CLAVICLE FRACTURES: ANATOMICAL PERSPECTIVE

A Van Tongel MD PhD
The clavicle

1. Introduction
2. Function
3. Anatomy
4. Distal clavicle fracture
5. Proximal clavicle fracture
6. Midshaft clavicle fracture
7. Conclusion
1. Introduction

E Codman
1. Introduction

Shouldergirdle = 3 joints

1. glenohumeral
2. acromioclavicular
3. sternoclavicular

clavicle
1. Introduction

Cleidocranial dysplasia
 cleido = clavicle
 cranial = head
 dysplasia = abnormal forming
1. Introduction

3 patient-based shoulder scores
- American Shoulder and Elbow score (ASES)
- Quick DASH
- patient-based Constant Murley score (CS).
1. Introduction

Results
- 36 patients (27 female, 9 male)
- mean age of 40 years
- Bilateral absence (17), bilateral partial absence (16) and 3 patients had a total absence on one side and a partial absence on the other side.
- The average patient-based CS at was 79, Quick DASH score was 11 and ASES score was 93.
- no correlation between partial and total absences and the shoulder scores.
2. Function

Bony framework for muscle insertions and origins

Deltoid – Pectoralis major

Stenocleidomastoideus

Ref: atlas of functional shoulder anatomy
2. Function

Bony framework for muscle insertions and origins

Clavicle is working as a boom
- maintain the appropriate length-tension relationship of the three muscles

Clavicle is working as a crank
→ functionally increasing biomechanical lever arms
→ optimizing their strength.
2. Function

Clavicle is working as a prop:
- The scapula has the tendency to go internal rotated, downward rotated and posterior tilted
- The clavicle holds the scapula away from the body → Optimal position of the scapula
3. Anatomy
3. Anatomy

- Sternoclavicular
- Acromioclavicular
3. Anatomy

SC joint

AC joint
3. Anatomy

SC joint

AC joint

A Cadaveric Study of the Structural Anatomy of the Sternoclavicular Joint

Original Communication

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4. Distal clavicle fracture

Neer classification

Ref: atlas of functional shoulder anatomy
4. Distal clavicle fracture

Type I
= Stable fracture
R/ Conservative treatment
4. Distal clavicle fracture

The aim of the study is to evaluate if all Type 1 are stable (non-displaced).
4. Distal clavicle fracture

- 5 CT-scan of Type I distal clavicle fracture showed displacement $\rightarrow$ unstable
- Displacement: protraction of the scapula (with small lateral fragment)
4. Distal clavicle fracture

- Supero-inferior instability? NO
- Antero-posterior instability? YES
  - Possible with intact CC ligaments?
4. Distal clavicle fracture

Conclusion:

- Type I distale clavicle fracture can be unstable
- Displacement: protraction of the scapula
  → clavicle is working as a prop
- Treatment
  - conservative?
  - operative?
5. Proximal clavicle fracture

Medial clavicle fractures: 2 to 3% of all clavicle fractures

Several classifications have been described
- Allman classification
- Edinburgh classification
- Trockmorton classification

5. Proximal clavicle fracture

No clinical consequence to classifications
5. Proximal clavicle fracture

The purpose of this study was to evaluate the intra and interobserver reliability of a new anatomically based (AB) classification system compared to other classification systems and to evaluate the correlation between the new classification and the clinical outcome of conservative treated fractures.
5. Proximal clavicle fracture

Type 1

Type 2
5. Proximal clavicle fracture

Non-displaced Type I = Type 1A

27 fractures
5. Proximal clavicle fracture

Displaced Type 1 = Type 1B

19 fractures
5. Proximal clavicle fracture

Non-displaced Type II = Type 2A

3 fractures
5. Proximal clavicle fracture

Displaced Type II = Type 2B

8 fractures
5. Proximal clavicle fracture

<table>
<thead>
<tr>
<th>Classification systems</th>
<th>Intraclass correlation</th>
<th>95% confidence interval</th>
<th>Interclass correlation</th>
<th>95% confidence interval</th>
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<tbody>
<tr>
<td>Edinburgh classification</td>
<td>0.741</td>
<td>[0.412-0.886]</td>
<td>0.753</td>
<td>[0.521-0.883]</td>
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<tr>
<td>Trockmorton classification</td>
<td>0.719</td>
<td>[0.362-0.876]</td>
<td>0.775</td>
<td>[0.563-0.894]</td>
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<tr>
<td>Anatomical based classification</td>
<td>0.921</td>
<td>[0.820-0.965]</td>
<td>0.847</td>
<td>[0.702-0.928]</td>
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</tbody>
</table>

- An anatomically based classification shows a high inter- and intra-observer reliability
5. Proximal clavicle fracture

55 patients (55 fractures)

4 patients (3 symptomatic non-union, 1 symptomatic malunion) **not consecutive**

7 patients died because of trauma
4 patients died unrelated to trauma
1 patient fascioscapulohumeral dystrophy
4 patients lost for follow-up

Follow-up of 35 patients
5. Proximal clavicle fracture

Clinical outcome 35 patients

- average age: 54 years  (between 19 and 84 years)
- average follow-up: 49 months  (between 6 and 101 months)
- symptomatic non-union: 1
- average Constant score: 76  (between 55 and 92)
- average Oxford score: 41  (between 25 and 48)
5. Proximal clavicle fracture

<table>
<thead>
<tr>
<th></th>
<th>number of patients</th>
<th>Constant Score</th>
<th>Oxford Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1A</td>
<td>18</td>
<td>79</td>
<td>43</td>
</tr>
<tr>
<td>Type 1B</td>
<td>12</td>
<td>70</td>
<td>38</td>
</tr>
<tr>
<td>Type 2A</td>
<td>2</td>
<td>90</td>
<td>48</td>
</tr>
<tr>
<td>Type 2B</td>
<td>3</td>
<td>79</td>
<td>41</td>
</tr>
</tbody>
</table>

- Significant difference between Type 1B and the Type 1A for Constant score ($p=0.035$), not for Oxford score ($p=0.158$)
- 3 symptomatic non-union not included in clinical follow-up $\Rightarrow$ Type 1B
5. Proximal clavicle fracture

1. The most common orientation is a fracture line originates anteriorly just at the limit of articular surface but includes a larger piece of bone posteriorly (Type 1)

2. Overall good clinical outcome of conservative treatment of medial clavicle fracture

3. Anterior displacement by pull pectoralis major → clavicle is working as a boom

4. Constant Score significant lower in displaced Type 1 fracture and a higher probability on symptomatic non-union
6. Midshaft clavicle fracture

- Osteosynthesis of mid-shaft clavicle fractures is increasing
- Several firms have developed anatomic plates.
6. Midshaft clavicle fracture

- Previous automated study showed a good fitting of these plates when the fracture is in the middle of the clavicle.

- However during clinical practice, fitting is not always perfect.


Ref: atlas of functional shoulder anatomy
5. Midshaft clavicle fracture


Inflexion point of clavicle is at 60%
6. Midshaft clavicle fracture

Fracture line 50%

Different curves if fracture line not at 50%

6. Midshaft clavicle fracture

The purpose of the study is to evaluate the location of the fracture in clavicle fracture.
6. Midshaft clavicle fracture

- A retrospective analysis was performed CT of acute clavicle fractures.
- First they were 3D reconstructed and analysed according the AO classification.

Non-comminuted  Wedged  Segmental
6. Midshaft clavicle fracture

- Next the contralateral clavicle was 3D reconstructed
- Using the mirrored contralateral side as a template, the clavicle fractures was anatomical reconstructed.

6. Midshaft clavicle fracture

- Next the centerline (CL) length was reconstructed and the location of the end of the fracture in the medial and lateral part of the clavicle were pointed out.

- The intersection between the fracture line and the CL were evaluated in percentage (0 is medial – 100 is lateral).
6. Midshaft clavicle fracture

- 25 clavicle fractures
- 6 females / 19 males
- Average age: 36.5 (between 17 and 72)
- 12 non-comminuted / 13 wedged
### 6. Midshaft clavicle fracture

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th><strong>CL (mm)</strong></th>
<th>Medial</th>
<th>Lateral</th>
<th>Middle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All</strong></td>
<td>25</td>
<td>162.1 (10.4)</td>
<td>45% (SD 6)</td>
<td>63% (SD 8)</td>
<td>54% (SD 5)</td>
</tr>
<tr>
<td><strong>Non-comminuted</strong></td>
<td>12</td>
<td>160.2 (SD 10)</td>
<td>46% (SD 6)</td>
<td>59% (SD 8)</td>
<td>53% (SD 5)</td>
</tr>
<tr>
<td><strong>Wedged</strong></td>
<td>13</td>
<td>164.3 (SD 9.2)</td>
<td>45% (SD 5)</td>
<td>67% (SD 8)</td>
<td>56% (SD 5)</td>
</tr>
</tbody>
</table>
6. Midshaft clavicle fracture

Positioning bicortical screw (perpendicular)

Non-comminuted

Wedge
6. Midshaft clavicle fracture

1. The middle of the fracture line of a clavicle is on average more lateral than the middle of the clavicle

2. The area where no perpendicular bicortical screws can be positioned is on average between 45 and 63%

3. This area is on average 9% larger in wedged clavicle fractures compared to non-comminuted
6. Midshaft clavicle fracture

Future investigation

- Current: displacement as indicator for surgery

Nonoperative Treatment Compared with Plate Fixation of Displaced Midshaft Clavicular Fractures
A Multicenter, Randomized Clinical Trial
By the Canadian Orthopaedic Trauma Society
6. Midshaft clavicle fracture

Future investigation

- Current: displacement as indicator for surgery $\rightarrow$ displacement depend on position?

Upright Versus Supine Radiographs of Clavicle Fractures: Does Positioning Matter?

Jonathon D. Backus, MD,* David J. Merriman, MD,† Christopher M. McAndrew, MD,* Michael J. Gardner, MD,* and William M. Ricci, MD‡

- In our opinion displacement depends on pro and retraction

6. Midshaft clavicle fracture
6. Midshaft clavicle fracture

Future investigation

- Current: displacement as indicator for surgery
  ⟷ Stability is indicator for surgery
7. Conclusion

1. The clavicle is working as a prop - as a boom - as a crank

2. Displacement depends on attachment of ligaments (proximal and distal) and on function

3. Current anatomic plates do not take location of the fracture line into account

4. Future: evaluation of stability of fractures and their clinical consequences
THANK YOU

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