War Injuries of the Extremities: Twelve-Year Follow-Up Data

Guarantor: Željko Bušić, MD PhD
Contributors: Željko Bušić, MD PhD*; Zvonimir Lovrč, MD PhD*; Enio Amić, MS MD*; Vlatka Bušić, MD†; Ljiljana Lovrč, MD‡; Ivan Marković, MD§

Background: More than 75% of all injuries in modern wars are injuries of the extremities, usually with highly contaminated wounds and major soft tissue destruction. In this review, we present the late functional results for 35 of 41 wounded patients who sustained solitary war injuries of the extremities with open fractures. Methods: During a 6-month period from August 1991 to February 1992, of a total of 1,050 injured patients, 49 wounded patients with isolated open fractures of the extremities were treated in General Hospital Nova Gradiška (Nova Gradiška, Croatia). The mean age was 34 years (range, 17–85 years); 44 wounded patients (90%) were male and 37 (76%) were soldiers. With primary amputations for 8 (16%) of 49 injured patients, external fixation was performed for 27 wounded patients (66%); primary internal fixation was applied for eight wounded patients (19.5%). After 12 years, 35 (85%) of the injured patients were available for evaluation concerning: (a) fractured bone nonunion, (b) osteomyelitis, (c) late amputation, (d) nerve palsy, and (e) function. Results: Osteomyelitis occurred for five patients (12%), only one with primary external fixation. In two cases of delayed conversion of external fixation to internal fixation, osteomyelitis occurred, requiring external fixator restoration. This has been no recurrence of osteomyelitis in the past 5 years and, after 12 years, more than three-fourths of wounded patients showed no or mild reduction of function of related proximal and distal joints. According to Index of Independence in Activities of Daily Living scores, grade B was found for only two wounded patients, with grade A for the others. Conclusion: The application of external fixation is the first and definitive choice of treatment for war-related open fractures of extremities, producing good late functional results. Conversion of external fixation to internal fixation leads to osteomyelitis, demanding another operation and application of secondary external fixation.

Introduction

More than 75% of all injuries in modern wars are injuries of the extremities.1-4 Two-thirds of injuries are caused by shell fragments, which cause open fractures in one-third of wound cases, usually with highly contaminated wounds and major soft tissue destruction.5-7 The use of external fixation in the management of such injuries is the method of choice, although, concerning the extent of soft tissue and bone damage, some authors dealing with open fractures suggest another approach.7-11

Such injuries are followed by a high risk of osteomyelitis attributable to many free and deperiosted bone fragments, as well as covering tissue defects and concomitant vascular injuries.5,7,8 The management of war-related open fractures of the extremities involves experience of the surgeon and requires patience of the wounded. Mangled extremities sometimes require primary amputations, in wartime based only on clinical assessment, which is not based on the Mangled Extremity Severity Score (MESS).12,13

Injuries caused by land mines usually lead to traumatic amputations of the foot or distal extremity amputations.12-14,15 In our group of wounded, no injuries were caused by land mines, only shell fragments (mortars, grenades, and bombs) and bullets.

General Hospital Nova Gradiška was one of the war hospitals in the eastern part of Croatia in 1991-1993 and was near the battlefield lines; therefore, it received many wounded directly from the battlefield. In this review, we present the late functional results for 35 wounded patients who sustained solitary war injuries of the extremities with open fractures.

Methods

During the 6-month period from August 1991 to February 1992, 1,050 injured patients were treated in the General Hospital Nova Gradiška, of them 49 wounded patients with isolated open fractures of the extremities. With a mean age of 34 years (range, 17–85 years), 44 (90%) were male and 37 (76%) were soldiers. The cause of wounding was shell fragments for 21 (66%) of the injured patients, whereas 14 (34%) were wounded by bullets. The mean time of transportation from the site of wounding to the hospital was 58 ± 41.5 minutes (range, 15–210 minutes). Primary amputations were performed for eight (16%) of 49 injured patients (three femoral, two below-knee, two forearm, and one hand amputations); these patients were excluded from additional statistical analyses. Concomitant injuries were found as follows: three radial nerve, three ulnar nerve, one peroneal nerve, and two femoral superficial artery injuries. No primary nerve reconstructions were performed, whereas immediate femoral artery reconstruction was performed with vein grafts. For six wounded patients (12%), two extremities were injured.

Primary external fixation was performed for 27 (66%) of 41 wounded patients, i.e., humeral fixation for 8 (20%), forearm fixation for 4 (10%), femoral fixation for 6 (22%), and below-knee fixation for nine (33%). For eight wounded patients (16%), primary internal fixation was applied, i.e., plates with screws for six fractures (two humeral, two forearm, and two femoral fractures) and fixation with pins and wires for two patellar fractures (Table I). We used only unilateral external fixators with half pins.

Secondary operations were performed, i.e., delayed skin-defect closure with split-skin grafts in three cases and bone grafting in four cases. Combined parenteral antibiotic therapy was...
TABLE I
LOCATION OF OPEN FRACTURES OF THE EXTREMITIES AND METHOD OF FIXATION FOR 35 WOUNDED PATIENTS

<table>
<thead>
<tr>
<th>Location</th>
<th>External Fixation (n = 27)</th>
<th>Internal Fixation (n = 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humerus</td>
<td>8 (29)</td>
<td>2 (25)</td>
</tr>
<tr>
<td>Antebrachii</td>
<td>4 (15)</td>
<td></td>
</tr>
<tr>
<td>Femur</td>
<td>6 (22)</td>
<td>2</td>
</tr>
<tr>
<td>Cruris</td>
<td>9 (33)</td>
<td></td>
</tr>
<tr>
<td>Patella</td>
<td>—</td>
<td>2</td>
</tr>
</tbody>
</table>

applied (metronidazole, 1,500 mg; ampicillin, 240 mg; penicillin G procaine, 20,000,000 IU).

In two cases in which external fixation of the femur was converted to internal fixation (Kuntscher fixation in one case and plate fixation in one case), osteomyelitis occurred and necessitated removal of internal fixation and application of secondary external fixation. In 2 (7%) of 27 cases, external fixators had to be changed because of pin-tract infection. In two (33%) of six cases with internal fixation, the plates were changed because of osteomyelitis.

The results were evaluated concerning a) fractured bone non-union, b) osteomyelitis, c) late amputation, d) nerve palsy, and e) function. Function was evaluated through the reduction of range of motion of proximal and distal joints of the fractured bone, as follows: 0: no reduction; 1: mild reduction (10-33% of normal); 2: serious reduction (34-66% of normal); 3: severe reduction (67-100% of normal). The Index of Independence in Activities of Daily Living was used to evaluate the ability to perform essential life functions.10

Results

Twelve years after injury and primary management, 35 (85%) of 41 wounded patients with isolated war injuries of the extremities were evaluated: 8 (16%) of 49 patients underwent primary limb amputations and 6 (12%) were not available for follow-up monitoring and were thus excluded from the statistical analyses. Among 35 evaluated patients, primary external fixation was applied for 27 (77%), whereas internal fixation was used for 8 (23%).

No delayed union or nonunion was recognized. For five patients (14%), osteomyelitis (methicillin-resistant Staphylococcus aureus) was the reason for additional treatment (two femurs, one tibia, and two patellae). In one case of a femoral fracture treated with external fixation, only repeated debridement and external fixation throughout 8 months led to bone union. No recurrence of osteomyelitis has occurred in the past 5 years. The leg is abbreviated 6 cm; the patient did not agree to proposed operative limb lengthening.

In a case of a femoral fracture primarily treated with internal plate fixation, refracture occurred because of osteomyelitis. It was treated with bone grafting and internal fixation twice. There has been no recurrence in the past 5 years. In a case of conversion of external fixation to internal fixation for a tibial fracture and osteomyelitis, extraction of Kuntscher intramedullary fixation, with delayed bone grafting and only cast immobilization, produced good results, with no recurrence of osteomyelitis in the past 5 years.

No late amputation was needed. In two cases with fractured patellae and internal fixation with wire cerclage, the osteosynthetic material had to be removed because of infection, with consecutive patellectomy and open wound treatment (lavage and sterile dressings on a regular basis). In both cases, mild functional reduction of the knee remained.

In cases with concomitant nerve injury, neurolysis in three cases (two ulnar nerves and one peroneal nerve) and tendon transposition because of complete radial palsy in two of three cases were performed. One patient rejected the reconstruction (ulnar and radial nerves) and has severely reduced function of the elbow and wrist.

In evaluation of the function of the proximal joint, no reduction of function was found for 21 patients, mild reduction for 10, serious reduction for 2, and severe reduction for 2. Concerning distal joint range of movements, no reduction was found in 15 patients, mild reduction in 9, serious in 9, and severe in 2 patients, respectively (Table II).

According to the activities of the daily living scale, 33 (94%) patients were scored as grade A (full ability to undertake the activities of daily living) and 2 as grade B (requiring assistance in getting dressed). They were not playing any sports. None of the wounded returned to the front line; all soldiers were volunteers in uniform because at that time the Republic of Croatia did not have a regular army, and a policy of material reparation for all wounded volunteers was applied as a kind of social security.

Discussion

Twelve years after wounding, more than three-fourths of wounded patients showed no or mild reduction of extremity function and were capable of all activities of daily living according to the Index of Independence in Activities of Daily Living.16 Experience in peacetime traumatology and the distinction of war surgery rules and war conditions can produce acceptable results even with restricted resources, time, and personnel.4 Because we had no delayed amputations, clinical assessment of the extent of injury seems to be sufficient for estimation of indications for primary amputation vs. external fixation for limb salvage, even when no MESS scoring was applied at admission. Although the MESS system is a relatively simple, readily available, scoring system of objective criteria that is highly accurate in acutely discriminating between limbs that are salvageable.

<table>
<thead>
<tr>
<th>Joint</th>
<th>Function Reduced, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Proximal</td>
<td>21</td>
</tr>
<tr>
<td>Shoulder</td>
<td>6</td>
</tr>
<tr>
<td>Elbow</td>
<td>1</td>
</tr>
<tr>
<td>Hip</td>
<td>7</td>
</tr>
<tr>
<td>Knee</td>
<td>7</td>
</tr>
<tr>
<td>Distal</td>
<td>15</td>
</tr>
<tr>
<td>Elbow</td>
<td>4</td>
</tr>
<tr>
<td>Wrist</td>
<td>—</td>
</tr>
<tr>
<td>Knee</td>
<td>6</td>
</tr>
<tr>
<td>Ankle</td>
<td>5</td>
</tr>
</tbody>
</table>

Military Medicine, Vol. 171, January 2006
and those that are unsalvageable and better managed by primary amputation. It should not be considered absolutely reliable in clinical practice.12.13

The application of external fixation may be the first and definitive choice of treatment for war-related open fractures of the extremities and, by leaving the opportunity for early physical therapy, may improve the range of motion of the joints.1,2,4,5,6,7,15 Many experiences from the homeland war in Croatia in 1991–1995 confirm this attitude.1,4,8,13 Based on our small series of wounded and 12-year follow-up data, with a high rate of infection (33%) when internal fixation with plates (two of six cases) or wires (two patellas) was applied as primary management and problems only with pin tract osteomyelitis with external fixation, we strongly recommend external fixation as the primary and definitive method for treating war-related open fractures. In cases of open fracture of the patella, patellectomy should be performed in a first attempt. External fixation also allows early mobilization, fewer problems with secondary closure of soft tissue defects, and delayed reconstructive surgery or additional fixation during the time of healing. Delayed conversion of external fixation to internal fixation leads to osteomyelitis, demanding another operation and application of secondary external fixation.1,4,8,15

References


