Advantages of Long Bones Deformity Correction Using Computer Assisted Ortho-SUV Frame

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Staged deformity components correction

Step 1: Distraction

Step 2: Correction of angular deformity and translation in frontal plane

Step 3: Correction of angular deformity and translation in sagittal plane

Step 4: Torsion correction
Gradual one-step deformity correction according to "integrated" trajectory is possible using **software-based hexapods**
Software Based Frames

Taylor Spatial Frame

Ilizarov Hexapod Apparatus (System)

Ortho-SUV Frame
Assembly of Ortho-SUV Frame

1 – proximal basic (reference, base) support
2 – struts
3 – distal basic (mobile, corresponding) support
4 - stabilizing supports
Passive computer navigation

Initial position of bone fragments - initial lengths of struts

Inputting of data in the software to provide a proper position of bone fragments

The newly calculated lengths of struts provide proper position of bone fragments

<table>
<thead>
<tr>
<th></th>
<th>IHS</th>
<th>TSF</th>
<th>Ortho-SUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of data inputted</td>
<td>23</td>
<td>25</td>
<td>16</td>
</tr>
</tbody>
</table>
Advantages

- Hardware
- Reduction capabilities
- Rigidity of fixation
- Software
Materials and Methods

306 bench tests:
36 – comparison of comfortability of the hardware use
30 - comparison of comfortability of the software use
120 – comparison of reduction capabilities
120 – comparison of rigidity of bone fragments fixation

178 cases of hexapod application:
43 – Taylor Spatial Frame
7 – Ilizarov Hexapod System (Apparatus)
146 (121 patients) – Ortho-SUV Frame
Used supports: Advantages

Supports of any external frame and any geometry can be used (as well as 2/3 rings and half-rings) (TSF “-”, IHS “-”)
Hardware
Range of strut length: Advantages

Length of strut: 84 mm – any necessary (depends on the length of a chosen standard 6 mm threaded rod)

No need for strut type sizes change
(TSF “-”, IHS “+”?)

The struts have the scale with 1 mm marking
(TSF “+”, IHS “-”)
Strut capabilities: Advantages

0.25 mm rate of correction is possible (TSF “-”, IHS “++”)

There is an opportunity of the hardware dinamization (TSF “-”, IHS “-”)

The struts are fixed to supports at 6 points: 3 – proximal and 3 – distal (TSF “-”, IHS “+”)

Quantity of strut fixation places: Advantages
Places of strut fixation: Advantages

No special places of strut fixation to support. Places of strut fixation to supports can be changed (TSF “-”, IHS “+”)

Use of Z-shaped pads increases the functional capabilities of frame assembling (TSF “-”, IHS “-”)
Places of strut fixation: Advantages

Struts can be fixed to stabilizing supports as well as to basic one (TSF “-”, IHS “-”)

no need for increasing the number of data to input in the software
Supports assembling: Advantages

Any angle of support assembling is possible. (TSF “-”, IHS “+”) Bone fragments can be located both in the external support centre, and out of the ring centre.

no need for increasing the number of data to input in the software
“Fast struts” mode

(TSF “++”, IHS “-”)
Software: Advantages

Can be placed on any matrix (CD, DVD, flash card, hard disc). No need for internet (TSF “-”, IHS “+”).

Any language variant for 2 weeks.

The number of data input in Ortho-SUV software manually has been decreased by 31-36%: 16 parameters are input “manually”, all other measurements are made directly in the software using its tools. (TSF “-”, IHS “-”).

High quality of user’s mistake control (TSF “-”, IHS “-”)
It is not necessary to use trigonometric calculations.

Software: Advantages

Standard orthopedic terminology

- Reference point
- Corresponding point
- A-P view frame offset
- Lateral view frame offset
- Axial frame offset
- Rotary frame offset
- A-P SAR offset
- Lateral view SAR offset
- Axial SAR offset
Software: Advantages

**STANDARD x-rays** are input directly in the software

(TSF “-”, IHS “-”)

The software has **scaling option**

(TSF “-”, IHS “-”)

Software: Advantages

Advanced mistake control of data input which are found through measurements on the frame and the x-rays (TSF “-”, IHS “-”)

NB! If even one of red lines doesn’t match the strut projection it means some data are input improperly. You must return and correct the mistake!
Software: Advantages

The software assumes orthopedic surgeon's routine work at planning deformity correction: drawing bone fragment axes (anatomic or mechanical) and drawing bone fragments contours.

(TSF “-”, IHS “-”)

Step 8
Mark the bone fragments on AP view
Mark the bone fragments on Lat view
- Basic fragm. marker
- Corresp. fragm. marker

Back  Fw

Step 10
Mark distal fragment middle line and skilgrams on AP and Lat view

Back  Fw
The program shows **REAL position of fragments** after deformity correction

(TSF “-”, IHS “+”)

**Software: Advantages**

The program shows **REAL position of fragments** after deformity correction.
Software: Advantages

Final position of mobile fragment can be changed (responsibility of the orthopedic surgeon)

Solution of the software

(TSF “-”, IHS “-”)

Decision of orthopedic surgeon

Ilizarov pelvic support osteotomy
The period of deformity correction is calculated by the software according to the lengthening of regenerate, main vessels and nerves (Structure at Risk)

( TSF “+”, IHS “-”)
The rate of correction, number of days for correction can randomly be changed by surgeon (responsibility of the orthopedic surgeon).

The recommendations (can be printed) include the change of each strut length four times per day (8AM, 12AM, 4PM, 8PM).

(TSF “-”, IHS “-”)

Software: Advantages

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Reduction capabilities

MUDEF:

II,12,110; III,9-3; IV,2,70 -o- V,12,110; VI,3-9; VII,1,70
Advantages: Reduction capabilities

![Bar chart showing reduction capabilities for different categories: Distraction, Int. transl., Ext. transl., Ant. transl., Post. transl., Varus, Valgus, Antecurvy, Recurv, Ext. rotation, Int. rotation. The chart compares different reduction techniques including TSF, Ortho-SUV, IHS, and Ilizarov device.]
Reduction capabilities: Why advantages?

An opportunity to use **threaded rods** to complete struts of **ANY length**

(TSF “-”, IHS “-”)

An opportunity to **fix struts both to basic supports and stabilizing ones**

(TSF “-”, IHS “-”)

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Rigidity of bone fragment fixation

Ilizarov device

Il, 12, 110; III, 9-3; IV, 2, 70; V, 12, 110; VI, 3-9; VII, 2, 70

NB!: The diameter of supports in TSF - 155 mm

Distance between supports – 150 mm

Ortho-SUV Frame

TSF

IHS
Initial instability
Rigidity of bone fragments fixation

(TSF “-”, IHS “++”)
# Application of Ortho-SUV Frame

(Nov. 2011)

<table>
<thead>
<tr>
<th>Fracture healing</th>
<th>Deformity Correction</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simple type</td>
<td>Middle type</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>3(3)</td>
<td>2(2)</td>
</tr>
<tr>
<td>Forearm</td>
<td>1(1)</td>
<td>2(2)</td>
</tr>
<tr>
<td>Femur</td>
<td>2(2)</td>
<td>13(13)</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>8(8)</td>
<td>3(3)</td>
</tr>
<tr>
<td>Foot</td>
<td>1(1)</td>
<td>0</td>
</tr>
</tbody>
</table>

15(15) 3(3) 28(28) 75 (100) 121 (146)

+ 11 patients with knee joint stiffness
Clinical Examples
M., 32 yo: Humeral bone fracture healing
M., 27 yo: Lower leg deformity correction
M., 33 yo: Ankle joint deformity correction
M., 48 yo: Both lower legs deformity correction
M., 27 yo: Both lower legs deformity correction
F., 45 yo: Lower limb deformity correction
M., 27 yo: Femoral bone two-level deformity correction
F., 22 yo: Two-level foot deformity correction
M., 62 yo: Pelvis support osteotomy
F., 38 yo: Severe knee joint stiffness
## Results (femur deformity correction)

### Time of correction

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
<th>Middle</th>
<th>Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ilizarov</strong></td>
<td>15±2,8 days</td>
<td>25,4±4,3 days</td>
<td>65,8±3,9 days</td>
</tr>
<tr>
<td><strong>Ortho-SUV Frame</strong></td>
<td>12±3,5 days</td>
<td>17,8±3,3 days</td>
<td>27±3,1 days</td>
</tr>
</tbody>
</table>

### Time of fixation

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
<th>Middle</th>
<th>Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ilizarov</strong></td>
<td>93±6,9 дня</td>
<td>134±8,1 дня</td>
<td>152±6,4 дня</td>
</tr>
<tr>
<td><strong>Ortho-SUV Frame</strong></td>
<td>89±6,7 days</td>
<td>131±8,6 день</td>
<td>144±4,8 дня</td>
</tr>
</tbody>
</table>

### Time of osteosynthesis

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
<th>Middle</th>
<th>Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ilizarov</strong></td>
<td>108±5,1 days</td>
<td>160±7,9 days</td>
<td>218±5,1 days</td>
</tr>
<tr>
<td><strong>Ortho-SUV Frame</strong></td>
<td>101±5,5 день</td>
<td>149±7,3 days</td>
<td>171±4,9 days</td>
</tr>
</tbody>
</table>
## Results (femur deformity correction)

### LEFS

<table>
<thead>
<tr>
<th>Results</th>
<th>Ilizarov</th>
<th>Ortho-SUV Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (70-80)</td>
<td>41%</td>
<td>52,4%</td>
</tr>
<tr>
<td>Good (51-69)</td>
<td>43,6%</td>
<td>38,1%</td>
</tr>
<tr>
<td>Satisfactory (45-50)</td>
<td>15,4%</td>
<td>9,5%</td>
</tr>
</tbody>
</table>

### SF-36

<table>
<thead>
<tr>
<th></th>
<th>Ilizarov</th>
<th>Ortho-SUV Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>80%</td>
<td>92%</td>
</tr>
<tr>
<td>Role-Physical (RP)</td>
<td>75%</td>
<td>89%</td>
</tr>
<tr>
<td>Bodily Pain</td>
<td>84%</td>
<td>85%</td>
</tr>
<tr>
<td>General Health (GH)</td>
<td>64%</td>
<td>63%</td>
</tr>
<tr>
<td>Vitality</td>
<td>67%</td>
<td>74%</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>90%</td>
<td>88%</td>
</tr>
<tr>
<td>Role-Emotional (RE)</td>
<td>75%</td>
<td>90%</td>
</tr>
<tr>
<td>Physical Component Summary</td>
<td>87%</td>
<td>85%</td>
</tr>
</tbody>
</table>
# Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Ilizarov device</th>
<th>Ortho-SUV Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin-tract infection</td>
<td>6.25%</td>
<td>7%</td>
</tr>
<tr>
<td>Non-union or hypotrophic distraction regenerate</td>
<td>3.75%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Breakage of transosseous elements, failure of device components</td>
<td>8.75%</td>
<td>7%</td>
</tr>
<tr>
<td>Secondary fractures and deformations</td>
<td>7.5%</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26.25%</td>
<td>23.2%</td>
</tr>
</tbody>
</table>
Conclusion
1. Reduction capabilities
2. Rigidity of fixation
3. Hardware (use of any external supports and angle of their assembling; the length of struts is not limited; high capabilities of struts fixation)
4. Software (use of conventional x-ray and terminology; decreased number of parameters measured manually; protection from improper data input; maximal visualization of calculations)
4. **Economic expediency** (any external supports can be used; the price of the set for multiple use and the software is ~ €1.800)
4. Broad indications
Deformity Correction Courses:

http://ortho-suv.org
http://rniito.org/solomin
http://www.rniito.org/download/ortho-suv-course-4-eng.pdf
Thank you!