Simulation and Assessment of Rotational Acetabular Osteotomy with Finite Element Analysis

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Purpose

For the purpose of this study is to investigate the effects of osteotomy at expectation by the preoperative simulation and postoperative result. Pre and post operative CT raw data were examined with finite element analysis.
Materials and Methods

- Raw data of CT Scan with Digital Imaging and COmmunication in Medicine(DICOM) format.
- Pre, post and one year after RAO.
- Software for finite element analysis and three-dimensional measurement (on market).
  - Mechanical Finder ver. 6.0 (RCCM Tokyo Japan)
  - Realia (Cybernet Systems Tokyo Japan)
- CT scan: 1mm slice, no gap, Siemens TRA2
Parameter of FEA

- mesh size: surface mesh 1.5mm tetrahedron
- internal mesh 1.5mm tetrahedron
- load force: 3000N
- Load axis: Z axis
- Load condition: pelvic wing
- restriction condition: femoral shaft, complete restriction
- Young's modulus: Kayak's CT value conversion
- Poisson’s Ratio: 0.4
Patient, History

- Thirty-six years old female
- With DDH history, cast treatment in the days of a baby. At the age of 13, Rt RAO was performed in other hospital.
- October 2009, Lt coxalgia was developed and consulted. April 2010, Rt RAO with self blood transfusion. May 2010 discharged by FWB with double crutch gait.
- May 2011, 1 year after RAO. No pain complain.

- Physical findings
  - JOA score: Pre RAO 67/65, 1 year after 94/94
  - ROM (flex cont. flex abd): 10, 100, 20, 0, 100, 30
  - SMD: 78 / 79, 79/80
  - FAI findings: — / —, — / —
Hip Plain Xp

Pre RAO
CE angle 6°
AHI 53%

Post RAO

1 year after RAO
Bone union +
FEA results of pre RAO model

- Maximum principal stress: 76.2 MPa
- Compressive stress: 55.2 MPa
- Joint surface: 72.2 MPa
Making and result of simulated RAO model

pre RAO  simulated RAO  real RAO

Maximum principal stress  52.2  Mpa
Compressive stress  38.2  MPa
joint surface  49.1  MPa
FEA results of 1 year after RAO model

Maximum principal stress: 48.6 Mpa
Compressive stress: 36.4 MPa
Joint surface: 46.7 MPa
## Discussion

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<thead>
<tr>
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<th>pre RAO</th>
<th>simulation</th>
<th>1 year after</th>
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<tbody>
<tr>
<td>Maximum principal stress</td>
<td>76.2</td>
<td>52.2</td>
<td>48.6 MPa</td>
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<tr>
<td></td>
<td>(76.0%)</td>
<td>(73.8%)</td>
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<tr>
<td>Compressive stress</td>
<td>55.2</td>
<td>38.2</td>
<td>36.4 MPa</td>
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<td></td>
<td>(69.3%)</td>
<td>(66.0%)</td>
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<tr>
<td>Joint surface</td>
<td>72.2</td>
<td>49.1</td>
<td>46.7 MPa</td>
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<tr>
<td></td>
<td>(68.0%)</td>
<td>(64.7%)</td>
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Conclusion

- Assessment for effect of RAO was analyzed with finite element method.
- After RAO, rotation of the fragment to anterior and lateral direction was seen visually.
- By the effect of RAO, enlargement of an area of loaded aspect and decrement of load per unit area were demonstrated.
- This method will be useful for choice of the means and decision for amount of rotation.