Original Article

MANAGEMENT OF COMBINED FEMORAL ARTERY AND VEIN INJURIES

Hasan Ekim[1], Dolunay Odabasi[2]

ABSTRACT

Objectives: The aim of this study was to review our experience with combined injuries to the femoral artery and vein, and to analyze the role of venous repair.

Methodology: Thirty two patients with penetrating injuries of the both femoral artery and vein underwent surgical management at our hospital from May 1999 to August 2009. Primary vascular repair was carried out whenever possible; if not possible the interposition graft was used.

Results: This study group consisted of 27 males and 5 females, ranging in age from 15 to 72 years with a mean age of 28.3 years. The mechanism of injury included gunshot wounds in 18 patients and stab wounds in 14 patients. Primary arterial repair was performed in 17 patients. Autogenous saphenous vein graft was used in nine patients and vein patch in two patients. Polytetraflouroethylene (PTFE) graft was used in four patients. All patients had associated venous injuries of which 24 patients had primary venous repair, five had vein graft interposition, and two had PTFE graft interposition. Seven patients had fasciotomies. Graft thrombosis occurred in three arterial repairs. Above-knee amputation was required in two patients with femur fracture.

Conclusion: Patients with combined femoral artery and vein injuries can be managed successfully with clinical assessment alone. In these dual vascular injuries, both the femoral artery and vein injuries should be repaired to avoid complications. If venous ligation becomes compulsory, adjuvant therapies and techniques should be recommended such as the use of fasciotomy, anticoagulation treatment, elevation of the lower limb and compression stockings.

KEY WORDS: Femoral Artery, Femoral vein, Injury.

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1. Hasan Ekim, MD,
2. Dolunay Odabasi, MD,
1-2: Yuzuncu Yil University,
Department of Cardiovascular Surgery,
Van, Turkey.
E-mail:dolunayodabasi@yahoo.com

Correspondence:

Dr. Hasan Ekim
Yuzuncu Yil University
Tip Fakultesi Hastanesi
Maras Caddesi-65200,
Van - Turkey.
E-mail: drhasanekim@yahoo.com

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INTRODUCTION

Complicated vascular injuries of the lower extremities may result in amputation and life-threatening complications more often than do injuries of the upper extremities, generally as a result of worse collateral pathways.[1] Combined injuries to the femoral artery and vein can be extremely difficult to manage because of the special problems inherent in obtaining control of the vein and its tributaries in the femoral triangle.[2] In these dual vascular injuries, there was increased extremity loss when there was inadequate venous drainage.[3] Therefore, we have

preferred venous repair rather than ligation. Although significant improvements in treatment have been achieved, such injuries are still important causes of mortality.[4]

The aim of this study was to review our experience with combined injuries to the femoral artery and vein, and to analyze the role of venous repair.

METHODOLOGY

Thirty two patients with penetrating injuries of the both femoral artery and vein underwent surgical management at our hospital from the beginning of May 1999 to the end of August 2009. Diagnosis was made by physical examination alone, or confirmed on preoperative angiography. Victims with associated abdomen, chest or head injuries were excluded from the study. Physical examination findings consisted of hard and soft signs of vascular injury. Hard signs of vascular injuries were defined as pulsatile bleeding, expanding or pulsatile hematoma, presence of a bruit or thrill, absent or diminished distal pulses, or distal ischemia. Soft signs were defined as stable hematomas, unexplained or transient hypotension, and wound in proximity to a neurovascular bundle.

In the beginning of the operation, control of the injured femoral vessels was achieved by femoral dissection. Common, superficial and profunda femoral arteries were dissected and clamped to prevent bleeding before opening the hematoma. Systemic heparinization was routinely employed for systemic anticoagulation before the vessels were clamped with vascular clamps. Fogarty catheters were routinely passed distally to remove any thrombus and a diluted heparin solution was given to flush distal arterial bed. Primary vascular repair was carried out whenever possible; if not possible the interposition graft was used. If interposition grafting was needed, reversed contralateral saphenous vein grafts were used in preference to synthetic ones. All vascular grafts and anastomotic suture lines were covered by soft tissue and muscle. Additionally, fasciotomies were undertaken when there was soft tissue edema caused directly by trauma or vascular injury of the ischemic muscle. Fasciotomy wounds were washed regularly and necrotic tissues were removed.

Low molecular weight heparin was administered throughout the period of hospital confinement. Oral anticoagulation therapy (coumadin) was initiated a few days before discharge, and the international normalized ratio (INR) value was maintained between two and three. Oral anticoagulation therapy was discontinued three months after operation, and aspirin then was administered.

All patients were given an intravenous prophylactic antibiotics course. The first dose was given before surgery and the course was administered over 72 hours, unless prolonged use was dictated by the presence of contamination or infection. Postoperatively, duplex color ultrasonography was used to evaluate patency of the repaired vessels.

RESULTS

This study group consisted of 27 males and five females, ranging in age from 15 to 72 years with a mean age of 28.3 years. All victims sustained penetrating wounds to the thigh. The mechanism of injury included gunshot wounds in 18 patients and stab wounds in 14 patients. Injuries involved both the femoral artery and vein in each case. 16 (50%) patients were in the state of shock at the time of admission.

The diagnosis of vascular injury was made based on clinical examination alone in 29 patients. They were taken directly to the operating room. The remaining three patients underwent preoperative angiography. The time interval between beginning of the trauma and taken to the operating room was changed one hour to 12 hours with a mean of 3.8 hours.

Primary arterial repair was performed in 17 patients (end-to-end anastomosis in 13, Lateral repair 4). Autogenous saphenous vein graft was used in nine patients and vein patch in two patients. Polytetraflouroethylene (PTFE) graft was used in four patients. In two patients who had injury at the level of femoral bifurcation, injured

profunda femoral artery was ligated owing to extensive injury. In both cases, PTFE interposition graft was employed between common and superficial femoral arteries.

All patients had associated venous injuries of which 24 patients had primary venous repair (end-to-end anastomosis in 18, Lateral repair in 6), five had vein graft interposition, and two had PTFE graft interposition. In the remaining one patient, venous repair was technically impossible as a result of extensive disruption of the vein (Figure-1). Therefore, venous ligation was performed. No pulmonary embolism was encountered.

Fracture of the femur occurred in six patients, all of whom had gunshot injuries. One of them had external bone fixation before we were consulted for revascularization. In the remaining five patients, vascular repair preceded external bone fixation. There were no vascular complications after orthopedic manipulation. An associated femoral nerve injury was present in two patients. Fasciotomy was performed for suspected compartment syndrome during the initial operation in seven patients. There were delays of over six hours before the arterial circulation was established.

Seventeen patients developed postoperative complications consisting of wound infection (four patients), ischemic symptoms due to graft thrombosis (three patients), deep venous thrombosis (two patients) and thrombosis of the venous repair (eight patients). Above-knee amputation was required in two patients due to severity of concomitant soft tissue and femur fracture with infection.

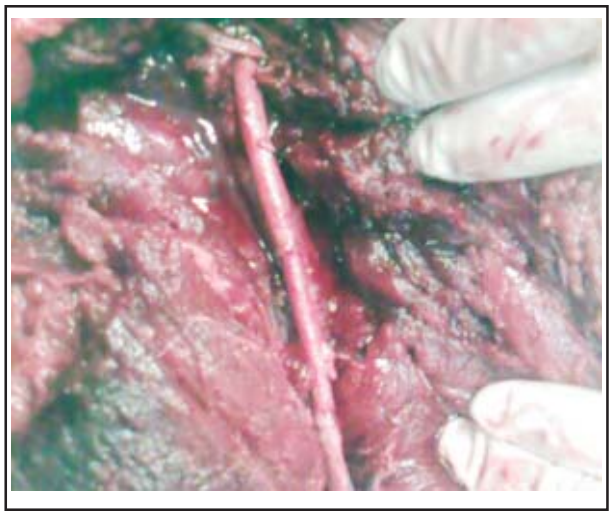

Figure-1: Reconstruction of injured superficial femoral artery with saphenous vein interposition graft.

Three arterial repairs (two PTFE grafts, one vein graft) were noted to be thrombosed within the first 24 hours following operation. Reoperation was performed successfully in these patients. They required revision of an anastomosis in addition to thrombectomy. Postoperatively, all patients experienced various degrees of edema in the lower limb. This edema decreased with elevation in all patients during the follow-up period. Two patients with bone fracture had deep venous thrombosis. They were successfully treated without any complication. Four patients experienced wound infection, but these infections were resolved within 16 days by antibiotic therapy. Postoperative venous Doppler studies showed thrombosed repair in eight cases (four cases with end-to-end anastomosis, two cases with PTFE graft and two cases with saphenous vein graft) without any complication.

There were no deaths. All patients were followed up at six weeks. There was no opportunity for long-term follow-up

DISCUSSION

Vascular injuries of the extremities remain the most important cause of extremity amputation, if not treated early and skillfully. Patients who presented within six hours of injury had a higher rate of extremity salvage than those who presented later. Additionally, patients with isolated vascular injuries had a higher rate of extremity salvage than those with associated bone fractures.[5] Similarly, our two patients requiring amputation had associated femur fracture and they were operated on after eight hours of injury.

The role of preoperative angiography in the diagnosis of vascular injury is controversial. Since early repair of vascular injuries in an ischemic extremity is necessary to maintain function, diagnostic studies such as angiogra-

phy or duplex scanning may contribute to the delay in operative repair and are contraindicated when the presence and location of the injury is obvious.[6] Angiography has been advocated only in stable patients, to delineate the site, nature and extent of injury. Recently duplex ultrasonography has emerged as a valuable diagnostic tool for the diagnosis of potential vascular injuries.[7] Especially, color-flow duplex ultrasonographic studies have been assessed as a screening device in suspected penetrating arterial injuries of the extremities[6] But subcutaneous air, large hematomas, casts, and large skin wounds may impede its performance. Further limitations are derived from operator dependence and lengthy examinations, which may be inappropriate in the acute care setting.[8] In our series, all patients with hard signs of vascular injury were taken to the operating room without preoperative angiograms. There were no negative explorations. Angiography was performed in three patients with associated soft signs of injury, to make a conclusive decision. However, we used duplex ultrasonographic examinations to evaluate the patency of the vascular reconstructions during the postoperative period.

Vascular repair has been shown to decrease amputation rates when performed before bone fixation in patients with combined with bone fracture.[9,10] Accordingly we have preferred vascular repair prior to bone fixation. The type of fixation depends on the individual preference of the orthopedists. In general external fixation is preferred because of the simplicity of the procedure, the low infection risk and the speed with which it can be accomplished.[1]

The presence of retrograde bleeding by itself does not completely rule out the presence of distal clots within the arterial system[2] So, we have routinely used a Fogarty catheter before completion of the vascular procedures.

Some authors recommend shunting for victims who have critical remote injuries such as thoracic or abdominal injuries or for those who have resistant hypovolemic shock and severe metabolic derangement. Once the victim's general condition is stabilized, normal vascular repair can then be carried out safely.[11] However, the placement of an intravascular shunt would be an additional step with no real benefits and may potentially cause vessel complications such as dissection or thrombosis.[12] Therefore, we have not used the placement of an intravascular shunt.

Although it is generally accepted that skeletal muscles can tolerate ischemia up to six hours, the ischemic time alone cannot be used to predict limb viability. The tolerance period to ischemia varies between human beings, depending on the severity of the ischemia and the presence of collateral flow.[12] Even in victims with complete motor deficit but without mottling, vascular reconstructions should be performed.[13] Revascularization was performed in our three patients with motor deficit without mottling; however, it was beneficial in only one patient. The remaining two had to undergo amputation because of extensive tissue damage combined with femur fracture and vascular injuries.

A major risk factor for limb loss is the development of compartment syndrome. Compartment syndrome has itself been linked to delay in restoration of blood flow; presence of associated venous injuries and lower extremity fractures. Early fasciotomy is warranted if there is any question of its occurrence.[14] However, Magee et al. argued that if early intervention is possible, fasciotomy is hardly necessary, especially in lower extremity vascular trauma.[15]

Venous repair remains one of the most controversial subjects related to the management of combined arterial and venous injuries.[11] It has several potential benefits, including improved patency of associated arterial repairs because preserved venous patency maintains normal vascular bed resistance, thus optimizing blood flow and reducing stagnation; and reduced incidence of chronic venous insufficiency and associated postphlebitic syndrome.[2] Experimental work in both dogs and baboons also supports venous repair.[16] Those studies show diminished flow rates in the femoral arterial system in the early postoperative period after

ligation of the deep femoral venous system. Thus patency after venous reconstruction should increase arterial patency rates.[17] It is suggested that ligation of the femoral vein in association with a femoral artery injury requiring an interposition graft for reconstruction is a highly significant risk factor for lower extremity amputation.[17] Therefore, whenever possible, venous repair should be attempted but in a number of patients this is technically impossible owing to extensive disruption of the vein. Venous ligation becomes inevitable under these circumstances and the use of fasciotomy, elevation of the limb and compressing stockings leads to results similar to those seen with venous reconstruction.[6,18]

It is postulated that after venous ligation, severe functional outcomes such as chronic venous insufficiency and detrimental effects on arterial repair are the result of not diagnosing early deep venous thrombosis. Therefore, anticoagulant treatment (Low molecular weight heparins, oral coumadin) and compression stockings were suggested in patients requiring venous ligation.[18] Also, in addition to its beneficial anticoagulant properties, heparin has an antiinflammatory effect such as cell adhesion molecule inhibition that also may be protective against the ischemia-reperfusion injury in these patients.[19]

It is reported that primary venous repair, including lateral venorrhaphy, end-to-end anastomosis, and limited vein patching have an acceptable early patency rate of nearly 80%. Complex venous repairs have an early patency rate of nearly 40%.[20] Therefore, simple venous repair should be preferred instead of interposition graft. If primary venous repair proves impossible, ligation should be performed instead of graft interposition. But, in the presence of obviously high venous pressure after restoration of arterial flow, venous continuity has been suggested by use of a vein graft.[11] Whenever venous reconstruction required an interposition graft, saphenous vein harvested from the contralateral lower extremity was our first choice if the vein was available and the diameter was sufficient, similar to arterial reconstruction. However, in our two patients, PTFE graft was compulsorily used as there was too great a discrepancy between the diameter of femoral vein and the diameter of the saphenous vein.

CONCLUSION

In patients presenting with vascular injury, the time of preoperative evaluation should be as short as possible to prevent irreversible ischemic changes. Therefore a detailed physical examination of the lower extremity vascular injuries may prevent time-consuming imaging modalities in most cases.

Ligation of the femoral artery leads to an amputation rate of approximately 50%.[21] Also, venous repair was recommended to avoid amputation risk.[17] Therefore, both the femoral artery and vein injuries should be repaired to avoid exsanguinations and amputation. It was felt that transient graft patency permitted venous and lymphatic collateralization, thereby preserving limb outflow.[22] So, we have encouraged performing complex venous repair using saphenous vein or PTFE graft, despite a high incidence of graft thrombosis. If venous ligation becomes compulsory due to extensive disruption, adjuvant therapies and techniques should be recommended such as the use of fasciotomy, anticoagulation treatment, and elevation of the lower limb and compression stockings.

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