

## Original Research Article

# Current results of arterial injuries seen at femoral and popliteal arteries in civil society

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### ABSTRACT

**Background:** Lower extremity arterial injuries caused by penetrating or fired-gun trauma may result in limb or loss of life. Early intervention has critical importance. The aim of this study was to investigate the importance of early intervention and outcomes.

**Methods:** We retrospectively reviewed the data on 144 patients (18 females, 126 males) who were treated in Istanbul Medipol University Hospital between January 2016 to 2018. All patients had an arterial injury at level of femoral and popliteal arteries. Standard statistical methods were used for data analysis.

**Results:** Revascularization was performed to all 144 (18 females, 126 males) patients. Autologous saphenous vein graft interposition was performed in 96 patients. End-to-end repair was performed in 39 patients. 9 patients underwent a polytetrafluoroethylene graft (8 mm ringed) interposition.

**Conclusions:** All viable limbs should be revascularized rapidly. The primary goal is to provide bleeding control rapidly and to prevent the prolongation of ischemic time. It should be kept in mind that in addition to surgical technique, fasciotomy may be required in arterial injuries with ischemic time of more than 6-8 hours.

**Keywords:** Arterial injuries, Lower limb injuries, Penetrating traumas, Graft interposition

### INTRODUCTION

Traumatic vascular injuries must be quickly intervened. In the industrialized world, deaths due to major arterial injuries constitute 20-25% of post-traumatic deaths.<sup>1</sup> Ischemia time is very critical to save patients' extremities and lives. Ischemia lasting more than eight hours can cause limb loss or death.<sup>2</sup> The way of repair varies according to the type and location of the trauma. Accompanying additional injuries, the presence or absence of collateral circulation in the extremities, and material stock are other determining factors. The location of the injury should be determined quickly. More than 70% of patients had large vascular trauma such as aorta and its branches die before coming to the hospital.<sup>3</sup> Most

of the lower extremity injuries consist of femoral artery 70% and popliteal artery 19%.<sup>4</sup> Intervention of vascular injuries should begin before the hospital. A significant number of limbs loss or deaths are observed due to the detection of vascular damage and delays in the transport of the patient.<sup>5</sup>

Today, developing endovascular interventions benefit patients with vascular injuries. However, traditional surgical treatments are still an important option. To better understand the characteristics of vascular injuries and to compare the effects of surgical methods, we retrospectively analyzed patients of vascular injuries that have undergone traditional surgery in a single center. All operations performed by vascular surgeons.

## METHODS

We retrospectively reviewed the data on 144 patients (18 females, 126 males) who were treated in Istanbul Medipol University Hospital between January 2016 to 2018. All patients had an arterial injury at level of femoral and popliteal arteries. All patients had an injury caused by cutting and penetrating tool or firearm. Vascular injuries seen at proximal to the inguinal ligament, patients who did not respond to resuscitation, patients had trauma below the knee and patients with total limb amputation were excluded. In addition, patients with a history of intravenous drug use and patients with iatrogenic vascular injuries were excluded from the study.



**Figure 1: 8 mm PTFE graft interposition to superficial femoral artery.**

End-to-end repairs were attempted for the patients (Figure 1). Autologous saphenous vein graft or polytetrafluoroethylene (PTFE) graft interposition was performed to selected patients (Figure 2a and b). The type of graft to be applied was determined perioperatively according to the suitability of the autologous saphenous vein. Fasciotomy was performed in patients have or possibility of tissue edema (Figure 3).

The head of the clinic and all the authors approved the submission and publication of this study. After explaining the interventions, risks, and benefits as a policy of the health system in the country, informed consent was obtained from the relatives of each patient before the procedures.

### ***Informed consent***

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### ***Availability of data and materials***

All data and materials kept up in centre where operations performed.

Statistical analysis was performed with the SPSS version 24.0 program (SPSS Inc. Chicago IL, USA). The normal distribution of the variables was examined by histogram graphs and the Kolmogorov-Smirnov test. Mean  $\pm$ SD (standard deviation) values were used to present descriptive analyzes. Pearson Chi-square and Fishers exact tests were compared with 2x2 tables. While normally distributed (parametric) variables were evaluated among the groups, student T-test was used.

Mann Whitney U test was used to evaluate nonparametric variables. Logistic regression tests were performed to find odds ratio. P values below 0.05 were evaluated as statistically significant results.



**Figure 2 (a and b): Saphenous vein graft interposition in patient with popliteal artery injury.**



**Figure 3: Patient who had fasciotomy due to prolonged ischemia time.**

## RESULTS

The mean age of the patients was  $31.75 \pm 12.8$  years. There were superficial femoral artery injuries in 64 (44.44%) patients, popliteal artery injuries in 51 (35.44%) patients, common femoral artery injuries in 19 (13.19%) patients, both first 2 cm injuries of the deep femoral artery and superficial femoral artery injuries in 7 (4.869%) patients, and isolated first 2 cm injuries of the deep femoral artery in 3 (2.08%) patients. Bone fractures were present in 21 patients. 27 patients had motor nerve damage, 20 patients had sensory nerve damage (13 patients had both bone damage and motor neuron damage).

**Table 1: Clinical information (gender, cause and location) was collected and defined as a percentage.**

Variables	Gender			Causes		
	Number N (%)	Female N (%)	Male N (%)	Trauma N (%)	Cutting tool injury N (%)	Gun N (%)
Superficial femoral artery	64 (44.44)	11 (7.63)	53 (36.80)	6 (4.16)	39	19 (13.19)
Popliteal artery	51 (35.44)	5 (3.47)	46 (31.94)	38 (26.38)	1 (0.69)	12 (8.33)
Common femoral artery	19 (13.19)	2 (1.38)	17 (11.80)	13 (9.02)	5 (0.69)	1 (0.69)
Superficial and deep femoral artery	7 (4.869)	0	7 (4.86)	1 (0.69)	1 (0.69)	5 (0.69)
Deep femoral artery	3 (2.08)	1 (0.69)	2 (1.38)	0	3 (2.08)	0

Revascularization was performed to all 144 (18 females and 126 males) patients. Autologous saphenous vein graft interposition was performed in 96 patients. End-to-end repair was performed in 39 patients. 9 patients underwent a PTFE graft (8mm ringed) interposition.

Fasciotomy was performed to all 13 patients whose hospital admission was delayed and revascularization period exceeding 6 hours, regardless of tissue edema status. Fasciotomy was not needed for those with a short ischemia time.

**Table 2: Surgical technique and patency rates.**

Variables	Autologous saphenous graft (%)	PTFE graft	End to end repair
Post-operative 1st week	100	100	100
Post-operative 12 months	98.92	57.14	100

Only 1 patient underwent re-operation at the 4th postoperative hour due to hematoma. The patient who underwent saphenous vein interposition was applied patchplasty with saphenous vein to another injured distal vascular segment in the second operation. A 34 years old drug addict patient who underwent PTFE graft interposition was re-operated on the 9th postoperative day due to graft infection. The patient was discharged with cure after antibiotic treatment.

The patients were followed up for 12±3.3 months, with 3 months intervals. No complication like bleeding were observed in patients who received medical treatment.

## DISCUSSION

Traumatic arterial injuries are very important in terms of death or loss of limb potential.<sup>6</sup> The most important reason is delay in the diagnosis and treatment process for high rates of morbidity and mortality.<sup>7</sup> To prevent this scenario, the emergency physician should have a high

level of suspicion. Patients with pulsatile bleeding, limb ischemia, enlarged hematoma and hypovolemic shock should be taken directly to the operating room without perform further diagnostic tests.<sup>8</sup> All patients included in our study underwent emergency computed tomography angiography (CTA).

Many studies have reported that traumatic vascular injuries are more common in young men.<sup>9-10</sup> The average age of our patients was 31.75±12.8 and 87.5% (126) were male. Consistency of these results may be related to the fact that young men in society have higher risk potential both in their working life and in their social life. In addition, intravenous drug use significantly increases the rate of injury in young people because it's easy to reach.<sup>11</sup>

Amputation risk may be more common in lower extremity artery injuries than upper extremity artery injuries. The risk of amputation is not only the localization of the injury; it is also associated with comorbid bone fracture, nerve injury and massive tissue damage.<sup>12</sup> While the rate of amputation is 4% in isolated arterial injuries, this rate rises to 60% when skeletal system and tissue injuries are together.<sup>13</sup> The timing of orthopedic fixation is controversial issue in multiple bone fractures or near-total tissue loss. While some surgeons advocate that skeletal system fixation should be performed before vascular repair, the general opinion is to provide bleeding control.<sup>14-15</sup> We believe that if bone fixation is given priority, the duration of ischemia will be prolonged, or bleeding cannot be controlled. In our study, patients were revascularized by providing bleeding control and then aimed to ensure tissue totality.

There are studies suggesting direct amputation in cases of delayed revascularization.<sup>16</sup> In delayed revascularization, ischemia reperfusion injury or compartment syndrome and associated tissue organ loss may develop. In such cases, fasciotomy is recommended to prevent the development of decompression.<sup>17</sup> There are studies representing that amputation rates are reduced by fasciotomy in delayed revascularization.<sup>18-19</sup> In our study, we determined the duration of ischemia as 12 hours and no need for amputation due to delayed revascularization. However, all delayed 13 patients underwent fasciotomy.

Grafting is the most suitable method for surgical treatment of arterial injuries. These vascular grafts include autogenous venous graft and artificial graft. The choice between autogenous venous grafts and PTFE grafts is still a controversial issue. Although autogenous vein grafts were reported to be much more successful in the early period in terms of limb salvage; in the long term, the difference between the patency rates of the grafts used has not been fully revealed.<sup>20-21</sup> In studies comparing patients who underwent arterial revascularization, it was reported that patients who underwent revascularization with autologous saphenous vein grafts had better results than those treated with synthetic grafts at 12 months of controls.<sup>22</sup> Six patients (3 autologous venous grafts, 1 end-to-end repair, 2 PTFE grafts) in our study were excluded from the follow-up because they did not come for control. Graft occlusion was detected in 4 patients (3 synthetic grafts and 1 autologous saphenous graft). One of the 3 patients who had synthetic graft and developed occlusion was re-operated (Figure 4). No reoperation was needed for other 2 patients with synthetic graft occlusion and for patient with autologous saphenous vein occlusion (table: Follow-up results).



**Figure 4: CT image of re-operated patient who had occluded PTFE graft.**

This study has limited experience due to its retrospective nature and physical conditions of the study center. More studies are needed to confirm the hypotheses revealed by the described observations.

## CONCLUSION

The primary goal is to provide bleeding control rapidly and to prevent the prolongation of ischemia time. All viable limbs should be revascularized rapidly. Accompanying muscle, bone and nerve injuries should be treated after arterial revascularization. It should be kept in mind that in addition to the surgical technique, fasciotomy may be required in arterial injuries with ischemia time of 6-8 hours.

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## REFERENCES

1. Kou HW, Liao CH, Huang JF. Eighteen years' experience of traumatic subclavian vascular injury in a tertiary referral trauma center. *Eur J Trauma Emerg Surg.* 2019;45(6):973-8.
2. Sharrock AE, Tai N, Perkins Z. Management and outcome of 597 wartime penetrating lower extremity arterial injuries from an international military cohort. *J Vasc Surg.* 2019;70(1):224-32.
3. Liu JL, Li JY, Jiang P, Jia W, Tian X, Cheng ZY, et al. Literature review of peripheral vascular trauma: Is the era of intervention coming. *Chinese J Traumatology.* 2020;23(1):5-9.
4. Cooper N, Roshdy M, Sciarretta JD. Multidisciplinary team approach in the management of popliteal artery injury. *J Multidiscip Healthc.* 2018;11:399-403.
5. Kelly JR, Levy MJ, Reyes J, Anders J. Effectiveness of the combat application tourniquet for arterial occlusion in young children. *J Trauma Acute Care Surg.* 2020;88(5):644-7.
6. Martin MJ, Holcomb JB, Polk T. The 'Top 10' research and development priorities for battlefield surgical care: Results from the Committee on Surgical Combat Casualty Care research gap analysis. *J Trauma Acute Care Surg.* 2019;87(1):14-21.
7. Shi L. The delayed management of main arterial injuries in extremity trauma: surgical challenges and outcomes. Shi L. The delayed management of main arterial injuries in extremity trauma: surgical challenges and outcomes. *Pak J Med Sci.* 2013;29(1):64-7.
8. Hafertepen SC, Davis JW, Townsend RN. Myths and Misinformation About Gunshot Wounds May Adversely Affect Proper Treatment. *World J Surg.* 2015;39:1840-7.
9. Li Z, Zhao L, Wang K, Cheng J, Zhao Y, Ren W. Characteristics and treatment of vascular injuries: a review of 387 cases at a Chinese center. *Int J Clin Exp Med.* 2014;7(12):4710-9.
10. Perkins ZB, Ath DHD, Aylwin C, Brohi K, Walsh M, Tai NR. Epidemiology and outcome of vascular trauma at a British Major Trauma Centre. *Eur J Vasc Endovasc Surg.* 2012;44:203-9.
11. Ilic A, Stevanovic K, Pejicic S. Vascular injuries in intravenous drug addicts - a single center experience. *Ann Vasc Surg.* 2020;S0890-5096(20):30326-5.
12. Wei HK. Eighteen years' experience of traumatic subclavian vascular injury in a tertiary referral trauma center. *European J Trauma Emergency Surg.* 2019;45(6):973-8.
13. Kim JS, Lee SA, Chee HK. Femoral arteriovenous fistula associated with surgery of proximal femoral

- fracture: a systematic review of the literature and case presentation. *Ann Transl Med.* 2020;8(6):291.
14. Xu Y, Xu W, Wang A. Diagnosis and treatment of traumatic vascular injury of limbs in military and emergency medicine: a systematic review. *Medicine.* 2019;98(18):15406.
  15. Isaji T, Hashimoto T, Yamamoto K. Improving the Outcome of Vein Grafts: Should Vascular Surgeons Turn Veins into Arteries. *Ann Vasc Dis.* 2017;10(1):8-16.
  16. Alarhayem AQ, Cohn SM, Nunez CO, Eastridge BJ, Rasmussen TE. Impact of time to repair on outcomes in patients with lower extremity arterial injuries. *J Vasc Surg.* 2019;69(5):1519-23.
  17. Farber A, Tan TW, Hamburg NM, Kalish JA, Joglar F, Onigman T, et al. Early fasciotomy in patients with extremity vascular injury is associated with decreased risk of adverse limb outcomes: a review of the National Trauma Data Bank. *Injury.* 2012;43:1486-91.
  18. Stella M, Santolini E, Sanguineti F. Aetiology of trauma related acute compartment syndrome of the leg: a systematic review. *Injury.* 2019;50(2):57-64.
  19. Liguoro S. The delayed management of main arterial injuries in extremity trauma: Surgical challenges and outcomes. *Pakistan J Med Sci.* 2013;29(1):64-7.
  20. Johnson WC, Lee KK. A comparative evaluation of polytetrafluoroethylene, umbilical vein, and saphenous vein bypass grafts for femoral-popliteal above-knee revascularization: a prospective randomized Department of Veterans Affairs cooperative study. *J Vasc Surg.* 2000;32:268-77.
  21. Toshihiko I. Improving the Outcome of Vein Grafts: Should Vascular Surgeons Turn Veins into Arteries. *Annals Vascular Diseases.* 2017;10(1):8-16.
  22. Bai H, Wang Z, Li M. Adult human vein grafts retain plasticity of vessel identity. *Ann Vasc Surg.* 2020;S0890-5096(20):30383-6.

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