Background: The forearm refractures are the most common and serious injuries in the childhood. In our practice the refractures in children occur from 1.3% up to 5.2% among all fractures in children. Clinical characteristics of the refractures were highlighted insufficiently.

Purpose: To study clinical signs of forearm refractures and effect of osteoreparative process.

Material and methods: In the department of children's trauma of Scientific Research Institute of Traumatology and Orthopedics during the period from 2002 to 2012 from the general number of the patients 136 children with refracture of the tubular bones were revealed. With regard to the number of fractures twice refractures were in 132 patients, three times refractures found in 4 patients. From these patients 102 were boys and 34 were girls. According to structure of refracture localization the forearm refractures were on the leading place, which were observed in 109 (80.1%) of patients. The refractures of the middle third forearm were noted in 82 patients, the refracture of middle upper third forearm - in 2 patients, the refracture of the lower third forearm was in 25 patients.

Results: In the refractures at the second stage of regeneration (time of occurrence more than 3 months), especially at the moment of active process of the callus ossification the close of medullar canal occur and hematoma volume became significantly less than in primary fracture. At refractures hematoma at the place of fracture was more localized. At the refracture the weak pain is defined, and sometimes pain can be absent (about the reasons is said above), and the main active and passive movements in the full volume. The cases of absence of crepitation are possible in refractures. It is important that in refractures the longitudinal and impacted displacement we did not observe. In cases with painless clinical course of the refracture in the patients the active and passive movements were saved in complete volume. We have noted above the presence of callus, insignificant volume of the hematoma or its fast resorption, weak pain syndrome can slow down processes of regeneration of bones in children.

The conclusions: Analyzing our observations we concluded that all clinical symptoms are important both in diagnostics and in a choice of strategy and tactics of the further treatment and achievement of complete consolidation of bones and complete restoration of the extremity function.

Keywords: Forearm, refracture, clinical signs, children, osteoreparative process


Background

The forearm refractures are the most common and serious injuries in the childhood (Baitner, Perry, Lalonde, Bastrom, Pawelek, Newton, 2007; Park, Yang, Joo, Park, Kim, 2007). The difficulties of diagnosis and treatment require from the children’s
traumatologist to know basic principles of reparative regeneration in the refractures. Clinical characteristics of the refractures were highlighted insufficiently. The diagnostic errors often occurred due to unspecified clinical picture of the refracture. Usually, in the fresh fractures of the long bones the typical signs of bone integrity are more expressed. The main symptoms of the fractures include edema in the area of the fracture, increase in the leg diameter, restricted movements and pain syndrome. The hemorrhage in the area of fracture is the first of two signs. The restriction of movements develops consequently after damage of the bone tissue integrity, displacement of the bone fragments and presence of pain syndrome (Beaupre and Csongradi, 1996). The lesions of pain receptors and nerve trunks result in occurrence of pain syndrome. As a rule in the refractures all clinical signs are feebly marked. The poor manifestation of clinical signs is found in subperiosteal fractures and epiphysiolysis without displacement of bone fragments (Schwarz, Pienaar, Schwarz et al., 1996). Consequently, the intensity of clinical signs depends on degree of displacement of bone fragments. Feebly marked clinical signs in refractures also rather depend on degree of bone fragments displacement which always has insignificant character. In our opinion the cause of this is the accumulation of the small quantity of blood in the area of fracture that is consequence of incomplete restoration of blood circulation.

Thus, our purpose was to study clinical signs of forearm refractures and effects of osteoreparative processes.

**Material and methods**

In our practice the refractures in children occur from 1.3% up to 5.2% among all fractures in children. In the department of children's trauma of Scientific Research Institute of Traumatology and Orthopedics (Tashkent, Uzbekistan) during the period from 2002 to 2012 from the general number of the patients 136 children with refracture of the tubular bones were revealed. All patients and their parents gave their consent for carrying out of the investigation work. With regard to the number of fractures twice refractures were in 132 patients, three times refractures were found in 4 patients. By type of a line of break it was revealed that all patients had transverse lines of fracture breaks. From these patients 102 were boys and 34 were girls. According to structure of refracture localization the forearm refractures were on the leading place, which were observed in 109 (80.1%) of patients. The refractures of the middle third forearm were noted in 82 patients, the refracture of middle upper third forearm - in 2 patients, the refracture of the lower third forearm was in 25 patients. With femoral refractures 11 (8.1%) patients referred to us. Among them 6 patients were with upper third femur refractures, 2 patients were with fractures of the middle third of the femur, 2 children were with refracture of the lower third of femur. The refracture of the humerus was observed in 16 (11.8%) patients, of them refracture of the lower third of humerus was found in 9 patients, the refracture of the middle third of the humerus was in one patients.

**Clinical picture**

There are a number of clinical signs of the refractures of long bones in children, which are described insufficiently. There are also no information about refractures with feebly expressed clinical symptoms and their causes.

In primary fracture the volume of hematoma around the bone is bigger, and in repeated fracture this parameter is proportional to stage of regeneration at the moment of fracture. The volume of hematoma in refracture may be compared with the volume of hematoma in primary fracture on the first day after its occurrence and only during first three months after primary fracture, that is, at the initial period of regeneration. We think that the cause of this at the initial period of regeneration is presence of massive parosteal and periosteal calluses closely attached to the surrounding soft tissue with good vascularization and incomplete development of endosteal callus. The patency of the medullar canal due to
absence of endosteal callus formation results in formation significant hematoma in the refractures. In the refractures at the second stage of regeneration (time of occurrence more than 3 months), especially at the moment of active process of the callus ossification the close of medullar canal occur and hematoma volume became significantly less than in primary fracture.

**Hematoma identification**

The periosteum has been injured in the primary fracture that results in formation of intramuscular and some cases of subcutaneous hematoma. In the refracture due to periosteal, endosteal and parosteal calluses the subcutaneous hematoma absent because periosteum closely attaches to the callus. Contrary to the primary fracture the injury of the surrounding soft tissues and subcutaneous fat tissue is not observed. So in refracture hematoma is not expressed, hematoma resorption in the refracture developed very rapidly - from 1 to 2 days. In primary fracture hematoma resolves during 4-5 days.

In the primary fracture the blood distributes through intraosseous, intramuscular, in sub- and periosteum accesses. In the refracture blood distributes only between bone fragments.

For determination of hematoma volume anthropometric measurements of injured and healthy segments are performed, with separation the both segments into relatively three parts. Measurement of the hematoma volume is performed by division of the injured segments into three parts and comparison of the data obtained with volume of healthy segment that is presented below.

The patient P., born in 2001, admitted into clinical hospital in 24.02.2011 with diagnosis:”Closed fracture of the middle third of forearm with displacement of bone fragments”. The patient has received a trauma during playing football owing to fall on a hand and has addressed to emergency department of the Scientific Research Institute of Traumatology and Orthopedics. Objectively: the left forearm was edematous, deformed, painful and is limited in movements. After rendering the necessary help to the patient the reposition was made. On the control roentgenogram position of the bone fragments was satisfactory, the patient has continued treatment in the out-patient. At anthropometry of proximal parts of a healthy segment its volume was 18 cm, the volume of the proximal part of the injured segment - 18.5 cm (Figure 1-A); the volume of the diaphyseal part of at the healthy segment - 17.5 cm, and the volume of the diaphyseal part of the injured segment - 18.8 cm (Figure 1-B), the volume of the distal part of the healthy segment - 13.0 cm, the volume of the distal part of the injured segment - 14.0 cm (Figure 1-D).


At anthropometric measurements it became clear, that hematoma at primary fractures as against refractures, is located not only on a place of direct fractures, but also a little distally and proximally, in the intramuscular space. Because of what there is a difference between anthropometric parameters of the injured segment in comparison with healthy one; in
other parts of the injured segment the changes were not observed. As a conclusion it is possible to say - at refractures hematoma at the place of fracture was more localized. Let's stop on the volume of hematoma more detailed.

**Measurement of the volume of hematoma in relation to changes in refracture**

In the refracture as in the primary fracture, the segment is divided into three parts (proximal, diaphyseal, and distal) and is measured by a centimetric tape. For example:

**Figure 2. A - Healthy and injured segments in refracture. B - Value of volume of the upper third of the injured segment. C - Value of the volume of the middle third of the injured segment. D - Value of the lower third of the injured segment**

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The patient X., born in 2003, was admitted in the clinic in 19.03.2011. The patient has addressed to the children’s department of the Scientific Research Institute of Traumatology and Orthopedics and was hospitalized with diagnosis: “Closed refracture of the middle third of the right forearm with displacement of the bone fragments”. From anamnesis the following is found out: in 08.01.2011 there was a fracture of the bones of the right forearm as a result of fall on a hand and was observed in the outpatient at a place of residence, where the plaster was used. The refracture happened in 19.03.2011 as a result of fall at home and the boy was hospitalized into the children’s department of the Scientific Research Institute of Traumatology and Orthopedics, where the diagnosis was established: “Closed refracture of the middle third of the right forearm with displacement of the bone fragments”. At refracture the volume of the proximal part of healthy segment was 17.5 cm, the volume of the proximal part of the injured segment was 17.5 cm (Figure 2-B), the volume of diaphysis of the healthy segment was 16.0 cm, the volume of diaphysis of the injured segment - 17.0 cm (Figure 2-C), the volume of the distal part of the healthy segment - 12.5 cm, the volume of the distal part of the injured segment - 12.5 cm (Figure 2-D).
The parameters of anthropometry of the first case showed the difference of volume between the injured and healthy segment 1.3 cm. The difference in case of refracture (case 2) was 1.0 cm. The difference between the length of a circle at primary and repeated fracture was 0.3 cm. On the basis of anthropometric parameters it is possible to say, that the anthropometric difference between primary fractures and refractures indicated about insignificance of the hematoma at the refractures, that it is visible on the following example from our observations.

**Table 1. Difference of the Hematoma Volume in Primary and Repeated Fractures of the Forearm Bones in Comparison with Intact Segments**

<table>
<thead>
<tr>
<th>Fractures</th>
<th>Number of patients (n)</th>
<th>Average volume of hematoma M±m (cm)</th>
<th>Amplitude of the individual values (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary fractures</td>
<td>32</td>
<td>1.26±0.044</td>
<td>1.0-1.6</td>
</tr>
<tr>
<td>Refractures</td>
<td>32</td>
<td>0.69±0.040***</td>
<td>0.5-1.0</td>
</tr>
</tbody>
</table>

Note: * - p<0.05; ** - p<0.001; *** - p<0.0001.

The Table 1 shows that difference between the parameters of hematoma at the primary and repeated fractures was highly reliable. Thus, at the primary fracture the volume of hematoma is more, than at the repeated fracture.

**Temperature changes**

The change of temperature at the refractures was insignificant - 36.6-37.2°C, and at the primary fractures the temperature reached 37.2-37.6 °C. At palpation of the refracture there was defined swelling, deformation and insignificant tenderness.

**Table 2. Comparative Parameters of the Common Thermometry in Primary Fractures and Refractures of the Long Bones in Children**

<table>
<thead>
<tr>
<th>Fractures</th>
<th>Number of patients</th>
<th>Average temperature parameters M±m (°C)</th>
<th>Amplitude of the individual parameters (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary fracture</td>
<td>34</td>
<td>37.2 ± 0.51</td>
<td>36.6 – 37.6</td>
</tr>
<tr>
<td>Refractures</td>
<td>34</td>
<td>36.8 ± 0.032***</td>
<td>36.6-37.2</td>
</tr>
</tbody>
</table>

Note: * - p < 0.05; ** - p < 0.001; *** - p < 0.0001.

Table 2 shows reliable difference in the rise of temperature at primary and repeated fractures. At the primary fracture there was noted more significant hemorrhage that caused appreciable rise of temperature and preserved it within 3-4 days because accumulated hematoma resolved for some days and positively influenced on the process of consolidation. In cases of refractures hematoma was not so significant, that induced low temperature and its normalization for 2 days and its resolution already occurred on the first day after fracture, that negatively influences on the regenerative process.

**Pain syndrome**

It is necessary to note intensity of the pain syndrome in primary fractures because of increase of tension in the soft tissues expressing by hemorrhage and by stimulation of the painful receptors, which does not occur at refractures because of small volume of hematoma. The pain syndrome in refractures was classified into three gradations in relation to the degree of intensity: a) the pains of severe degree; b) the pains of moderate severity; c) endurable pains. So, the pains at refractures were observed at its occurrence in term about 2 months after primary fracture. It is explained by closed adjoint of the massive periosteal and parosteal calluses to the soft tissues, i.e. at the place of pain receptors localization their stimulation occurred that explains intensity of the pain syndrome at the initial period, as well as by large volume of hematoma in this time. The pain of moderate intensity was observed more often at insignificant displacement of bone
fragments and at small volume periosteal hematoma. In some cases, when refractures occurred, the pain receptors in the surrounding soft tissue have been “cicatrized” and become resistance to stimulation, and that explains absence of the pain syndrome in similar cases.

The intensity of pain was also defined in active and passive movements in the immobilized extremity. Thus, because of a strong pain the active movements can be absent, the passive movements result in intensification of the pains. At moderately expressed pain the active movements of the extremity are insignificant; the passive movements are rather free. At the refracture the weak pain is defined, and sometimes pain can be absent (about the reasons is said above), and the main active and passive movements in the full volume.

**Crepitation**

As to crepitation, in cases of primary fracture crepitation was expressed in connection with mobility of the ends of bone fragments. Crepitation at refractures was not obligatory, as it became clear from clinical materials of our research, in 7 cases there was noted insignificant “soft” crepitation, in the other cases the latter was not found. The cause of this phenomenon became presence of the callus after the primary fracture, that “has smoothed” friction between bone fragments. At repeated fractures crepitation is auscultated only at displacement of bone fragments and as against of crepitation in primary fractures is less expressed, that is explained by more “soft” friction of bone fragments due to fixing of their primary callus. The cases of absence of crepitation are possible in refractures.

**Deformation**

At primary fracture with displacement the deformation of the site of fracture is clearly visible, and at refracture it is less expressed because of presence of periosteal callus.

<table>
<thead>
<tr>
<th>Type of displacement</th>
<th>forward outside</th>
<th>forward inside</th>
<th>back outside</th>
<th>back inside</th>
<th>Totally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refracture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forearm refractures</td>
<td>8</td>
<td>15</td>
<td>9</td>
<td>11</td>
<td>43</td>
</tr>
</tbody>
</table>

At primary fracture the displacement of bone fragment is significant, that is frequently not characteristic for refractures because of presence of parosteal and periosteal calluses, and sometimes they are absent at all. The deformation can be observed at significant displacement of the bone fragments or at the presence of significant swelling, in the other cases of the both attributes of fracture can be absent. Parosteal and periosteal calluses, adjoining to the periosteum and muscles, create circular clutch and, therefore, even the large injuring force displaces bone fragments insignificantly (Figure 3).
As it is visible from Figure 3 and Table 3 in all cases of the refractures the angular deformation was noted. Besides, in our clinical observations there were no cases of open refracture with rough heavy displacements that, in our opinion, is connected with cicatricial changes and close adhesions with the surrounding soft tissues not allowing displacement of the bone fragments. It is important that in refractures the longitudinal and impacted displacement we did not observe.

**Extremity function**

At the refractures of the long bones the pain was noted in at active and passive movements. If in the patients the acute pain was observed, the active movements were limited due to pain the passive movements are partially limited. In the patients with insignificant tenderness the active movements were partially limited, and passive movements were observed in full volume. In cases with painless clinical course of the refracture in the patients the active and passive movements were saved in complete volume.

**Conclusion**

Analyzing our observations we concluded that all clinical symptoms are important both in diagnostics and in a choice of strategy and tactics of the further treatment and achievement of complete consolidation of bones and complete restoration of the extremity function. Displacement of bone fragments in refracture isn’t occurred considerably as in primary fractures and it is relation via the callus's volume. As we have noted above the presence of callus, insignificant volume of the hematoma or its fast resorption, weak pain syndrome can slow down processes of regeneration of bones in children. Worsening of the reparative processes lead to extend the immobilization period, recovering processes are behavior as slowly and also, reconstruction of bone structures. We can suggest the following recommendations:

- in diagnostics we must pay attention to the clinical signs extends and callus volume of the forearm segment refractures;
- the choice of the treatment method should be made according to the callus formation period;
- the immobilization period must prolong to two or three weeks than primary fractures.

**References**


