Comparison study of K wire fixation stability in hammer toe correction


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Comparison study of K wire fixation stability in Hammer toe correction

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My disclosure is in the Final AOFAS Mobile App.
I have no potential conflicts with this presentation.
The most popular digital phalanx stabilization technique for a hammer toe deformity correction is intramedullary Kirschner wire (K-wire) fixation.

The purpose of the study is to compare the biomechanical stability of various K-wire fixation configurations in hammer toe correction.
The geometry of the 2st phalange was created from slices of conventional computer tomography (CT) scans.

The hounsfield units (HU) of bone range were selected so as to constructed 3D bone models using Mimics software (Materialise, Belgium).

- Date: Aug 22, 2008
- Age / Gender: 21 / Female
- Slices size: 512 x 512
- Number of Slices: 353
Methods

**Single K-wire**
- Make a circle selected boundary on cutting plane of proximal phalange
- Make a sphere from 2st digital phalange and create guide line connecting center points of sphere and circle
- By connecting two points, a vector was made to guide K-wire

**Double K-wire**
- Make an offset plane from cutting plane and cut 2st proximal phalange
- Make a vector using lateral & medial points(1,5) on base plane and then quadrisect the vector(2,3,4)
**Methods**

**Double K-wire**

- Make a plane from A-method guide line and the center point of digital phalange sphere and cut 2st digital phalange

- Make a vector using lateral & medial points (a,e) on base plane and then quadrisection the vector (b,c,d)

- By connecting 2&b and 4&d points, two vectors was made to guide parallel K-wires

- Make two cross guide lines from 2 & d and 4 & b points
Models

S

Single K-wire

D

Double Parallel K-wire

D

Double Cross K-wire
Loading conditions

**Bending test**

- Deflection load
  - Applied 10 N to the same direction with earth gravity on the 2nd distal phalange.

**Torsion test**

- Twisting torque
  - Moment force was applied 1 N-m on the 2nd distal phalange at the X-axis.
Results

Maximum von-mises stress

Bending test

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Double parallel</th>
<th>Double cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>von-mises stress [MPa]</td>
<td>6.67</td>
<td>3.277</td>
<td>4.65</td>
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<tr>
<td></td>
<td>31.41</td>
<td>17.79</td>
<td>15.98</td>
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Torsion test

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Double parallel</th>
<th>Double cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>von-mises stress [MPa]</td>
<td>1.09</td>
<td>0.6</td>
<td>1.26</td>
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<td></td>
<td>8.22</td>
<td>1.7</td>
<td>1.97</td>
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<tr>
<td></td>
<td>7.15</td>
<td>0.83</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Disital, middle, proximal
Results

Sliding distance on fracture plane

**Bending test**

- **Single**: 7.83 mm
- **Double parallel**: 3.62 mm
- **Double cross**: 3.84 mm

**Torsion test**

- **Single**: 90.09 mm
- **Double parallel**: 5.93 mm
- **Double cross**: 6.99 mm
We can know that **double k-wire configurations are best results** in hammer toe fixation.

In the case of double k-wire configuration, **double parallel k-wire** is statistically stable compared with double **cross** k-wire configuration.

Consequently, **double parallel k-wire configuration** will be better than conventional single k-wire configuration.