Minimal Fixation in the Treatment of Open Hand and Foot Bone Fractures Caused by Explosive Devices: Case Series

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Aim. To evaluate minimal fixation method with Kirschner's wires in the treatment of open fractures of the hand and foot short bones, caused by explosive devices.

Method. There were 270 wounded persons with open fractures of hand and foot short bones, who were surgically treated at the Department of Surgery at the Osijek University Hospital. The stabilization of an unstable open fracture was performed with intramedullary positioned Kirschner's wires. In a few cases, satisfactory stabilization was achieved with Kirschner's wires positioned percutaneously alongside the wound and perpendicularly through the fracture. In the rest of the wounded, plaster immobilization was sufficient after surgical treatment and fracture reposition.

Results. Among 270 persons with 412 open hand and foot bone fractures, 49% had fracture only in the feet, 27% only in the hands, and 24% in both hands and feet. Unstable short bone fractures were found in 56 patients (21%). Such fractures were stabilized with Kirschner’s wires (n=71). In 58 patients (21%) partial hand and foot amputations had to be performed. Reconstructive operations to improve pseudarthrosis after minimal osteosynthesis were performed on 5 short bones (7%). Osteitis was found on four short bones (6%) after minimal osteosynthesis.

Conclusion. Minimal osteosynthesis with Kirschner’s wires is a reliable and adequate method of the treatment of open unstable short bone fractures caused by explosive devices.

Key words: amputation; foot injuries; fracture fixation, intramedullary; fractures, open; hand injuries; war; wound infection

External fixation is a method of choice for the stabilization of open unstable long bone fractures caused by explosive devices, as well as open fractures of the second and third degree (1-4). However, open unstable fractures of the first degree and closed unstable fractures of long bones are treated by internal stabilization (4).

The treatment of unstable fractures of hand and foot short bones with low-profile mini-plating system can cause formation of scars and contractures of functionally important joints (5). Minimal osteosynthesis with Kirschner’s wires is accompanied by minor operative trauma and satisfactory functional results in peace (6-8) and war trauma (9-11).

We used Kirschner’s wires, which we positioned mostly intramedullary, for the treatment of open hand and foot short bone fractures caused by explosive devices. The frequency of accompanying postoperative complications (pseudarthrosis and osteitis) documented the validity of this surgical approach. Primary surgical wound treatment in accordance with war surgical doctrine is always preferred because of lower postoperative complications (12). We recommend the most suitable surgical materials for fracture stabilization, skillful operative technique, as well as a contact of local antiseptic with the wound and elements of the osteosynthetic material (13,14).

In the minority of patients a reoperation was indicated to improve the loss of the range of motion. We presume that the necessity for such interventions was greater, but because of the war conditions we could not detect them all (15). We also noticed high frequency of osteitis after reoperation of the long bones where the outer fixation method was replaced with inner stabilization (2).

The aim of this report is to describe the advantages of the minimal osteosynthesis with Kirschner’s wires for the stabilization of open unstable hand and foot short bones fractures caused by explosive devices.

Patients and Methods

In the 1991–2000 period, 270 wounded persons with open fractures of hand and foot short bones were treated at the Surgical Department of the Osijek University Hospital. Most open fractures (96%) were caused by explosive devices (mines and shrapnel of different size). The key characteristics of such wounds were large soft tissue lesions, multiple injuries, and frequent damage to the important neurovascular structures (16). The ratio of hand and foot injuries (n=672) to the number of wounded persons with open fractures (n=270) was 2.4, indicating the high frequency of...
simultaneous damage to the hand and foot. Most of the persons (89%) in the study were wounded during the period of direct Serbian aggression on Osijek (1991-1992) or up to three years later. Every fifth patient had an open multifragmental fracture of the hand and foot short bones, with soft tissue defects, which demanded surgical fracture stabilization. In such cases, the surgical treatment included the removal of small bone fragments (mostly deperistionted), which was frequently accompanied by large bone defects. Satisfactory stabilization was achieved with Kirschner’s wires positioned mostly intramedullary and pulled distally from the base of the metacarpal or metatarsal bone. Rarely, wires were positioned percutaneously alongside the wound and perpendicularly through the fracture. The stabilization of unstable open fractures of the hand and foot short bones by the external fixation method (small fixators for short bones) was not satisfactory in four patients, who were operatively treated elsewhere. In such cases, we removed the fixators and performed intramedullary stabilization with Kirschner’s wires. Our clinical experience indicates that the applied Kirschner’s wires had an optimal diameter (1.4 mm and 2.5 mm), as recommended by other authors (13,14), (Figs. 1 and 2)

Surgical treatment of the soft tissues was performed in accordance with the war surgical doctrine (12). In the postoperative period, open wounds were dressed with local antiseptic (povidone-iodine). The wounded hands and feet were subsequently immobilized in a plaster cast.

The necessary amputations of a finger or parts of the hand and/or foot were performed in the most distal vital part. The stripped bone mass of amputated finger was covered with the flexor tendon in cases where flexor and extensor stitches were not under tension. In the cases of fractures accompanied with defects of joint bone, primary surgical treatment was performed in accordance with war surgical doctrine. Adequate Kirschner’s wires inserted between the neighboring bones ensured the appropriate position of the remaining joint surfaces. Intermediate joint position was further achieved by twisting of the Kirschner’s wires. Bone mass defect was covered with a stitched tendon in cases where stitches were not under tension. In some rare cases with greater soft tissue defects (mostly in the foot region), postponed microvascular reconstructive operation was indicated (11,17).

Results

In the group of 270 wounded persons with open fractures of the hand and foot short bones, a total of 672 injuries was registered, 263 on the hands and 409 on the feet. Among these, 412 were open short bone fractures, 145 on the hands and 267 on the feet (Table 1). Stabilization of open short bone fractures was performed in 17%, and amputation in 18% of total number of fractures (n = 412). Kirschner’s wires were used for the stabilization of unstable fractures in 56 (21%) patients, with a total of 71 stabilizations performed. The stabilization of instable fractures in most of our patients was performed on a single hand or foot bone (n = 44), in nine patients on two bones, and in

<table>
<thead>
<tr>
<th>Injury</th>
<th>No (%) of injuries to</th>
<th>hand</th>
<th>foot</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open fractures</td>
<td>145 (35)</td>
<td>267 (64)</td>
<td>412 (100)</td>
<td></td>
</tr>
<tr>
<td>Injuries</td>
<td>263 (39)</td>
<td>409 (60)</td>
<td>672 (100)</td>
<td></td>
</tr>
<tr>
<td>Amputations</td>
<td>48 (33)%</td>
<td>28 (10)%</td>
<td>76 (18)%</td>
<td></td>
</tr>
</tbody>
</table>

5%8 persons affected.

5%Percentage of open fractures.

Table 1. Patients with open fractures of the hand and feet short bones (N = 270), surgically treated at the Department of Surgery, Osijek University Hospital
three patients on three bones (Table 2). In the rest of the wounded, plaster immobilization was sufficient after surgical treatment and fracture reposition. In 58 persons (21%), the amputation of finger parts and parts of the hand and foot in the most distal vital parts had to be performed (total of 76 amputations). Despite the stabilization by the minimal osteosynthesis method (n = 71), five patients developed pseudarthrosis on a short bone, which had to be surgically treated later. Pseudarthrosis rate reached 7% (Table 2). In four patients, each having a single bone stabilized with Kirschner’s wires, an additional operative intervention was necessary to heal the developed infection and osteitis, and the osteitis rate reached 5.6% (Table 2). In a group of 270 wounded persons with open hand and foot short bone fractures, 132 (49%) sustained fractures only in the feet, 74 (27%) only in the hands, and 64 (24.7%) in both, hands and feet.

Discussion

The group of 270 patients with 412 open fractures of the hand and foot short bones, which were caused mostly by explosive devices, were treated at the Surgical Department of the University Hospital Osijek. In 56 patients with open and unstable fractures of the hand and foot short bones, the surgical treatment demanded stabilization, which was performed using Kirschner’s wires positioned mainly intramedullary. We showed that intramedullary positioned Kirschner’s wires were suitable for the treatment of unstable fractures of the hand and foot short bones in most cases. In a small number of cases, satisfactory stabilization was achieved with Kirschner’s wires positioned percutaneously alongside the wound and perpendicularly through the fracture’s crack. Plaster immobilization was sufficient after surgical treatment and fracture reposition in the rest of the wounded. In the cases of bone defects, we allowed minor metacarpal or metatarsal bone shortening to achieve better bone fragment reposition, as it was described for open unstable war fractures of long bones treated by external fixation method (1, 2, 18). In the cases of joint bone defect, Kirschner’s wires inserted between the neighboring bones ensured the appropriate position of remaining joint surfaces. Intermediate joint position was achieved by twisting of Kirschner’s wires. Surgical treatment of the soft tissues was performed in accordance with the war surgical doctrine. In some rare cases, where greater soft tissue defects were present, postponed microvascular reconstructive operation was indicated (11, 12, 17).

Additional surgical intervention was necessary in 6% of the short bones treated with the minimal osteosynthesis method, due to infection and osteitis. Wound infections were effectively treated by better exposition to local antiseptic, whereas osteitis of short bones was treated mostly with gentamicin “globules”. We had similar postoperative rate of osteitis using the method of external fixation for the treatment of the war-related open unstable long bone fractures (2). The 7% rate of pseudarthrosis was similar to that reported for war-related open unstable long bones fractures treated by external fixation method (2).

The brutality of the injury and contamination of open fractures, rather than the result of inadequate operative technique or method applied, can explain relatively high postoperative complications rate of 6% and 7% for serious accompanying infections and pseudarthrosis, respectively. We usually performed a reoperation to improve the reduced range of motion in big joints (19), but rarely did so on small hand and foot bones and joints. Reoperations on the hand and foot bones were less frequently performed than in some other studies (5, 20), due to the impossibility of adequate follow-up of the patients in war (15). On the other hand, in the reoperations of open fractures of long bones, caused by explosive devices, we noticed a considerably high osteitis rate where the outer fixator was replaced with inner stabilization (2).

According to our clinical experience with four patients operated in other hospitals, we can say that the method of external fixation for stabilization of unstable fractures of the hand and foot short bones (small fixators for short bones) is less successful and operative lesions are greater.

In 58 wounded persons with open fractures, 76 amputations of finger parts and parts of the hand and foot in the most distal vital parts had to be performed. Our results indicated that the feet were the most frequent site of open fractures caused by explosive devices, and that considerable number of patients had fractures of both the feet and the hands (almost a quarter of patients), which is in accordance with the findings of other authors (21, 22). In our wounded patients, the ratio of amputations to open fractures was 3 times higher for the hands than for the feet, indicating better foot protection.

<table>
<thead>
<tr>
<th>No. of patients with complications</th>
<th>No. (%)a of minimal osteosynthesis</th>
<th>No. (%)b of complications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>hand</td>
<td>foot</td>
</tr>
<tr>
<td>One bone (n = 44)</td>
<td>21 (14)</td>
<td>23 (8)</td>
</tr>
<tr>
<td>Two bones (n = 9)</td>
<td>6 (4)</td>
<td>12 (4)</td>
</tr>
<tr>
<td>Three bones (n = 3)</td>
<td>6 (4)</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>33 (22)</td>
<td>38 (14)</td>
</tr>
</tbody>
</table>

a Percent of minimal osteosyntheses performed on open fractures in the hand, foot, and both hand and foot (shown in Table 1).
b Percent of complications of the total number of minimal osteosynthesis performed on the hand, foot, or both.
In conclusion, our results suggest that minimal osteosynthesis is the method of choice for the treatment of open unstable fractures of short bones in the hand and foot, caused by explosive devices. Using this method in combination with skilful operative technique, most suitable surgical materials for fracture stabilization, and ample use of local antiseptic for the wound and elements of osteosynthetic material, we have reduced postoperative complications to acceptable frequency. Our clinical experience shows that fracture stabilization is satisfactory and operative injuries tolerable when Kirschner’s wires are used. We consider permanent invalidity in our patients as a consequence of brutality of injury and contamination of open fractures.

References

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