Evaluation of Frequency and Properties of CT Angiographic Findings and their Influence on Management in Patients Suspicious to Traumatic Arterial Injuries Referred to CT Scan Department of Imamreza Hospital

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ABSTRACT

Introduction: Peripheral vascular injuries include about 80% of all vascular injuries and the studies performed so far in this area showed that the prevalence of vascular trauma is higher in men than women. The aim of this study was to evaluate the frequency and types of traumatic arterial injuries in patients referred to Computed Tomography (CT) department of Imam Reza Hospital.

Materials and Methods: This cross-sectional study was approved by the ethics committee of Mashhad University of Medical Sciences. Patients’ information were recorded in a checklist, all patients who were referred to CT scan department of Imam Reza Hospital for Computed Tomography angiography (CTA) because of traumatic vascular injuries were enrolled in the study. Data were recorded about patients’ demographic characteristics (age and sex), mechanism of trauma such as accident (motorcyclist, pedestrian, car-ride), assaults, falls and so on, clinical symptoms at admission, type of arterial injury, and the report of CTA and the existence of musculoskeletal or neurologic comorbidities. Patients’ management details were also evaluated. Data were coded and analyzed by SPSS Version 16.

Results: 200 patients were evaluated in this study. The most common sites of involvement were the lower limbs (76%), thorax (16%), and upper limbs (8%). The most common abnormal angiographic pattern was run-off/cut-off (52%), hematoma (15%), and aneurysm (5.5%). There was also nerve damage in 19% of patients. Surgical management was performed and included, end to end anastomosis in 32% of patients, thrombectomy in 23%, amputation in 18%, and ligation in 4% and vascular graft in 7%.

Conclusion: In our study, there was vascular injury in 63.5% of patients based on the results of CTA. All vascular injuries were diagnosed by CTA were confirmed after vascular intervention and no serious vascular injury was reported in patients with negative CTA result at the follow-up period. So, CTA is a noninvasive and accurate diagnostic test.

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Introduction

Arterial injuries with increasing frequency is known as an important complication of trauma. Such complications may lead to multiple pathologic lesions, and cause involvement of visceral and peripheral arteries. The peripheral arteries are especially susceptible to injuries by blunt trauma. Because they are closer to the surface and due to their proximity to the bone, brachial and femoral arteries are more susceptible. Clinical prognosis depends on early diagnosis and repair of the injury (1, 2). The physical examination has a major role in the evaluation and treatment of patients with arterial damage. Evaluation and follow-up of this type of damages have been changed in the last decades from routine surgical exploration to selective arteriography and recently to selective evaluation based on physical examination (2, 3). Several imaging modalities have been proposed for evaluation of vascular lesions including Catheter...
Angiography (CA), duplex ultra-sonography (DUS), magnetic resonance angiography (MRA) and Computed Tomography Angiography (CTA) (4-7).

Although the gold standard for the diagnosis of traumatic vascular injuries is conventional angiography through catheter by Digital Subtraction Angiography (DSA) technique (8-11), but this modality becomes useless in vascular injuries in limbs by developing new noninvasive techniques (12-16).

Today, CTA has become an important method for initial evaluation of patients with trauma and is increasingly used for diagnosis of damages caused by blunt and penetrating trauma in the neck and limbs (17-23) and is considered as a choice method in these cases (24).

Patients with clinical symptom suggestive for arterial injury such as hematoma, significant bleeding, trill or limb ischemia should immediately undergo surgical exploration. Among these, there is a group of patients whom might benefit from vascular radiology studies. This group includes the patients with clear signs of arterial damage, severe bone fracture, massive damage of soft tissue, wounds from bullets and gun hunting, as well as the patients who don’t have clear signs of arterial damage, but have shown the symptoms of involvement in follow up (25).

In this research project, the frequency and types of arterial injuries following trauma in patients referred to the department of CT scan in Imam Reza hospital was studied. The study location was the Computed Tomography (CT) department of in Imam Reza hospital which is the main referral center for evaluating traumatic patients with CTA in Mashhad.

Materials and Methods

This cross-sectional study was performed on patients suspected to arterial injury who were referred to the department of CT scan in Imam Reza Hospital.

Patients’ selection

Sample size was estimated about 200 patients. Patients who were suspected to arterial injury and were referred to Imam Reza Hospital for CTA and were enrolled the study. The patients were excluded from the study if they could not undergo CTA (sensitivity to Contrast agent, etc.).

Methods

After approval by the ethics committee of Mashhad University of Medical Sciences, the checklist of the variables related to the research project was designed. Information on those who were referred to CTA department was recorded.

The information included: the characteristics of birth certificate (name and surname, age, sex), mechanism of traumatic accident (motorcyclist, pedestrian, car rider), assaults, falls and so on, clinical symptoms of traumatic patient at admission, type of arterial injury and the CTA report, comorbidities were also recorded. Type of treatment procedures related to vascular injury was determined.

Statistical analysis

Data were recorded and entered into SPSS software Version 16. Data was described using frequency tables and quantitative data were compared by student test and data correlation by qualitative data was performed through Chi-square test. P<0.05 was considered as significant level.

Results

200 patients were evaluated in this study. 188 patients (94%) were male and 12 (6%) female. The most common sites of involvement were the lower limbs (76%), thorax (16%), and upper limbs (8%). The damage was caused by trauma and accident in 84.5% of patients and by conflict in 15.5% of them.

The most common age groups were 16 to 30 years (46.5%), 31 to 45 years (20%), < 15 years (12.5%), > 60 years (11%), and 46 to 60 years (10%). There was fracture in 66% of patients and 34% of damages were without fracture. 12.5% of patients (n = 25) died. Figure 1: Shows the frequency of abnormal CTA angiographies.

![Figure 1: The frequency of abnormal CTA angiographies](image)

Based on the results of angiography, there was vascular injury in 63.5% of patients. The most common abnormal pattern of angiography was run-off (36%), cut-off (16%), hematoma (15%), and aneurysm (5.5%). There was also nerve damage in 19% of patients. End to end anastomosis was performed in 32% of patients, thrombectomy in 23%, amputation in 18%, ligation in 4%, and vascular graft in 7%. Supportive treatments alone or in addition to other therapies were used for 47% of patients.

There was vascular injury in 67.8% of patients based on the results of Doppler ultrasound. Table 1 showed various factors’ relationship with arterial damage.
### Table 1: Various factors relationship with arterial damage

<table>
<thead>
<tr>
<th>Anatomic site</th>
<th>Arterial injury</th>
<th>Negative</th>
<th>Positive</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower limb</td>
<td>39 (89)</td>
<td>113 (54.3)</td>
<td>14 (45.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Thorax</td>
<td>32 (43.8)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper limb</td>
<td>2 (2.7)</td>
<td>14 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15</td>
<td>7 (9.6)</td>
<td>18 (14.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 to 30</td>
<td>43 (58.9)</td>
<td>50 (39.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 to 45</td>
<td>11 (15.1)</td>
<td>29 (22.8)</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>45 to 60</td>
<td>1 (1.4)</td>
<td>19 (15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;60</td>
<td>11 (15.1)</td>
<td>11 (8.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fracture</td>
<td>Positive</td>
<td>49 (67.1)</td>
<td>84 (66.1)</td>
<td>0.877</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>24 (32.9)</td>
<td>43 (33.9)</td>
<td></td>
</tr>
<tr>
<td>Mechanism of trauma</td>
<td>Conflict</td>
<td>63 (86.3)</td>
<td>106 (83.5)</td>
<td>0.594</td>
</tr>
<tr>
<td>Nerve injury</td>
<td>Positive</td>
<td>1 (1.4)</td>
<td>36 (28.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>72 (98.6)</td>
<td>91 (71.7)</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>Positive</td>
<td>6 (8.2)</td>
<td>16 (12.6)</td>
<td>0.341</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>67 (91.8)</td>
<td>111 (87.4)</td>
<td></td>
</tr>
<tr>
<td>Supportive treatment</td>
<td>Positive</td>
<td>53 (72.6)</td>
<td>40 (31.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>20 (27.4)</td>
<td>87 (68.5)</td>
<td></td>
</tr>
</tbody>
</table>

### Discussion

Peripheral vascular injury includes about 80% of all vascular injuries and the studies performed so far in this area show that the prevalence of vascular trauma is higher in men than women (90%) and the incidence ratio of men to women is 1/5 to 1/7. The middle-aged people are the victims of these events more than other age groups (20-40 yrs) (2, 7, 19, 22, 26, and 27).

In previous studies showed that lower limbs are at more risk for developing vascular injuries following trauma than the upper limbs (58 vs. 81%) (3). In our study also, the most common sites were the lower limbs (76%), thorax (16%) and upper limbs (8%), respectively.

In the present study, accident was the cause of 84.5% traumas and damage from conflict occur in 15.5% of cases. In general population, vascular injuries in limbs are associated with both blunt and penetrating trauma (28). The incidence of these complications varies in different areas, depending on the incidence of trauma. In some studies, penetrating trauma includes 45% of cases, and anther studies include 70% to 90% of vascular injuries (29, 30).

However, it seems that the major mechanism is the cases was penetrating trauma like gunshot, and thenmore common mechanism is the cases with blunt traumas motorcycle accident (31). In the study of Safaei, the most cases included knife or sharp penetrating trauma (63%) and blunt trauma accounted in 21% of cases. There was both penetrating and blunt trauma 16% of cases (32).

In this study, there was fracture in 66% of patients and 34% of damages were without fracture. 12.5% of patients (n = 25) died. In the study of Nemati, 86.7% of vascular injuries occurred along with fracture (33). In the study of Qadusi, there was bone fracture in 9.5% of cases with trauma (33). In general population, association of vascular injuries with bone fracture may vary regarding traumatic mechanisms.

In Hagh study, 42% of patients had simultaneous comorbidities and the most common affected system was central nervous system (CNS) (34). In our study, the frequency of arterial injury confirmed in CTA was not significantly different in patients with comorbidities.

In our study, end to end anastomosis was performed in 32% of patients, other interventions were thrombectomy (23%), amputation (18%), arterial ligation (4%), and vascular graft (7%). Supportive treatments alone or in addition to other therapies were used in 47% of patients.

In Mahmoudi study, simple vascular repair and end to end anastomosis was performed in patients with 32% of patients, other interventions were thrombectomy (23%), amputation (18%), arterial ligation (4%), and vascular graft (7%). Supportive treatments alone or in addition to other therapies were used in 47% of patients.

In a previous study, types of vascular injuries were reported as 38.5% pseudoaneurysm and 24.5% arterial occlusion with or without arteriovenous fistula (AVF) (35). Perry and colleagues had found 16 cases of pseudoaneurysm and 4 cases of AVF in patients diagnosed with vascular injuries after trauma (36). In the study of Yilmaz, 52.5% pseudo aneurysm and 12.5% arterial occlusion and 35% AVF have been reported (32). In a study in Egypt, 52.6% pseudo aneurysm, 26.3% artery stenosis, and 10.5% total occlusion and AVF had been occurred (33). In our study, pseudoaneurysms were observed in 5.5% of traumatic patients that could result from differences in the injury mechanism and site of trauma.

In Zafarghandi study, there was simultaneous lesion arterial trauma in 56% of cases. 33% of patients had primary nerve damage (37). In our study also, 19% of patients had negative injuries other than vascular injury. It seems that the prevalence of neurologic comorbidities can vary because of the mechanism and site of trauma.

In our study, there were vascular injuries were reported in 63.5% of patients in CTA. The results of Doppler ultrasound showed vascular involvement in 67.8% of patients. All vascular injuries in CTA were confirmed after vascular interventions and none of patients with negative CTA had experienced serious sign and symptoms of vascular injury in follow up period (at least 6 months).

In our study, 12.5% of patients (n = 25) died. In the study of Mahmoudi, the morbidity rate was 4.5% and mortality 8.6%, the cause of mortality might be the extension of vascular lesion which caused massive bleeding and other comorbidities (38). In a study, type of blunt trauma, comorbidities, delayed capillary filling, the distal pulse status before and after surgery, surgery duration and duration of hospital stay, were influenced morbidity and morbidity. The early diagnosis of...
vascular injury, early rehabilitation and patient's transfer to the vascular center and providing appropriate care for complicated cases can effectively reduce morbidity (39).

In a study, vascular injury due to prolonged ischemia, despite appropriate treatment led to amputation in 30% of cases (40). In another study, amputation was performed in 8.3% of traumatic patients (38). In our study, amputation was limb was performed in 18% of patients with vascular injury. The co-existence of neurological deficit might be another probable cause for amputation. Moreover, this study was conducted in a referral center, so, the rate of complicated cases was higher. Also, some studies have shown that the incidence of nerve injury can predict becoming handicap and the need for amputation in patients with vascular injuries (38). Streptococci infections are another common cause for limb amputation in traumatic patients (39).

Overall, CTA has numerous advantages in the diagnosis of vascular trauma. Regardless of non-invasive method, it has the ability to completely image the arterial tree in shorted time duration (which might be important in traumatic patients) and also diagnosis of associated deformities caused by trauma to the surrounding muscles and bone (20-23). In addition, other benefits compared to CA can be pointed to no need for arterial cannulation, thus avoid all the complications of arterial puncture, and there is no need to the presence of the surgery team and interventional radiologist who are required for CA. The sensitivity and specificity of CTA in the diagnosis of suspected vascular injuries is reported ranging from 95 to 100% for sensitivity and 90 to 100% for specificity (7, 28, 31, and 33).

Conclusion

In our study, there was vascular injury in 63.5% of patients based on the results of CTA. All vascular injuries were diagnosed by CTA were confirmed after vascular intervention and no serious vascular injury was reported in patients with negative CTA result at the follow-up period. So, CTA is a noninvasive and accurate diagnostic test.

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