MULTI-DETECTOR COMPUTED TOMOGRAPHY ANGIOGRAPHIC EVALUATION OF EXTREMITY VASCULAR TRAUMA: CASE SERIES

ABSTRACT

Objective; The purpose of this article is to review the multidetector computed tomography (MDCT) angiography within the evaluation of extremity trauma. Trauma could be a great public health dilemma in developing and developed countries and regularly involves teenagers. Among different kinds of trauma, vascular injuries of the extremities need special consideration because they'll be threatening to limb and life. Vascular injury going to exsanguination and hemorrhagic shock is second to central nervous system injury; thus, imaging diagnosis is crucial for the trauma victim as early as possible from admission to the hospital. Although the speed of successful management of those injuries has been increased because of proper pre hospitalization, early referral of patients to specialized trauma centers, and proper surgical interventions, these injuries remain a challenging problem, especially in developing countries.

Conclusion; With the rising trend of road traffic accidents and violence, vascular injuries have become a significant contributor of limb loss, with increased morbidity and mortality. MDCT Angiography has become the most non-invasive diagnostic imaging vascular triage tool applicable to all or any varieties of extremity trauma. Axial sections, multiplanar reconstructions and 3D volume-rendered images should aid within the detection and improve the interpretation of such vascular injuries, osseous and soft-tissue injuries which could be of immense help to the clinician planning surgical procedures.

KEYWORDS; Computed Tomography Angiography**,** Extremity trauma, Extremity vascular trauma**,** Multi-detector Computed Tomography Angiography.

INTRODUCTION

"Trauma is that the leading explanation for death worldwide in patients younger than 45 years and also the sixth leading reason for all death, accounting for 10% of all mortality" [1]. "Extremity vasculature emergencies coming to the emergency department have different management and outcomes depending on the cause and nature of injury. They range from symptoms of chronic claudication to critical limb ischemia with risk of loss of limb and life.Classifying them with a non-invasive test is essential before the decision for intervention and to plan the approach" [2]."Previously, Digital subtractionangiography (DSA) was the gold standard and also the first-line imaging modality accustomed to assess vascular injury. However, screening DSA for every individual who presents to the emergency department with suspicion of vascular injury or limb ischemia is not practical, safe, or cost-effective" [2].Computed Tomography Angiography (CTA) has since replaced diagnostic angiographic examinations, which were only used complementary to inconclusive CTA examinations. CTA has an important and established place in every trauma patient's evaluation. The technology of MDCT enables depiction of detailed vascular anatomy, and CTA is a component of the routine evaluation.

"CTA as a first-line imaging modality within the setting of vascular trauma has several advantages, which include the following: 1. the examination is non-invasive, available, and rapid, with excellent negative predictive value. 2. It can save within the number of diagnostic angiograms needed and enables simultaneous evaluation of various body areas.3. During the identical examination, extravascular pathologies may be depicted, and also the vascular images are useful for the interventionist or surgeon who perform the next treatment.4.In a happening of mass trauma, CTA serves as a triage tool" [3].

"Several trauma-related vascular pathologies may be depicted by the CTA examination; these include arterial spasm, arterio-venous fistula, intimal flap, dissection, arterial occlusion, pseudo-aneurysm, and active bleeding. In cases of quite single-organ injury, the traumatologist can choose the prompt therapy in step with the amount of trauma severity in several organs" [4]."Sensitivity and specificity of CT for detecting vascular damage in trauma patients in numerous areas are very high. CTA has become the most imaging vascular triage tool both in daily traumas, terrorist acts, and in wartime and is applicable to all or any varieties of trauma" [5].

The aim of this study was to judge the role of CTA in evaluation of patients with missed vascular injury of the upper and lower extremity following trauma, so as to spot the presence of lesion, its nature and exact site.

CASE PRESENTATION

CASE-1.45 years old man with road traffic accident (RTA) presented with suspected fractures of right thigh to emergency trauma care centre. On physical examination he had right thigh painful swelling, fractures of femur and feeble lower limb pulses. X-ray revealed comminute fractures of distal half of femur with displacement of fracture fragments. Patient underwent CTA **(Fig.1)** to study the blood flow status of lower limbs.

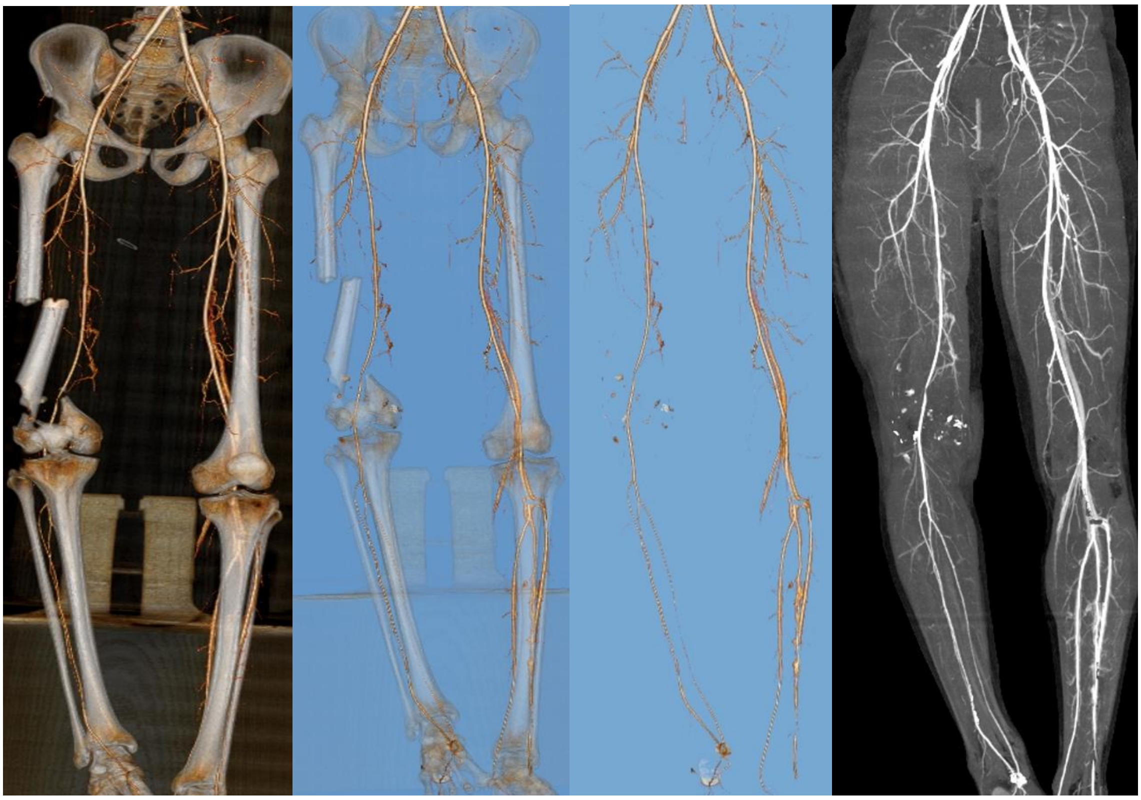

FIG.1 (A-D).3D volume rendered (A-C) and maximum intensity projection (MIP)(D) CTA images reveal comminute fractures of distal half of femur with displacement of fracture fragments, causing focal kinking and external compression of distal one third of superficial femoral artery.

CASE-2. 20 years old male with motor cycle crash and right knee injury,was brought to the casualtyfor evaluation of injury. Physical examination revealed dislocation of knee joint, knee hematoma, and absent dorsalis pedis artery pulses. Emergency CTA **(Fig.2)** of lower limbs was performed to study lower limb vessels.

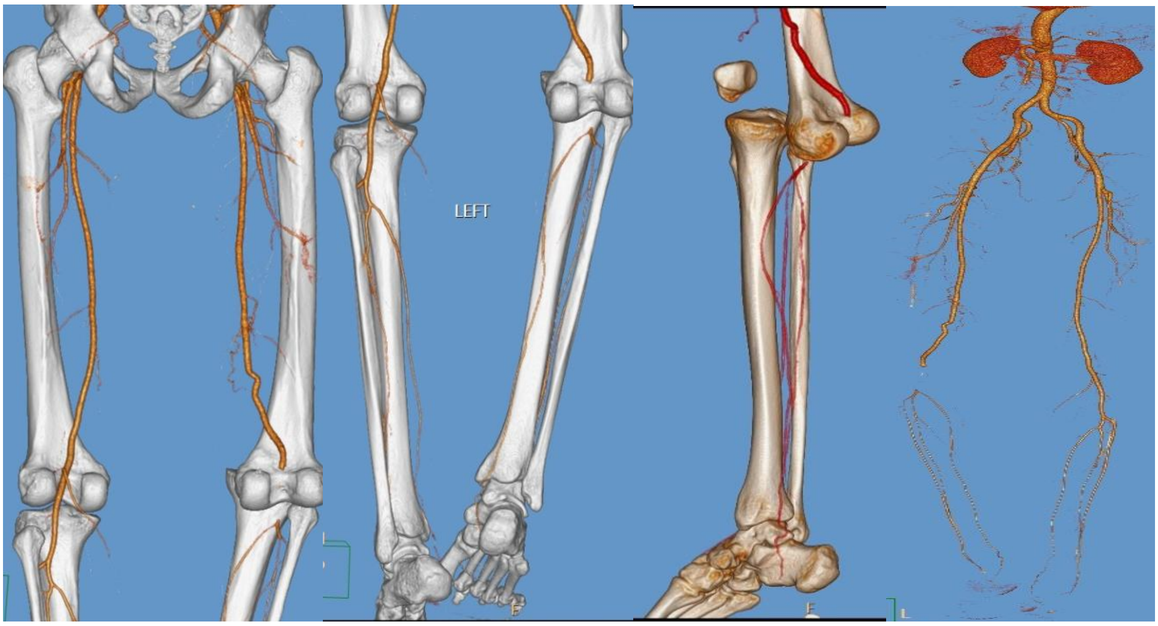

FIG.2(A-D). 3D volume rendered CTA images reveal, dislocation of right knee joint, with haemarthrosis, occlusion of popliteal artery , faint filling of proximal two third of anterior tibial artery and nonvisualisation of dorsalis pedis artery.Complete transection of popliteal artery was found at surgery.

CASE-3. 35 year old man with run over car accident brought to trauma care centre for treatment of injuries.Physical examination revealed stable upperlimb pulses, extensive swelling of left leg with suspected fractures and feeble lower limb pulses. X-ray showed comminuted fractures of both bones of left leg with displacement of fracture fragments. Patient underwent CTA**(Fig.3)** of lower limbs to study the vascularity.

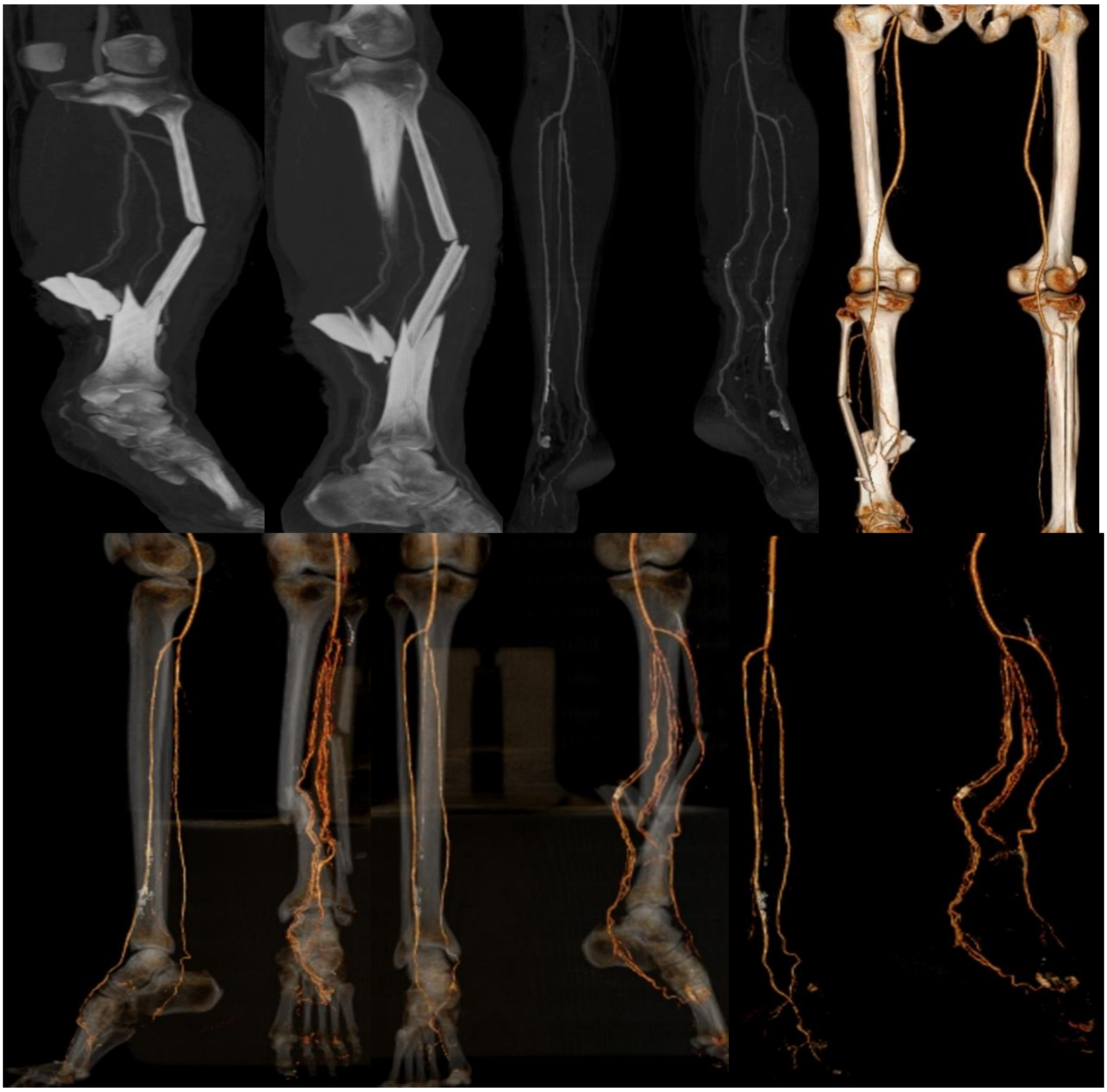

FIG.3(A-G). MIP(A-C) and 3D volume rendered (D-G) CTA images of lower limb vessels shows comminuted fractures of middle third of both bones of left leg with displacement of fracture fragments, displacing the vessels and causing minimal compression over them.

CASE-4. 56year old male with stab injury to right thigh following a group clash presented with swelling in groin**.** Physical examination revealed pulsatile swelling in right groin. CTA **(Fig.4)** was performed to look for groin vacular injury.

FIG.4 (A-C). CTA 3D volume rendered images of lower limb vessels showed pseudoaneurysm of right common femoral artery.

CASE-5. 59 year old man with rivalry attack and stab injury to left knee joint. Physical examination revealed pulsatile swelling in posterior left knee joint. CTA **(Fig.5)** was performed to look for knee vascular complication.

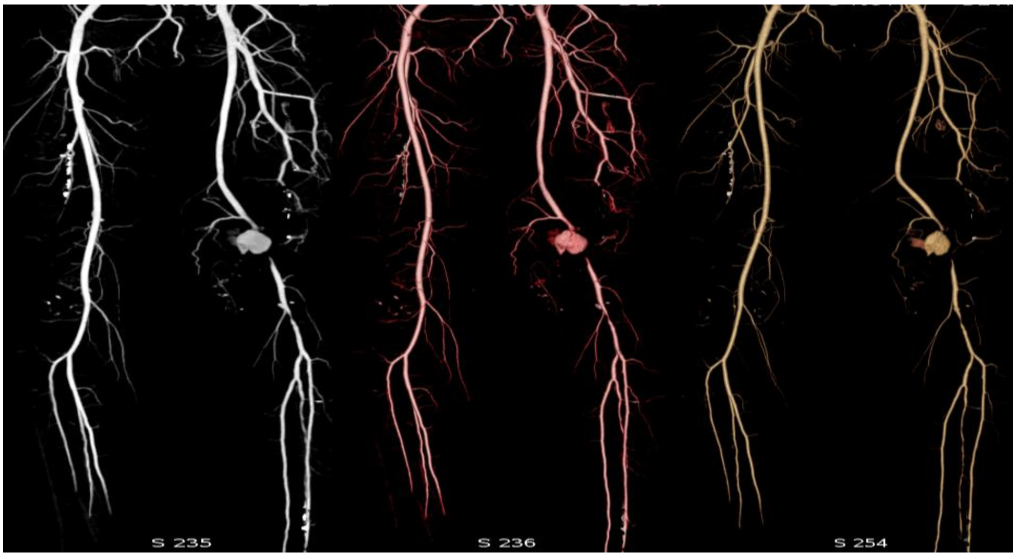

FIG-5(A-C). CTA Maximum intensity projection (MIP) (A) and 3 D volume rendered (B,C) images show pseudoaneurysm of left popliteal artery.

CASE-6. 45 year old man with old history of trauma to right hand in a factory work, presented with pain & swelling of hand. Physical examination revealed engorged dilated arteries & veins of hand. CTA **(Fig.6)** done to exclude vascular malformation.

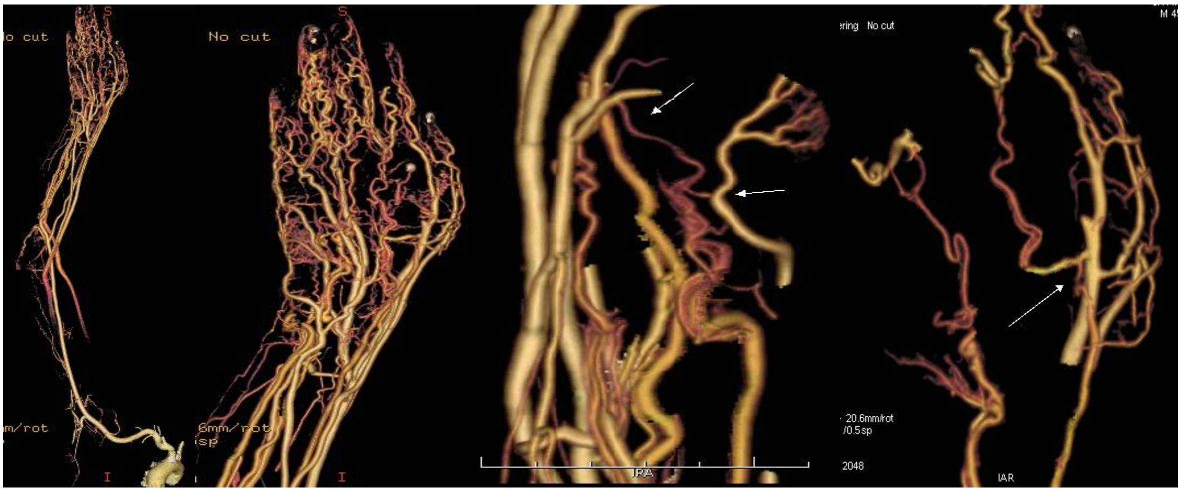

FIG.6(A-D) CTA 3D volume rendered multiplanar images reveal multiple arterio-venous fistula of right hand.

CASE-7. 19 Year old male with history of fall from height presented to Emergency department with swelling in axilla and upper limb pain. On physical examination tender swelling in right axilla with absent brachial, radial and ulnar artery pulses noted. Patient was stable otherwise and underwent emergency CTA **(Fig.7)** to know the vascular complications.

FIG.7(A-E).Contrast enhanced axial (A,B), reconstructed coronal (B,C) and volume rendered (E) CTA images show right axillary intramuscular hematoma causing axillary artery occlusion. Segmental thrombosis was found at surgery.

CASE -8. 27 year old man with motorbike lorry collision accident who sustained right upper limb injuries was brought to trauma care centre. Physical examination showed suspected fracture bones of right upper limb, swelling and feeble forearm pulses. CTA **(Fig.8)** was performed to look for vascular compromise.

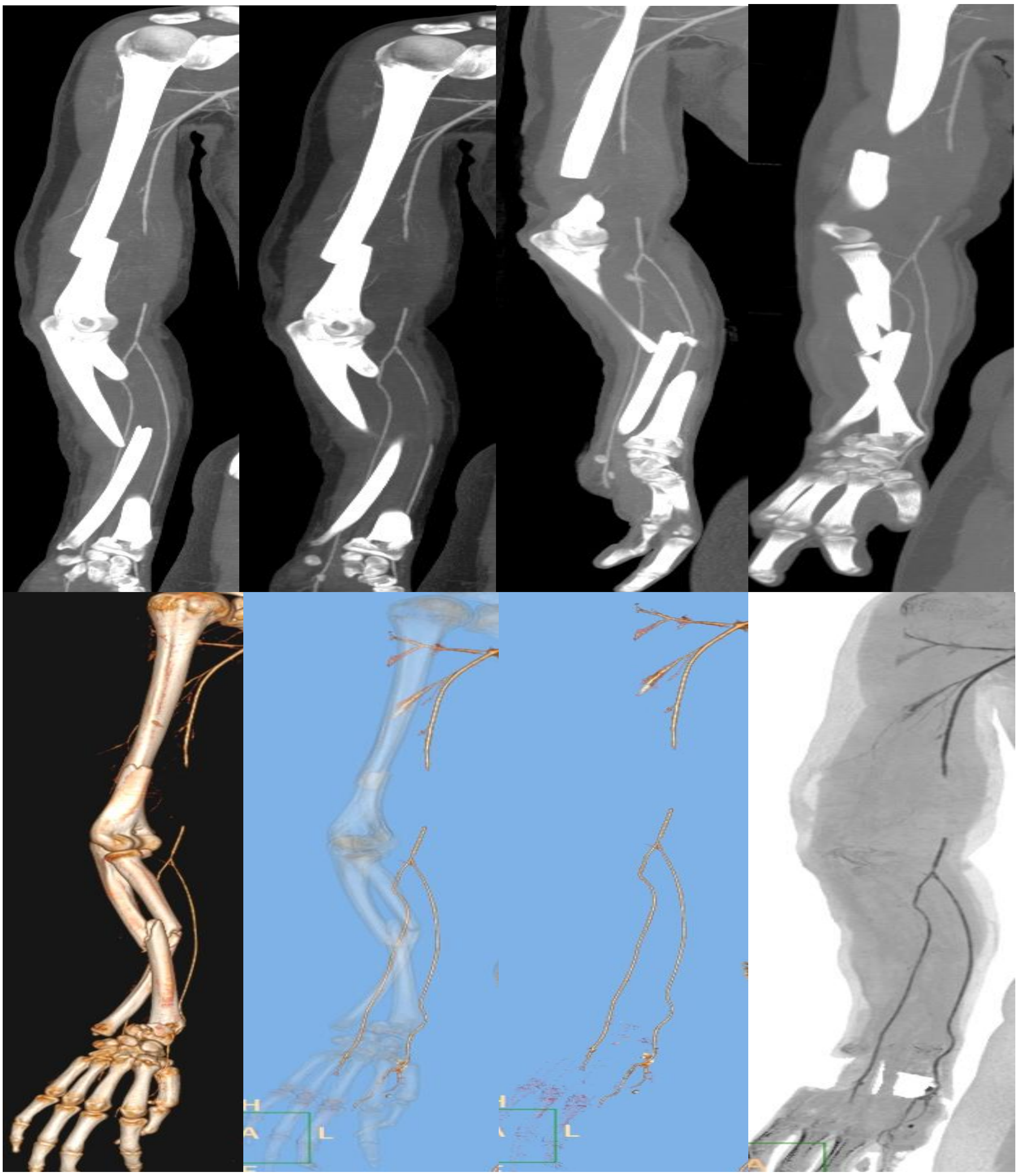

FIG.8(A-H). CTA multiplanar (MPR)(A-D) and 3D volume rendered (E-G) and positive image (H) reveal fracture lower third of humerus and middle third of both bones of right forearm with displacement of fracture fragments, intramuscular hematoma of arm & forearm and lower third segmental occlusion of brachial artery. Complete segmental transection & rupture was found at surgery.

CASE-9. 19 year old boy with racing motorbike accidental fall and injury to right forearm was admitted for treatment of injuries. Physical examination showed suspected fracture bones of right upper extremity, swelling and absent ulnar pulses. CTA **(Fig.9)** was performed to look for ulnar artery injury.

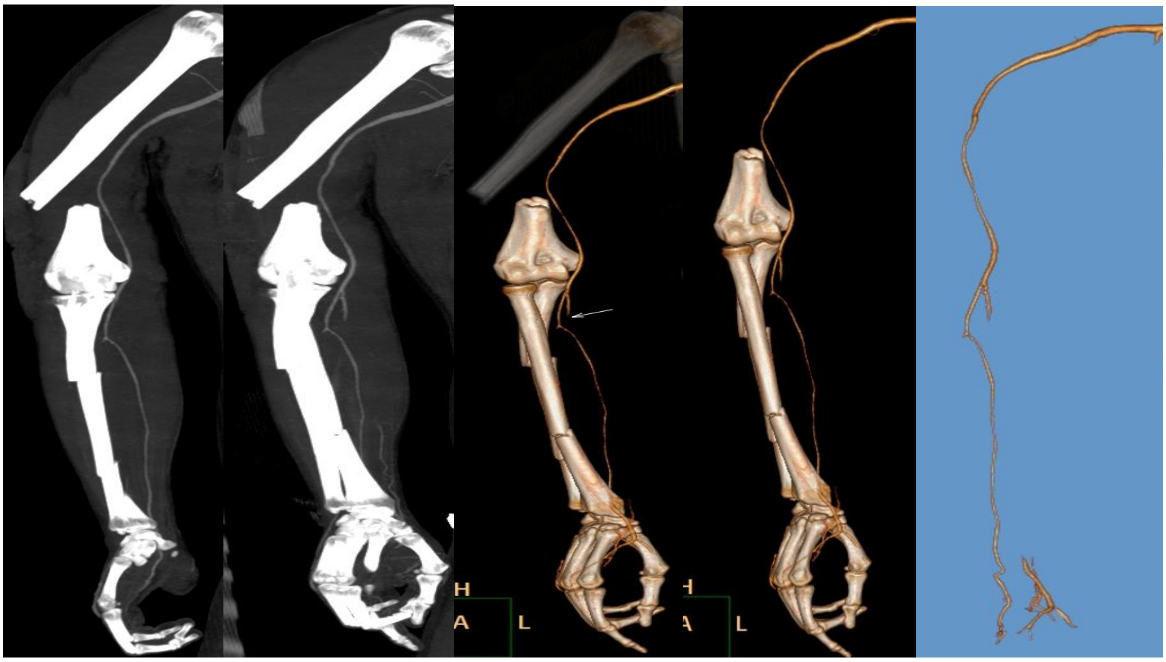

FIG.9(A-E) CTA 2 D reformatted coronal (A,B) and 3D volume rendered (E-G) image reveal fracture lower third of humerus and communitted fracture middle third of both bones of right forearm with displacement of fracture fragments, intramuscular hematoma of arm & forearm with occlusion of proximal ulnar artery. Vessel narrowing & occlusion was found at surgery.

CASE-10.26 year old boy involved in collission while riding motor cycle who presented with soft tissue injuries & fracture. Physical examination revealedswelling of left elbow joint with suspected fracture dislocation and absent radial pulse. CTA **(Fig.10)** was performed to look for vascular injury.

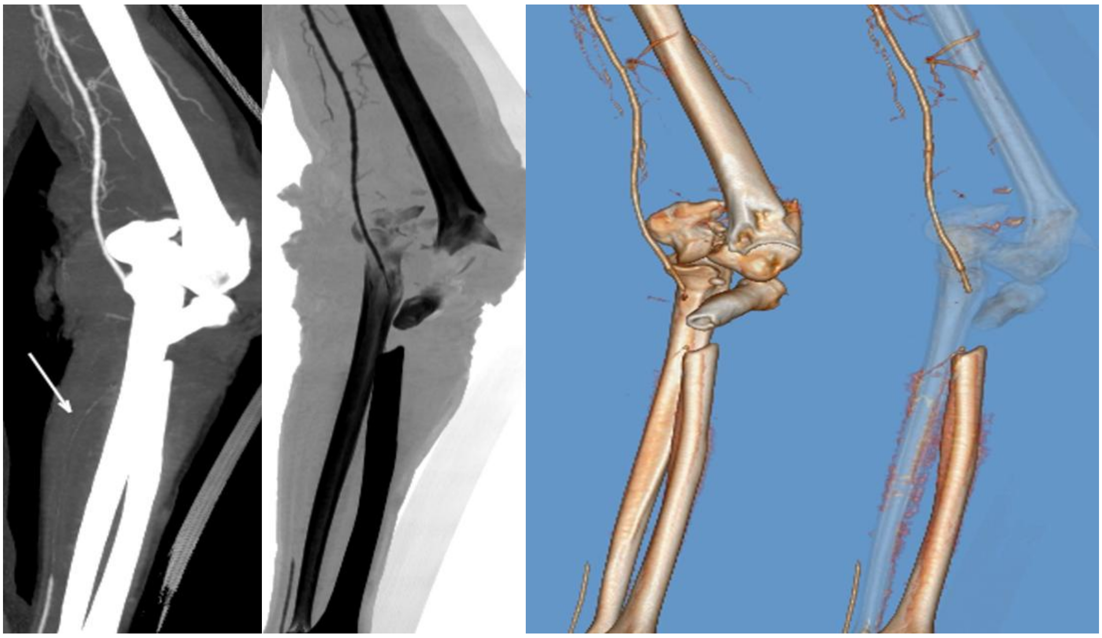

FIG.10(A-D) CTA MPR (A), positive image (B) and 3D volume rendered (C,D) image reveal communitted fracture lower end of left humerus with posterior dislocation, fracture proximal third of radius of forearm with displacement of fracture fragments, intramuscular hematoma of elbow & proximal forearm with occlusion of brachial artery bifurcation, radial artery & proximal two third of ulnar artery. Complete rupture & transection of brachial artery bifurcation was noted at surgery.

DISCUSSION

Clinical findings of vascular injury from penetrating or blunt trauma as described by Compton and Rhee [6] will be categorized into hard and soft signs. Hard signs include absent or diminished pulses, active haemorrhage, large expanding or pulsatile hematoma, bruit, thrill, or distal ischemia. Soft signs include a small stable hematoma, injury to an anatomically related nerve, unexplained hypotension, and proximity of an injury to a major vessel [6]. "Patients presenting with hard signs could potentially proceed on to operative management. However, it's desirable to perform CTA altogether in patients who are sufficiently stable to undergo the examination because it will be rapidly performed, decreases diagnostic ambiguity, provides valuable information to the vascular surgeon or interventionist, avoids unnecessary intra-operative exploration, and reduces procedure time. The IV contrast agent administered for CTA usually doesn't hinder additional use should it become necessary to perform conventional arteriography. In our experience, CTA of the lower extremities is being increasingly performed for the complete spectrum of vascular injuries and together with CT of other body parts, particularly in patients with complex multi-trauma” [7].

CTA signs of vascular injury in lower extremity trauma include active contrast extravasation, an extravascular contrast material– containing collection, abrupt vessel narrowing **(FIG.1),**and loss of opacification or occlusion of an arterial segment **(FIG.2),** intraluminal filling defect, early venous opacification, and abnormal change in vessel calibre, contour, or course **(FIG.3)** [8–10].

“Vessel calibre reduction on CTA can indicate the presence of spasm, dissection, or external compression. Lumen narrowing with irregular contour signifies a partial-thickness wall injury and thrombus” [9]. Active extravasation of contrast-enhanced blood, indicative of ongoing haemorrhage, manifests as an irregular blush of extra luminal contrast medium near the focal arterial mural disruption which will insinuate into adjacent soft tissues and muscles. A more organized extravascular contrast filled sac connected to a vessel through a neck at a site of focal arterial wall discontinuity is indicative of pseudo-aneurysm formation **(FIG.4 & 5)** [11].

“Arterial transection and complete rupture may result in segmental vessel occlusion. Injuries that end in vessel narrowing may cause or reach lack of lumen opacification and segmental occlusion” [12]. “Intraluminal filling defect can represent thrombus or intimal flap, with the latter appearing linear and denoting the presence of a localized dissection. However, dissection may also appear as a semilunar lumen deformation, eccentric stenosis, or segmental thrombotic occlusion” [12]. Arterial injury not only may result in thrombus at the location of injury but can also cause thrombo-embolism further downstream.

Early venous enhancement on properly timed arterial phase CTA should prompt evaluation for post-traumatic arterio-venous fistula **(FIG.6).** There may be an accompanying increase in size or calibre of the veins moreover, especially if the fistula is subacute to chronic. In some instances, the precise site and nature of communication between the artery and vein are incompletely defined by CTA and need conventional catheter angiography [13].

“The most common anatomic location of penetrating injury is that the superficial femoral artery followed by the popliteal and common femoral arteries” [14]. “In isolated lower extremity vascular trauma, mortality is more common in injuries to the common and superficial femoral arteries (4.8 %), than in injuries to the popliteal or tibial arteries (1.4 %)” [14]. “However, popliteal artery injury is associated with a higher incidence of amputation” [15].

“In the upper extremity, penetrating trauma mechanism is commonest (73 %) and also the majority of patients (78 %) suffer concomitant upper extremity injuries with soft tissue and nerve injuries being most prevalent” [16].

“Upper extremity arterial injuries are often less encountered than those affecting the lower extremity vasculature. Imaging of the upper extremity arterial system is sometimes performed in trauma patients, patients with ischemic symptoms of the upper extremities, for preoperative planning of complex upper extremity vascular reconstructions and dialysis access, and for evaluation of post endovascular surgical procedures” [17].

Traumatic injuries to the axillary **(FIG.7)** and brachial **(FIG.8 & 10)** arteries remain rare, representing 15–20% of arterial injuries to the upper extremity. Forearm arterial injuries **(FIG.9 & 10)** are commonest followed by brachial and axillary arterial injury [18]. Approximately 6% of those injuries are because of blunt trauma, with the bulk occurring following fracture-dislocations **(FIG.10)**. Less than 1% of vascular injuries to the upper extremity are related to a traumatic dislocation alone **(FIG.10)** [19]. Mortality and amputation are rare following axillary and brachial injuries.

“High sensitivity and specificity of CTA in detecting suspected vascular injuries of the extremities were described, in many studies starting from 95% to 100% and 90–100%, respectively” [10,20].“CTA is a useful tool to classify the nature of vascular injury. It is advisable to use a composite score for maximum diagnostic value” [21].

“CTA is able to predict the need for revascularization and may be an effective diagnostic tool for suspected vascular injury though it did not entirely replace the need for traditional angiography”[22].“CTA has become overused among patients with extremity trauma, as determined by the outcome of vascular abnormalities that underwent vascular intervention but were missed by physical examination” [23].

CONCLUSION

With the rising trend of road traffic accidents and violence, vascular injuries are getting a significant contributor of limb loss, with increased morbidity and mortality. MDCT Angiography has become the most non-invasive diagnostic imaging vascular triage tool applicable to all or any types of extremity trauma. Axial sections, multiplanar reconstructions and 3D volume-rendered images should aid within the detection and improve the interpretation of such vascular injuries, osseous and soft-tissue injuries which could be of immense help to the clinician planning surgical procedures.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

CONSENT

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

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