Is vertical fragment acceptable in MIPO for acute clavicle mid-shaft fractures?

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INTRODUCTION

- Mid-clavicle fracture
  - High union rate
  - Satisfactory clinical outcomes
  - Non-union after OR/IF

Stanley D, JBJSBr, 1988
Sankarankutty M, Injury, 1975
Rowe CR, CORR, 1968
Neer CS, 1960, J Am Assoc

Traditionally prefer non-operative treatment
Some evidence indicates *unsatisfactory outcomes* after Non-operative treatment
- Initial *shortening* more than 2.0cm
  \[\text{Hill JM, JBJS Br, 1997}\]
- Decreased shoulder strength and endurance
  \[\text{McKee MD, JBJS Am, 2006}\]
- 10% shortening change shoulder kinematics
  \[\text{Noboru et al., AJSM, 2010}\]

Operative treatment is increasing
MIPO for mid-clavicle fracture

- Widely applied to long bone meta / diaphyseal Fx.

- Recently Introduced and provided good clinical results in mid-clavicle fracture

  Jeong et. al, proceedings, JKFS, 2007
  Jung et. al, Clin Ortho Surg, 2013
  Lee et. al, Injury, 2013
  Sohn et. al, J Orhtop Trauma, 2013
Struggle with MIPO

- Risk of non-union
  - Lack of cortical continuity (<50%) following fixation

- Indirect reduction and handling of interposed fragments

*Cheli et al. Injury. 2015*
Additional fixation during MIPO

- Stability in distal femur fracture
  - Combination of locking plate and **interfragmentary screws**
    > Locking plate alone (MIPO)
    
    *Wang et. al, International J of Surg, 2019*

- MIPO with **cerclage wiring** in periprosthetic femoral shaft fracture provide satisfactory reduction, stability and healing

  *Theerachai et. al, Trauma Sug, 2012*
MIPO for clavicle fracture

- If postoperative *interposed fragment after MIPO* is vertical fracture fragment
  - Complication
    - Nonunion
    - Shortening

“There is no study dealing with this issue”
Purpose

- To compare clinical and radiologic outcomes of MIPO for clavicle mid-shaft fractures according to reduced status of interposed fragment
Materials

- 2012.2 - 2017.12 (MIPO)
- Retrospective review
- Inclusion criteria (34 cases)
  - Age 17-73 (Mean age: 45.25)
  - MIPO for acute clavicular mid-shaft fracture
- Exclusion criteria (2 cases)
  - Follow up loss before 1 year
- Finally, 32 patients were enrolled
- Indication
  - Clavicle fracture robinson type 2B
  - Displacement > 2cm, Shortening > 2cm

Rockwood And Green’s Fractures in Adults(7th Edition)
Method

- Divide 2 groups
  - According to clavicle position of interposed fragment after surgery
  - Vertical vs non-vertical

- Vertical fracture fragment definition
  - Being tilted more than 45 degrees compared to long axis of clavicle
Evaluation

- **Radiologic evaluation**
  - Time to union
  - Clavicle thickness and length ratio after union compared to opposite side

- **Clinical evaluation**
  - Q-DASH, KSS, SST, ASES

- Independent two-sample t-test
- P-value less than 0.05 was considered as statistically significant.
Results
## Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
<th>Non-vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patient</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>42.25</td>
<td>47.05</td>
</tr>
<tr>
<td>Sex (male:female)</td>
<td>11:1</td>
<td>16:4</td>
</tr>
<tr>
<td>Involved side (right:left)</td>
<td>4:8</td>
<td>9:11</td>
</tr>
</tbody>
</table>

### Factors affecting union

<table>
<thead>
<tr>
<th>Factor</th>
<th>Vertical</th>
<th>Non-vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>DM</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

### Trauma mechanism

<table>
<thead>
<tr>
<th>Event</th>
<th>Vertical</th>
<th>Non-vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip down</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Car accident</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
## Radiologic outcomes

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
<th>Non-vertical</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean time to union (months)</td>
<td>4.33</td>
<td>4.80</td>
<td>0.162</td>
</tr>
<tr>
<td>Mean clavicle thickness ratio</td>
<td>1.203</td>
<td>1.233</td>
<td>0.726</td>
</tr>
<tr>
<td>after union (AP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean clavicle thickness ratio</td>
<td>1.142</td>
<td>1.097</td>
<td>0.723</td>
</tr>
<tr>
<td>after union (Lordortic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean clavicle length ratio</td>
<td>0.999</td>
<td>1.024</td>
<td>0.095</td>
</tr>
<tr>
<td>after union</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- All cases achieved bone union
### Clinical outcomes

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
<th>Non-vertical</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSS (Korean Shoulder Score)</td>
<td>96.92</td>
<td>98.30</td>
<td>0.578</td>
</tr>
<tr>
<td>DASH (Disabilities of the Arm, Shoulder and Hand)</td>
<td>1.00</td>
<td>1.36</td>
<td>0.776</td>
</tr>
<tr>
<td>ASES (American Shoulder and Elbow Score)</td>
<td>98.83</td>
<td>98.60</td>
<td>0.829</td>
</tr>
<tr>
<td>SST (Simple Shoulder Test)</td>
<td>11.58</td>
<td>11.55</td>
<td>0.933</td>
</tr>
</tbody>
</table>

- No specific complication in both groups.
Case 1

- M/18
  - Slip down

Pre-op
Case 1

- Interposed fragment after MIPO
  - $57^\circ > 45^\circ$: Vertical group
Case 1

- Bony union was identified on POD 5 months

POD 5 Mo.
Case 1

- **Clavicle length ratio**
  - $239/236 = 1.01$

- **Clavicle thickness ratio**
  - $24/21 = 1.14$

- **Functional score**
  - KSS 100
  - DASH 0
  - SST 12
  - ASES 100
Case 2

- M/37
  - Slip down

Pre-op
Case 2

- Interposed fragment after MIPO
  - $2^\circ < 45^\circ$: Non-vertical group

Immediate
Case 2

- Bony union was identified on POD 4 months
Case 2

- Clavicle length ratio
  - $\frac{169.2}{174.3} = 0.97$

- Clavicle thickness ratio
  - $\frac{12.1}{12.6} = 0.96$

- Functional score
  - KSS 92
  - DASH 9.16
  - SST 10
  - ASES 96
Limitation & Strength

- Limitation
  - Retrospective study
  - Small number of the patients

- Strength
  - 1st trials to evaluate bone healing according to fragment reduction status
Conclusion

- MIPO in mid-clavicle fracture, whether interposed fracture fragment was vertical or not, there are similar radiologic and clinical outcomes.

- Even if postoperative interposed fragment after MIPO is vertical, satisfactory outcomes can be expected without complication including non-union or significant clavicle shortening.
Thank You for your Attention!