Patients-specific guides for forearm osteotomies in children: preliminary results

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Background

- Postraumatic and congenital forearm deformities in children are difficult to appreciate in all planes.

- Cases with loss of forearm rotation and DRUJ instability = challenging to treat.

- Advances in 3D printing allow precise analysis of deformity in all planes.
Traditional surgical strategy

- Site of osteotomy and correction
- Preop radio and CT
- Perop evaluation

- Open reduction
- Internal fixation

X ray = 2D
Methodology

- 3D CT scan
- Specific protocol
- Both forearms
- Analysis of deformity
- Simulation with engineers of the osteotomy site and correction required
- Design osteotomy and drill guides with the use of a 3D printing
Drill guide

- 3D Modélisation of the plate
Osteotomy guide

- Location, plan, and size defined by preop computer simulation
Patients

<table>
<thead>
<tr>
<th>Sexe</th>
<th>Age</th>
<th>Site avant-bras</th>
<th>Indication</th>
<th>Coté</th>
<th>Dominant</th>
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<tbody>
<tr>
<td>M</td>
<td>10,6</td>
<td>Distal</td>
<td>Madelung</td>
<td>D</td>
<td>O</td>
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<tr>
<td>M</td>
<td>13,1</td>
<td>Diaphyse</td>
<td>Cal vicieux</td>
<td>G</td>
<td>N</td>
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<tr>
<td>F</td>
<td>14,6</td>
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<td>Cal vicieux</td>
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<td>F</td>
<td>17,3</td>
<td>Distal</td>
<td>Epiphisiodèse post tr.</td>
<td>G</td>
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</table>
Distal RUJ instability
Computer model
Superimposed on mirror image of normal side (blue)
Guides

42.5mm

Parallel

Volar View

Parallel

Volar View

Radial View

Radial View

Ulnar View

Ulnar View
3D Printing
Intraoperative view

- Screw length anticipated
- Automatic compression of osteotomy site
Postop radiograph demonstrating correction
Post op testing

Pré op

Post op
14 yo – Madelung deformity
Postop radiograph
Results

• Mean time tourniquet = 120 min (90-120)

• Complication: one regressive radial posterior interosseous nerve palsy

• Correction was closed as planification:

→ Preop versus postop correction: $5.3° \pm 7°$
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Population</th>
<th>Real osteotomy vs planification 3D</th>
<th>Comparizon with non planified osteotomy</th>
<th>Improving length of surgery</th>
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<tbody>
<tr>
<td>Bauer2015</td>
<td>19</td>
<td>Children</td>
<td>Non studied</td>
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<td>Non studied</td>
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<td>Vlachopoulos2015</td>
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<td>Open wedge $\rightarrow$ 8.30° $\pm$ 5.35°</td>
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<tr>
<td></td>
<td></td>
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<td>Closed $\rightarrow$ 3.47° $\pm$ 1.09°</td>
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<td>Roner2017</td>
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<td>5.8° $\pm$ 3.6°</td>
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<td>Byrne2017</td>
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<td>1.63°</td>
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<td>Oka2019</td>
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<td>&lt; 1°</td>
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<tr>
<td>Trousseau2020</td>
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<td>Children</td>
<td>5.3° $\pm$ 7° (pour 5 patients analysés)</td>
<td>Yes $\rightarrow$ 15 cases</td>
<td>Yes</td>
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</table>
Conclusion

- Planification 3D > 2D
- Preop goal obtained
- Improve:
  - Understanding of deformity
  - Operating time
- Surgery more simple

- Irradiation
- Contralateral Segment
- Soft tissues