

# Risk factors for amputation in extremity vascular injuries in Saudi Arabia

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**Abstract:** Amputation is most closely associated with blunt, lower limb injuries associated with vascular trauma. These vascular injuries require a special attention to prevent life and limb loss. Patient outcomes can also be improved by organizing vascular trauma data into appropriate systems to facilitate future studies.

**Keywords:** vascular injuries, extremities trauma, amputation, ischemia

## Introduction

Trauma from road traffic accidents (RTAs) is a leading public health problem, worldwide. The incidence of vascular injuries has increased worldwide during the past few years and RTAs are now the most common human accident.<sup>1</sup> The rise of RTAs is the result of rapidly growing urban developments, and increase in the number of roads. Saudi Arabia has the highest RTA-toll in the world, according to a report from the World Health Organization. From 2008 to 2009, the total number of RTA deaths was 645,813, and around one-third of all hospital beds is occupied by RTA victims, with the most common RTA-injury being limb loss. In addition, 13 of every 1,000 accidents result in a fatality.<sup>2-5</sup>

The frequency of extremity-localized vascular injuries is difficult to quantify. Worldwide reports of vascular injuries of the extremities often include other causes of trauma such as penetrating injuries, falls, and explosions. At a high-volume urban trauma center in Houston, TX, USA, Feliciano et al<sup>6</sup> reported ~55 lower-extremity vascular injuries/year. Magee et al<sup>7</sup> reported 4.7 injuries/year in the UK and, in Australia, Tobin et al<sup>8</sup> reported 10 injuries/year.<sup>6-8</sup>

There have been few reports about vascular injuries from RTA in our region. Jawas et al<sup>9</sup> reported that 1.87 patients/10,000 patients were hospitalized because of vascular injuries from RTAs in Al-Ain city, United Arab Emirates and upper limb vascular injuries were the most common.<sup>9</sup> Al-Salman et al<sup>10</sup> stated that 91% of vascular injuries associated with limb fractures were caused by RTA; and Wali<sup>11</sup> reported that 33% of upper limb vascular trauma in Asir region, Saudi Arabia, was caused by RTAs.<sup>10,11</sup>

There have been no reports of limb loss as a result of these vascular injuries. This may be because RTAs most commonly affect younger individuals. RTAs are associated with devastating socioeconomic and psychological impacts on the affected victim and his/her family and community, especially if the RTA results in limb loss. Depression and anxiety are the most common psychological effects of RTAs amputee population.<sup>11</sup>

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Limb loss as the effect of extremity vascular trauma are classified by the mode, site, and clinical findings of the injury.<sup>12</sup> Blunt injuries during RTAs are most commonly associated with limb loss; and penetrating injuries yield the highest mortality rates.<sup>13,14</sup> In lower limb trauma, although the superficial femoral artery is the most commonly injured, the popliteal artery, especially when associated with nerve damage, is the most commonly associated with limb loss.<sup>12-14</sup> There is a lack of comprehensive data on extremity-specific vascular injuries and the outcomes of patients with these injuries in Saudi Arabia and the Middle East. Upper limb amputation resulting from vascular injuries is also sparsely studied.

Our goal is to identify the risk factors associated with limb loss in vascular injuries, at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. We will try to identify the most common site and mode of vascular injuries associated with limb loss, and evaluate associated injuries' effect on patient's outcome.

## Methodology

Our study was conducted at the Emergency Department (ED) at KAMC in Riyadh, Saudi Arabia; this is categorized as a high-flow, level III trauma center. This department is also recognized as the fourth-best ED outside USA. The ED at KAMC houses an admission area, triage area, critical care, adult care, pediatric care, and urgent care, and ED observation area. The maximum capacity of the ED is 500 patients. All extremity-localized vascular injuries treated between January 1992 and December 2011 at KAMC were included in our study. Both sexes, all age groups, and outcomes, without time limits, were considered. Limbs with irreversible ischemia were excluded.

This study was conducted as an analytical cross-sectional study (ie, we tested our hypothesis and examined our results to reveal the prevalence of RTA-caused extremity-specific vascular injuries among included patients at the time of our study). We also employed a well-defined inclusion criteria, sampling methods, and data-collection methods.

To reveal the risk factors associated with extremity-loss after vascular injuries, we used the online sample calculator from (Raosoft Inc., Seattle, WA, USA). That has a margin of error of 10%, a confidence level of 95%, and an expected prevalence of 50%. As the population size is unknown, we used an estimation of 20,000 patients, (As we used 20,000 patient population the sample size should be 96, however we studied 32 patients only due to study limitations mentioned at the end of the paper).

We used a nonprobability convenience to select the sample between January 1992 and December 2011 at

KAMC. We also included a self-developed data-collection form, created using data from literature reviews, and reviewed by vascular surgery experts. The data were collected from charts by our co-investigator, and were analyzed using SPSS and EXCEL programs (IBM Software, New York, NY, USA).

The data-collection form contains quantitative data (eg, age), and qualitative data (eg, sex, mode of injury, vessel(s) injured, clinical findings, associated injuries, type of injury on exploration, type of procedure performed, and the outcome of the procedure). The procedures' outcomes were compared among all other qualitative data.

Statistical analysis of collected data was performed using SPSS. Descriptive statistics include percentages and frequencies. To calculate inferential statistical data, we used Fisher's exact test to compare limb-lost and limb-salvaged patients. A *P*-value of <0.05 is considered statistically significant in this study.

The approval for this study was submitted to King Abdullah International Research Centre; and once we received the approval, data collection was started. We ensured patient confidentiality by using a coding system to identify patients during data entry. The data were also saved in protected computers and on hard disks, where only the principle investigator and co-investigators could access. As a policy of King Abdulaziz Medical City, all patients (or their relatives) sign an informed consent that their file information may be used for research without their name or identity.

## Results

Selecting patients who met our inclusion criteria yielded 32 patients, however, because of missing data, only few files were complete. The most common missing data were clinical findings (23 missing data), type of injury observed upon exploration (14 missing data), and associated injuries (ten missing data).

Amputations represented 46% of patient outcomes in our study. The most common mode of injury was blunt injury, with 22 injuries (ie, 71% of all RTA-caused extremity injuries). The other modes of injury we observed were stab and shotgun injuries (29%).

The most common vessels injured were the profunda brachii arteries (five injuries) in the upper limb and dorsalis pedis arteries (five injuries) in the lower limb; constituting 19% of the total RTA-caused vascular limb injuries. The least common vessels affected were the superficial femoral arteries (one injury) and the axillary arteries (one injury). The

most common type of vessel injury was complete transection and interposition vein graft was the most common type of repair. Also, simple nerve injury was the most common clinical findings.

The highest amputation rate was caused by blunt trauma mode and damage to the superficial femoral artery and the above-knee popliteal artery (100% amputation rate; Tables 1 and 2). None of the upper limb injuries caused amputation.

The presence of compound fractures, associated with limb arterial injury yielded the highest incidence of limb loss in the “associated injuries” category, with a 100% amputation rate. The most common associated injury was a simple fracture (eleven injuries). The least frequent incidence of amputation was in case of associated nerve injuries (Table 3).

**Table 1** Mode of injury and association with amputation

Mode Of Injury	Amputation	
	No	Yes
Blunt	10 45%	12 55%
Stab	7 100%	0 0.0%
Shotgun	2 100.0%	0 0.0%

**Table 2** Vessel injured and association with amputation

Vessel Injured	Amputation	
	Yes	No
Common femoral artery	1 50%	1 50%
Deep femoral artery	2 100%	0 0.0%
Superficial femoral artery	0 0.0%	1 100.0%
Above knee popliteal artery	0 0.0%	3 100%
Below knee popliteal artery	2 50%	2 50%
Combined above below popliteal artery	0 0.0%	1 100%
Axillary artery	1 100%	0 0.0%
Profunda brachii artery	5 100.0%	0 0.0%
Ulnar artery	2 100%	0 0.0%
Dorsalis pedis artery	5 100%	0 0.0%

**Table 3** Statistical significance of injury mode, limb injured, and associated injuries with amputation

Mode of injury	Amputation		P-value
	Yes	No	
Blunt	12	10	0.02
Other	1	9	
<b>Limb injured</b>			
Upper limb	0	8	0.02
Lower limb	8	10	
<b>Associated injuries</b>			
Compound fractures	7	8	0.03
Nerve injury	0	7	

## Discussion

The incidence of extremity vascular injuries has increased during the last decade. These injuries are caused by a wide spectrum of mechanisms. The most common mode of injury in civilian practice that we observed was blunt injuries, but the incidence of penetrating injuries is also increasing.

Vascular injuries were most commonly associated with blunt-force trauma 71% (n=22). Also, amputation was highly associated with blunt-force injuries as 92% of blunt-force affected limbs resulting from RTAs were amputated (n=12,  $P=0.02$ ). In Saudi Arabia and Gulf countries, there are few studies that examine the association between vascular injuries and amputation rates. In a local study in Riyadh, Saudi Arabia, Al-Salman et al<sup>10</sup> reported that 57% of vascular injuries were caused by blunt trauma, and 91% of these blunt-trauma vascular injuries were caused by RTAs.<sup>10</sup> In contrast to our study, the most common mode of injury in Kuwait between 1992 and 2000 was penetration, representing 43% of injuries.<sup>15</sup> This may be an effect of the Gulf war. Hafez et al<sup>12</sup> reported that penetrating injuries were the most common mode of injury and have a higher amputation risk than other modes of injury.<sup>13</sup> In Finland and Sweden, Shaban et al<sup>17</sup> also observed a 34% incidence of blunt-force injuries.<sup>17</sup>

In our study, lower limb injuries (n=8,  $P=0.02$ ) are more likely to result in amputation than upper limb injuries. Similar to our findings, Kauvar et al reported that popliteal artery injuries were associated with 50% of amputations performed.<sup>14</sup> Whereas, Topal et al<sup>18</sup> showed that one of the significant risk factors for amputation is multiple arterial injuries below knee ( $P<0.001$ ).<sup>18</sup>

Vascular injuries are also associated with many other injuries. Fractures and amputation were closely linked among our patient pool and nerve injuries were less commonly associated with amputation ( $P=0.03$ ). Hafez et al<sup>13</sup> found that bone fracture(s) presented with lower limb arterial injury yielded the most frequent limb loss (24.8%).<sup>13</sup>

Our study has many limitations. The sample is small and several needed data were not documented in the charts. Our new computerized patients' files system will help in collecting data in our future studies.

## Conclusion

In this part of the world, amputation risk factors require more investigation, especially studies on large patient populations. A national vascular trauma registry also needs to be created to facilitate the identification of vascular trauma mechanisms and the risk factors for adverse effects (eg, amputation). This will help us to devise prevention strategies for unwanted

outcomes for patients with vascular injuries of the limbs. We aim to use this study as a proposal for a vascular trauma registry in our hospital.

## Disclosure

The authors report no conflicts of interest in this work.

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