technique any time soon.

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Table 1: Blunt Subclavian artery injury case reports and case series

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study(year)** | **age** | **sex** | **Mechanism**  | **Main vascular presentation** | **Associated presentation** | **Cranial injury** | **Vertebral injury** | **Other Vascular injury** | **Chest wall injury** | **Lung injury** | **Facial injury** | **Limb injury** | **Abdominal injury** | **Seatbelt sign** | **Diagnostic modality** | **Type of injury** | **treatment** | **Type of open repair** | **Type of graft** | **Type of repair** | **Complications**  |
| **Fatime *et al(2010)*** | 20 | M | Pedestrian MVA | Upper limb pain | polytrauma |  |  |  |  |  | Yes  | Yes  |  |  | angiography | Dissection  | Open repair | Direct repair |  | E to E | None  |
| **Stefan’Czyk *et al(2010)*** | 10 | F |  | Bleeding |  |  |  |  |  | HPN |  |  |  |  | CTA and Doppler | PA | Endovascular  |  |  |  | None  |
| **Günday *et al* (2013)** | 31 | M | Other  | Chest pain | Shock |  |  |  | Rib fracture | PNT |  |  |  |  | Doppler and angio | Dissection  | Endovascular  |  |  |  | None  |
| **Sandiford *et al* (2001)** | 85 | F | Fall | Bp/pulse deficit | None |  |  |  |  |  |  | Yes |  |  | CTA and Doppler | PA  | Endovascular  |  |  |  | None  |
| **Fuduric *et al(2014)*** | 20 | M | MCI | Bp/pulse deficit | Polytrauma |  |  |  |  |  |  | Yes |  |  | CTA | Dissection  | Open repair | Graft repair | PPG |  | ULC |
| **Assenza *et al (2012)*** | 70 | M | Fall  | ASCS |  |  |  |  | Clavicle fracture |  |  |  |  |  | CT | Laceration  | Endovascular  |  |  |  | None  |
| **Queiroz *et al (2018)*** | 27 | M | Bicycle injury  | Shock |  |  |  |  |  | HTX |  |  |  |  | CT | PA | Open repair | NS |  |  | Dead |
| **Serrano *et al (2003)*** | 60 | F | Fall | PSCS |  |  |  |  | Clavicle fracture |  |  |  |  |  | Angiography  | PA  | Open repair | Graft repair | CAB |  | None  |
| **Derom *et al(2008)*** | 93 | F | Fall | PSCS |  |  |  |  | Clavicle fracture |  |  |  |  |  | CT | PA  | Endovascular  |  |  |  | ULC |
| **Nikolaos *et al(2009)*** | 70 | M |  | ?DAE |  |  |  |  | Clavicle fracture | HTX |  |  |  |  | CT | Rupture  | Endovascular  |  |  |  | None  |
| **Weber  *et al (2017)*** | 57 | M | MCI | Shock  | Polytrauma  | Yes | Yes |  |  | HPN |  |  | Yes |  | CT | Laceration  | Endovascular  |  |  |  | CVA |
| **Campfield *et al (2016)*** | 64 | F | Fall  | Shock | Brachial plexopathy |  |  |  | Clavicle fracture |  |  |  |  |  | CT | Laceration  | Open repair  | direct repair  |  | SSR | ULC\* |
| **Yonezawa *et al(2016)*** | 55 | M | MCI | Chest pain |  |  |  |  | Rib fracture | CHPN |  |  |  |  | Angiography  | Laceration  | Endovascular  |  |  |  | Dead  |
| **Cheema *et al(2008)*** | 43 | M | MVC | Shock  | Polytrauma | Yes |  |  | C&R fracture  | HPN |  |  |  |  |  | Rupture | Open repair | Direct repair |  | Ligation  | None  |
| **Diaz-Gutierrez  *et al(2016)*** | 20 | M | MVC | Shock  | Polytrauma  |  |  |  | Rib fracture  | CHPN  |  |  | Yes | No  | CT | PA  | Hybrid  |  |  |  | None  |
| **Elkbuli  *et al(2019)*** | 30 | M | MCI | Shock |  |  |  | SCV injury  |  | HPN |  |  |  |  | Angiography  | Rupture  | Open repair | Graft repair  | CAB |  | None  |
| **Enamorado-Enamorado  *et al(2011)*** | 24 | F | MVC | Shock | Polytrauma  |  |  |  |  |  |  | Yes |  |  | CTA | PA | Endovascular  |  |  |  | None  |
| **Nakada  *et al (2014)*** | 41 | M | MVC | Bp/pulse deficit |  |  |  |  | Clavicle fracture | PNT |  |  |  | No | Angiography  | Dissection  | Endovascular  |  |  |  | None  |
| **Gullo *et al(2012)*** | 53 | M | Fall | PSCS | Brachial prexopathy |  |  |  | Clavicle fracture  |  |  |  |  |  | Doppler | PA  | Hybrid |  |  |  | None  |
| **Hirose *et al(2005)*** | 30 | F | MVC | Bp/pulse deficit |  |  |  |  | C&R fracture | HTX |  |  |  | Yes | Angiography | PA  | Endovascular |  |  |  | None  |
| **Ipaktchi  *et al(2014)*** | 14 | M | Other | Bp/pulse deficit | None |  |  |  |  |  |  |  |  |  | CTA | Rupture | No treatment |  |  |  | - |
| **Continued**  |
| **Jaiswal  *et al(2018)*** | 74 | M | Fall  | PSCS | Brachial plexopathy |  |  |  |  | CHPN |  |  |  |  | CTA | PA  | Open repair | Direct repair  |  | SSR | None  |
| **Ostovan *et al(2017)*** | 21 | M | MVC | Bp/pulse deficit | ASCS |  |  |  |  |  |  | Yes  |  |  | Angiography | Dissection | Endovascular |  |  |  | None  |
| **Kapetanakis *et al(2006)*** | 51 | M | MVC | Chest pain | Polytrauma  |  |  |  | R&S fracture  | HPN |  | Yes | Yes | Yes | CT | Rupture | Open repair | Graft repair  | PPG |  | None  |
| **Karkos *et al(206)*** | 21 | M  | Pedestrian MVA |  | Poltyrauma |  |  |  |  |  |  | Yes  |  |  |  | Laceration  | Open repair  | Graft repair  | SBG |  | RI |
| **Noh  *et al(2018)*** | 33 | M | Other  | Shock  |  |  |  | SCV injury |  | HPN |  | Yes  |  |  | CT | Rupture | Open repair | Graft repair | PPG |  | None  |
| **Kluemper *et al(2017)*** | 18 | M | MVC | Bp/pulse deficit | Brachial plexopathy |  |  |  | C&R fracture | HPN |  |  |  |  | Doppler | Compression | Hybrid |  |  |  | ULC\* |
| **Knobloch *et al (2006)*** | 52 | M | MCI | Bp/pulse deficit |  |  |  |  | Clavicle dislocation |  |  | Yes |  |  | CTA | Dissection  | Open repair  | Graft repair  | CSB |  | None  |
| **Sabbagh  *et al(2016)*** | 45 | M | MVC | Bp/pulse discripancy | Polytrauma Brachial plexopathy  | Yes | Yes |  | Sternal fracture | PNT |  | Yes | Yes |  | CT | Rupture | Hybrid |  |  |  | ULC\* |
| **Mirza *et al(2018)*** | 83 | F |  | PSCS |  |  |  |  | Clavicle fracture  |  |  |  |  |  | CTA | PA  | Endovascular |  |  |  | None  |
| **Faisham *et al(2010)*** | 19 | M | MCI | Bp/pulse discripancy | Polytrauma |  |  |  | Clavicle fracture  | HPN | Yes | Yes |  |  | Angiography  | Spasm | Open repair | Graft repair  | SBG |  | None  |
| **Quinones-Baldrich(2009)** | 33 | M | Sport injury | PSCS | None |  |  |  |  |  |  |  |  |  | CTA | PA | Endovascular  |  |  |  | None  |
| **Gill *et al(2013)*** | 13 | M | Sport injury | ASCS | Brachial plexopathy  |  |  |  | Clavicle fracture |  |  |  |  |  | CTA | Compression  | Open repair  | Direct repair |  | CD | ULC\* |
| **Rodriguez-Merchan *et al*** | 46 | M |  | PSCS |  |  |  |  | Clavicle fracture |  |  |  |  |  | Angiography | PA  | Endovascular  |  |  |  | None  |
| **Scheffler *et al(2003)*** | 58 | F | Sports injury | Bp/pulse deficit | None |  |  |  |  |  |  |  |  |  | Doppler & angiography  | Dissection  | Medical/rTPA  |  |  |  | None  |
| **Sodhi *et al (2007)*** | 20 | M | MVC | Shock |  | Yes |  |  | C&R fracture | HTX |  |  |  |  | Angiography | Compression | Open repair | Graft repair | CSB |  | None  |
| **Zaharudin *et al(2016)*** | 53 | M | MVC |  |  |  |  |  | Sternum fracture | PC |  |  |  |  | Doppler | PA | Hybrid |  |  |  | None  |
| **Tachtsi *et al(2011)*** | 67 | F | MVC | UL pain  |  |  |  |  | Clavicle fracture |  |  |  |  |  | Angiography | PA  | Open repair | Direct repair |  | Ligation | None  |
| **Tennysona *et al(2018)*** | 48 | M | MVC | Shock |  |  |  |  | Rib fractures | CHPN | Yes |  |  | No | CXR | Laceration  | Open repair | Direct repair |  | PR | None  |
| **Mandal *et al(2004)*** | 55 | M | Sport injury | Bp/pulse deficit |  |  |  |  | Clavicle fracture |  |  |  |  |  | MRA | PA | Open repair | Graft repair | SBG |  | RI\*\* |
| **Schaik *et al(2015)*** | 52 | M | Bicycle accident  | Bp/pulse deficit |  |  |  |  | Clavicle fracture |  |  |  |  |  | CTA | Dissection  | Open repair | NS |  |  | None  |
| **Watanabe *et al(2005)*** | 72 | M | Fall | PSCS | Brachial plexopathy  |  |  |  | Clavicle fracture |  |  |  |  |  | Angiography | PA  | Open repair | Direct repair |  | E to E  | None  |
| **Zhang *et al(2015)*** | 50 | M | Engineering accident | Bp/pulse deficit | RLN palsy |  |  |  |  |  |  |  |  |  | CTA | PA | Endovascular  |  |  |  | None  |
| **Continued**  |
| **Butterworth *et al(2001)*** | 42 | M | Sports injury | Bp/pulse deficit |  |  |  | SCV injury | Clavicle fracture |  |  |  |  |  | Angiography  | Stenosis  | Observation  |  |  |  | None  |
| **Sladojevic *et al(2016)*** | 51 | M | MVC |  |  |  |  |  | Rib fracture |  |  |  |  |  | CTA | PA  | Open repair  | Graft repair  | ICSBG |  |  |
| **Bukhari *et al(2005)*** | 45 | M | MVC | Bp/pulse deficit |  | Yes |  |  | Clavicle fracture | PNT |  |  |  | Yes | CTA | PA  | Enodvascular  |  |  |  | None  |

ASCS: acute supraclavicular swelling, Bp: Blood pressure, C&R: clavicle and rib, CAB: carotid axillary bypass, CD: clavicle disimpaction, CHPN: contusion with hemopneumothorax, CSB: carotid subclavian bypass, CT: computed tomography, CTA: computed tomography angiography, CVA: cerebrovascular accident, CXR: Chest Xray, DAE: decreased air entry, E to E: end to end anastomosis, HPN: hemopneumothorax, HTX: Hemothorax, ISCBG: innominate subclavian carotid bypass graft, MCI: motor cycle injury, MRA: magnetic resonance angiography, MVA: motor vehicle accident, MVC: motor vehicle collision, NS: not specified, PC: pulmonary contusion, PNT: pneumothorax, PPG: prostathic interposition graft, PR: patch repair, PSCS: progressive supraclavicular swelling, R&S: rib and sternum, RI: repeat intervention, SBG: saphenous bypass graft, SCV: subclavian vein, SSR: simple suture repair, UL: upper limb, ULC: upper limb complications

\*not secondary to the vascular injury

\*\*failed endovascular repair and open repair afterwards

Table 3: Blunt thoracic aortic injury case reports and case series

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study(year)** | **age** | **sex** | **Mechanism**  | **Main vascular presentation** | **Associated presentation** | **Cranial injury** | **Vertebral injury** | **Other Vascular injury** | **Chest wall injury** | **Lung injury** | **Facial injury** | **Limb injury** | **Abdominal injury** | **Seatbelt sign** | **Diagnostic modality** | **Location**  | **Type of injury** | **treatment** | **Type of open repair** | **Perfusion** | **Complication**  |
| **Matsumoto *et al(2005)*** | 69 | F | MVC | Chest pain |  |  |  |  |  | HTX |  |  |  |  | Angiography  | Arch | PA  | Open repair | Graft repair | PCPB | None |
| **Benedetto *et al(2008)***  | 19 | M | MVC | shock | Polytrauma  |  |  | Innominate Artery |  |  |  |  | Yes |  | CT | D&I aorta | Rupture | Hybrid |  |  | None |
| **Badmanaban *et al(2003)*** | 29 | F | MVC |  | Polytrauma |  |  |  | Rib fracture  | HTX | Yes |  | Yes | Yes | Angiography | D&I aorta | Rupture | Open repair | Graft repair | PCPB | Fetal loss  |
| **Boulate *et al(2018)*** | 41 | M | MVC |  | Polytrauma | Yes |  | Innominate artery  | Sternum fracture  | PNT |  |  |  |  | Angiography | Ascending  | Dissection  | Open repair | Patch repair  | CCPB | None  |
| **Boulate *et al(2018)*** | 23 | F | Animal injury |  |  |  |  |  | Sternum fracture |  |  |  |  |  | Angiography  | Ascending  | PA | Open repair | Graft repair  | CCPB | None |
| **Boulate *et al(2018)*** | 26 | F | Pedestrian MVA | Altered mentation  |  |  |  |  | Sternum fracture | HTX |  |  |  |  | CT | Arch | rupture | Open repair | Patch repair | CCPB | CVA |
| **Chock *et al(2014)*** | 25 | M | MCI |  | Paraplagia |  | Yes |  | Rib fracture  | PNT |  | Yes |  |  | CTA | D&I aorta | PA  | Endovascular  |  |  | Paraplagia  |
| **Coppi *et al(2012)*** | 24 | M | MCI | Altered mentation  | Polytrauma | Yes  |  |  |  |  |  |  |  |  | CT | D&I aorta | PA | Open repair | Graft repair | SCS | None  |
| **Eckhauser *et al(2013)*** | 12 | M | MCI | Shock |  | Yes |  | Innominate artery  | Rib fracture  | HPN | Yes |  |  |  | CTA | Ascending  | Rupture  | Open repair  | Patch repair  | CCPB | None |
| **Fraedrich *et al(2003)*** | 81 | M | MVC |  |  |  |  | LSC&I artery | R&S fracture  | PC |  | Yes |  |  | CT | Arch | Dissection  | Endovascular  |  |  | None  |
| **Ochoa *et al(2011)*** | 39 | M | MVC | Altered mentation  | Polytrauma  | Yes  |  |  | R&S fracture |  |  | Yes |  |  | CT | D&I aorta  | PA  | Endovascular  |  |  | None |
| **Gombert *et al(2016)*** | 15 | M | MVC | Chest pain  | Polytrauma  |  |  |  |  |  |  | Yes | Yes  |  | CT | D&I aorta | PA  | Hybrid  |  |  | None |
| **Ryu *et al(2010)*** | 73 | F | MVC | Chest pain  | Polytrauma  |  |  |  |  |  |  | Yes |  |  | CT | Arch  | PA  | Hybrid |  |  | None  |
| **Ktenidis *et al(2012)***  | 30 | M | MVC | Chest pain  |  |  |  |  |  |  |  | Yes |  |  | Angiography  | D&I aorta  | PA  | Hybrid  |  |  | None  |
| **Kovari *et al(2017)*** | 31 | F | Fall |  |  |  | Yes |  | Rib fracture  | HPN |  | Yes | Yes |  | CT | D&I aorta | PA  | Endovascular  |  |  | None  |
| **Kovari *et al(2017)*** | 32 | M | MVC | Shock  |  | Yes | Yes |  | Rib fracture  | CHPN  |  | Yes  | Yes  |  | CT | Arch  | PA  | Endovascular  |  |  | None  |
| **Mattison *et al(2001)*** | 21 | M | MVC | Shock  | Polytrauma  | Yes  |  |  | Rib fracture  | HPN |  | Yes | Yes |  | Angiography  | D&I aorta | Rupture  | Endovascular  |  |  | Dead |
| **Moore *et al(2001)*** | 23 | M | Workplace injury | Chest pain  |  |  | Yes  |  |  | HPN |  | Yes |  |  | Angiography  | D&I aorta | PA  | Hybrid  |  |  | None  |
| **Murphyv*et al(2009)*** | 26 | M | Animal injury | Chest pain |  |  |  |  | C&R fracture  |  |  |  |  |  | CTA | Arch  | Rupture  | Endovascular  |  |  | None  |
| **Piffaretti *et al(2015)*** | 64 | M | MVC | Jugular tightness  | Polytrauma  |  |  | RASCA injury | Rib fracture  | PNT |  |  | Yes |  | CTA | D&I aorta | PA  | Endovascular  |  |  | None  |
| **Piffaretti *et al(2015)*** | 47 | M | Fall  | Shock  |  | Yes |  |  | Rib fracture  | CHPN |  | Yes |  |  | CTA | Arch  | PA  | Endovascular  |  |  | None  |
| **Continued**  |
| **Patel *et al(2002)*** | 53 | M | MVC |  |  |  |  | Innominate artery |  |  |  |  |  |  | Angiography  | Arch  | PA  | Open repair  | Graft repair  | CCPB | None  |
| **Gandhi *et al(2003)*** | 12 | F  | MVC | Altered mentation  | Polytrauma  | Yes  |  |  |  |  | Yes | Yes | Yes  | No  | Angiography  | D&I aorta  | PA  | Open repair  | Graft repair  | PCPB | None  |
| **Bradley *et al(2006)*** | 40 | F | MVC | Chest pain  |  | yes | Yes  |  |  |  |  | Yes |  |  | CT | Arch  | Rupture  | Open repair  | Graft repair  | CCPB | None  |
| **Serna *et al(2006)*** | 28 | M | MVC | Bp/pulse deficit |  |  |  | LSCA injury | Rib fracture  |  |  |  |  | No | Angiography  | Arch  | Rupture  | Open repair  | Graft repair  | CCPB | None  |
| **Propper *et al(2009)*** | 32 | M | MVC |  | Polytrauma  |  |  |  |  | HPNT | Yes | Yes | Yes |  | CT | D&I aorta | Rupture  | Endovascular  |  |  | None  |
| **Reynolds *et al(2011)*** | 21 | F | MVC | Altered mentation  | Polytrauma  | Yes  |  |  |  |  | Yes  |  |  |  | CT | D&I aorta  | PA  | Endovascular  |  |  | CNS insult\* |
| **Reynolds *et al(2011)*** | 40 | M | MVC | Shock  | Polytrauma  | Yes  |  |  |  |  |  |  | Yes  |  | CTA | D&I aorta  | Rupture  | Endovascular  |  |  | Dead  |
| **Reynolds *et al(2011)*** | 47 | M | MVC |  | Polytrauma  |  |  |  |  |  |  | Yes  | Yes  |  | CTA | Arch  | Rupture  | Endovascular  |  |  | None  |
| **Siddiqi *et al(2015)*** | 21 | M | Pedestrian MVA | Shock  | Polytrauma  | Yes  |  | Innominate artery  |  | CHPN |  | Yes  | Yes  |  | CT | D&I aorta  | PA  | Open repair  | Graft repair  | SCS | CNS insult\* |
| **Thompson *et al(2006)*** | 46 | M | Fall  |  | Polytrauma  |  |  |  |  |  |  |  | Yes  |  | CT | D&I aorta  | PA  | Endovascular  |  |  | -  |
| **Turhan *et al(2004)*** | 31 | M | MVC | Bp/pulse discripancy |  |  |  |  |  |  |  |  |  |  | Echocardiography  | D&I aorta  | Dissection  | Open repair  | Graft repair  | NS | None  |
| **Waldenberger *et al(2003)*** | 81 | M | MVC |  | Polytrauma  |  |  | LSC&I artery | C&R fracture  | PC |  | Yes |  |  | CT | Arch  | Dissection  | Endovascular  |  |  | None  |
| **Yeo(2015)** | 20 | M | MVC | Chest pain  |  | Yes  |  |  |  |  |  |  |  |  |  | Arch  | Dissection  | Hybrid  |  |  | None  |

Bp: Blood pressure, C&R: clavicle and rib, CHPN: contusion with hemopneumothorax, CT: computed tomography, CTA: computed tomography angiography, CVA: cerebrovascular injury, D&I: descending and isthmus, HPN: hemopneumothorax, HTX: Hemothorax, LSC&I: left subclavian and innominate, LSCA: left subclavian artery, MCI: motor cycle injury, MVA: motor vehicle accident, MVC: motor vehicle collision, NS: not specified, PC: pulmonary contusion, PNT: pneumothorax, RASCA: right aberrant subclavian artery, R&S: rib and sternum, RI: repeat intervention, SCS: simple clamp and stitch, SCV: subclavian vein,

\*not secondary to the vascular injury

Table 5: Blunt Innominate artery injury case reports and case series

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study(year)** | **age** | **sex** | **Mechanism**  | **Main vascular presentation** | **Associated presentation** | **Cranial injury** | **Vertebral injury** | **Other Vascular injury** | **Chest wall injury** | **Lung injury** | **Facial injury** | **Limb injury** | **Abdominal injury** | **Seatbelt sign** | **Diagnostic modality** | **Type of injury** | **treatment** | **Type of open repair** | **Type of graft** | **Type of repair** | **Complication**  |
| **Al-khaldi *et al (2006)*** | 35 | M | MVC | DAE |  |  |  | RASCA injury | SCR fracture  | CHPN |  |  |  | Yes  | CTA | PA  | Open repair  | Graft repair  | PPG |  | None  |
| **Dhaliwal  *et al(2005)*** | 20  | M  | Fall | PSCS |  |  |  | SVC injury  |  |  |  |  |  |  | Angiography  | PA  | Open repair  | Primary repair |  | SLR | None  |
| **Knosalla *et al (2000)*** | 18 | M | MCI | Altered mentation  | Polytrauma  | Yes  |  |  |  | PC | Yes  |  |  |  | Angiography  | Dissection  | NS |  |  |  |  |
| **Hirose *et al(2004)*** | 46 | M | MVC | Bp/pulse discrepancy  |  |  |  |  |  |  |  |  |  |  | Angiography  | PA | Open repair  | Graft repair  | AIA G |  | None  |
| **Hirose *et al(2003)*** | 56 | M | MVC | Bp/pulse discrepancy  |  |  |  |  |  |  |  |  |  | No | Angiography  | Dissection  | Open repair  | Graft repair  | ACSG |  | None  |
| **Stover *et al(2001)*** | 37 | M | MVC | Chest pain  |  |  |  |  | R&S fracture  |  |  | Yes  |  | Yes  | Angiography  |  | Open repair  | Graft repair  | AIA G |  | NS |
| **Stover *et al(2001)*** | 30 | M | MVC | Chest pain  |  |  |  |  |  |  |  |  |  | Yes  | Angiography  | PA  | Open  | NS | NS |  | NS |
| **Axisa *et al (2000)***  | 21 | M | MVC |  | Polytrauma  |  |  |  | Rib fractures  | PNT  | Yes  | Yes  | Yes  |  | Angiography  | PA | Endovascular  |  |  |  | None  |
| **Omrane *et al(2014)*** | 48 | M | MVC | Bp/pulse deficit  | Polytrauma  | Yes  |  |  |  |  |  |  |  |  | CT | Dissection  | Open repair  | Graft repair  | NS |  | None  |
| **Bito *et al(2014)*** | 40 | F | Fall | Shock  |  | Yes  |  |  | Rib fractures  |  |  | Yes  |  |  | CT | Rupture  | Open repair  | Graft repair  | ASR |  | CVA |
| **Boutayeb *et al(2014)*** | 54 | M | MVC |  | Polytrauma  |  |  |  | Rib fracture  |  | Yes  |  |  |  | CT | PA | Open repair  | Graft repair  | AIA G |  | None  |
| **Watanabe *et al(2001)*** | 36 | M | Sport injury  | Bp/pulse deficit  | Altered mentation  |  |  |  |  |  |  |  |  |  | Angiography  | Rupture  | Open repair  | Graft repair  | PPG |  | CVA |
| **Davidović *et al(2010)*** | 55 | F | MVC | Shock  |  |  |  |  | R&S fractures |  |  |  |  |  | Angiography  | PA | Open repair  | Graft repair  | ACSG |  | None  |
| **Dias-Neto *et al(2018)*** | 41 | M | Fall  | Chest pain  |  | Yes  | Yes  |  | C&R fractures | HTX | Yes  | Yes  |  |  | Angiography  | Dissection  | Open repair  | Graft repair  | AIA G |  | None  |
| **Miles *et al(2003)*** | 29 | M | MVC |  |  | Yes  |  |  | Rib fractures  |  |  |  |  | Yes  | Angiography  | Rupture  | Endovascular  |  |  |  | NS |
| **Howe *et al(2017)*** | 50 | M | Fall | UL pain  |  |  |  | RSC&RCCA injury  | Rib fractures  | PNT |  |  |  |  | CTA | Dissection  | Open repair  | Graft repair  | IABG |  | None  |
| **Huang *et al(2008)*** | 36 | M | MVC | Chest pain  |  |  |  |  |  | HPNT | Yes  | Yes  |  |  | CT | PA | Endovascular  |  |  |  | None  |
| **Lee *et al(2015)*** | 55 | M | Fall | Chest pain  |  |  |  |  |  |  |  |  |  |  | CT | PA | Hybrid  |  |  |  | None  |
| **Mousa *et al (2010)*** | 51 | M | MVC | Chest pain  |  |  |  |  |  |  |  |  |  |  | CTA | PA | Open repair  | Graft repair  | AIA G |  | None  |
| **Ormazabal *et al(2012)*** | 21 | M | MVC |  |  |  |  |  | Sterna fracture  |  |  |  |  | Yes  | CT | Dissection  | Open repair  | NS  |  |  | NS |
| **Chu *et al(2006)*** | 19 | M | MVC | Altered mentation  | Polytrauma  |  |  | Aortic injury  | Clavicle fracture  | PC |  | Yes  | Yes  | Yes  | CT | Rupture  | Open repair  | Graft repair  | AIAG |  | None  |
| **Roberts *et al(2000)*** | 24 | F | MVC |  |  |  |  |  |  |  |  |  |  | No | Angiography  | Dissection  | Open repair  | Graft repair  | PPG |  | None |
| **Sladojevic *et al(2015)*** | 25 | M | MVC | Bp/pulse deficit  |  |  |  |  |  |  | Yes  | Yes  |  |  | Angiography  | PA | Open repair  | Graft repair  | ACSG |  | None  |
| **Sladojevic *et al(2015*** | 56 | M | MVC |  |  |  |  |  | R&S fractures  |  |  |  |  |  | Angiography  | PA | Open repair  | Graft repair  | ACCG |  | None |
| **Continued**  |
| **Symbas *et al (2005)*** | 32 | M | MCI | Shock | Polytrauma  |  | Yes  |  | Rib fracture  | CHPNT | Yes  |  | Yes  |  | CT | PA | Open repair | Graft repair  | AIAG |  | None  |
| **Symbas *et al (2005)*** | 32 | M | MCI | Chest pain | Polytrauma |  |  |  | Rib fracture | PC |  | Yes  |  |  | Angiography  | PA | Open repair | Graft repair | AIAG |  | None  |
| **Symbas *et al (2005)*** | 40 | M | MVA | Bp/pulse deficit |  |  |  |  | Rib fracture | CHPNT |  |  |  |  | Angiography  | PA | Open repair | Graft repair | AIAG |  | None  |
| **Boulate *et al(2018)*** | 18 | M | MCI |  | Polytrauma  |  |  |  | Rib fractures  | HPNT | Yes  |  |  |  | Angiography  | PA | Open repair  | Graft repair  | PPG |  | CVA |
| **Boulate *et al(2018)*** | 30 | M | MVA |  |  |  |  |  | R&S fractures | PNT |  |  |  |  | Angiography  | PA | Open repair  | Graft repair  | AIAG |  | RI |

ACSG: Aorto-right common carotid and right subclavian bifurcated graft, ACCG: ascending to common carotid bypass graft, AIAG: ascending to innominate artery graft repair, ASR: ascending to subclavian graft, Bp: Blood pressure, C&R: clavicle and rib, CHPN: contusion with hemopneumothorax, CT: computed tomography, CTA: computed tomography angiography, CVA: cerebrovascular accident, DAE: decreased air entry, E to E: end to end anastomosis, HPN: hemopneumothorax, HTX: Hemothorax, ISCBG: innominate subclavian carotid bypass graft, IABG: innominate axillary bypass graft, MCI: motor cycle injury, MVA: motor vehicle accident, MVC: motor vehicle collision, NS: not specified, PC: pulmonary contusion, PNT: pneumothorax, PPG: prostathic interposition graft, PR: patch repair, PSCS: progressive supraclavicular swelling, R&S: rib and sternum, RI: repeat intervention, RCCA: right common carotid artery, RSC&RCCA: right subclavian and right common carotid arteries, SCR: sternum, clavicular and rib fracture, SCV: subclavian vein, SLR: simple laceration repair, SSR: simple suture repair.

Table 2: Demographics, mechanism of injury and clinical manifestations of patients with Subclavian artery injuries

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Subcategory  | Number  | Percentage(%)  |
| Age category | 1-17 years | 3 | 6.5 |
|  | 18-44 years | 18 | 45.7 |
|  | 45 years and above | 25 | 54.3 |
| Sex | Male  | 36 | 78.3 |
|  | Female  | 10 | 21.7 |
| Mechanism of injury | Pedestrian motor vehicle accident | 2 | 4.3 |
|  | Motor vehicle collision | 15 | 32.6 |
|  | Motor cycle injury | 6 | 13.0 |
|  | Falling down accident  | 8 | 17.4 |
|  | Sports injury | 5 | 10.9 |
|  | Bicycle | 3 | 6.5 |
|  | Workplace injury | 2 | 4.3 |
|  | Other and non specified | 5 | 10.9 |
| Clinical presentation | Blood pressure or pulse deficit  | 16 | 34.8 |
|  | Hemodynamic instability | 10 | 21.7 |
|  | Progressive supraclavicular swelling | 8 | 17.4 |
|  | Decreased Air entry | 1 | 2.2 |
|  | Upper limb pain | 2 | 4.3 |
|  | Acute supraclavicular swelling  | 2 | 4.3 |
|  | Chest pain/dyspnea | 3 | 6.5 |
|  | External bleeding | 1 | 2.2 |
|  | Non-specified | 3 | 6.5 |
| Associated injuries |  |  |  |
| Chest wall injuries | Chest wall injury |  |  |
|  | Clavicle fracture alone | 19 | 41.3 |
|  | Rib fracture alone  | 5 | 10.9 |
|  | Sternum fracture alone  | 2 | 4.3 |
|  | Rib and clavicle fracture | 5 | 10.9 |
|  | Rib and sternum fracture  | 1 | 2.2 |
|  | None/not reported | 14 | 30.4 |
| Lung/intrathoracic injury | Lung parenchymal/intrathoracic injury |  |  |
|  | Pneumothorax alone  | 4 | 8.7 |
|  | Hemothorax alone  | 4 | 8.7 |
|  | Hemopneumothorax | 7 | 15.2 |
|  | Lung contusion alone  | 1 | 2.2 |
|  | Lung contusion with hemopneumothorax | 3 | 6.5 |
|  | None/Not reported | 27 | 58.7 |
| Other area injuries | Face injury | 3 | 6.5 |
|  | Subclavian vein injury | 1 | 2.2 |
|  | Extremity injury | 11 | 23.9 |
|  | Abdominal injury | 4 | 8.7 |
|  | Traumatic brain injury  | 5 | 10.9 |

Table 4: Demographics, mechanism of injury and clinical manifestations of patients with Thoracic aorta injuries

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Subcategory  | Number  | Percentage(%)  |
| Age category | 1-17 years | 3 | 8.8 |
|  | 18-44 years | 22 | 64.7 |
|  | 45 years and above | 9 | 26.5 |
| Sex | Male  | 26 | 76.5 |
|  | Female  | 8 | 23.5 |
| Mechanism of injury | Pedestrian motor vehicle accident | 2 | 5.9 |
|  | Motor vehicle collision | 23 | 67.6 |
|  | Motor cycle injury | 3 | 8.8 |
|  | Fall from height  | 3 | 8.8 |
|  | Animal related injury | 2 | 5.9 |
|  | Workplace injury | 1 | 2.9 |
| Clinical presentation  | Chest pain | 8 | 23.5 |
|  | Hemodynamic instability | 7 | 20.6 |
|  | Altered mentation | 5 | 14.7 |
|  | Blood pressure or pulse deficit | 2 | 5.9 |
|  | Other | 3 | 8.8 |
|  | Non-specified | 9 | 26.5 |
| Related complaint  | Polytrauma  | 17 | 50 |
| Chest wall injury | Rib fracture alone | 9 | 26.9 |
|  | Sternum fracture alone  | 3 | 8.8 |
|  | Sternum and rib fracture  | 3 | 8.8 |
|  | Rib and clavicle fracture | 1 | 2.9 |
|  | None/not reported | 18 | 52.9 |
| Lung parenchymal/ intrathoracic injury | Pneumothorax alone  | 3 | 8.8 |
|  | Hemothorax alone  | 3 | 8.8 |
|  | Hemopneumothorax | 5 | 14.7 |
|  | Lung contusion alone  | 2 | 5.9 |
|  | Lung contusion with hemopneumothorax | 3 | 8.8 |
|  | None/Not reported | 18 | 52.9 |
| Associated vascular injury | Innominate artery | 5 | 14.7 |
|  | Left subclavian with Innominate artery | 2 | 5.9 |
|  | Left common carotid artery  | 1 | 2.9 |
|  | Right aberrant subclavian artery | 1 | 2.9 |
|  | None/Not reported | 25 | 73.5 |
| Other area injuries  | Face injury | 5 | 14.7 |
|  | Extremity injury | 17 | 50 |
|  | Abdominal injury | 13 | 38.2 |
|  | Traumatic brain injury  | 13 | 38.2 |
|  | Vertebral injury | 5 | 14.7 |

Table 5: Demographics, mechanism of injury and clinical manifestations of patients with Innominate artery injuries

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Subcategory  | Number  | Percentage(%)  |
| Age category | 18-44 years | 20 | 69.0 |
|  | 45 years and above | 9 | 31.0 |
| Sex | Male  | 26 | 89.7 |
|  | Female  | 3 | 10.3 |
| Mechanism of injury | Motor vehicle collision | 19 | 65.5 |
|  | Motor cycle injury | 4 | 13.8 |
|  | Fall from height  | 5 | 17.2 |
|  |  Sports injury | 1 | 3.4 |
| Clinical manifestations  | Chest pain  | 7 | 24.1 |
|  | Blood pressure or pulse deficit | 6 | 20.7 |
|  | Altered mentation | 2 | 6.9 |
|  | Hemodynamic instability | 3 | 10.3 |
|  | Progressive supra-clavicular swelling | 1 | 3.5 |
|  | Ischemic limb pain  | 1 | 3.5 |
|  | Decreased air entry | 1 | 3.5 |
|  | Other | 1 | 3.5 |
|  | Non-specified | 7 | 24.1 |
| Related complaint | Polytrauma  | 8 | 27.6 |
| Chest wall injury | Rib fracture alone | 9 | 31.0 |
|  | Sternum fracture alone  | 1 | 3.4 |
|  | Clavicle fracture | 1 | 3.4 |
|  | Sternum and rib fracture  | 4 | 13.8 |
|  | Rib and clavicle fracture | 1 | 3.4 |
|  | Rib, clavicle and sternum fracture  | 1 | 3.4 |
|  | None/not reported | 12 | 41.4 |
| Lung parenchymal/intrathoracic injury | Pneumothorax alone  | 3 | 10.3 |
|  | Hemothorax alone  | 1 | 3.5 |
|  | Hemopneumothorax | 2 | 6.9 |
|  | Lung contusion alone  | 3 | 10.3 |
|  | Lung contusion with hemopneumothorax | 3 | 10.3 |
|  | None/Not reported | 17 | 58.6 |
| Associated vascular injury | Aorta  | 1 | 3.5 |
|  | Right subclavian and right common carotid artery | 1 | 3.5 |
|  | Right aberrant subclavian artery | 1 | 3.5 |
|  | Superior vena cava injury | 1 | 3.5 |
|  | None/Not reported | 25 | 86.2 |
| Other area injuries  | Face injury | 8 | 27.6 |
|  | Extremity injury | 8 | 27.6 |
|  | Abdominal injury | 3 | 10.3 |
|  | Traumatic brain injury  | 4 | 13.8 |
|  | Vertebral injury | 3 | 10.3 |
| Seatbelt sign | Yes | 6 | 20.7 |
|  | No | 3 | 6.9 |
|  | Not reported | 21 | 72.4 |