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Treatment of Open Tibial Shaft Fracture with Soft Tissue and Bone Defect Caused by Aircraft Bomb – Case Report

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SUMMARY

Introduction Aircraft bombs can cause severe orthopaedic injuries. Tibia shaft fractures caused by aircraft bombs are mostly comminuted and followed by bone defects, which makes the healing process extremely difficult and prone to numerous complications. The goal of this paper is to present the method of treatment and the end results of treatment of a serious open tibial fracture with soft and bone tissue defects resulting from aircraft bomb shrapnel wounds.

Case Outline A 26-year-old patient presented with a tibial fracture as the result of a cluster bomb shrapnel wound. He was treated applying the method of external bone fixation done two days after wounding, as well as of early coverage of the lower leg soft tissue defects done on the tenth day after the external fixation of the fracture. The external fixator was removed after five months, whereas the treatment was continued by means of functional plaster cast for another two months. The final functional result was good.

Conclusion Radical wound debridement, external bone fixation of the fracture, and early reconstruction of any soft tissue and bone defects are the main elements of the treatment of serious fractures.

Keywords: aircraft bomb; open tibial fracture; bone defect; external fixation

INTRODUCTION

In war conflicts, orthopaedic trauma is the most frequent type of wounds (71%) [1]. According to Johnson et al, during the Iraq war, among 1,236 wounded people, 39.5% had limb injuries and 25.8% had lower extremity injuries [2].

Aircraft bombs can cause severe orthopaedic injuries [3]. When an aircraft bomb explodes, the resultant projectiles gain high acceleration. In the immediate vicinity of the explosion, aircraft bomb shrapnels have the initial velocity of up to 3,000 m/s [4].

Aircraft bomb shrapnels are irregular in shape and cause extensive injuries to tissues they hit. At the moment of passage through the tissues, shrapnel discharges a part of its kinetic energy onto the surrounding tissues. The shock wave that develops knocks the tissues forward, laterally and backwards. A cavity is produced that, in the case of high-velocity shrapnels, is some 30-40 times larger in size than the shrapnel itself. Within this cavity, pressure of up to 100 atm is produced. This temporary cavity lasts several milliseconds; its pulses gradually stop, leaving behind the residual sagittal channel. During the cavity pulsation, there is an alternation between positive and negative pressures, which leads to the air and external materials being sucked up into the wound, which in turn explains primary tissue contamination [5].

The resistance of the tissue to the shrapnel impact depends on the quantity of tissue fluids, that is, their specific weight. Tissues with higher specific weight are more susceptible to destruction. The worst injuries are suffered by bone and muscle tissues and parenchymatous organs [6].

Tibia fractures caused by high velocity missiles are mostly comminuted and followed by bone defects, which makes their healing process extremely difficult and prone to numerous complications [7, 8].

The goal of this paper is to present the method of treatment and the end results of treatment of a severe open tibial fracture with soft and bone tissue defects resulting from aircraft bomb shrapnel wounds.

CASE REPORT

A 26-year-old soldier was admitted at the Orthopaedic Clinic of Niš on April 4th, 1999, because of explosive wound of the lower leg caused by an aircraft bomb in the course of war actions in Kosovo.

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He was injured by aircraft bomb shrapnel on April 2nd, 1999. The wound was first surgically treated in the Peć hospital, after which plaster immobilization was applied.

Upon admission, a 5×3 cm wound was registered on the anterolateral side in the medial third of the right lower leg, with muscle tissue damage extending all the way to the bone, the fragments of which were protruding through the wound. The neurocirculatory finding in the lower leg was normal. The x-rays of the right knee and lower leg registered a comminute fracture in the proximal third of the right tibia, with a bone mass defect (Figure 1).

Immediately after admission, antibiotic therapy was also started (500 mg Amikacin ampoule every twelve hours, 2,400,000 IU Jugocillin ampoule every 24 hours, and 4,000,000 IU benzylpenicillin ampoule every four hours), and anti-tetanus immunization was also administered.

After a short pre-operative preparation, a comprehensive debridement of the explosion wound was done in general anaesthesia on the same day, whereas the fracture was stabilized with Mitković-type external fixator after adequate reposition (Figure 2).

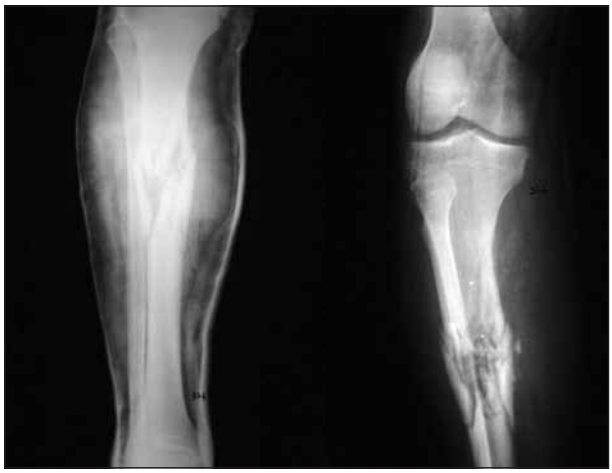

Figure 1. Comminuted fracture of the right tibia with massive bone mass loss

Early postoperative course was normal. On the fourth post-operative day, third-generation cyclosporine was introduced in the therapy instead of penicillin, which was administered in combination with aminoglycoside (2 g/24 h Longacef ampoules and 500 mg/12 h amikacin ampoules).

The existing cutaneous and muscular tissue defects were regularly dressed and prepared for muscle flap coverage. Several wound cultures were taken for biograms and antibiograms. The administered antibiotic therapy and regular dressing change resulted in the elimination of infection (1 g Tolicar and 500 mg amikacin every 12 hours).

After a complete pre-operative preparation, surgical procedure was done on April 14, 1999. An extensive wound necrectomy was done, followed by the advancement of the medial head of m.gastrocnemius into the cavity. Over the muscle, a skin flap auto-transplant taken from the right upper leg was placed, as advised by Thirsch. The secondary defect was directly sutured layer by layer. In the postoperative course, the patient developed infection of the flap. Through regular change of dressing and antibiotic therapy, the flap infection was eliminated (Figure 3).

The patient was stimulated to walk using crutches, but without weight-bearing on his right leg. Early physical therapy was initiated at the Clinic for Orthopaedic Surgery and Traumatology of the Clinical Centre Niš. The local wound site was normal. There were no signs of inflammation around the external fixator pins or at the flap site. On May 5, 1999, the patient was transferred to the Niš Military Hospital for further treatment.

In July 1999, the patient started his further treatment at the Belgrade Military Medical Academy. Five months after injury and fracture stabilization with the external fixator, the

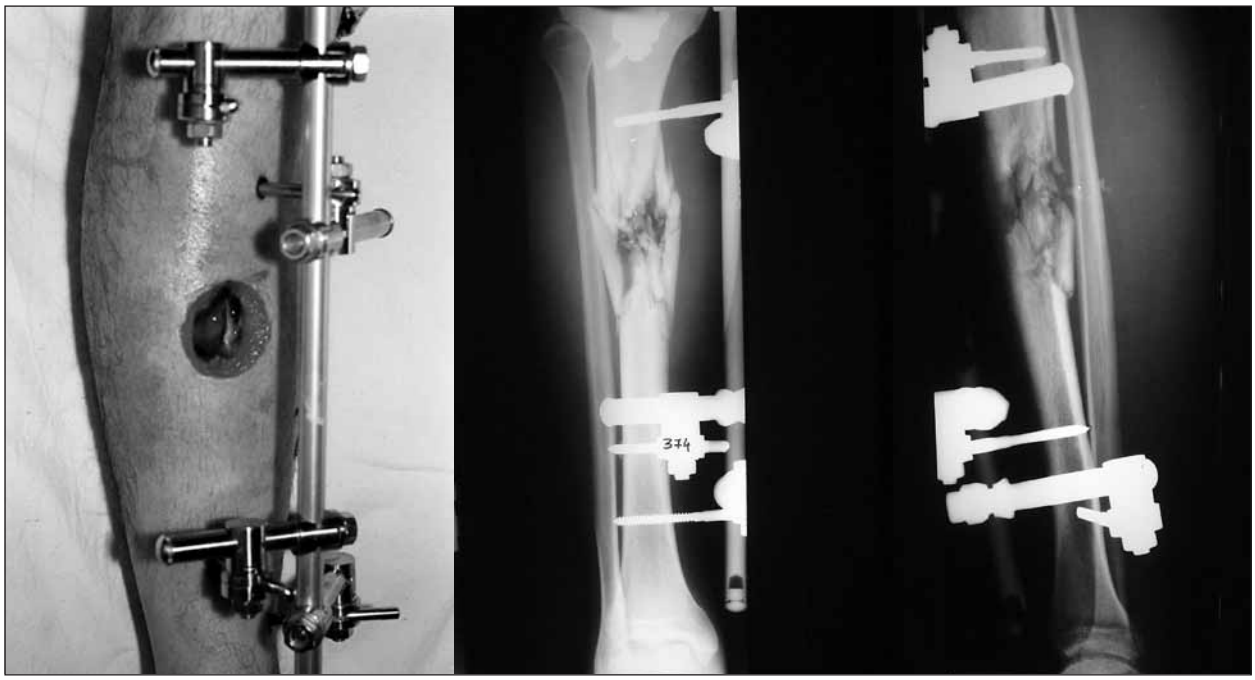

Figure 2. Right lower leg and X-ray after surgical debridement and fracture stabilization using external fixator

Figure 3. Soft tissue defect resultant from cluster bomb shrapnel wound covered with the medial head of the m. gastrocnemius inserted into the cavity. A free skin flap according to Thirsch taken from the right upper leg placed over the muscle. The secondary defect directly sutured layer by layer.

external fixator was removed and a plaster cast was placed above the patient's knee (Figure 4). After the external fixator pin wounds healed, the plaster cast was removed and a functional brace was placed according to Sarmiento. The patient started walking and was allowed to full weight-beraing on the injured leg with the functional brace. The functional cast immobilization according to Sarmiento was kept in place for seven months. After the removal of the functional cast, the patient started with rehabilitation.

At the time of control examination four years after his wounding, in June 2003, the patient complained of pain of the right ankle during prolonged standing or walking. The x-rays of the right lower leg showed a large oval-shaped bony tissue defect in the middle of the tibial shaft, resulting from the aircraft bomb shrapnel wound. Around the defect there was hypertrophy and sclerosis of the surrounding bony tissue (Figure 5).

Clinical examination revealed a milder ankle contracture. The patient could walk without support. After completing his treatment, the patient continued his life and work activities as before wounding. The final functional result of the treatment was good (Figure 6).

DISCUSSION

The goal of the modern treatment of sagittal fracture is not only to avoid infection and to achieve fracture union, but to return the full functionality of the injured limb as well [9].

In our patient, the protocol by the Geneva International Committee of the Red Cross was applied in the management of sagittal fractures caused by aircraft bomb shrapnels. The protocol includes arteriography to determine arterial damage, clinical examination to determine the damage of the poste-

Figure 4. Five months after injury the external fixator is removed and an above knee plaster cast was placed

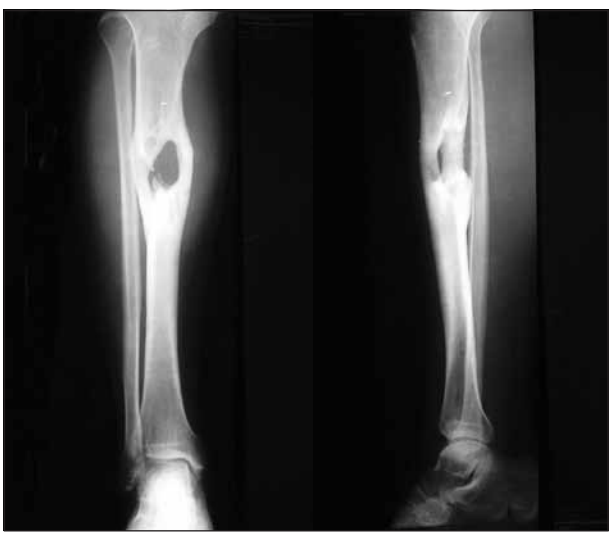

Figure 5. X-ray of the right lower leg four years after wounding by aircraft bomb

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Figure 6. Condition of the right lower leg four years after wounding

rior tibial nerve, and consideration of the justification for primary lower-leg amputation in the event that such lesions cannot be managed. To prevent infection, it is necessary to perform primary surgery, which includes a radical wound debridement, to rinse the wound rigorously, to apply external fracture fixation, to leave the wound open, to administer antibiotics and to carry out anti-tetanus immunization [10].

The main objectives of primary surgical procedure are to remove the devitalized tissue that could serve as the bacterial culture basis. For better detection of the boundary between the vital and devitalized tissue, the existing wound may be enlarged according to the classical approach. The devitalized skin is to excised until bleeding occurs, and the damaged subcutaneous fat tissue is to be excised extensively. To evaluate muscle vitality (colour, bleeding, contractility, and consistency) some rules ought to be applied. All free bone fragments in the sagittal fracture zone ought to be removed, even if large in size, because they are dead and are the chief cause of infection. The periosteum ought to be saved if possible, since it is the source of callus formation. Each fragment that is firmly attached to the periosteum ought to be retained [11].

External fixation is the modern method of stabilization of bone fragments occurring in sagittal fractures. It provides good stability of the fracture and enables unhindered access to the fracture and to the wound for the purpose of dressing change and reconstructive surgery of soft and bony tissues. Application of internal fixation is not allowed except for Kürschner pins when absolutely necessary [12].

In sagittal wounds with bone fractures, antibiotics play a very significant role in the prevention of infection. Immediately on admission or during the primary surgical management of sagittal wounds, intravenous administration of benzyl penicillin ought to be initiated in the dosage of 10 million IU every six hours together with aminoglycoside. Depending on the fracture type, antibiotics dosage could be smaller. Penicillin therapy is applied for three days. Then, a third-generation cephalosporin antibiotic is introduced for four days. Concomitantly with the third-generation cephalosporin, either 500 mg amikacin or 120 mg gentamicin is administered every 12 hours. The total duration of therapy is seven days. The therapy should be continued only if infection signs persist, whereas antibiotics are chosen based on antibiogram. Anti-tetanus immunization is to be done according to the classical protocol [13].

Primary suture of a sagittal wound of extremities is not permitted. It is to be done only in cases of sagittal injuries of the joints, when the synovial membrane is sutured. After primary surgical management, the sagittal fracture wound is to be left open to be later closed by means of delayed primary or secondary sutures, with free, local or distant skin flaps [4]. Nowadays, it is considered that all reconstructive operations of soft tissue should be done within seven days, and the operation of the bones within 21 days. If the wound does not show signs of infection it may be closed with direct suture, Tirsch transplant or flap depending on the size of the wound. Muscle flaps or musculocutaneous flaps are most commonly used in the reconstruction of the tibial soft tissue defect (latissimus free flap) [14].

Bone tissue defect caused by sagittal wounds may be resolved by means of autospongioplasty or bone transport. Nowadays, beside osteoplasty, we also use the method of bone transport (distraction osteogenesis) which implies cutting of the tibia diaphysis in metaphyseal area and lowering of the bone in the zone of defect. For this technique, the most commonly used is the device advocated by Ilizarov or the combination of intramedular nail and a skeletal fixator [15, 16].

Radical wound debridement, abundant rinsing, leaving the wound open, administration of antibiotics and anti-tetanus immunization, external skeletal fixation of the fracture, and early reconstruction of soft-tissue and bony defects are the principal elements of treatment of severe fractures.

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Лечење отвореног прелома потколенице с мекоткивним и оштећењем кости изазваним гелерима авионске бомбе – приказ болесника

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КРАТАК САДРЖАЈ

Увод Пројектили авионске бомбе изазивају тешке ортопедске повреде. Преломи потколенице изазвани шрапнелима авионске бомбе су често праћени великом коминуцијом и оштећењима кости, што њихово лечење чини изузетно тешким. У раду је приказан резултат лечења овог тешког прелома потколеног сегмента спољном скелетном фиксацијом.

Приказ болесника Мушкарац стар 26 година рањен је гелерима авионске бомбе, при чему је задобио отворени прелом потколенице с мекоткивним и оштећењима кости. Примарно је збринут у локалној болници тоалетом рана и гипсаном имобилизацијом. По пријему на Ортопедско-трауматолошку клинику у Нишу урађена је примарна обрада рана, а прелом потколенице стабилизован је спољним скелетним фиксатором другог дана од повреде. Одмах је започета и терапија антибиотицима. Десетог дана је урађено покривање мекоткивног оштећења на потколеници. Болесник је спољни фиксатор на потколеници носио пет месеци, а лечење је настављено функционалним гипсом за ходање још два месеца. Крајњи функционални резултат је био добар.

Закључак Радикална примарна хируршка обрада, спољна скелетна фиксација прелома, рана реконструкција меких ткива и надокнада оштећења кости, адекватна антибиотска парентерална терапија и антитетанусна заштита јесу основни елементи лечења ових тешких прелома.

Кључне речи: авионска бомба; отворени преломи потколенице; оштећење кости; спољна скелетна фиксација

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