



Missile vascular injuries: 19-year experience

Mermi ile gerçekleşen vasküler yaralanmalar: 19 yıllık deneyim

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BACKGROUND

Missile vascular injuries have reached an epidemic proportion in Kashmir valley since the eruption of militancy. The present study was undertaken to analyze the mode, pattern, presentation, and management of missile vascular injuries.

METHODS

A retrospective study of patients with missile vascular injury from January 1990 to October 2008 was undertaken. Five hundred eighty patients with missile vascular injury were studied. All patients with vascular injury due to causes other than missiles were excluded from the study.

RESULTS

Most of the patients were treated by interpositional saphenous vein graft or end-to-end anastomosis. The most common complication was wound infection (22.7%) followed by graft occlusion (3.8%). The amputation rate was 3.3% and was higher in patients with a delay of >6 hours to revascularization and associated fractures.

CONCLUSION

Missile vascular injury requires prompt resuscitation and revascularization. Preoperative angiography is seldom necessary. Doppler study may sometimes be needed to aid in the diagnosis.

Key Words: End to end anastomosis; saphenous vein graft; vascular injuries.

AMAÇ

Militanlığın patlak vermesinden itibaren mermi ile gerçekleşen vasküler yaralanmalar, Kaşmir vadisinde epidemik bir orana ulaşmıştır. Bu çalışma, mermi ile gerçekleşen vasküler yaralanmaların tipi, mekanizması, başvuru şekli ve tedavisini analiz etmek için yapılmıştır.

GEREÇ VE YÖNTEM

Bu retrospektif çalışmada, Ocak 1990 ile Ekim 2008 tarihleri arasında mermi ile gerçekleşen vasküler yaralanması olan hasta kayıtları incelendi. Mermi ile gerçekleşen vasküler yaralanması bulunan 580 hasta üzerinde çalışıldı, bu tip yaralanması olmayanlar çalışma dışında tutuldu.

BULGULAR

Hastaların çoğu, safen ven interpozisyon grefti veya uç uca anastomoz yöntemi ile tedavi edilmiştir. En yaygın olarak karşılaşılan komplikasyonlar, enfeksiyon (%22,7) ile greft tıkanıklığı (%3,79) olmuştur. Ampütasyon oranı %3,3 olmuştur. Ampütasyon oranı, >6 saatlik bir gecikme ve eşlik eden kırıklarla başvuran hastalarda daha yüksek olmuştur.

SONUÇ

Mermi ile gerçekleşen vasküler yaralanma, acil resüsitasyon ve revaskülarizasyon gerektirir. Ameliyat öncesi anjiyografi nadiren gerekir. Taniya yardımcı olmak üzere bazen Doppler incelemesi gerekli olabilir.

Anahtar Sözcükler: Uç uca anastomoz; safen ven grefti; vasküler yaralanmalar.

Over the past two decades, there has been an enormous increase in firearm injuries in Kashmir valley. As a result, the Department of Cardiovascular and Thoracic Surgery at Sheri-Kashmir Institute of Medical Sciences (SKIMS) has admitted an increasing number of patients with missile vascular injuries. The purpose of this study was to evaluate our management policy with respect to missile vascular injury.

MATERIALS AND METHODS

Sheri-Kashmir Institute of Medical Sciences (SKIMS) is the only referral center for management of missile vascular injuries in the entire state of Jammu and Kashmir. This retrospective study comprised data acquired from January 1990 to October 2008. During this period, 23,480 patients were admitted to the hospital through the Accident and Emergency Depart-

ment, with firearm- or blast-related missile injuries. Of these, 580 (2.4%) patients were operated for missile vascular injuries. Excluded from the study were patients with vascular injuries due to causes other than missile injuries. Patients were initially resuscitated in emergency reception and were categorized into two groups based on clinical examination:

Category 1 (Hard Signs): These included pain, pallor, pulselessness, paraesthesia, pulsatile bleeding, and a large or expanding hematoma.

Category 2 (Soft Signs): These included a relatively diminished but palpable pulse, a non-expanding hematoma and a peripheral nerve injury.

Patients in Category 1 were transferred directly to the emergency theater and explored. Patients in Category 2 were subjected to vascular Doppler before exploration.

All patients received a third-generation cephalosporin and an aminoglycoside at induction of anesthesia. The injured vessel was exposed after proximal and distal control of bleeding. Extent of injury was assessed. Patients with >2.5 cm segmental loss were revascularized by reverse saphenous vein graft. Thorough debridement of soft tissue was done.

Different surgical procedures like direct end-to-end anastomosis, saphenous vein graft interposition and lateral repair were performed for revascularization. Heparin was instilled locally in every patient, and each patient also received anticoagulation therapy postoperatively in the form of heparin, clopidogrel and aspirin to decrease the chance of postoperative thrombus formation. Liberal fasciotomy was performed in most of the patients whenever indicated on clinical assessment. All fractures were fixed before vascular repair. All patients underwent Doppler study postoperatively on the 10th postoperative day to ensure the patency of the vessel before discharge. The mean hospital stay was 12.34 days.

RESULTS

The patients' ages ranged from 10 to 70 years (mean, 32 years), and the majority were male (497, 85.6%). The patients were received in the Accidental Emergency Department between 30 minutes to 24 hours after the injury. Mean delay was 4.38 hours. Four hundred forty-seven of the patients were revascularized within 6 hours of injury (77.0%). The popliteal artery was the most common vessel involved (41.3%) followed by the brachial artery (24.1%). Table 1 shows the arterial distribution in our series. The right side was involved in 59.6% of patients. Transection was the most common type of injury followed by laceration (44.6% vs 39.1%). We defined laceration as cut-through injury with ragged margins and lateral tear as

Table 1. Distribution of vessels

	n	%
Popliteal artery	240	41.37
Brachial artery	140	24.13
Femoral artery	70	12.06
Tibial	48	8.27
Radial/Ulnar	30	5.17
Carotid	28	4.82
Others	24	4.13

Table 2. Type of injury

	n	%
Transection	259	44.65
Laceration	227	39.13
Lateral tear	47	8.10
Contusion	47	8.10

Table 3. Revascularization procedures performed

	n	%
Interpositional graft	313	53.96
End-to-end anastomosis	232	40
Lateral repair	35	6.03

Table 4. Distribution of venous injuries

	n
External jugular	12
Femoral	28
Popliteal	82
Axillary	02

Table 5. Management of venous injury

	n
Repair with graft	66
End-to-end repair	43
Lateral repair	12
Repair with venous patch	3

injury involving less than one-third of the vessel wall. Table 2 shows the type of injuries. Most of the patients were diagnosed by critical clinical assessment 394 (67.9%). Doppler aided in the diagnosis in the remainder of the patients. Most of the patients were revascularized using venous graft or end-to-end anastomosis (53.9% vs 40%). Lateral repair was done in 6.0% of the patients (Table 3). Venous injury was associated in 21.3% of patients (Tables 4, 5). All venous injuries in our series were major veins. We preferred repair of these veins as it relieves acute venous hypertension, compartment syndrome and edema. Liberal fasciotomy was performed in 78.8%. Associated skeletal trauma was present in 39.8% of the patients. Nerve injuries were associated in 19.3% of the patients (Ta-

Table 6. Associated injury

	n
Skeletal fractures	231
Nerve injuries	112
Abdominal injuries	20
Penetrating chest injury	03
Head injury	3

Table 7. Complications

	n	%
Wound infection	132	22.75
Bleeding from anastomosis site	11	1.89
Compartment syndrome	14	2.41
Thrombosis of graft	22	3.79

Table 8. Effect of skeletal injury

	No. of patients	Limb salvage
With fractures	231	219 (94.80%)
Without fractures	349	343 (98.28%)

Table 9. Effect of time lapse

	No. of patients	Limb salvage
<6 hours	447	442 (98.88%)
>6 hours	133	120 (90.22%)

ble 6). Only 14 primary nerve repairs were done. The rest of the nerves were repaired in the second session. Wound infection was the most common complication followed by graft occlusion and thrombosis (Table 7). The amputation rate was 3.3% in peripheral missile vascular injury, and was not influenced by the type of injury, type of repair or presence of associated venous injury. However, associated skeletal trauma increased the amputation rate (Table 8). Another important factor influencing the amputation rate was delay in revascularization from time of injury. Patients who were revascularized over 6 hours after injury had higher amputation rates (Table 9). Eighteen patients underwent amputation. Nine patients had severe functional loss because of delayed revascularization after severe trauma to the neurovascular bundle.

DISCUSSION

Missile vascular injuries have reached an epidemic proportion after the eruption of militancy in Kashmir valley. Missile vascular injuries pose a serious threat to life and limb of the injured. Murphy^[1] performed the first successful vascular end-to-end anastomosis in a man in 1896. Because of improvement in vascular repair techniques, accompanied by substantial progress in anesthesia, blood transfusion and use of antibiotics, there was a successful repair in vascular inju-

ries in the Korean conflict as compared to that during World War II.^[2,3] The most recent studies have documented the continuous improvement in limb survival after vascular injuries, a reflection of primary repair or interposition graft. A cardinal operative principle in managing vascular trauma is to obtain proximal and distal control of the injured vessel before entering the surrounding hematoma.^[4] In extremities such as in the neck, control is achieved using standard extensile vascular exposure techniques.^[5,6]

Early recognition of missile vascular injury is a must for successful outcome. Diagnosis is usually by critical clinical assessment aided by vascular Doppler whenever necessary. We used the following standard techniques for management of missile vascular injuries:

1. Proximal control of bleeding and resuscitation with fluids and blood.
2. Adequate exposure with assessment of injury with distal control of vessel.
3. Distal thromboemblectomy, using Fogarty balloon catheter.
4. Irrigation of distal arterial tree with heparinized saline (5000 IU per 100 cc).
5. Repair of vessel by primary end-to-end anastomosis after debridement of edges, or by reversed saphenous vein graft from contralateral limb if there is a segmental loss.
6. Small lacerations treated by lateral repair only.
7. All fractures fixed before vascular repair.
8. Systemic anticoagulation in the form of subcutaneous heparin or heparin infusion soon after the surgery and continued for 3 to 5 days, depending on the clinical status. This was followed by oral aspirin or clopidogrel, as it decreases chances of thrombus formation.
9. Liberal performance of fasciotomy.

Although the popliteal vein was successfully ligated by many authors,^[7-10] we advise repair of the popliteal vein, which enhances the success of arterial repair, as it relieves acute venous hypertension, compartment syndrome and edema. However, arterial repair precedes venous repair to decrease ischemia time. Associated venous injury did not increase the amputation rate as reported by some authors. As previously reported,^[8,11-17] the significant factor associated with increased limb loss is the time lapse between injury and operation, as there is progression of muscle ischemia and small vessel thrombosis that prevents successful outcome of repair. This was true in our patients as well. Another important factor contributing to limb loss is associated fracture.^[14,18] In our study, associated fracture had a significant impact on the amputation rate. We used fasciotomy often and liberally as

advised by many authors,^[11] which positively affected the prognosis in our series as well, having reduced the amputation rate remarkably to 3.3%.

In our study, wound infection was very high due to wound contamination by the missiles and improper asepsis at the site of injury at the time of mass casualties. Proper resuscitation, revascularization and technique of repair are the only correctable factors that improve the limb/life survival, and implementation of all three of these cannot be overemphasized.

REFERENCES

1. Murphy JB. Resection of arteries and veins injured in continuity: end-to-end suture, experimental and clinical research. *Med Rec* 1897;51:73.
2. Debakey ME, Simeone FA. Battle Injuries of the Arteries in World War II: An Analysis of 2,471 Cases. *Ann Surg* 1946;123:534-79.
3. Hughes CW. Acute vascular trauma in Korean War casualties; an analysis of 180 cases. *Surg Gynecol Obstet* 1954;99:91-100.
4. Rich NM. Vascular trauma in Vietnam. *J Cardiovasc Surg (Torino)* 1970;11:368-77.
5. Hirshberg A, Wall MJ, Johnston RH Jr, Burch JM, Mattox KL. Transcervical gunshot injuries. *Am J Surg* 1994;167:309-12.
6. Valentine RJ, Wind GG. *Anatomical exposure in vascular surgery*. Philadelphia, Lippincott, Williams and Wilkins, 2003.
7. Sullivan WG, Thornton FH, Baker LH, LaPlante ES, Cohen A. Early influence of popliteal vein repair in the treatment of popliteal vessel injuries. *Am J Surg* 1971;122:528-31.
8. Daugherty ME, Sachatello CR, Ernst CB. Improved treatment of popliteal arterial injuries using anticoagulation and extra-anatomic reconstruction. *Arch Surg* 1978;113:1317-21.
9. Timberlake GA, O'Connell RC, Kerstein MD. Venous injury: to repair or ligate, the dilemma. *J Vasc Surg* 1986;4:553-8.
10. Swetnam JA, Hardin WD Jr, Kerstein MD. Successful management of trifurcation injuries. *Am Surg* 1986;52:585-7.
11. Orcutt MB, Levine BA, Root HD, Sirinek KR. The continuing challenge of popliteal vascular injuries. *Am J Surg* 1983;146:758-61.
12. Dajani OM, Haddad FF, Hajj HA, Sfeir RE, Khoury GS. Injury to the femoral vessels--the Lebanese War experience. *Eur J Vasc Surg* 1988;2:293-6.
13. Dar AM, Ahanger AG, Wani RA, Bhat MA, Lone GN, Shah SH. Popliteal artery injuries: the Kashmir experience. *J Trauma* 2003;55:362-5.
14. McNamara JJ, Brief DK, Stremple JF, Wright JK. Management of fractures with associated arterial injury in combat casualties. *J Trauma* 1973;13:17-9.
15. Conkle DM, Richie RE, Sawyers JL, Scott HW Jr. Surgical treatment of popliteal artery injuries. *Arch Surg* 1975;110:1351-4.
16. Menzoian JO, LoGerfo FW, Doyle JE, Hirsch EF, Nowak M, Sequeira JC, et al. Management of vascular injuries to the leg. *Am J Surg* 1982;144:231-4.
17. Downs AR, MacDonald P. Popliteal artery injuries: civilian experience with sixty-three patients during a twenty-four year period (1960 through 1984). *J Vasc Surg* 1986;4:55-62.
18. Odland MD, Gisbert VL, Gustilo RB, Ney AL, Blake DP, Bubrick MP. Combined orthopedic and vascular injury in the lower extremities: indications for amputation. *Surgery* 1990;108:660-6.