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WAR WOUNDS CAUSED BY CLUSTER BOMBS - NATURE AND RESULTS OF TREATMENT

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Summary. *Extremities are the most often affected during the war (50-75%). War wounds are more severe and their treatment more complicated. The mistreatment of war wounds with fractures can lead to many complications where chronic osteitis is most serious and its treatment is very expensive and even uncertain. In order to prevent a wrong treatment we used one protocol, which is combination of the protocol of the International Committee of Read Cross (ICRC) and previously suggested our protocol for treatment of complicated open fractures. The series of civilian patients wounded by cluster bombs including patients wounded during the bombardment of the residential areas and Clinical Centre of Niš are shown. The nature of the wounds caused by cluster bombs is different from war wounds made by conventional arms. The main characteristic is higher percentage of amputation due to high rate of neurovascular damage. For fracture fixation Mitković external fixation system has been used routinely, primarily during the first operation. This well investigated system provides high success of fracture healing (all fractures healed) with no chronic infection. The system was used for solving of bone defect. For solving of soft tissue defects, the most often it was used rotator fasciocutan flap.*

Key words: *Cluster bombs, war wounds, fractures, external fixator*

Introduction

War wounds with fractures represent a big problem and a challenge for orthopaedic surgeons and health organisations. The aim of modern weapons is rather to inflict grave injuries on living force than to kill people. Thus hospital beds are occupied, health funds are spent and injured people become invalids with further social consequences. Today, like in the past, during the times of war the extremities are affected most frequently and represent 50-70% of all injuries to the human body. Nature of the wounds caused by cluster bombs is different in comparison to the war wounds caused by conventional arms. The mistreatment of war wounds with fractures can lead to many complications where chronic osteitis is most serious and its treatment is very expensive and even uncertain. In order to prevent a wrong treatment, the International Committee of Read Cross (ICRC) suggested a protocol for war wound treatment (Rowley 1996) and a classification of war wounds with fractures (Coupland 1990).

For organised treatment of war wounds in Yugoslavia 1999, we suggested that the ICRC protocol be modified in combination with our earlier suggestions suitable for our conditions. One of the most important points of this modified protocol is the fixation of fractured bones. During the past 16 years in Niš we have developed a very flexible external fixation system (Mitkovic 1991, 1994) which was verified during the war in Bosnia and Herzegovina as the most effective system for war fracture treatment (Grubor 1996). The aim of this study was to examine the nature of wounds caused by cluster bombs and review the results obtained by using the above mentioned protocol for their treatment.

Subject and Method

The clinical material used in this study is represented by series of civilian war victims primarily treated in the Orthopedic and Traumathology Clinic of the Clinical Centre of Niš and patients primarily treated in Kosovo and transported from the centres of this province, Priština, Djakovica, Prizren and Gnjilane, to our clinic.

During the treatment the protocol of the treatment shown on Table 1 was used.

Regarding antibiotic administration we used the scheme shown on Table 2.

Antitetanic protection is always administrated.

For fracture fixation the Mitković external fixation system produced in Ei FMD in Niš was used. It is a 3-dimensional (3D) external fixation system (Fig. 1) con-

sisting of three components: bar, carrier of the clamp and adjustable clamp. The system is a high mobile fixator allowing accurate 3D correction of dislocated fragments. Introducing new concept in external fixation construction provides high mobility: rotator and axial mobility of all three components in all of 3 dimensions (Fig. 2). This chess like versatility enables surgeons to create frames according to the situation. The pins are self-tapping and self drilling. The diameter of the pins is 6 mm.

Table 1. Protocol used for the treatment of war wound with fractures

1. Assessment of arterial damage according to arteriography and damaging of the tibial nerve (in the lower leg) according to clinical examination and consideration of primary amputation.
2. First operation has to be done as soon as possible: debridement of soft tissues and bones, vigorous wound cleaning, living it open, administrating of antibiotics and antitetanic protection.
3. External fixation
4. Second operation, 4-5 days later, repeated debridement if necessary or closing of the wound.
5. Reconstruction of soft tissue defects 7 days of injury and reconstruction of bone defect 3 weeks after injury.

Table 2. Scheme of the antibiotics administration

Type of war wound	Antibiotic administered	Duration of the treatment
Soft tissue wound only	Aminoglycoside every 12 hours (Amicacin 500mg, Gentamycin 120mg)	5-6 days
Bigger soft tissue wound	Aminoglycoside every 12 hours + 3rd generation cephalosporin	5-6 days
War wound with fracture	Crystal Penicillin 10 millions of i.u. in 500 ccm saline infusion during 2 hours. Repetition of the dose every 6 hours + Aminoglycoside every 12h	First 3 days
War wound with fractures	3rd generation of Cephalosporins + Aminoglycoside every 12 h	From 4th to 7th day after fracture
If infection is evident	Antibiotic according to antibiogram	Dependant from infection
If there is severe damage to the muscles and anaerobe infection is possible	Metronidazole amp 500 mg every 12 hours (+ Aminoglycoside and Cephalosporin)	One week

This external fixation system has been investigated biomechanicaly in AO institute in Davos (Switzerland) comparing two frames: with parallel and frame with convergent orientation of the pins. The results of biomechanical investigations showed that the external fixator with parallel pins has non-balanced AP:LL stability where AP stability is very low and LL stability is very high. The ratio was AP:LL=1:12. At the same frame with 90^0 convergent orientation of the pins (Mitković concept) shows nearly equal stability in AP, LL and axial direction. Ratio was AP:LL=1.2:1, which is very near to the natural stability of long bones.

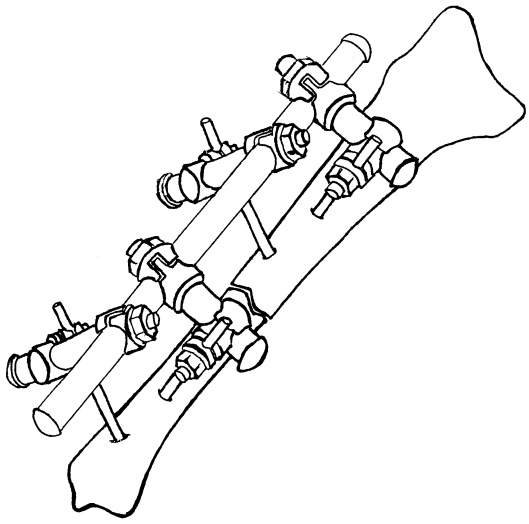

Fig. 1 Mitkovic's external fixator on tibia

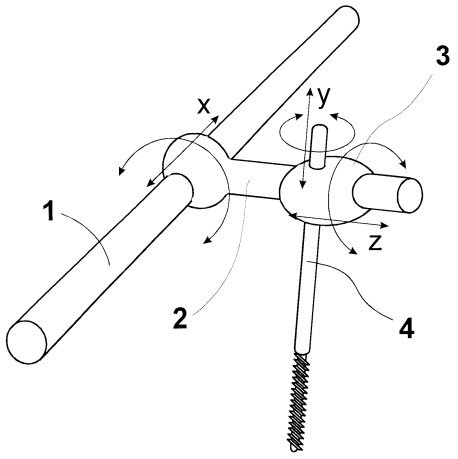

Fig. 2 Mitković's concept of high mobile external fixator: rotator and axial mobility in all three dimensions

Method of application

Each pin is inserted independently, without using any guidance. Distances and angles between pins are not limited and can be chosen according to the actual situation of the bone fragments and soft tissues. It is desirable, because of the biomechanical advantages for fracture healing, convergent orientation of the pins (60^0-90^0). After skin incisions and pin insertion, the frame is attached onto the pins during a few minutes.

Results

Distribution of the fractures according to the localisation is shown on Table 3.

Most of the victims were injured by cluster bombs. Only 18 patients sustained open fractures caused by sniper or automatic arm fire.

Distribution of the patients according to age is shown on Table 4.

Table 3. Distribution of the war wounds with fractures, treated in the Orthopaedic and traumathology clinic in Niš according to affected area

Segment	Number of injuries
Shoulder	3
Humerus	6
Elbow	4
Forearm	4
Wrist	2
Hand	7
Hip	7
Femur	30
Knee	7
Lower leg	32
Ankle	2
Foot	22

Table 4. Distribution of the injured patients according to the age

Age	Number of patients
20-29	28
30-39	29
40-49	12
50-59	16
60-69	8
70-79	6

Average age of the patients was 37.8. The youngest patient was 20 and the oldest 77.

Distribution according to the grade of the injury according to ICRC classification is shown on Table 5.

Table. 5 Distribution according to the grade of the injury according to ICRC classification

Grade	Number of injuries
I st grade	16
II nd grade	52
III rd grade	31

The nature of the war wounds and war fractures caused by cluster bombs

A cluster bomb consists of several hundreds of smaller bombes, 1-3 kg each, dropped from the air and expulsed from a container at a desirable altitude. Each bomb has a small parachute in order to provide the bombs to cover a desirable ground surface. During the simultaneous explosions of many cluster bombs, many of the schrapnels, with a very high initial speed, from all sides attack the human body. Most frequently the lower extremities are injured, especially the foot and the lower leg. Such wounds have specific characteristics. The size of the wounds is from a few millimetres to 40 centimetres (Fig. 3) where the entry wound is much smaller than the exit wound. The borders of the wounds are irregular, with several mm to several cm wide necrotic wedges and with hemathomas. The sides of wound are represented by conquasated soft tissues (fat, muscles) with big thickness of dead tissues, ordinary 1-5 cm. The big schrapnel is on the bottom of the wound, if there is no exit wound. The space of the wound in this case is much bigger than the entry wound so, for wound cavity assessment and treatment, it is routinely necessary to make additional skin incision. If there is a fracture, it is represented by the high comminution. Many of the bone fragments are deperiostated as new independent shrapnels in surrounding soft tissues cause additional damaging. On X-rays one to several schrapnels per wound can be seen and in all body many schrapnels are present. One of the killed civilians has been wounded with more than 100 schrapnels. When the foot is wounded then nearly all small bones are fractured and dislocated even without considerable skin wounds. When such a foot is palpated there is a sensation of having a bag filled with nuts. In all wounds with fractures, especially when the knee and tibia are injured, in about 29% nerves have been injured and in about 18% main arteries have been ruptured. It was the main reason that a markedly higher percentage of injuries was indicated for amputation, in comparison to war fractures caused by gun or sniper fire.

Fig. 3 Patient PD (482/99), civilian sustained war wound with multifragmentar fracture of the tibia caused by cluster bomb on the city market area

For bone fixation it has always been used Mitkovic type external fixator (Fig. 4).

Fig. 4 Patient from fig. 3 after first operation including external fixation fixation using Mitković's fixator

For reconstruction of soft tissue defect the following was peformed: fasciocutan rotator flap (Fig. 5) and muscle flap. For reconstruction of two tibial bone defect we used a sliding tibial bone graft.

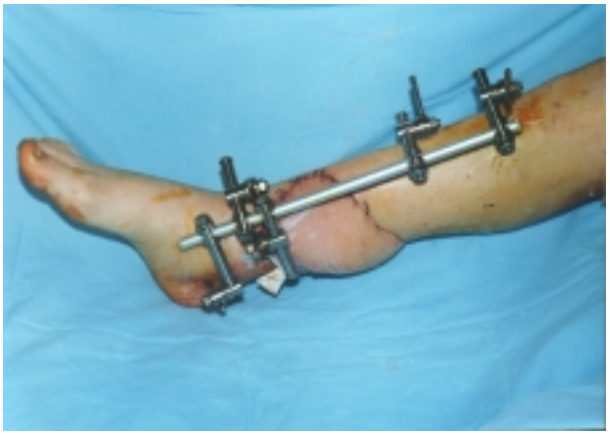

Fig. 5. Patient from fig 3 and 4 after fasciocutan rotator flap used for solving of soft tissue defect

All treated fractures healed.

We had no bone infections in the series of the patients primarily treated in our clinic. However we received two patients primarily treated in Kosovo, 8 days before they were transferred to our clinic. One of these two patients sustained traumatic amputation of one femur and grade III war fracture of another femur. Several bone debridements were performed and after 6 months wound and bone healed. The other patient was with infection on proximal tibia where the Papineau method was used and the wound healed after 6.5 months.

Discussion

Injuries in modern warfare are most frequently sustained from cluster bombs or sniper arms. These fractures are followed by massive destruction of soft tissues and bones. Neurovascular elements are very often involved in the devastation of soft tissues giving additional problems in attempting to solve the problems of the extremities. For a better evaluation of the injuries, especialy in comparison to other evaluation in other areas, we used the Classification of war wounds suggested from ICRC. This classification is suitable for use and covers all important points in war wounds. In order to improve the war wounds treatment, one protocol accepted by all the medical centres and all levels of patient treatment is recommended. We found that ICRC protocol is suitable for all conditions in war areas. However, it can not be completely the same in all wars. During the Kosovo crisis we had special circumstances. This province is a small area with several trauma centres relatively good equipped for emergency war wound treatment. Most of the patients were transferred to these centres although helicopters transported directly to our centre a numbers of civilian patients. On the other hand this province was one potentially unsafe area and patients were regularly transported to the centres out of province. Later on, after the destruction of the bridges and roads the helicopter transportation become impossible. Therefore the patients were treated inside the province for a longer time.

However, most of our patients from residential area of the City of Niš sustained injuries during the bombardment by cluster bombs.

External fixation is one of the most important stages in war fracture treatment especially when transportation is needed. In the protocol of treatment of war wounds with fractures (Rowley 1996) it is mentioned that during the first operation, the main fragment fixation should be undertaken. It is recommended in this paper that for fixation plaster cast, or external fixator (if it is available and if surgeon is familiar with its application), or skeletal traction can be used. If the plaster cast is used, it is necessary to be replaced with an external fixator during the next operation (four days later), or with skeletal traction. We accepted only the external fixator as a method of bone fixation, always applied during the first operation, because: 1. The external fixator gives the best possibilities for a successful fracture treatment, 2. The external fixator enables the transportation of the patient to be painless regardless of the type of transportation, 3. The management of the wound as second or third operation, including reconstructive operations and changing dressing is very easy, 4. We have the necessary supplies of fixators. For external fixation we always use the Mitković external fixation system, because: 1. It is the easiest for application, 2. It provides conditions for better fracture healing (3D balanced stability which is similar to natural stability), 3. Majority of the surgeons in this country are educated (via previously organised courses) to use the Mitković external fixation system.

War wounds caused by cluster bombes are extremely severe. Limb amputations are inevitable more often than in wounds caused by conventional arms. The reason is a wide devastation of soft tissues and bones, including the neurovascular destruction. The results showed that ICRC protocol, with some modifications, used for the war wound treatment is sussessful. The application of the external fixator during the first operation prevents bone infection and provides an easier transportation of the patient, better assesment of the wound and a quicker treatment of the soft tissue and bone defects. The Mitković external fixation system has been proven as the most successessful external fixator for the war fracture treatment in comparison with other external fixators available on the international market.

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RATNE RANE NANEŠENE DEJSTVOM KASETNIH BOMBI – PRIRODA I REZULTATI LEČENJA

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Kratak sadržaj: *U toku rata ekstremiteti su najčešće zahvaćeni delovi tela (50-75%). Korišćenje eksplozivnih rasprskavajućih sredstava kao što su kasetne bombe dovode do istovremenog povredjivanja velikog broja ljudi. Povrede su sve teže a njihovo lečenje sve komplikovanije. Prvenstveni cilj agresora je danas je ne ubijanje civila i vojnika već njihovo što teže ranjavanje čije će lečenje biti skopčano sa velikim materijalnim izdacima, dugotrajnim tretmanom i invalidnošću. U radu se prikazuje priroda ratne rane nanesene kasetnim bombama pri bombardovanju civilnih ciljeva kao rezultati lečenja povredjenih na našoj klinici korišćenjem posebnog protokola. Protokol je imao za cilj da se izbegnu greške u lečenju ovih teških povreda a nastao je sintezom protokola koga preporučuje Medjunarodni Komitet Crvenog Krsta iz Ženeve i našeg ranije predloženog protokola za lečenje teških otvorenih preloma. Glavni doprinos je rutinsko uvodjenje spoljnjeg fiksatora u rutinsku primenu još prilikom prve operacije. Korišćen je aparat po Mitkoviću koji je jednostavniji za aplikaciju od drugih postojećih aparata, koji obezbedjuje bolje uslove za zarastanje preloma i koji obezbedjuje mogućnost rane selektivne rehabilitacije teško povredjenog zglova. Za pokrivanje defekta mekih tkiva najčešće su korišćeni fasciokutani rotacioni režnjevi, a za nadoknadu kostnog defekta gore pomenuti fiksator. Nije bilo komplikacija u smislu hroničnih infekcija.*

Ključne reči: *Kasetna bomba, ratna rana, prelomi, spoljna fiksacija*

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