

Multidisciplinary Approach in “Pat Pat” Injuries: The Role of Vascular Surgeon

“Pat Pat” Yaralanmalarında Multidisipliner Yaklaşım: Damar Cerrahinin Rolü

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ABSTRACT In Turkey, farm machinery accidents are important factors for morbidity and mortality. In Western Blacksea region, a specific farming tool is used, called 'Pat Pat'. In our clinic, we operated two patients with multiple lower extremity injuries occurred due to Pat Pat machines. First case had a right Gustilo-Anderson type IIIC open tibial fracture, anterior tibial artery disruption, and a left massive soft tissue defect with popliteal nerve and artery disruption as determined by digital subtraction angiography. The second case had a right Gustilo-Anderson type IV open proximal tibial fracture, distal femoral fracture, and popliteal artery disruption. All injuries of popliteal arteries and veins repaired with saphenous vein interposition. On follow up, we observed that the saphenous vein grafts were thrombosed. We suppose that vascular injuries occurred in those cases due to both penetrating and blunt mechanisms. Repeated thrombectomy was performed, and the patency of the grafts were achieved. Heparin infusion (1000U/hour) was administered in first post-operative 24 hours, and the patient was followed up every hour to keep activated clotting time ≥ 200 sec. Consequently, saphenous veins of both cases were protected from thrombosis. In conclusion, combination of penetrating and blunt trauma causing fractures and vascular injury to lower extremities can be managed with coordination of orthopedic, vascular and plastic surgeons. Prompt diagnosis, early intervention, heparin infusion in first 24 hours and continuing with low-molecular-weight heparin results in successful management with palpable distal pulses and limb salvage in those challenging injuries.

Key Words: Vascular system injuries; popliteal artery; popliteal vein

ÖZET Türkiyede tarım aletleri ile olan kazalar morbidite ve mortalite için önemli bir faktördür. Batı Karadeniz’de Pat Pat adı verilen özellikli bir tarım aleti kullanılmaktadır. Kliniklerimizde Pat Pat makineleri kaynaklı multipl alt ekstremitte yaralanması olan iki olgu opere ettik. Birinci olguda sağ Gustilo-Anderson tip III C açık tibial fraktür, anterior tibial arterde parçalı kopma mevcuttu; ek olarak hastada solda geniş doku defekti, popliteal sinir defekti ve dijital substruktion anjiyografi ile tespit edilen popliteal arter defekti mevcuttu. İkinci olguda ise Gustilo-Anderson tip IV açık proksimal tibia fraktürü, distal femur fraktürü ve popliteal arterde parçalı kopma mevcuttu. Tüm popliteal arter ve ven yaralanmaları safen ven interpozisyonu ile tamir edildi. Kontrol muayenelerinde safen ven greftlerin tromboze olduğunu gözlemledik. Bu iki olguda vasküler yaralanmaların hem penetre edici hem de ezici mekanizmaların her ikisi ile de meydana geldiğini düşündük. Tekrarlayan trombektomiler ile greft açıklığı sağlandı. Postoperatif ilk 24 saatte hastaya heparin infüzyonu başlandı (1000U/saat) ve aktive pıhtılaşma zamanı ≥ 200 saniye olacak şekilde takip yapıldı. Sonuçta, her iki olguda da safen ven trombozundan korunulmuş oldu. Sonuç olarak, penetre edici ve ezici travmaya neden olan kırıklar ve beraberinde alt ekstremitte vasküler yaralanmaları ortopedi, vasküler cerrahi ve plastik cerrahi koordinasyonunda yönetilebilir. Hızlı tanı, erken müdahale, ilk 24 saatte heparin infüzyonu ve devam eden düşük molekül ağırlıklı heparin tedavisi, böylesi zorlu yaralanmalarda palpe edilebilir distal nabızlar ve ekstremitte kurtarılması ile sonuçlanabilir.

Anahtar Kelimeler: Vasküler sistem yaralanmaları; popliteal arter; popliteal ven

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Farm machinery accidents are an important factor for morbidity and mortality in Turkey.¹ 'Pat Pat' is one of the specific farming tool used commonly frequently in hazelnut production in Wwestern Bblack sea regionarea. It is mostly similar to terrain vehicles, and acts as a small-scale tractor. Moreover, it has added bycontains the various multifunctional various tools. That means manyA number of organs including vessels, bones, muscles and nerves may be affected in the accidents occurring withof this machine.² Of one them are is vascular injury that only endangers extremities or may be fatal especially particularly when a rotating blade attachment is used. We Hherein, we discussed about such a multi-trauma patients with multiplmultiple organ injuries.

CASE REPORT

CASE 1

A 60-year-old man was applied to the emergency department after a motor vehicle accident, occurred with a vehicle called 'Pat-Pat'. He had a

right Gustilo-Anderson type IIIC open tibial fracture, anterior tibial artery disruption, and also he had a left massive soft tissue defect with including popliteal nerve and artery disruption, as determined by with Ddigital subtraction angiography (DSA) (Figures 1, 2). The arterial injury of 1 Left popliteal artery and right anterior tibial artery injuries were repaired with saphaneous vein interposition, using by excision of contra lateral saphaneous veins. Then, left tibial nerve repair, open reduction and internal fixation of right lateral malleolus of tibia and debridement were performed by the orthopedist and neurosurgeon. In control examination On control examination after two hours from operationlater, we observed that the saphenous vein grafts have been thrombosed. Repeat thrombectomy was performed, and the patency of the grafts were achieved; 2 U of erythrocyte suspension and 1 U of fresh frozen plasma were replaced intraoperatively, and the patient was taken to cardiovascular surgery intensive care unit. During postoperative follow up, four-compartment fasciotomy was performed liberally to prevent compartment syndrome below the open

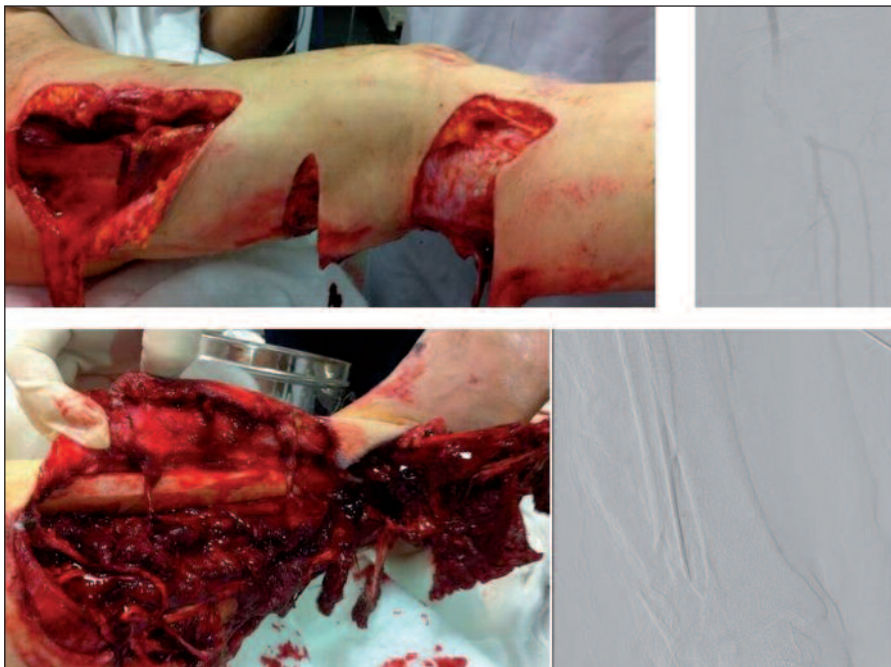


FIGURE 1: Upper left: Preoperative photograph of left lower extremity of our first case in emergency department; Upper right.: Preoperative angiography showed popliteal artery injury of left lower extremity; Lower left: Preoperative photograph of right lower extremity of the same patient; Lower right: Anterior tibial artery injury and the fractures of right tibia and fibula are seen in the preoperative angiography of right lower extremity.



FIGURE 2: Preoperative photograph and X-ray of our second case: Left popliteal artery and vein injuries together with the bone fractures, and near-subtotal amputation are seen.

left knee through both medial and lateral longitudinal incisions. Heparin infusion (1000U/hour) was administered, and the patient was followed by hourly measurements of activated clotting time (ACT) hourly measurements. The patient had minimal bleeding, in the style of leakage from the bandage, however heparin infusion was continued, and ACT was followed kept over 200 seconds. Two units of 2 U erythrocyte suspension were replaced on the first postoperative day postoperatively, and subcutaneous low-molecular-weight heparin (LMWH) (called enoxsaxaparine), 1000 IU/10 kg twice daily was replaced given instead of heparin after the first 24 hours. Distal pulses were palpable in both Bilateral lower extremities distal pulses were palpable on the postoperative examinations examination. and Then, the patient was transferred to plastic surgery and orthopedics servicesclinics. The soft-tissue defect was reconstructed with free vascularized soft -tissue flap transfer by plastic surgerysurgeons.

CASE 2

A 29-year-old man was applied to the emergency department after a motor vehicle accident, occurred with a vehicle called 'Pat-Pat'. He had a right Gustilo–Anderson type IV open proximal tibial fracture, distal femoral fracture, and popliteal artery disruption. DSA could not be performed because of due to the hemodynamic instability of the patient. The injury of popliteal artery and vein injuries were repaired with saphenous vein inter-

position (Figure 3). Then, external fixation and debridement were performed by the orthopedist (Figure 3). In On the control examination after two hours after from surgerythe operation, we observed that the saphenous vein grafts were thrombosed. Repeat thrombectomy was performed, and the patency was achieved. Four-compartment open fasciotomy through both medial and lateral longitudinal incisions were performed liberally intraoperatively because of pending compartment syndrome. 4 U erythrocyte suspension and 1 U fresh frozen plasma were replaced given intraoperatively, and heparin infusion (1000 U/hour) was administered, and the patient was followed up every hour forly ACT. He was followed up similar to our first patient postoperatively, and only 1 U eritrocyteerythrocyte suspension replacement was made at on the first day. After the first 24 hours, subcutanoussubcutaneous LMWH (enoksaparine enoxaparin 1000 IU/10 kg, 2X1) was started, and the it was seen that bilateral lower extremity distal pulses were assessed palpable in the postoperative course. The patient subsequently have been developed a massive soft -tissue defect in his lower leg. The soft -tissue defect was reconstructed with free vascularized soft -tissue transfer by plastic surgery- surgeons.

DISCUSSION

In Turkey, farm machinery accidents are an important factors for morbidity and mortality.¹ Similarly, in a study that was made by Gerberich et al.

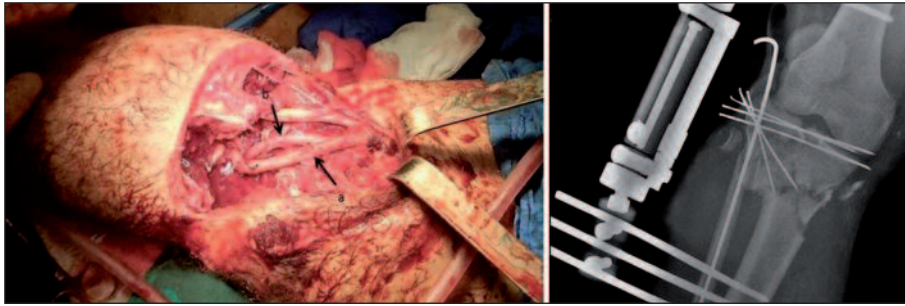


FIGURE 3: Perioperative vascular repair with saphenous vein interposition, and postoperative X-ray of our second case.

it has been showedn that from among all injuries that occurred due to agricultural instruments, 19.8% with were caused by the large-scale farming tools, 8.9% with the tractors, and 9.4% with the farm equipment that can could be used with hand and are smalsmaller thanl from tractors, and the rest of the injuries are were the combined injuries.³ In Wwestern Bblacksea region, thea farm tool called Pat Pat is used for transportation and agriculture on mountainous areas that is are not suitable for agricultural vehicles such as tractors. In a study that was made by Sami et al. reported thatThe Pat Pat- related injuries are were more common in the second and fourth decades of life, and can could have serious consequences such as similar to the other agricultural tool-rs related injuries.² In the same study, at the top of these injuries there areit was reported that the most frequent injuries were head, neck and spine injuries in 53.3% of the patients, followed by thoracic trauma in of head, neck and spine injuries and following 42.9%, of thoracic traumas and upper extremity traumas in 42.9% upper extremity traumas of the patients..

50 Fifty percent of % of the all arterial injuries are seen onat the extremities.⁴ Among them, the upper extremity arterial injuries are more frequently, but lower extremity arterial injuries are more serious injuries, and generally occur due to trauma. Traumatic These injuries that occurred as a result of trauma, causes limb loss and even death.⁴ Both of our patients cases cameadmitted with lower extremity arteriovenous injuries, close near to the knee.

The patients that are evaluated in the emergency department with open fractures, vascular injury and massive soft tissue defects in lower extremity are important because of the decision of amputation or limb salvage. In the treatment of a severely damaged limb, amputation is decidedsion is rather than the an attempt of salvage. In 1969, Gustilo designated complicated fractures as types I, II, and III.⁵ Also bBased on the grade of the injury and the order of poor prognosis, in 1984, Gustilo et al. subdivided type III injuries into three subgroups as III-A, IIIB, and III-C, in 1984. The severity of a type III-C fracture alone is reflected by amputation rates that range from 42% to 78%.⁶ Furthermore, Russell et al. developed a limb injury index, which was based on skin (0 to 1 points), muscle (0 to 2 points), bone (0 to 2 points), nerve (0 to 2 points), vein (0 to 1 points) and arterial injuries (0 to 2 points), and also length of warm ischemia time (0 to 4 points).⁷

In this study, Russell identified the score of the patients who were given amputation decision, as 6 and over. These indexes are able to support the decision of the surgeon by asistingassisting for the assessment assessing of the viability of the injured limb, and the possibilitypossibility of success in salvaging the limb. Several principles were arised reported to guide the surgeons for decision of amputation decision.

First, amputation is a collective decision in which the vascular injury may be the least important component. The destiny of the damaged limb is often decided with the degree of the nerve, bone,

and soft-issue damages, but for the reconstruction these elements are less amenable than the artery. Secondly, except for open subtotal amputations, the decision of amputation is always given intraoperatively. The damaged limb should be examined carefully under the optimally controlled conditions of the operating room. This is the only reliable way to assess the full extent of the damage, and especially the nerve continuity is a particularly critical factor in the decision.

In a study that was made by Franz et al., arterial injuries were categorized into penetrating mechanisms (56%) and blunt mechanisms (44%).⁴ Probably vascular injuries occurred in these cases probably occurred due to the both types of mechanisms, because of the rotating blade apparatus of the Pat Pat machine.

Early diagnosis is the most important part of the factor in vascular injuries. In the diagnosis of the vascular injury, there are hard and soft signs that helps in the clinic. Clinical evaluation of a vascular injury includes examination of distal pulses, colour and temperature of the extremity. Hard signs are active hemorrhage, absent pulses, large expanding hematoma, distal ischemia and bruit or thrill. The soft signs are small hematoma, nerve deficit, decreased diminished distal pulses, and history of arterial bleeding. In one of our two patients, there was a subtotal amputation, and or both patients had no pulse with loss of temperature in both. Although physical examination is the determining factor in the injury, doppler ultrasonography, computed tomography with contrast angiography (CT-A), multi-detector computerized tomography with contrast angiography (MDCT-A), MR and magnetic resonance angiography are used in the diagnosis. DSA is still the gold standard for diagnosing arterial lesions in patients with traumatic extremity injuries.⁸ If the traumatic patient has active bleeding, immediate surgical intervention can be done without imaging.⁹ In our first case, after initial assessment we used arteriography after initial assessment to establish the exact level of arterial injury. but However in the our second case, he was instable, and had a subtotal amputation; therefore that's why he was under

urgent surgery al operation without imaging. Concomitant venous and arterial injuries take place occur mostly in the superficial femoral and popliteal vessels.¹⁰ Similarly, there was also accompanying popliteal vein injury in the our second case, and the diagnosis was done intraoperatively.

The patients that have combination of orthopedic and vascular injuries, need underwent the surgery in coordination for of various departments in surgery to providing the circulation and stabilization of the extremity. If there is a extremity is viable in presence of a extremity fracture, the perfusion can may be assessed after reduction, because reduction can may basically restore perfusion. , but if there is malperfusion, restoration of perfusion is a priority in case of malperfusion.¹⁰ Barros suggested that the fractures may be reduced and stabilized either by internal or external fixation before repairings of artery and vein.¹¹ And Barros was also recommended bridging shunts that were bridged between the ends of injured vessels for to avoiding ischemia and its pathophysiological sequelae.¹¹ Popliteal vein and accompanying popliteal artery injuries may be repaired with end- to- end anastomoses, saphenous vein interposition grafts obtained from the contralateral lower extremity, primary repairs such as lateral repair and patching, or ringed polytetrafluoroethylene (PTFE) interposition grafts when indicated.⁹ Ekim et al. have used saphenous vein interposition or PTFE grafts in the treatment, but they performed bone stabilization after vascular surgery.⁹ If it is possible, endovascular techniques can also be administered after imaging. Among the endovascular techniques Balloon occlusion and percutaneous transcatheter embolization are available endovascular techniques. And also In addition, the placement of endovascular stents and stent grafts can be alternative to open surgery. We performed saphenous vein interposition in the surgical treatment of the our two cases.

Compartment syndrome developed in two both of our patients. Compartment syndrome is an emergency situation that which is observed as a complication of diverse conditions, and treated by vascular surgeons. The diagnosis of acute compart-

ment syndrome begins with a high index of suspicion. Symptoms of the compartment syndrome include pain that is disproportionate to the magnitude of injury and paresthesias in distal extremity. Intracompartmental pressure (ICP) measurement should be recorded regularly, especially particularly in case of unclear suspicion cases, loss of senseless patients, and pediatric patients with suspected compartment syndrome. The most commonly used ICP measuring systems are the arterial line manometer, handheld Stryker system, and White side manometer. It has been recommended that near-infrared spectroscopy and laser Doppler flowmetry are able to be used as noninvasive techniques to aid for identification of an evolving compartment syndrome. We are using an arterial line manometer. Clinical criteria for a fasciotomy include a swollen and tense compartment, pain with passive motion of muscle groups which are traversing that compartment, and neurologic findings referable to the compartment. Indications for fasciotomy are summarized in Table 1, as absolute and potential indications.¹²

We are also performed vascular surgery first at the beginning of surgery, before the bone stabilization. In our both cases, early thrombosis occurred in the repaired vascular structures that we repaired. Patency was achieved with repeat thrombectomy operation surgeries in both of our patients. It was thought we supposed that the arterial injury that depends on occurred due to Pat Pat machine occurred due to included both of the two mechanisms (penetrating and blunt mechanisms). We thought supposed that twenty four 24-hour hours heparin

infusion provided aning ACT value overlonger than 200 sec. And then continuing with LMWH may be helpful to prevent thrombosis of grafts, despite bleeding risk of in a large tissue injury. In our experience, there was oozing bleeding from the lesions were oozy type, and 2 U of erythrocyte suspension replacement was needed for our first patient and while the only 1 U of erythrocyte suspension replacement was required for our second one were needed patient.

Combination of penetrating and blunt traumas generating fractures and vascular injury to lower extremities can be managed in coordination of orthopedics, vascular and plastic surgeons. Prompt diagnosis, early intervention, liberal use of fasciotomy and 24- hour heparin infusion with continuing LMWH resulted in successful management of those difficult injuries with palpable distal pulses, and salvage of the limb salvage.

TABLE 1: Indications for fasciotomy.

Absolute Indications	Potential Indications
Tense compartment plus either Pain with passive motion of muscles traversing the same compartment or Paresis paresthesias referable to the same compartment	Acute ischemia > 6 h with few collaterals
Tense compartment in a patient who cannot be examined serially due to obtundation or need for other operations	Combined arterial and venous traumatic injuries
ICP minus mean blood pressure <40 mmHg	Plegmasia serula dolans
ICP minus diastolic blood pressure <10 mmHg	Tense compartment after crush injury or fracture

ICP: Intracompartmental pressure.

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