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Comparison of the Results of Open Vascular Surgery Interventions in Patients with Arterial Injury Caused by Penetrating Trauma Below the Knee in the Vascular Surgery Center of Golestan Ahvaz Hospital

Seyyed Masuod Moosavi[1], Iraj Nazri[2], Seyyede Sahar Saleh[3]

1- Ahvaz jundishapur university of medical science,Ahvaz, Iran
2- Ahvaz jundishapur university of medical science,Ahvaz,Iran
3- Ahvaz jundishapur university of medical science,Ahvaz,Iran

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ABSTRACT

Vascular damage is one of the life-threatening emergency situations and is considered one of the most common causes of death worldwide. Considering the frequency of penetrating vascular injuries, especially in our country and Khuzestan province, as well as complications and mortality caused by vascular injuries, this study was designed to investigate the effect of vascular surgery intervention on patients with arterial trauma trauma below the knee.

Method:

In this descriptive and analytical study, all trauma patients suspected of penetrating arterial injuries below the knee in terms of parameters of age, gender, type of trauma, location of trauma, type of intervention, location of arterial repair, angiographic and clinical findings including damaged arteries, type of injury Arterials were also examined for the presence of fracture or dislocation in the vicinity of vascular damage.

Results:

The results of this study showed that among the penetrating trauma patients requiring surgical intervention, 89.1% were men and only 10.9% were women. The average age of the patients was 35 years. The most frequent trauma requiring surgical intervention in this study was the trauma caused by firearms (gunshot and shotgun) and the least urban and occupational trauma. There was a significant relationship between trauma.

The highest rate of injury was to the popliteal artery below the knee (8.47%), and the most vascular intervention was saphenous vein entrapment. 9.73% of the patients had a fracture injury and 3.16% had a dislocation with vascular injury.

Conclusion:

According to the results of the present study, the association of vascular injuries with orthopedic fractures was higher and mostly in the popliteal region. Complications including infection, fasciotomy, reperfusion syndrome and amputation have a direct and significant relationship with the type of penetrating trauma.

1. Introduction:

The main treatment of vascular traumas is surgery, which of course, in case of unstable bone fractures such as open hip fractures or joint dislocations, its initial stabilization is necessary. In case of fixed fractures without deformity, primary vascular repair is recommended to prevent limb ischemia. After ensuring the organ's viability, the sialistic shunt and the like can be used for better blood supply to the distal organ (7). Among the arteries of the organs, the femoral artery is the most common artery that is damaged by trauma. On the other hand, popliteal artery injury is one of the main causes of inability to preserve the injured limb during vascular injuries (1)

Traumas can cause damage to different parts of the body, and many of these injuries can be irreparable. Meanwhile, the vessels of the organs, especially the arteries, as the main elements of blood supply, are exposed to the most damage. Different types of arterial damage lead to organ blood supply disorders and tissue ischemia. Occurrence of acute blockage in an artery that is responsible for blood supply to the organ is considered an emergency situation, and in case of lack of sufficient collateral vessels and in the conditions that the artery is blocked, the only source of blood supply to the organ, within six hours, ischemia can be irreversible.

Therefore, early diagnosis and immediate treatment are extremely important, and with timely treatment, while re-establishing blood supply, the spread of the clot to the distal arteries and venous system will be prevented, and as a result, irreversible ischemia, necrosis (tissue corruption) and loss of The death of the relevant organ will be prevented (8 9). Considering the frequency of penetrating vascular injuries, especially in our country and Khuzestan province, as well as complications and mortality caused by vascular injuries, this study aims to investigate the effect of vascular surgery intervention on patients. It was designed with arterial injury trauma below the knee.

• Material and Method

The present study was an analytical epidemiological study that was conducted on trauma patients who were referred to Golestan Ahvaz Hospital with suspicion of penetrating arterial injuries below the knee. The present proposal was submitted to the Ethics Committee of Jundishapur University of Medical Sciences for approval. In this study, all patients trauma patients who were referred to Golestan Hospital in Ahvaz during 1399-1401 with suspicion of penetrating arterial injuries below the knee were investigated. The inclusion criteria included patients aged 12 years and older who were referred to the vascular surgery service with the diagnosis of penetrating arterial injury of the lower limb (below the knee) and underwent surgical intervention.

Patients with multiple injuries or those that can be treated with non-surgical methods were excluded from the study. After approving the proposal and obtaining permission from the Ethics Committee of Ahvaz University of Medical Sciences and obtaining informed consent, the patients were included in the study. All patients were eligible to enter the study. In this study, all trauma patients who were referred to Golestan Hospital in Ahvaz with suspicion of penetrating arterial injuries below the knee during the years 1399-1401 were examined.In this sense, special forms include the parameters of age, gender, type of trauma (knife wound (Wound Stap), far or near gun shot (7 meters), gunshot, falling debris, location of trauma, type of intervention (use of ligature, saphenous grasp, Bypass, primary repair, anastomosis site (end to end, side to end), artery repair site (popliteal artery below the knee, anterotibial artery, posterior tibial or both or peroneal), time interval from the time of trauma to referral and surgery , design and information were taken directly from the patients and their companions and included in the forms. Then, vascular surgery intervention,examination of the damaged limb,angiographic and clinical findings including damaged arteries, type ofarterial damage (including complete arterial occlusion, external pressure effect and spasm, arterial cut with active bleeding, arteriovenous fistula and pseudoaneurysm) (and also the presence of fracture or dislocation inTheproximity of vascular damage was examined and recorded. The data collection tool will include a two-part questionnaire containing demographic characteristics (including age, gender, ethnicity, occupation) and specific questions designed by the researcher.

O Sample size:

The size of the studied sample included all the patients who were referred to Golestan Hospital in Ahvaz during 1399-1401 and underwent surgery due to vascular (arterial) trauma below the knee.
O Statistical analysis:
After the end of the study, all the data were analyzed using statistical software version 25 (Windows for SPSS corp, IBM). Were presented numerically and required tables and graphs were used to present the information. After checking the information in terms of normal distribution using Chi Square, One Way ANOVA; Paired T test, the statistical test of using with Kolmogrov Smirnov and Pearson's correlation statistical analysis or its non-parametric equivalent were used.

O Results:
The information of 92 patients was studied, collected and subjected to statistical analysis. The demographic and clinical information of the patients can be seen in Table No. 1. According to the findings of the study, most of the patients (1.89%) were male and the average age of the patients was 97.35 ± 601.9 years.
According to the presented results, the most type of trauma was the trauma caused by firearms (gunshot and shotgun) (48.9%) and the least trauma was urban and occupational trauma (13%). The most common site of intervention was the popliteal artery below the knee. 8.47% and the lowest intervention location was the peroneal artery (8.9%). The most frequent type of intervention was the use of venous occlusion for vascular repair (58% (inter pose) (6.44%) and the lowest was bypass (1.14%). () was the most common type of arterial damage, arterial severing with active bleeding (7.45%), which was 64.2% with thrombosis, and the least was pseudoaneurysm (3.4%). The most common type was end-to-end anastomosis with 7.83. 73.9% of trauma patients had accompanying fracture and 16.3% of patients had dislocation.
According to the results presented in table number 2, the highest incidence of infection was related to gunshot trauma. According to the statistical analysis, there was a significant relationship between the incidence of infection and the type of penetrating trauma (P=0.000). The highest rate of infection was related to the use of ligatures. But there was no significant relationship between the incidence of infection and the type of intervention (P=0.051). Incidence of infection was 13 cases in total of interpause and bypass, including 10 cases related to interpause and 3 to bypass. The highest rate of infection was related to the popliteal artery below the knee. Statistical analysis did not show a significant relationship between the incidence of infection and the location of the intervention (P=0.164). The findings showed that there was no significant relationship between the incidence of infection and the presence of accompanying injuries.
Based on the results presented in Table 3, the highest incidence of fasciotomy was related to urban and occupational traumas. According to the statistical analysis, there was a significant relationship between the incidence of fasciotomy and the type of penetrating trauma (P=0.000). The rate of fasciotomy in shotgun and gunshot was a total of 12, of which 5 related to shotgun and 7 related to gunshot.
Included The highest rate of fasciotomy was related to interpose. According to the statistical analysis, there was no significant relationship between the incidence of fasciotomy and the type of intervention (P=0.243). The total number of fasciotomy required for interpose and bypass was 11, including 10 cases related to interpose and 1 bypass. The highest incidence of fasciotomy was related to the popliteal artery below the knee. According to the statistical analysis, there was no significant relationship between the occurrence of fasciotomy and the location of the intervention (P=0.420). According to the statistical analysis, there was no significant relationship between the incidence of fasciotomy and the presence of accompanying injuries.
Based on the results presented in Table 4, the longest hospitalization period was related to gunshot trauma. According to the statistical analysis, there was no significant relationship between the duration of hospitalization and the type of penetrating trauma (P = 0.234). The average length of hospitalization in the total of shotgun and gunshot was 11.06±1.4, which was 36.10±130.4 for shotgun and 76.11±70 for gunshot. The longest hospitalization period was related to the posterior tibial artery. According to the statistical analysis, there was no significant relationship between the duration of hospitalization and the location of the intervention (P=0.551). According to the

statistical analysis, there was no significant relationship between the duration of hospitalization and the presence of accompanying injuries.

Based on the results presented in Table 4, the longest hospitalization period was related to gunshot trauma. According to the statistical analysis, there was no significant relationship between the duration of hospitalization and the type of penetrating trauma (P = 0.234). The average length of hospitalization in the total of shotgun and gunshot was 11.06±1.4, which was 36.10±130.4 for shotgun and 76.11±70 for gunshot. The longest hospitalization period was related to the posterior tibia artery. According to the statistical analysis, there was no significant relationship between the duration of hospitalization and the location of the intervention (P=0.551). According to the statistical analysis, there was no significant relationship between the duration of hospitalization and the presence of accompanying injuries.

Based on the results presented in Table 5, the highest average amount of bleeding was related to shotgun trauma. According to the statistical analysis, there was no significant relationship between the average amount of bleeding and the type of penetrating trauma (P = 0.494). The average amount of bleeding in the total of gun shot and gun shot was 71.411 ± 830.194, which is 07.441 ± 852/206 was related to gun shot and 1382/35 ± 809/182 was related to gun shot. The highest average amount of bleeding was related to the use of ligatures. According to the statistical analysis, there was no significant relationship between the average amount of bleeding and the type of intervention (P = 0.513). The average volume of bleeding in interpause and bypass was 94.394 ± 223.170, which was 374.374 ± 218.163 for interpause and 38.415 ± 229.177 for bypass. The highest mean amount of bleeding was related to the anterotibial artery. According to the statistical analysis, there was no significant relationship between the average amount of bleeding and the location of the intervention (P=0.912).According to the statistical analysis, there was no significant relationship between the average amount of bleeding and the presence of accompanying injuries.

Based on the results presented in Table 6, the longest operation time was related to gunshot trauma. According to the statistical analysis, there was a significant relationship between the duration of the operation and the type of penetrating trauma (P = 0.010). The average operation duration of shotgun and gunshot was 41.3 ± 0.894, which was 36.36 ± 0.989 for shotgun and 47.3 ± 0.800 for gunshot. The longest operation time was related to bypass. According to the statistical analysis, there was no significant relationship between the duration of the procedure and the type of intervention (P = 0.930). The average duration of operation in the total of interpose and bypass was 3.08 ± 1.076, which was 02.3 ± 084 ± 1.084 for interpose and 1.068 ± 15.3 for bypass. The longest operation time was related to the anterotibial artery. According to the statistical analysis, there was a significant relationship between the duration of the operation and the location of the intervention (P=0.007). According to the statistical analysis, there was no significant relationship between the duration of the operation and the presence of associated injuries.

According to the results presented in Table 7, the highest incidence of reperfusion syndrome was related to occupational and urban traumas. According to the statistical analysis, there was a significant relationship between the incidence of reperfusion syndrome and the type of penetrating trauma (P = 0.000). The rate of reperfusion in shotgun and gunshot was a total of 14, including 8 for shotgun and 6 for gunshot. The highest incidence of reperfusion syndrome was related to interpause. According to the statistical analysis, there was no significant relationship between the incidence of reperfusion syndrome and the type of intervention (P = 0.061). The incidence of reperfusion syndrome in interpause and bypass was 15, of which 14 cases were related to interpause and 1 case was related to bypass. The highest incidence of reperfusion syndrome was related to the popliteal artery below the knee. According to the statistical analysis, there was no significant relationship between the incidence of reperfusion syndrome and the location of the intervention (P=0.281).According to the statistical analysis, between the incidence of reperfusion syndrome and the presence of injuries there was no significant association.

Based on the results presented in Table 8, the highest amount of amputation was related to gunshot trauma. According to the statistical analysis, there was a significant relationship between the amount of amputation and the type of penetrating trauma (P = 0.001). The amount of amputations in shotgun and gunshot was 11 in total, of which 4 were related to shotgun and 7 were related to gunshot.

Included. The highest amount of amputation was related to the interpose. According to the statistical analysis, there was no significant relationship between the amount of amputation and the type of intervention (P = 0.686). The total number of amputations of interpose and bypass was 9, of which 6 were related to interpose and 3 were related to bypass. The highest rate of amputation was related to the anterotibial artery. According to the statistical analysis, there was no significant relationship between the amount of amputation and the location of the intervention (P=0.161). According to the statistical analysis, there was no significant relationship between the amount of amputation and the presence of accompanying injuries.

• Discussion:

Vascular trauma of organs is a challenging issue. Vascular injuries of organs constitute only 3% of all traumatic injuries, but they are associated with potentially dangerous complications such as limb loss and even death (10).

The results of this study showed that among the penetrating trauma patients requiring surgical intervention, 89.1% were men and only 10.9% were women. The average age of the patients was 35 years. This result is similar to other studies on patients with vascular trauma (12 11). According to studies, ages between 18 and 40 years are associated with the highest prevalence of trauma (11)

The most frequent trauma requiring surgical intervention in this study was the trauma caused by firearms (gunshot and shotgun) and the least urban and occupational traumas. Based on the results of this research, the incidence of infection in patients with gunshot trauma and urban traumas and Occupation was more than other cases. On the other hand, the need for fasciotomy was included in urban and occupational traumas, gunshot, shotgun and knife wounds, respectively.

The incidence of reperfusion syndrome was the highest in patients following urban and occupational traumas. The incidence of amputation was the highest in gunshot trauma and zero in urban and occupational traumas.

According to the results, there was a significant relationship between the incidence of infection, the need for fasciotomy, amputation, and the duration of the operation with the type of trauma.

Among all lower limb vascular injuries, popliteal artery injury is still one of the main causes of inability to preserve the injured limb during vascular injuries. In the current study, the highest rate of injury was to the popliteal artery below the knee (8.47%), and the most vascular intervention was the saphenous vein. In Ghafari et al.'s study, the most frequent location of vascular injury was in the area of the popliteal artery, which It is consistent with the present study. In the present study, 73.9% of the patients had a fracture injury and 3% had a dislocation with vascular injury. In this regard, in Ghaffari's study, in terms of the type of injury orthopedics, 86% had fractures and 14% had dislocations (13) Thakur.and his colleagues in 2019, in a prospective study, followed up 104 patients with lower limb arterial injury with the aim of investigating diagnosis and treatment methods, from the time of admission to 1 month after discharge. Most of the patients (76%) had musculoskeletal injuries (14)

The most common cause in a study was injuries caused by firearms (97.5%), while knife injuries (1.5%) were among the causes (15). Similar to the results of the present study, most of the cases were young men (86%). And end-to-end anastomosis was used in two-thirds of the cases.

In the present study, after examining the type of vascular injury, 7.45% of the cases had complete arterial occlusion with active bleeding.

In another similar study (16), out of 135 cases, 127 people (94%) were men. The average age was 28.8 ± 11.5 years. The average length of stay in the hospital was 11 ± 92.3 days (range: 4-22 days). Popliteal artery injury was the most common and more than half of them were with complete arterial sever injury (55.6%). In the results of their study entitled "Management of Vascular Trauma in the Lower Extremity", Alam and his colleagues stated that the priority of managing these patients is rapid control of bleeding and rapid surgery. Vascular injury repair should be done quickly and skillfully to minimize limb ischemia time. Otherwise, whenever possible, TIVS should beplaced and the patient transferred to a higher level of care (17)

Severe vascular trauma creates difficult problems in diagnosis and treatment. Any delay in treatment may result in limb loss or death. It is important to use fast, cheap, minimally invasive diagnostic

methods, to repair severe vascular damage by surgery as soon as possible (18). Immediate control of bleeding and quick repair of blood flow disorders are the main goals of vascular trauma treatment. Surgery It is still the mainstay of treatment for vascular injuries. Endovascular treatment is a promising option that has been proven to be safe and effective, and is the right choice for patients. In summary, prompt diagnosis and timely surgical intervention are the mainstays of treatment. However, many issues should be resolved with further studies (4)

• Limitations:

Due to the small sample size and conducting the research in only one treatment center, it seems necessary to conduct research with a larger sample size and a longer and multi-year (perennial) follow-up.

• Conclusion:

According to the results of the present study, the association of vascular injuries with orthopedic fractures was higher and mostly in the popliteal region. Complications including infection, fasciotomy, reperfusion syndrome and amputation have a direct and significant relationship with the type of penetrating trauma.

Table No. 1 Demographic and clinical information of the studied patients

Frequency	abundace	variable	
89/1%	82	male	gender
10/9%	10	female	
38%	35	Stab wound	Type of penetrating trauma
30/4 %	28	shot gun	
18/5%	17	gun shot	
13%	12	Urban and occupational traumas	
47/8%	44	Popliteal artery below the knee	Place of intervention
25%	23	Anterotibia artery	
17/4%	16	Anterotibia artery, posterior tibial artery or both	
9/8%	9	peroneal artery	
47/8%	44	Popliteal artery below the knee	
26/1%	24	Use of ligature	Type of intervention
44/6%	41	Interpose	
14/1%	13	Bypass	
15/2%	14	Perform initial repair	
18/5%	17	including complete arterial occlusion (thrombosis)	Type of arterial injury
18/5%	17	The effect of external pressure and spasm	
45/7%	42	Arterial cut with active bleeding	
13%	12	Arteriovenous fistula	
4/3%	4	pseudoaneurysm	
83/7%	77	end to end	Anastomosis type
16/3%	15	end to side	
73/9%	68	Fracture	Associated injuries
16/3%	15	Dislocation	

Table number 2, the rate of infection in the studied patients

P-Value	Have not		have		Infection rate	
Chi-square= 7/758 P=0/051	11		13		Use of ligature	Type of intervention
	41	31	13	10	interpose	
		10		3	bypass	
	11		3		Perform initial repair	
Chi-square= 22/778 P=0/000	30		5		Stab wound	Type of penetrating trauma
	29	23	16	5	Shot gun	
		6		11	Gun shot	
	4		8		Urban and occupational traumas	
Chi-square= 5/106 P=0/164	34		10		Popliteal artery below the knee	Place of intervention
	16		7		Anterotibia artery	
	9		7		Anterotibia artery, posterior tibial artery or both	
	4		5		peroneal artery	
Chi-square= 0/83 P=0/493	46		22		fracture	Associated injuries
Chi-square= 0/196 P=0/455	11		4		dislocation	

Table number 3. The incidence of fasciotomy in the studied patients

P-Value	Have not		have		The incidentce of fasciotomy	
Chi-square= 4/180 P=0/243	15		9		Use of ligature	Type of intervention
	33	31	11	10	interpose	
		12		1	bypass	
	11		3		Perform initial repair	
Chi-square= 19/284 P=0/000	23		3		Stab wound	Type of penetrating trauma
	33	23	12	5	Shot gun	
		10		7	Gun shot	
	4		8		Urban and occupational traumas	
Chi-square= 2/824 P=0/420	36		8		Popliteal artery below the knee	Place of intervention
	16		7		Anterotibia artery	
	10		6		Anterotibia artery, posterior tibial artery or both	

	7	2	peroneal artery	
Chi-square= 0/301 P=0/400	50	18	fracture	Associated injuries
Chi-square= 0/27 P=0/550	11	4	dislocation	

Table No. 4. Duration of hospitalization in the studied patients

P-Value	Average + standard deviation		Duration of hospitalization	
P= 0/963	11/00 ± 3/575		Use of ligature	Type of intervention
	10/77 ± 3/614	10/54 ± 4/093	interpose	
		11/00 ± 3/136	bypass	
	10/64 ± 4/584		Perform initial repair	
P= 0/234	11/14 ± 3/889		Stab wound	Type of penetrating trauma
	11/06± 4/1	10/36 ± 4/130	Shot gun	
		11/76 ± 4/070	Gun shot	
	9/00 ± 2/256		Urban and occupational traumas	
P= 0/551	11/07 ± 3/378		Popliteal artery below the knee	Place of intervention
	9/74 ± 4/298		Anterotibia artery	
	11/25 ± 4/919		Anterotibia artery, posterior tibial artery or both	
	10/78 ± 2/906		peroneal artery	
P=0/437	10/93 ± 3/967		fracture	Associated injuries
P=0/616	11/20 ± 4/617		dislocation	

Table number 5. Bleeding rate in the studied patients

P-Value	Average + standard deviation		Bleeding rate	
P=0/513	437/50 ± 201/759		Use of ligature	Type of intervention
	394/94 ± 170/223	374/39 ± 163/218	interpose	
		415/38 ± 177/229	bypass	
	400 ± 58/835		Perform initial repair	
P=0/494	381/43 ± 128/958		Stab wound	Type of penetrating trauma
	411/71 ± 194/830	411/71 ± 194/830	Shot gun	
		382/35 ± 182/809	Gun shot	

	387/50 ± 122/706	Urban and occupational traumas	
P=0/912	401/14 ± 172/697	Popliteal artery below the knee	Place of intervention
	417/39 ± 181/289	Anterotibia artery	
	378/13 ± 142/558	Anterotibia artery, posterior tibial artery or both	
	394/44 ± 142/400	peroneal artery	
P= 0/762	403/68 ± 167/581	fracture	Associated injuries
P= 0/169	346/67 ± 85/496	dislocation	

Table No. 6. Operation duration (hours) in the studied patients

P-Value	Average + standard deviation		Duration of operation (hours)	
P= 0/930	2/96 ± 1/160		Use of ligature	Type of intervention
	3/08 ± 1/076	3/02 ± 1/084	interpose	
		3/15 ± 1/068	bypass	
	3/14 ± 0/535		Perform initial repair	
P= 0/010	2/66 ± 1/056		Stab wound	Type of penetrating trauma
	3/41 ± 0/894	3/36 ± 0/989	Shot gun	
		3/47 ± 0/800	Gun shot	
	2/83 ± 1/026		Urban and occupational traumas	
P= 0/007	3 ± 1/078		Popliteal artery below the knee	Place of intervention
	3/48 ± 0/846		Anterotibia artery	
	3/06 ± 0/680		Anterotibia artery, posterior tibial artery or both	
	2/11 ± 1/167		peroneal artery	
P= 0/363	2/99 ± 1/072		fracture	Associated injuries
P= 0/713	3/13 ± 1/125		dislocation	

Table No. 7. The incidence of reperfusion syndrome in the studied patients

P-Value	Have not		have		The incidence of reperfusion syndrome	
Chi-square= 7/385 P=0/061	16		8		Use of ligature	Type of intervention
	39	27	15	14	interpose	
		12		1	bypass	

	6		8	Perform initial repair	
Chi-square= 22/691 P=0/000	29		6	Stab wound	Type of penetrating trauma
	31	20	14	8	Shot gun
		11		6	Gun shot
	1		11	Urban and occupational traumas	
Chi-square= 3/822 P=0/281	33		11	Popliteal artery below the knee	Place of intervention
	14		9	Anterotibia artery	
	10		6	Anterotibia artery, posterior tibial artery or both	
	4		5	peroneal artery	
Chi-square= 1/099 P=0/214	43		25	fracture	Associated injuries
Chi-square= 1/350 P=0/113	8		7	dislocation	

Table No. 8. The incidence of amputation in the studied patients

P-Value	Have not		have		The incidence of amputation	
Chi-square= 1/482 P=0/686	21		3		use	Type of intervention
	45	35	9	6	interpose	
		10		3	bypass	
	13		1		Perform initial repair	
Chi-square= 16/072 P=0/001	35		0		Stab wound	Type of penetrating trauma
	34	24	11	4	Shot gun	
		10		7	Gun shot	
	10		2		Urban and occupational traumas	
Chi-square= 5/157 P=0/161	41		3		Popliteal artery below the knee	Place of intervention
	19		4		Anterotibia artery	
	13		3		Anterotibia artery, posterior tibial artery or both	
	6		3		peroneal artery	
Chi-square= 0/172 P=0/455	59		9		fracture	Associated injuries
Chi-square= 0/009 P=0/643	13		2		dislocation	

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