Aims of this course: Day 1

Update shoulder pathology
- Biomechanics
- Etiology
- Shoulder pathology diagnoses based on impingement symptoms

Clinical Examination
- Clinical reasoning
- Specific shoulder tests
- Diagnostic value
Aims of this course: Day 2

Rehabilitation principles

- Clinical reasoning
- Rehabilitation principles and practical program for instability, rotator cuff tendinopathy, scapular dysfunction….
- Kinetic chain approach

Part II Advanced Course

Day 1: Scapular rehabilitation

1. Scapular biomechanics & kinesiology
2. Advanced evaluation of scapular dyskinesis: measuring scapular position and strength
3. Scapular rehabilitation exercises: from early to advanced sport-specific rehabilitation
4. Scapular taping techniques
Part II Advanced Course

Day 2: Capita selecta

1. Rehabilitation of the patient with SLAP lesions and biceps related pathology: conservative and post-operative approach
2. Return to sports after shoulder injury: high level performance training and return-to-play criteria
3. Conservative Treatment of (partial and full thickness) rotator cuff tears
4. Rehabilitation of the patient with MDI – Multidirectional Instability of the shoulder

Part III Clinical Workshop

8 cases refreshing clinical reasoning and practical skills

1. Rotator cuff tendinopathy
2. Rotator cuff tear
3. SLAP & tenosynovitis LHB
4. Internal impingement based on instability
5. Multidirectional instability
6. Impingement - Scapular dyskinesis type I
7. Impingement - Scapular dyskinesis type II
8. Impingement - Scapular dyskinesis type III
SHOULDER PATHOLOGY: “What’s new from a biomechanical and clinical point of view?”

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“Impingement”

Most common shoulder complaint

44-65% of all shoulder diagnoses

Variety in clinical presentation - multifactorial
(Cools BJSM 2008, Lewis BJSM 2010)

Considerable loss of function and disability
(Ludewig 2000, Klintberg Int Orthop 2015)

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Impingement:
historical perspective – Neer 1972

- Subacromial impingement
- Stadia I to III based on severity
- Painful arc – impingement signs
- Treatment: “raise the roof” ⇒ anterior acromioplasty
- Results: from “excellent” (70-80’s) to very questionable (Ketola et al. 2016, Familiari et al. 2015, Kukkonen et al. 2015)

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Impingement = symptom
(Umbrella of variety of conditions – Lewis BJSM 2009)

DIAGNOSIS - PATHOLOGY
associated with impingement symptoms

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Change of terminology?

"Subacromial Pain Syndrome?"

"Rotator cuff disease" - “RC related shoulder pain”?

“Anterolateral shoulder pain?”

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Shoulder pain: can one label satisfy everyone and everything?
Ann M Cools, Lori A Michener

‘We should not try to put all patients under the same umbrella—the umbrella will never be big enough to keep everyone out of the rain’.

Rather than relying solely on an inferred structural diagnoses, physiotherapy strategies are based on the identified impairments, tissue irritability and patient-related goals and expectations.

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Impingement: how can we classify the problem?

**Cause:** primary (structural) versus secondary (functional)

**Severity:** Neer stadium I, II, en III

**Localisation:** acromion – glenoid – coracoid

**Structures:** supraspinatus, infraspinatus, biceps, subscapularis

« Time to think about…. »

What are the possible causes of shoulder impingement?

- ...
- ...
- ...
- ...
- ...

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Conflict between humeral head and scapula.

Impingement of soft tissue (tendon) between bony components.

External (Subacromial) Impingement

(A Cools 2017)
Impingement of soft tissue (tendon) between bony components

Internal (postero superior glenoid) Impingement

(Walch 1990, Drakos JBJS 2009, Ludewig JBJS 2009)

“HYPER-ANGULATION”

Shoulder impingement revisited: evolution of diagnostic understanding in orthopedic surgery and physical therapy

Jonathan F. Brunn - Keita D. Zhao - Roderick J. Lawrence - Alicia M. Hartman - Paula M. Lotric

sided tearing. Although internal impingement was originally identified as occurring posteriorly, such articular side rotator cuff to glenoid contact is now known to also occur with normal humeral elevation at higher angles [19, 61] as well as at end range flexion and internal rotation, produced during the Neer test position [19, 26, 59, 67].

motion [3, 24, 61]. It appears that the lateral surface (Fig. 1) of the greater tuberosity and proximal humeral shaft is what approximates the acromion at higher angles rather than the tendon footprints or rotator cuff attachment sites [24]. Because the rotator cuff is not attached to the lateral surface of the humerus, the rotator cuff is not compressed between the lateral humeral edge and the acromion at higher angles of elevation. The range of arm

DIAGNOSES associated with shoulder impingement

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Excessive humeral head translations

Lack of scapular stability & mobility

Narrowing subacromial space

Diagnosis associated with impingement:
SUBACROMIAL ABNORMALITIES
Primary Impingement

- Type II or III acromion
- Swelling soft tissue (rot cuff – bursa)
- Calcifications

However: no causative relationship between these structural changes and shoulder pain
Functional Impingement?

- Excessive humeral head translations
- Lack of scapular stability & mobility

Narrowing subacromial space

Diagnosis associated with impingement:

**ROTATOR CUFF DYSFUNCTION/PATHOLOGY**

1. Rotator cuff **tears** (“older” patients)
2. Rotator cuff **tendinopathy** (overuse)
3. Rotator cuff **weakness** (athletes)
1. ROTATOR CUFF TEARS

Localisation of the tear:
- bursal side: result of impingement
- articular side: instability
- intratendinous: degenerative, overuse
  Articular > intratendinous > bursal (role of the acromion?)

Rare spontaneous recovery:
- < 20% cured or decreased in severity
- > 50% larger tear (100% PT tear @ 80y?)
- > 30% full-thickness tear (50% FT tear @ 80y?)

Which tendons? (Kemf et al. 1999, Keener 2009, Hughes 2014)
- Most affected tendon: SS
- Combined SS + IS: 40%
- Combined SS + IS + SC: 10%

Symptomatic / asymptomatic
Only 45% of the small tears is symptomatic
Only 60% of the moderate/large tears is symptomatic
(Andy Car ICSET 2010)
2. ROTATOR CUFF TENDINOPATHY

• From «tendinitis» (pre 1990s) to «degeneration without inflammation» (paradigm of the 2000s) (Rees BJSM 2014)
• Continuum: reactive tendinopathy → tendon dysrepair → degenerative tendinopathy (Cook BJSM 2009)
• Collagen stimulation using exercises
• No consensus in literature regarding exercise modalities: «eccentric» vs «heavy load» vs «low load high rep» vs «isometric»


2. ROTATOR CUFF TENDINOPATHY: recent updates?

• Load is more important than the modality of load
• A tendon forgets it is a tendon if it is not loaded enough
• Maybe we should only train a tendon eccentrically if the tendon’s functional load is eccentric
• There are 11 theories explaining tendinopathy, of which 4 are plausible: tendinopathy is still an enigma…

3. ROTATOR CUFF WEAKNESS

Biomechanical model force couple

rotator cuff vs deltoid
Discussion

Which of the rotator cuff muscles is the most vulnerable and should be the topic of intervention?

a) Internal rotators – Subscapularis
b) External rotators – infraspinatus/supraspinatus
c) Both sides are equally vulnerable

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RC dysfunction: evidence for dysfunction/adaptation?

2. Early signs of tendinosis in infraspinatus in elite adolescent tennis players (Johansson JAT 2014)
3. ER weakness = risk factor for shoulder injury in high level handball players and baseball players (Clarsen BJSM 2014, Byram 2010)
4. Experimentally induced pain in SS results in decreased activity of IS (fMRI) (Castelein JSES 2016)

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Excessive humeral head translations

Lack of scapular stability & mobility

Narrowing subacromial space

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Diagnosis associated with impingement: INSTABILITY

• Young patients – overhead activities
• Classification based on degree of instability: dislocation – subluxation - functional instability
• Classification based on cause and direction (TUBS-AMBRI-AIOS)

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TRAUMATIC UNIDIRECTIONAL BANKART SURGERY

B (Walton 2002)

Incidence of Re-rupture (%)

0 20 40 60 80 100

£3 Fr £2 Fr £6 Fr

TRAUMATIC MULTIDIRECTIONAL BILATERAL REHABILITATION INFERIOR

Capsular Shift Surgery

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Acquired Instability Overstress Syndrome

Excessive humeral head translations

Functional Impingement?

Narrowing subacromial space

Lack of scapular stability & mobility
Diagnosis associated with impingement:
BICEPS PATHOLOGY & SLAP LESIONS

**Tendinitis** caput longum biceps
- Bicipital groove point tenderness
- Only 5% primary inflammation, 95% + RC or SLAP tear

**Tendinosis** caput longum biceps
- Degeneration based on overuse in overhead athletes

**Tenosynovitis** caput longum biceps
- Stretching is more painful than muscle contraction
- Dynamic contraction after elongation is painful

**SLAP-lesions**

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(Churgay 2009)

Diagnosis associated with impingement:
BICEPS PATHOLOGY & SLAP LESIONS

= Superior Labrum lesion from Anterior to Posterior
Type I: degenerative changes in labrum, fraying of labrum
Type II: labrum ripped off glenoid, unstable base biceps tendon origin

(Snyder 1991)

Type III: “bucket handle”, labrum torn off glenoid, intact biceps origin
Type IV: + longitudinal tear biceps tendon
SLAP-LESION

Cause?

‣ Acute trauma
‣ Sportspecific injury (traction trauma on LHB)?

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SLAP lesion: mechanism?

excessive load on biceps tendon during deceleration and follow through phase of throwing?

1. Changes in direction biceps tendon
2. shear- & torsion forces ↑

(Burkhart 2003)

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Functional Impingement?

- Excessive humeral head translations
- Narrowing subacromial space
- Lack of scapular stability & mobility

“Diagnosis” associated with impingement:

G.I.R.D. = Glenohumeral Internal Rotation Deficit
G.I.R.D. is:

- Occuring in **a-symptomatic young overhead athletes** from the age of 10-14 years (Kibler 2003, Cools JAT 2013)
- GIRD ↑ with increasing **age/years** of overhead athletic activity (Kibler 2013, Tyler 2010, Cools JAT 2013)
- "**basic alteration in cascade to shoulder injury**" (Kibler 2003, Tyler AJSM 2000, Myers AJSM 2006)
- GIRD is **risk factor** for shoulder injury (Wilk 2011, Shanley 2011, Clarsen 2014), however no consensus (Tyler AJSM 2014)

G.I.R.D. is associated with

1) **changes in GLENOHUMERAL kinematics**

Early and Increased anterior translation humeral head (Harryman JBJS am 1990)
G.I.R.D. is associated with

2) changes in **SCAPULAR** kinematics

Scapular dyskinesia (Borich 2006, Laudner 2008)

<table>
<thead>
<tr>
<th>Scapular Position</th>
<th>Internal Rotation at 90° Flexion</th>
<th>Internal Rotation at 90° Abduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Control</strong></td>
<td><strong>Deficit</strong></td>
</tr>
<tr>
<td>Internal rotation</td>
<td>53.9 ± 13.3</td>
<td>38.2 ± 13.1</td>
</tr>
<tr>
<td>External rotation</td>
<td>21.6 ± 8.4</td>
<td>14.6 ± 13.4</td>
</tr>
<tr>
<td>Anterior tilting</td>
<td>3.0 ± 9.1</td>
<td>14.0 ± 11.5</td>
</tr>
<tr>
<td>Posterior tilting</td>
<td>13.3 ± 10.7</td>
<td>24.0 ± 11.7</td>
</tr>
</tbody>
</table>

^P < .05 between groups.

^P < .06 between groups.

^Significant differences between the groups across both glenohumeral positions, PC, 0.04.

G.I.R.D. is associated with

3) changes in the **SUBACROMIAL SPACE**

Decreased subacromial space (Maenhout AJSM 2012)

Quantifying Acromiohumeral Distance in Overhead Athletes With Glenohumeral Internal Rotation Loss and the Influence of a Stretching Program

Amelie Maenhout, PT, Ph.D., Jolene Van Deusen, PT, Louise Van Damme, PT, Sophie Van Cauwenberghe, PT, and Anne Gijsels, PT, Ph.D.

Guest investigators of the Department of Rehabilitation Sciences and Physiotherapy, Ghent University, Ghent, Belgium.
G.I.R.D.: criteria for measurement?

**IR:** < 18-25° difference D-nonD

(Wilk 2011, Shanley 2012, Kibler 2016)

**Total ROM concept:** < 5-10° decrease in total ROM compared to nonD side

(Ellenbecker 2009, Clarsen 2014)

Mechanisms resulting in GIRD:

- **Posterior** Capsule stiffness
- Posterior Soft tissue inflexibility/contracture (posterior RC)

**Bony** adaptations to sports performance (increased retrotorsion)

(Barber et al., 1999; Crockett et al., 2002; Reagan et al., 2002; Burkhart et al., 2003; Gagey et al., 2004; Laudner et al., 2006; Grossman et al., 2005; Lintner et al., 2007; Reinold et al., 2008; Poser et al., 2008; Borsa et al., 2008; Hibberd 2014)
Increased retroversion humeral head
(Crockett AJSM 2002)

CAUSE?
Immature bone – growth plate
Traction on humeral head by muscles during childhood

CONSEQUENCE:
Increased laxity of anterior ligaments, more external rotation

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Important to measure total range of motion (ER + IR)
(Braun et al. JBJS 2009, Ellenbecker & Cools 2010)

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G.I.R.D. 

Repetitive strain follow through

Shortening/thickening posterior capsule
Mechanotransduction
(post band IGHL)

GIRD

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(Burkhart et al. Arthroscopy 2003, Kibler 2013, Khan BJSM 2009)

---

G.I.R.D.

GIRD

Imbalance in hammock principle of anterior and posterior band

Increased Humeral translations

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G.I.R.D.

Increased humeral translations

“Impingement”

Cocking: postero-superior translation:
⇒ Internal Impingement

Follow through: antero-superior translation:
⇒ Subacromial Impingement

Role of Glenohumeral External Rotation?

- GER should be 5-10° D>ND
- GER depends upon position forearm: 6-10° less GER in pronation (tension on biceps)

(Kibler & Sciascia 2016, Wilk et al. AJSM 2015)
Excessive humeral head translations

Lack of scapular stability & mobility

Narrowing subacromial space

Role of the scapula in normal shoulder function
Diagnosis associated with impingement: SCAPULAR DYSKINESIS

Abnormal static scapular position and/or dynamic scapular motion characterized by medial border prominence

Inferior angle prominence and/or early scapular elevation/ shrugging on arm elevation

Rapid downward rotation of the scapula during arm lowering

(Second Scapula Summit 2006, Lexington, USA)

How many shoulder patients have scapular dyskinesis?

“Scapular dyskinesis is significantly more common in patients with shoulder pain, and the absence of dyskinesis after treatment is significantly correlated to a better outcome.” (Klaus Bak, SECEC Lyon Sept 2011)

- 87% of patients with shoulder pain have clinical signs of scapular dyskinesis (vs 21% in healthy control group)

- No difference among diagnoses: impingement, instability, AC pathology, labral tears, RC tears

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Scapular movements

Rotation

Translation

Upward ( & downward) rotation (sagittal axis)
Posterior ( & anterior) tilting (frontal axis)

External ( & internal) rotation (longitudinal axis)
Abnormal scapular orientation and kinematics?

Is there a relationship between subacromial impingement syndrome and scapular orientation? A systematic review

(Ludewig JOSPT 2009)

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>SUMMARY OF SCAPULAR KINEMATICS DURING ARM ELEVATION IN HEALTHY AND PATHOLOGIC STATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Healthy</td>
</tr>
<tr>
<td></td>
<td>Primary scapular motion</td>
</tr>
<tr>
<td></td>
<td>Secondary scapular motion</td>
</tr>
<tr>
<td></td>
<td>Accessory scapular motion</td>
</tr>
<tr>
<td></td>
<td>Presumed implications</td>
</tr>
</tbody>
</table>

(Ludewig JOSPT 2009)
Research scapulothoracic (dys)function

Analysis of scapular muscle function

strength, flexibility, muscle balance, timing

Scapular Muscle Function

Serratus Anterior

Trapezius

UPPER

MIDDLE

LOWER

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Role of the pect minor/rhomboid/lev scap?

See Shoulder Course level II

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Scapular force couple

Muscles with different/opposite action
Working together around an axis of rotation
Specific action/rotation
Functional stability and performance

Muscle Balance!

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Scapular force couple UPWARD ROTATION

**UT + SA**

Muscle Balance?
- Strength
- Amount of activity
- Timing….

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Scapular force couple

UT + SA: MOVEMENT

MT + LT: STABILITY & CONTROL

Anatomical and histological arguments (Johnson Clin Biomech 1994, Lindman et al. 1995)

Upper trapezius
Upward rotation + elevation

Serratus Anterior
Upward rotation + protraction

Middle & Lower trapezius
Stability and movement control
Abnormal scapular muscle performance?

Conclusion: Patients with SIS and glenohumeral instability display numerous variations in scapulothoracic muscle activity compared to healthy controls. In the SIS-group, the UT and SA muscle activity is decreased. In addition, the UT muscle activity is increased among the SIS patients, whereas no clear change is seen among patients with glenohumeral instability. Although the scapulothoracic muscle activity changed, no consensus could be made regarding muscle recruitment timing.

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Remote mechanisms associated with scapular dyskinesis
- Pain mechanisms
- Cervical spine disorders
- Thoracic spine mobility
- Core stability insufficiency
- Kinetic chain breakage lower limbs

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CAUSE - CONSEQUENCE RELATIONSHIP?


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CAUSE - CONSEQUENCE RELATIONSHIP:
“Secondary phenomenon based on muscle inhibition as result of pain”

Reflexive muscle inhibition known phenomenon

Aspecific scapular dyskinesis, no direct correlation with specific shoulder pathology (Bak SECEC 2011)

Experimentally induced pain changes scapular position and EMG activity (Wassinger 2013, Cools et al. Unpublished data)

---

CAUSE - CONSEQUENCE RELATIONSHIP:
“Primary cause of shoulder pain and impingement symptoms”

Scapular dyskinesis tends to narrow subacromial space (Ludewig JOSPT 2009)

Weakness in scapular muscles is associated with decreased acromiohumeral distance (AHD) (Leong JSMS 2016)

Scapular dyskinesis and pect minor shortness are possible risk factors for shoulder pain in overhead athletes, however no consensus (Reeser 2010, Kawasaki 2012, Tate 2012, Struyf 2013, Myers JSES 2013, Clarsen 2014)
Preliminary conclusion:

Primary predisposition, aggravated by pain inhibition mechanisms

Clinical evaluation scapular dyskinesis: classification into type I to III scapular dyskinesis

Type I scapular dyskinesis

Prominent inferior angle of the scapula
Anteriorly tilted scapula

Lack of soft-tissue flexibility
Lack of muscle performance

Scapular muscles
GH muscles/capsule
Muscle Control
Muscle Strength

Pectoralis minor
GIRD
Dysfunction lower trap/serrant
Type II scapular dyskinesis

Prominent medial border of the scapula

Internally rotated scapula

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Type III scapular dyskinesis

Prominent superior/medial angle of the scapula
Downward rotation of the scapula
“shrug” with elevation

Lack of soft-tissue flexibility
Lack of muscle performance

Scapular muscles
GH muscles/capsule
Muscle Control
Muscle Strength

Tightness of levator scapulae

Dysfunction
Upper trap/serr ant
Upper trap/ lower trap

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Scientific evidence??

1. Acceptable intra-tester reliability (Kibler JSES 2002); moderate to substantial inter-tester reliability (68 to 83% agreement) when palpation is added (Huang TS Man Ther 2015)

2. Dyskinesis patterns often combined (Mc Clure JAT 2009, Huang Man Ther 2015)

3. In normal people, scapular “dyskinesis” is often observed (Uhl T Artr 2009)

4. Specific kinematics (3D) and muscle activity (EMG) in type I and II scapular dyskinesis: ant tilt, int rot, UT ↑, LT ↓. (Huang TS JSES 2015)

Mc Clure’s quote: “the best 3D tracking device is our eyeball”

Observation of scapular dyskinesis (Yes/no method) (after standardized training of the assessor) is reliable

Clinical method is valid, distinguishing scapular dyskinesis from normal scapular movement

Patients with “obvious dyskinesis” have reduced external rotation, and increased upper trapezius activity
Conclusion

Have we talked about « your » causes of impingement?

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The role of central sensitization in shoulder pain?

Systematic reviews: Sanchis et al. 2015, Noten et al. 2016

Incl: unilateral shoulder pain, including SIS

Conclusion: “CNS becomes hypersensitive in a subgroup of patients with unilateral shoulder pain, including SIS, and the phenomenon of CS may play a role in the frequent pain complaints reported by these patients”

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Conclusion

- Impingement is a symptom, not a pathology
- Detect underlying diagnosis, based on biomechanical background
- GH level: watch out for GIRD!
- Look for relevant scapular dyskinesis
- Take into account central sensitization mechanisms