Peripheral vascular injury-related deaths

Periferik damar yaralanmalarına bağlı ölümler

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BACKGROUND
Peripheral vascular injuries are frequently encountered in lethal and nonlethal trauma. Although significant improvements in treatment have been achieved, such injuries are still important causes of mortality.

METHODS
In this study, the records of 6769 autopsies performed between 1996 and 2006 at the Council of Forensic Medicine Bursa Group Chairmanship Morgue Department were evaluated retrospectively.

RESULTS
The 63 cases (0.9%) who were determined to have died due to vascular injury were included in this study. Fifty-seven cases (90.5%) were men (mean age: 36 years); 58.7% of the injuries were due to stab wounds. The femoral artery and vein were the most frequently injured vessels. The origin was a homicide in 85.7% of the cases. In 25% of the cases, blood alcohol levels were between 44 and 256 mg/dL.

CONCLUSION
The availability of experienced surgical teams and effective prehospital emergency care are vital for decreasing the mortality due to extremity vascular injuries. In the autopsy of a patient who died primarily due to extremity vascular injury, the injured vessel, numbers of injuries and of lethal injuries, and locations and sides of the injuries shed light on the possible presence of intention.

Key Words: Autopsy; extremity; trauma; vascular injuries.

AMAÇ
Periferik damar yaralanmaları sıkıla ölümçul ve ölümçul olmayan travmalarda saptanmaktadır. Tedavide önemli ilerlemler kaydedilmesine karşın, bunlar hala önemli ölüm nedenleri olarak kalmaktadır.

GEREÇ VE YÖNTEM

BULGULAR
Çalışmaya, damar yaralanmasına bağlı hayatını kaybettiği saptanan 63 (%0.9) olgu dahil edildi. Olguların %57’si (%90.5) erkek olup, yaş ortalaması 36 buludu; yaralanmaların %58.7’si kesici delici alet yaralanmasına bağlı idi. Olguların %85.7’inde orijinin cinayet olduğu belirildi; %25’inde kan alkol seviyesi 44 ile 256 mg/dL arasında saptandı.

SONUÇ
Ekstremiteler damar yaralanmalarında, mortaliteyi azaltmak açısından tecrübeli cerrahi ekipin bulunması, bunun yanında etkifidir hastane öncesi acil girişim yapılması hayatı önem taşımaktadır. Primer ekstremiteler damar yaralanmasına bağlı olanların otopsilerinde; yaralanın damar, yaralanma sayısı ve ölümçul yaralanma sayısı, yaralanma yerleşimi ve tarafa özellikli üzerinde durulması gerek konulmalıdır.

Anahtar Sözcükler: Otopsi; ekstremiteler damar yaralanmaların travma

Peripheral vascular injuries are frequently encountered in lethal and nonlethal trauma; although significant improvements in treatment have been achieved, such injuries are still important causes of mortality. In the absence of a potentially lethal injury at some other location, death caused by extremity injury is possible due to major vascular injury or development of complications. Demonstration of the injured vessel, determination of whether the vascular injury is lethal by itself and determination of the

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number, locations and sides of the injuries are important for assessment of the possible intention to kill or to inflict injury.[1,2]

In this study, the frequency and characteristics of deaths due to peripheral vascular injury among the forensic autopsies performed at the Council of Forensic Medicine Bursa Group Chairmanship Morgue Department were determined.

**MATERIALS AND METHODS**

In this study, the records of 6769 autopsies performed between 1996 and 2006 at the Council of Forensic Medicine Bursa Group Chairmanship Morgue Department were evaluated retrospectively. The 63 cases (0.9%) who were determined to have died due to vascular injury were included in this study. Cases with a potentially lethal injury at some other location were not included.

The major cause of death in all cases was the vascular injury; all other death causes were excluded after performing autopsy, toxicologic analysis and pathologic investigation. Only those cases with isolated vascular injuries were included in this study.

Age, gender, type of the incident, injury locations and the injured vessels, cause of death, blood alcohol levels, extremity fracture, and duration of hospital treatment were considered.

Statistical analysis was performed using SPSS 11.0 version for Windows (SPSS Inc., Chicago, IL, USA). Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as frequencies (n, %). One sample chi-square test was used. A p value of less than 0.05 was regarded as a statistically significant difference.

**RESULTS**

Of the 6769 forensic autopsies, the primary cause of death was determined to be peripheral vascular injury in 63 cases (0.9%). Fifty-seven cases (90.5%) were men and six (9.5%) were women (p<0.001). Mean age was 35.6±12.3 (range: 16-66 years). The age group with the highest number of cases was 30-39 (n=18, 28.6%) (p=0.002) (Fig. 1). Stab wound was the most frequent type of injury (n=37, 58.7%), followed by shotgun wounds (n=14, 22%) (p<0.001). The most frequent origin was a homicide (n=54, 85.7%) (p<0.001). Of the homicides, 68.5% (n=37) were due to stab wounds and 20.4% (n=11) were due to shotgun wounds. Three of the suicides were due to stab wounds (Table 1). Of the homicides, 27.8% (n=15) were in the 30-39 age group (p=0.006).

No significant difference was detected among month and/or year distribution of the cases (p>0.05).

Of the lethal vascular injuries, 54 (85.7%) were in the lower extremity (Fig. 2) and 9 (14.3%) were in

**Table 1. The origins and types of the injuries**

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Murder n</th>
<th>Murder %</th>
<th>Suicide n</th>
<th>Suicide %</th>
<th>Accident n</th>
<th>Accident %</th>
<th>Total n</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stab wound</td>
<td>37</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>37</td>
<td>58.7</td>
</tr>
<tr>
<td>Shotgun injury</td>
<td>11</td>
<td>78.6</td>
<td>3</td>
<td>21.4</td>
<td>0</td>
<td>–</td>
<td>14</td>
<td>22.2</td>
</tr>
<tr>
<td>Cut</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>6</td>
<td>9.5</td>
</tr>
<tr>
<td>Traffic accident</td>
<td>0</td>
<td>–</td>
<td>3</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Work machine-related accident</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>1</td>
<td>100</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Explosion</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>1</td>
<td>100</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Total*</td>
<td>54</td>
<td>85.7</td>
<td>6</td>
<td>9.5</td>
<td>3</td>
<td>4.8</td>
<td>63</td>
<td>100</td>
</tr>
</tbody>
</table>

* Percentages of the row were calculated.
Peripheral vascular injury-related deaths

the upper extremity (Fig. 3); 40 (63.5%) were in the left lower extremity, 13 (20.6%) in the right lower extremity and 1 (1.6%) in both lower extremities. The majority of the stab wounds [33 (89.2%)] were in the lower extremity (Table 2).

The femoral artery was the most frequently injured vessel (n=47, 74.6%); in 35 of these cases, the accompanying vein was injured concomitantly. Another frequently injured vessel was the brachial artery (n=4, 6.3%) (Table 3).

The number of wounds on a cadaver varied between 1 and 8; 32 cases (50.8%) had one wound, 12 (19.1%) had two wounds, 8 (12.7%) had three wounds, 4 (6.3%) had five wounds, 2 (3.2%) had four wounds, 2 (3.2%) had six wounds, and 1 (1.6%) had eight wounds. Two cases had been hospitalized, and the initial examination findings had not been recorded properly; subsequent healing and therapeutic interventions compromised determination of the number of wounds.

According to the autopsy reports, the cause of death was hypovolemia in 61 cases (96.8%) and various complications in 2 (3.2%). Twenty-three cases (36.5%) had been hospitalized: 17 (73.9%) died on the day of admission, 2 (8.2%) on the 1st day, 2 (8.7%) on the 2nd, 1 (4.3%) on the 16th and 1 (4.3%) on the 20th. Six cases (9.5%) were already dead on admission. In 12 cases (19%), an extremity fracture along with a vasculature injury was detected. Sixteen of the hospitalized patients (25.4%) had undergone surgery. Amputation was applied to three of the cases.

Ethanol at levels between 44 mg/dL and 256 mg/dL (mean: 153±63 mg/mL, median: 148 mg/dL) were detected in the blood of 18 male cases (28.6%) and 1 female case (1.6%). Eighteen of these (92%) were homicides and one (5.3%) was suicide. The distribution of the ethanol levels is presented in Figure 4.

Table 2. The injured extremities in all injuries and stab wounds

<table>
<thead>
<tr>
<th>Extremity</th>
<th>All cases n (%)</th>
<th>Stab wounds n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right lower</td>
<td>13 (20.6)</td>
<td>10 (27)</td>
</tr>
<tr>
<td>Left lower</td>
<td>40 (63.5)</td>
<td>23 (62.2)</td>
</tr>
<tr>
<td>Right upper</td>
<td>4 (6.3)</td>
<td>2 (5.4)</td>
</tr>
<tr>
<td>Left upper</td>
<td>4 (6.3)</td>
<td>2 (5.4)</td>
</tr>
<tr>
<td>Left and right lower</td>
<td>1 (1.6)</td>
<td>– (0)</td>
</tr>
<tr>
<td>Left and right upper</td>
<td>1 (1.6)</td>
<td>– (0)</td>
</tr>
<tr>
<td>Total</td>
<td>63 (100)</td>
<td>37 (100)</td>
</tr>
</tbody>
</table>

Table 3. The injured vessels

<table>
<thead>
<tr>
<th>Extremity</th>
<th>Injured vessel</th>
<th>n</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>A. femoralis</td>
<td>47</td>
<td>74.6</td>
</tr>
<tr>
<td>extremity</td>
<td>V. femoralis</td>
<td>35</td>
<td>55.6</td>
</tr>
<tr>
<td></td>
<td>A. poplitea</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>V. poplitea</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>A. tibialis</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Upper</td>
<td>A. brachialis</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td>extremity</td>
<td>V. brachialis</td>
<td>4</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>A. ulnaris</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>V. ulnaris</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>A. axillaris</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>V. axillaris</td>
<td>2</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* The percentages were calculated on the total of 150 patients.
According to the District Attorney (DA) archives, the crime scene was documented as outdoors in 26 cases (41.3%), an office in 3 (4.8%) and a hotel in 2 (3.2%). In 23 cases (36.5%), the crime scene was not mentioned in the DA’s reports.

**DISCUSSION**

Developments in vascular surgery and improved general awareness in first aid have contributed to the increasing treatment success and decreased mortality in extremity vascular injuries.\(^1\) In the present study on autopsies performed between 1996 and 2006 in Bursa the frequency of deaths due to extremity vascular injury was 0.9%. Although this figure may seem low, in such injuries, first aid in the form of direct compression or proximal occlusion followed by expert surgical intervention at the hospital provide the highest chance of success.

There is a marked male dominance in peripheral vascular injuries in both hospitalizations as well as autopsy cases.\(^1,6\) In the present study, 90.5% of cases (n=57) were men. This may be due to the fact that men are more active socially and they are more frequent participants in events that set the stage for injury.

In the literature, extremity vascular injury patients are generally young adults.\(^1,4\) In the present study, mean age was 36 and the majority of the cases (n=18, 29.6%) were in the 30-39 age group.

Studies on hospitalized patients as well as autopsy series in our country showed that the most frequent mechanism of injury was a stab wound followed by gunshot wounds.\(^5,7,10,12\) In Georgia,\(^11\) 87% of the cases were due to penetrating trauma and 13% were due to blunt trauma. In Pakistan,\(^9\) 54% were due to gunshot wounds, 18% due to blunt trauma and 12% due to stab wounds. In England,\(^14\) 46% of the lower extremity vascular injury cases were due to gunshots, 19% due to blunt trauma and 12% due to stab wounds. In the present study, stab wounds were most frequent (n=37, 58.7%). This may be due to the fact that sharp objects can be carried easily and these are implicated in other deaths as well.\(^15\) Violence with sharp objects is the most common cause of homicidal deaths in Sweden\(^14,15\) and in many other countries in Europe,\(^16-18\) Africa\(^19\) and Asia.\(^20\)

As in similar studies,\(^1,5\) the left lower extremity was the most frequently injured extremity in the present series (n=40, 63.5%). It has been argued that the higher frequency of the left lower extremity may be explained by stab assaults usually being perpetrated by a right-handed individual.\(^11\) Accordingly, in the present study, the left lower extremity was more frequently affected in stab wounds (n=23).

In this study, the femoral artery and its branches (n=45, 71.4%) were the most frequently injured vessels. Similar results were obtained in other studies.\(^3,6,9,11,13,14\)

In this series, 36.5% of the patients died during hospital treatment and an operation could be performed in 25.4%. In hospitalized patients, autopsy is important for the assessment of the wound, characteristics of the medical treatment and the complications. Two cases had been hospitalized, and the initial examination findings had not been recorded properly; subsequent healing and therapeutic interventions compromised the determination of the number of wounds.

Extremity fracture along with a vasculature injury was detected in 40% of the cases in one study,\(^21\) and high mortality rate has been reported with a 10-40% amputation risk in these cases.\(^22\) In our study, extremity fracture along with a vasculature injury was detected in 12 cases, and amputation was applied to three of the cases.

In accordance with previous studies,\(^1\) 30.2% of the cases had detectable levels of alcohol in the blood. We think alcohol contributes to the mortality of extremity vascular injury. Alcohol consumption may compromise the capacity for self protection as well as escape from the scene of injury.\(^13\) Furthermore, the vasodilator effect of alcohol may cause increased bleeding and accelerate death.

In conclusion, the availability of experienced surgical teams and effectiveprehospital emergency care are vital for decreasing the mortality due to isolated

**Fig. 4.** The distribution of the blood alcohol content.

Blood alcohol (mg/dl)

- 0-50
- 51-100
- 101-150
- 151-200
- 201-250
- 251-300

- 0
- 1
- 2
- 3
- 4
- 5
- 6
vascular injuries. Since most wounds are due to stabbing, the reason the involved sharp object was in the possession of the potential assailant should be questioned in detail. Demonstration of the injured vessel, determination of whether it is lethal by itself and determination of the number, locations and side of the injuries are important for the assessment of the intention to kill or to injure. Autopsy is vital in the evaluation of lethal peripheral vascular injuries.

REFERENCES