ORIGINAL ARTICLE

The Role of 320 Slice CT Angiography in Predicting Vascular Trauma

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Abstract

Objective: To determine the accuracy of multidetector CT angiography (MDCT angiography) as initial diagnostic technique in depicting and characterizing post traumatic vascular injuries, looking for additional injuries and confirming the findings with intervention and follow-up.

Study Design: Descriptive analytical study.

Place and Duration of Study: Department of Radiology, Shifa International Hospital, Islamabad, from June 2010 to October 2013.

Methodology: Patients who underwent MDCT angiography for clinically suspected post traumatic vascular injury were included. All MDCT angiographies were performed on 320 slice CT (Aquilion One^{TM}) and were reviewed by two independent consultant radiologists. The sites of injury were intracranial, neck and maxillofacial, chest, abdomen and extremities. The presence and characteristics of vascular injuries were confirmed by post-operative findings or digital subtraction angiography (DSA). Sensitivity and specificity was calculated.

Results: The age of the patients ranged from 7 to 90 years with 94% (48) males and 6% (3) females. Blunt trauma was commoner than penetrating trauma. The site of injury in majority was extremities. Majority of patients had post-traumatic pseudoaneurysm formation followed by arterial occlusion, thrombosis, active extravasation, spasm, arteriovenous malformation and combination injuries. Twenty-one (41%) patients were reported as having vascular injury and confirmed by surgery or DSA. Fifteen (29.5%) patients were reported as normal and had no intervention on follow-up. The sensitivity and specificity of MDCT angiography was found as 100% and 88%, NPV of 100%, PPV of 94% and accuracy of 96%.

Conclusion: MDCT angiography can be reliably used as an initial diagnostic technique for the evaluation and characterization of post-traumatic vascular injuries.

Key Words: *MDCT angiography. Trauma. Vascular injuries. 320-slice CT.*

INTRODUCTION

Trauma is a common presentation in the emergency department and vascular injury is a known complication.[1] Vascular injury has serious consequences resulting in functional disability, limb ischemia to amputation as well as mortality. The clinical signs of vascular injury from either blunt or penetrating trauma can be widely categorized as hard and soft signs. Hard clinical signs are absent or diminished pulses, active hemorrhage, large expanding or pulsatile hematoma, bruit, thrill, or distal ischemia. Soft clinical signs include a small stable hematoma, injury to an anatomically related nerve, unexplained hypotension, and proximity of an injury to a major vessel.[2]

Vascular trauma can be diagnosed by a variety of modalities including conventional angiography, Doppler ultrasonography, Magnetic Resonance Imaging (MRI) and CT Angiography (CTA). Choosing an appropriate modality which helps in prompt diagnosis and rapid repair of arterial injuries is crucial in management as it improves the outcome in terms of function and mortality.[3-6] Conventional angiography was previously used for the diagnosis of arterial injuries as it was the only available modality at that time. It is now used in only those cases where intervention is also required due to the cost of procedure, the delay that occurs for prerequisites required in angiography and the need for a specialized team.[3,4,7] The method of choice would be such an imaging modality which not only helps in rapid diagnosis, but is non-invasive and acquired by a single trained technologist. Doppler ultrasonography having less sensitivity and specificity, needs an experienced operator and is relatively more time-consuming.[8-13] Magnetic resonance angiography has not become common because it is currently impractical to perform in the setting of trauma as it requires patient co-operation as well as time.[14]

Multidetector CT angiography (MDCT angiography) is rapidly performed, as it decreases diagnostic ambiguity, provides required information to the surgeon or interventionist avoiding unnecessary exploration and decreasing procedure time. Less scanning time allows the physician to add MDCT angiography in the

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diagnostic algorithm without delaying patient treatment.[15] It also yields additional information regarding the relationship of injured vessel to underlying bones and soft tissues. It also allows simultaneous visualization of osseous and soft tissue injuries reducing time required by additional diagnostic modalities.

Metallic streak artifacts, motion artifacts, and inadequate arterial opacification may render a CT angiogram non-diagnostic.[16] Multiplanar reformations as well as 2D and 3D reconstructions have further increased the utility of MDCT angiography in terms of efficacy in diagnosis. It is also beneficial for the critically injured patient as anatomical details can be visualized in multiple planes without altering the patient's posture. With the evolution of multidetector 320 slice computed tomographic angiography, the role of other imaging modalities for arterial injury has been challenged.

The purpose of this study was to determine the accuracy of MDCT angiography performed on 320 slice CT as initial diagnostic technique to depict vascular injury in patients with trauma, to characterize vascular lesions, to look for additional injuries and confirm the MDCT angiography findings with intervention and follow-up.

METHODOLOGY

It was a descriptive analytical study performed at Department of Radiology, Shifa International Hospital, Islamabad, from June 2010 to October 2013. Institutional Review Board approval was taken.

Patients who had undergone MDCT angiography for clinically suspected post traumatic vascular injury, after informed consent, were included. Patients who had MDCT angiography for etiology other than trauma, i.e. atherosclerotic disease related morbidity or critical ischemia, were excluded.

The type of trauma was broadly divided into blunt and penetrating. Blunt trauma included RTA and crush injuries while penetrating trauma included stab wounds, firearm injuries and interventional procedures. The site of injury was classified as intracranial, neck and maxillofacial, chest, abdomen and extremities. Vascular injuries were then assessed and characterized as pseudoaneurysm, occlusion, thrombosis, spasm, dissection, arteriovenous malformation (AVM), active extravasation and combination injuries.

Pseudoaneurysm was defined as extravascular contrast material containing collection connected to arterial wall, occlusion as loss of opacification of an arterial segment, thrombosis as filling defect in vessel, spasm as vessel narrowing, dissection as intimal flap, arteriovenous malformation as early venous opacification with abnormal change in vessel caliber, contour or course, active extravasation as active contrast extravasation from vessel and combination injuries as combination of two or more above described injuries.[15] The combination injuries were majorly dissection and thrombosis, occlusion and thrombosis, occlusion and pseudoaneurysm.

MDCT findings were correlated with the management of patients. The presence and characteristic of vascular injury was confirmed by postoperative findings on surgery or digital subtraction angiography (DSA). The associated findings were also evaluated on CT i.e. fractures and combination of associated findings like fractures, hematomas, muscular injuries and air in soft tissues.

All MDCT angiographies were performed at 320 slice CT machine (Aquilion one TM, Toshiba, Japan). Protocol included 1 ml/kg bolus of non ionic contrast material injected at 5 ml/sec. Multiplanar reformation with 3D and 2D reconstructions using Maximum Intensity Projections (MIP) and Volume Rendered (VR) images were performed on Vitrea fx workstation and reviewed by two independent consultant radiologists.

Statistical analysis was performed on SPSS version 13. Sensitivity and specificity were calculated using 2 x 2 tables. Negative and positive predictive values were also assessed.

RESULTS

A total of 51 patients had undergone MDCT angiography during the study period of 28 months for clinically suspected post traumatic vascular injury, out of whom 39 patients had documented vascular injury.

The age range of patients was 7 to 90 years with mean age of 37 ±18.5 years. Forty-eight (94%) were males while 3 (6%) were females. Blunt trauma was commoner seen in 68% (n=35) and penetrating trauma was seen in 33.3% (n=16). The site of injury was central nervous system in 10 patients, neck and maxillofacial in 9, abdomen in one, and extremities in 31 patients. None of the patients presented with chest trauma.

The vascular injuries were then characterized. Majority of patients had post traumatic pseudoaneurysm formation i.e. 13 patients followed by arterial occlusion in 11, thrombosis in 1, active extravasation in 1, spasm in 3, arteriovenous malformation in 3, and combination injuries in 7 patients. In combination injuries, 2 patients had dissection and thrombosis, 2 had occlusion and thrombosis and 3 had occlusion and pseudoaneurysm. The additional findings in related anatomical structures were reviewed and 53% (n=27) patients were found to have fractures and 47% (n=24) were found to have combination of associated findings, i.e. fractures, hematomas, muscular injuries and air in soft tissues.

The management of patients was retrospectively reviewed. The MDCT angiography findings were

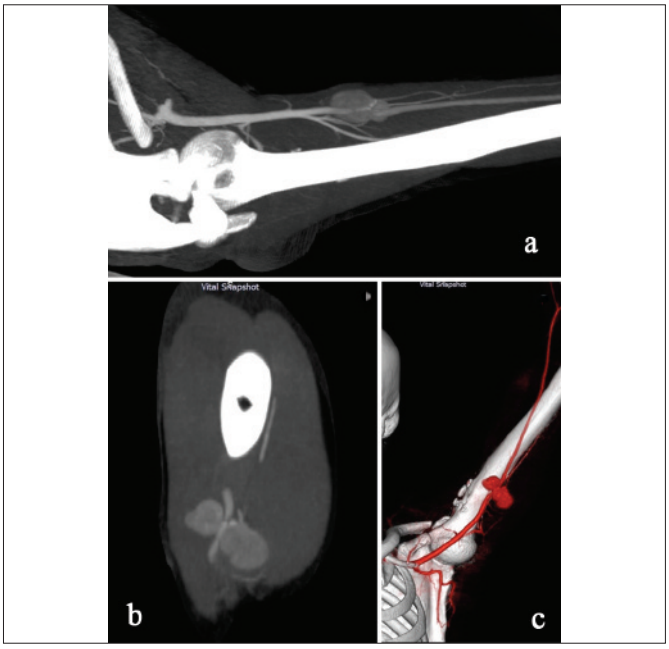

Figure 1 (a,b,c): Coronal oblique CT VR image showing post traumatic bilobed pseudoaneurysm arising from the left brachial artery.

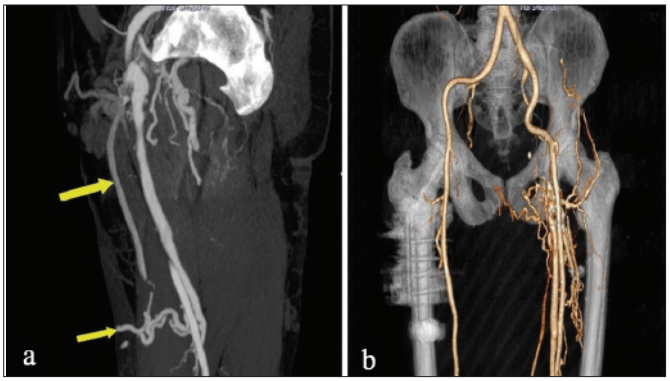

Figure 2 (a,b): Coronal oblique VR **(a)** and Saggital oblique CT **(b)** images showing opacification of common femoral vein, superficial and deep femoral veins and great saphenous vein in arterial phase signifying arteriovenous malformation.

correlated with their surgical findings, digital subtraction angiography findings and follow-up. The patients, reported as having vascular injury on CTA, were confirmed by surgery or digital subtraction angiography. Furthermore, the character of arterial injury was also confirmed. Twenty-one (41%) patients were confirmed surgically and by digital subtraction angiogram. The patients had then undergone surgical repair. One patient, confirmed by digital subtraction angiography, had undergone coiling of pseudoaneurysm. Fifteen (29.5%) of patients were reported as normal on CTA and had no intervention on follow-up. Thirteen (25.5%) had lost to follow-up and 2 (4%) died. The sensitivity and specificity of MDCT angiography in our study was found to be 100% and 89% with negative predictive value of 100%, positive predictive value of 94% and accuracy of 96%. Few of the major injuries discussed in this study, are shown in Figure 1 and 2.

DISCUSSION

The prevalence of arterial injuries is rising due to rise in the number of traumatic events and interventional procedures. The choice of an appropriate diagnostic modality has remained a dilemma for a long time.

Digital subtraction angiography and surgery have long been the gold standard but with the advent of newer modalities, unnecessary intervention is undesirable. Doppler ultrasonography has led to good results[17] but is operator-dependant, time consuming and arterial injury may lead to disastrous consequences as the time passes from the initiation of event to the execution of intervention. MR angiography has substantial limitation of time consumption as well as artifacts related to motion.

CT angiography has not only changed the approach to management but also helped in rapid depiction of arterial injury as well as the diagnosis of additional injuries in the associated anatomical structures. With the advent of newer 2D and 3D multiplanar reformations on 320 slice CT, it has been possible for the surgeons to visualize the injured vessel as well as to know the details of anatomical relationship of vessels to surrounding structures requiring intervention. It has also helped the surgeons to plan their management accordingly as to those requiring active intervention or who require only observation and follow-up. In this study, we determine the usefulness of 320 slice CT angiography in detection of post traumatic vascular injuries and associated injuries.

Vascular trauma is common in the younger age groups. Fishman *et al*. reviewed different studies and found male to female ratio in the range of 5 - 7:1 with a mean age of 29 - 37 years.[18] This study found male to female ratio as 16:1 with a mean age of 38 years. This signifies that post traumatic vascular injuries are common in young patients. Inaba *et al*. showed blunt trauma common while Soto *et al*. and Zaitoon *et al*. showed penetrating trauma being common.[19-21] This study showed blunt trauma being common cause. This may owe to lack of medicolegal presentation to our department. Majority of data available in literature is vascular trauma to extremities. The most common site of injury in our study was also extremities corresponding to observation made by Gakhal *et al*.[15]

CTA allows simultaneous visualization of other injuries related to trauma. The associated injuries, i.e. fractures were assessed in different studies and was found to be in 39% by Inaba *et al*. and 32 - 46% by Soto *et al*.[19,20] This study showed fractures in 52% with other findings being hematomas, air in soft tissues, muscular injuries as well as miscellaneous injuries.

The characterization of vascular injury was based on data in literature and findings were correlated with surgery and/or DSA. Majority of patients were found to

have similar characterization of vascular injury on surgery as well. The sensitivity and specificity of this study was comparable with study by Reiger *et al*. (studied 87 patients) who found the above to be 99% and 88%, respectively;[22] while this study showed it to be 100% and 89%. Zaitoon *et al*. studied 19 patients and Soto *et al*. studied 134 patients showing sensitivity as 94% and 95% and specificity as 100% and 98%, respectively. Munera *et al*. showed sensitivity as 100% and specificity as 98% in vascular injuries of neck.[23]

The major limitation in this study was the retrospective method of data collection.

CONCLUSION

MDCT angiography can be used reliably as initial diagnostic method in patients with suspected post traumatic vascular injuries. It permits significant and reproducible detectability and characterization of vascular injury. Moreover, it allows simultaneous visualization of muscular and bony structures thus reducing need of additional studies. Consequently, it helps in appropriate and prompt surgical management of patients.

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