VADEMECUM
Glenohumeral Joint Instability (GHJI)

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INTRODUCTION
The shoulder is a joint evolved for mobility, and to some extent, stability has been sacrificed to achieve a wide range of motion (Hayes et al. 2002). Consequently, the shoulder is the most mobile joint in the body, and the shoulder’s range of normal laxity values varies widely. Determining laxity of the glenohumeral joint (GHJ) and distinguishing from pathological instability is challenging, because of the complexity of the combined motions of the glenohumeral and scapulothoracic articulations. Many clinicians believe that shoulder laxity is difficult to assess on physical examination (Bahk et al. 2007). A first important step is to define the difference between laxity and instability.

DEFINITIONS
- **GHJ Laxity:**
  - Looseness of the passive stabilisers of the shoulder
  - Laxity of normal shoulders is not known (Tzannes et al. 2002)
  - Caused by increased length and elasticity of the normal joint restraints, allowing a greater degree of translation of the articular surfaces (Johnson et al. 2010)
  - Detectable as an increased range of joint movement and distractibility

- **GHJ Instability (GHJI):**
  - Syndrome occurring when shoulder laxity produces symptoms (Hayes et al. 2002)
  - Results in poor control of the movement of the humerus on the glenoid (Tzannes et al. 2002)
  - Biomechanically, can be defined as a lack of control of the centre of rotation (Bak et al. 2010)

EPIDEMIOLOGY
According to Handoll et al. (2010), the incidence of first traumatic GHJI in North American population is 8.2/100,000 persons years, while the incidence of all types of instabilities is 11.2/100,000 person years. The estimated prevalence rate is 0.7% for men and 0.3% for women.

ANATOMY AND BIOMECHANICS
An in depth discussion of anatomy and biomechanics of the shoulder is not an aim of present product. A complete picture is given, among others, by Neumann (2010). We can briefly recap that the restraints to movement of the humeral head on the glenoid include static and dynamic components. A description of the role of every single ligament in shoulder stability according to many authors is exposed in the review from Bahk et al. (2007).

- **Static stabilizers:** Bony, labral, ligamentous or capsular shoulder structures and negative intra-articular pressure.
  - The glenohumeral ligaments are superior glenohumeral lig. (SGHL), coracohumeral lig. (CHL), the middle glenohumeral lig. (MGHL) and the inferior glenohumeral lig. complex (IGHLC) (Bahk et al. 2007)

- **Dynamic stabilizers:** Shoulder musculature and the ‘compression concavity’ mechanism created by the rotator cuff (Bahk et al. 2007)

- **Proprioceptive mechanisms:** Static and dynamic aspects should not be considered as separate mechanisms. It has been suggested that proprioceptive mechanisms involving reflexive muscular action may protect against excessive translations and rotations of the glenohumeral joint (Hayes et al. 2002)

AETIOLOGY AND CLASSIFICATION
Classification of GHJI is a difficult task, because it must simultaneously consider aetiology, direction, degree and frequency of instability (Finnoff et al. 2004). Numerous classifications of clinical instability in the shoulder have been published and used, but none have become universally accepted. A list of the most widely used types of classification is presented by Bak et al. (2010).
For clarity purpose we present a classification aiming to sum up the most relevant information of different authors (Hayes et al. 2002, Finnoff et al. 2004, Van der Berghe et al. 2005, Castagna et al. 2007, Bak et al. 2010, Johnson et al 2010), to find a compromise with respect to simplicity and capacity to identify all possible instability variations.

First time dislocations or subluxations can have a traumatic or atraumatic origin, leading to traumatic or atraumatic instability.

- **Traumatic instability:**
  - Around 90-95% of first-time shoulder dislocations
  - Results from either a forceful collision, falling on an outstretched arm, or a sudden wrenching movement.
  - The stabilizing structures are forcefully stretched in a sudden manner
  - Is sub-classified in:
    - **Traumatic anterior dislocation:** In up to 98% of cases the shoulder displaces in anterior direction (most common mechanism: forced external rotation and abduction of the humerus)
    - **Traumatic posterior dislocation:** 1-2%
    - **Traumatic inferior dislocation:** 1-2%
Atraumatic multidirectional instability:
- Around 5% of primary dislocations have atraumatic origin (e.g. minor incidents such as raising the arm or moving during sleep)
- Individuals can have capsular laxity or altered muscle control or both
- Individuals can dislocate or subluxate their shoulders with minimal force application or by putting their arms into certain positions
- Is associated with generalized ligamentous laxity, also including pathological conditions (Ehlers-Danlos syndrome, Marfan syndrome, osteogenesis imperfecta, and benign joint hypermobility syndrome)
- Its definitive etiology is still not clear and it may be multifactorial
- Can be sub-classified into voluntary and involuntary categories. Some patients with voluntary instability have associated psychological pathology, which portends a poor outcome if surgical stabilization is performed

Recurrent instability:
- Important complication (sequela) of primary instability
- About 70% of those who have already dislocated can expect to dislocate again within 2 years of the initial injury
- Age and gender result to be the most important factors in determining the rate of recurrence after a first dislocation

Minor instability:
- Also defined as acquired joint hyperlaxity
- Symptoms are commonly unilateral in the dominant shoulder, and other joints are often normal
- Swimmers, weight-lifters, rowers, gymnasts, and those playing racquet, overhead, or throwing sports are commonly affected, as are those whose jobs require prolonged use of the arm overhead

Grading of GHJI
Different measures for quantifying translations of the humeral head on the glenoid have been reported in the literature. The most valid and reliable one is modified Hawkins grading (Bahk et al. 2007)

- **Grade 0:** little to no movement (normal motion)
- **Grade I:** humeral head rides up onto the glenoid rim
- **Grade II:** humeral head can be dislocated (over the rim), but spontaneously relocates (subluxation)
- **Grade III:** humeral head does not relocates (lock out) when the pressure is removed (dislocation) (Tzannes et al. 2002)

![Fig. 1 Degree of humeral translation according to modified Hawkins grading (Bahk et al. 2007)](image)

ASSESSMENT
The diagnosis of GHJI is frequently based on:
- Patient's history
- Findings of the physical examination, including clinical tests

Many patients report a history of a painful dislocation or subluxation with or without a reduction. However, some patients do not have the classic history of this condition or they are unsure of what exactly happened to the shoulder (Farber et al. 2006). Atraumatic, multidirectional and subtler glenohumeral instability are often harder to diagnose (Tzannes et al. 2002).

Patient history
The clinical history is usually a very helpful guide for identifying GHJI. Based on the recommendations of the following authors, Finnoff et al. (2004), Van der Berghe et al. (2005), Bak et al. (2010), Johnson et al. (2010), in addition to an usual interview, the following specific questions should be included in a proper patient's anamnesis:
- Age of initial dislocation (if present)
- History of trauma, dislocation, subluxation (mechanism and arm position)
- Total number of instability episodes
- Degree of voluntary control of instability
- Extremity Dominance
- Occupation (position of arm when working, overhead activities)
- Sports participation (contact, throwing, overhead)
Symptoms:
- Vague symptoms: pain, popping, catching, locking, an unstable sensation, stiffness, swelling
- Weakness, numbness, paresthesias, ‘dead arm’
- Night pain (continuous or related to position)
- Instability during sleep
- Aggravating factors
- Alleviating factors
- Stiffness, ROM limitation
- Family history (hyperlaxity, soft tissue disorders)

Scoring systems
Scoring systems are recommended tools to evaluate patients with instability to make clinical decisions (Plancher et al. 2009 and Bak et al. 2010). Plancher et al. (2009) describe many of these scoring systems and recommend using:
- Melbourne Instability Shoulder Score (MISS) (Watson et al. 2005)
- Western Ontario Shoulder Instability Index (WOSI) (Kirkley et al. 1998)

There is a large consensus between many authors in considering WOSI the best scoring system for GHI.
For an electronic version of WOSI: http://www.orthopaedicscore.com/scorepages/oxford_wosi_score.html

Physical examination
According to the recommendations of Finnoff et al. (2004) and Van der Berghe et al. (2005), the key points of prior interest during the physical examination are:
- Visual inspection of the patient’s shoulder girdle: posture, deformity, swelling, muscle atrophy, discoloration and scars (the last two could suggest presence of connective tissue disorders)
- ROM: active and passive (including scapulothoracic and spine motion)
- Strength testing: all of the upper extremity muscles (emphasis on rotator cuff and scapular stabilizers)
- Proprioception: proprioceptive abilities of the shoulder
- Reflex testing: biceps (C5-6), brachioradialis or pronator (C5-6), triceps (C7-8)
- Palpation

Clinical tests
Despite the increasing emphasis on diagnostic imaging (Lo et al. 2004) accurate noninvasive clinical tests of shoulder instability are important in assessing and planning treatment for glenohumeral joint stability (Tzannes et al. 2002). In Table 1 the relevant data are reported to state accuracy of main clinical tests, according to different authors. For a detailed description of every test see Magee (2008).

Clinical tests can be divided in two main groups (Johnson et al. 2010):
- Laxity tests: examine the degree of translation of the humeral head on the glenoid (anterior and posterior Load and Shift, Sulcus Sign)
- Provocative tests: should provoke symptoms to consider a test positive (anterior and posterior Apprehension, Relocation and Release)

In general, sensitivity of clinical tests for GHJI is low, whereas specificity is higher. This means:
- High specificity → positive test will rule disorder in
- Low sensitivity → negative test will not rule disorder out

1. Tests for anterior and posterior instability: Since anterior instability is by far the most common type, tests aim primarily to detect it.
- Load and Shift Test:
  - Can be performed in 0° abduction (patient seated) and in 90° abduction (supine position)
  - Posterior direction, more reliable when performed in the 0° abducted position (patient seated)
  - Is the only test validated to assess anterior and posterior laxity in 90° abducted position → no consensus on validity of anterior and posterior drawer test (Tzannes et al. 2002)

Also for provocative tests, sensitivity is low and specificity is higher. Furthermore, for these three tests specificity varies depending on whether pain or apprehension is used as the criterion for diagnosis. All included authors agree in considering the provocative tests most accurate when apprehension alone is considered as a positive test.
- Apprehension (Crank) Test:
  - Is the only test examined by all the considered studies, alone or in combination with others
  - There is no significant difference in the outcomes between sitting or supine position (Farber et al. 2006)
Table 1 Clinical tests for assessing GHJI

<table>
<thead>
<tr>
<th>Test/Author (year)</th>
<th>Direction of instability</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Likelihood ratio</th>
<th>Predictive value (%)</th>
<th>Interexam reliability (ICC)</th>
</tr>
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<tbody>
<tr>
<td>Load and shift</td>
<td>Anterior</td>
<td>90</td>
<td>100</td>
<td>&gt;100</td>
<td>0,5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Posterior</td>
<td>14</td>
<td>100</td>
<td>&gt;100</td>
<td>0,9</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Inferior</td>
<td>8</td>
<td>100</td>
<td>80</td>
<td>0,9</td>
<td>-</td>
</tr>
<tr>
<td>Load and shift</td>
<td>(criteria for positive test)</td>
<td>Sensitivity (%)</td>
<td>Specificity (%)</td>
<td>Likelihood ratio</td>
<td>Predictive value (%)</td>
<td>Interexam reliability (ICC)</td>
</tr>
<tr>
<td></td>
<td>Anterior</td>
<td>68</td>
<td>100</td>
<td>&gt;100</td>
<td>0,3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Posterior</td>
<td>53</td>
<td>99</td>
<td>-</td>
<td>-</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Inferior</td>
<td>90</td>
<td>56</td>
<td>1</td>
<td>0,9</td>
<td>14</td>
</tr>
<tr>
<td>Relocation</td>
<td>Anterior (Relief of Apprehens.)</td>
<td>57</td>
<td>100</td>
<td>&gt;100</td>
<td>0,5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(Relief of Pain)</td>
<td>40</td>
<td>43</td>
<td>-</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(Relief of Pain or Appr.)</td>
<td>46</td>
<td>54</td>
<td>-</td>
<td>-</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>(Relief of Apprehens.)</td>
<td>32</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Relocation (Relief of Pain)</td>
<td>30</td>
<td>90</td>
<td>3</td>
<td>0,8</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>(Relief of Apprehens.)</td>
<td>81</td>
<td>92</td>
<td>10</td>
<td>0,2</td>
<td>53</td>
</tr>
<tr>
<td>Sulcus sign</td>
<td>Inferior</td>
<td>72</td>
<td>85</td>
<td>5</td>
<td>0,3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>&gt; 1cm</td>
<td>28</td>
<td>97</td>
<td>9</td>
<td>0,7</td>
<td>-</td>
</tr>
<tr>
<td>Combined tests:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>➔ Apprehension + Relocation + Release (Surprise)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farber et al (2006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>➔ Only 2 of the 3 tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>➔ Apprehension + Relocation</td>
<td></td>
<td></td>
<td></td>
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</table>

1 ICC = Interclass correlation coefficient

- **Relocation Test:**
  - Performed immediately after the Apprehension test (patient still in position of apprehension)
  - High inter-examiner reliability if performed in 90° abduction, not full external rotation (Tzannes et al. 2002)
  - No consensus about qualities of Relocation Test in the examined studies
  - Nevertheless considered important (essential to permit performing the Release Test)

- **Release (Surprise) Test:**
  - Most accurate individual examination manoeuvre
  - Excellent overall PPVs and NPVs
  - With a sudden release of the posterior force, the anterior structures are stressed maximally (more than during Apprehension or Relocation testing as the patient is in a position of more external rotation) (Lo et al. 2004)

An overall clinical anterior instability examination should not only consider single individual tests but a combination of tests (see table 1). Even though the surprise test is the most accurate individual examination manoeuvre, Lo et al. (2004) suggest using this test not exclusively but in a sequence of three tests.

**In summary,** when apprehension is used as a criterion for a positive Apprehension, Relocation or Release test and when reproduction of instability symptoms rather than pain is used as a criterion for a positive provocative test, these three tests are valuable examination techniques for helping in traumatic anterior and posterior shoulder instability diagnosis.

2. Tests for inferior and multidirectional instability

- **Sulcus Sign:**
  - Its role is being questioned (always found in individuals with generalized hypermobility, and the inter-observer and intra-observer reliability is low)
  - Biomechanically, it puts the rotator interval, the coracohumeral ligament, and the SGHL under stress, thus it fails to test the IGHLC which is most often involved in GHJI (Bak et al. 2010)
On the other hand, a sulcus sign of 1 centimetre was more sensitive, and lightly less specific than the load and shift test in assessing inferior laxity (Tzannes et al. 2002).

- Have a specificity of 97% for multidirectional instability when the sulcus is 2 or more centimetres. However, using this strict criteria the sensitivity is poor (28%) (Tzannes et al. 2002)

Gold standard for diagnosis
There is no consensus about the gold standard for diagnosis:

- According to Johnson et al. (2010), the diagnosis relies strongly on the history and clinical examination; special radiographic investigations usually do not provide additional information.
- According to other authors, the gold standard for soft tissue (including rotator cuff tears) and bone contusions evaluation is magnetic resonance imaging (MRI) (Van de Berghe et al. 2005, Bak et al. 2010).
- For other authors it is represented by mobilization under anaesthesia, since the passive stabilisers of the shoulder are tested in isolation (Tzannes et al. 2002).
- X-rays is considered the golden standard for bone damages as alternative to the MRI by some authors (Hayes et al. 2002).
- Finally arthroscopic inspection is believed to be the best diagnostic tool by some.

Lack of consensus is probably due to the fact that considered tools do not measure instability directly, but instead test the presence of soft or bony tissue damages, that are generally supposed to cause instability.

Practical use of clinical tests
The following is the sequence of laxity and provocative tests for GHJI suggested by Tzannes et al. (2002):

- **Patient seated:**
  - Sulcus Sign
  - Posterior Load and Shift (0° abduction)

- **Patient supine:**
  - Anterior and posterior Load and Shift (90° abduction)
  - Apprehension
  - Relocation focusing on apprehension rather than pain
  - Release (Surprise)

As mentioned, these tests have generally high specificity but low sensitivity. This means:

- **High specificity** → positive test will rule disorder in
- **Low sensitivity** → negative test will not rule disorder out → in case of doubt referral to specialist

In case of any doubt, referral to a specialist is always suggested.

Using external rotation for differential diagnosis
Lo et al. (2004) showed how the measure of the degrees of external rotation achieved during Apprehension and Relocation Tests can help to differentiate between multidirectional (MDI), posterior (PI), anterior instability (AI) and other shoulder pathologies. Differentiate MDI is possible because they can generally tolerate increased external rotation (average 130°) when compared, respectively, to PI (average 100°) and AI patients (average 83°).

Specific red and yellow flags for referral

Red flags: Patients with multidirectional shoulder instability may have specific patterns of collagen abnormality. Those with a suspected connective tissue disorders (Ehlers-Danlos syndrome, Marfan syndrome), genetic bone tissue disorders (ostogenesis imperfecta) and other pathologies such as benign joint hypermobility syndrome should be referred for special examinations (Johnson et al. 2010, Van der Berghe et al. 2005).

Yellow flags: Some patients with voluntary instability have associated psychological pathology, which portends a poor treatment outcome (Finnoff et al. 2004). In this case, referral for integrative psychological therapy could be recommended.

TREATMENT

Operative vs conservative treatment
In general:

- There is large consensus on the fact that conservative treatment is highly successful after GHJ subluxation episodes, and in patients with multidirectional instability and minor shoulder instability (throwing sports and overhead activities) (Finnoff et al. 2004, Bak et al. 2010).
- Decision between nonoperative treatment versus immediate surgical stabilization is more controversial for patients who have a traumatic first time anterior GHJ dislocation (Finnoff et al. 2004).
An instability-free period of two years after a primary dislocation can be regarded as a landmark in the treatment of the patient, at which time he or she may be counselled that the likelihood that a recurrent dislocation will develop is low (Robinson et al. 2006).

Conservative treatment
To the researchers' best knowledge, no high level evidence study has ever been performed to establish the best conservative treatment of GHJI. The following details about conservative treatment are based on indications about therapeutic goals and interventions suggested by Finnoff et al. (2004), Van der Bergh et al. (2005) and Johnson et al. (2010). The program presented here should be considered as a general frame. Based on this, the treatment plan specific for every patient should be individualized according to the singular needs.

- **Pain and oedema control:**
  - Taping can decrease pain, improve joint biomechanics, enhance neuromuscular re-education, reduce anterior humeral head translation (AI), elevate the centre of the humeral head (MDI)

- **Protection of the static GHJ stabilizers:**
  - Avoid impingement positions
  - Decrease capsular stress
  - Prevent tendon overload
  - Immobilization to consider only for comfort reasons

- **Obtaining full function of the dynamic stabilizers:**
  - Re-establishing appropriate force couples about the glenohumeral and scapulothoracic joints:
    - One significant force couple involves the synergistic contraction of the deltoid, supraspinatus, infraspinatus, teres minor, and subscapularis to allow glenohumeral joint abduction
    - Another force couple involves the coordinated contraction of the serratus anterior and upper and lower trapezius to facilitate upward rotation of the scapula during shoulder elevation

- **Correcting associated kinetic chain deficits:**
  - Postural and kinetic chain deficits need to be identified and corrected

- **Restoring joint proprioception:**
  - Rhythmic stabilization and proprioceptive neuromuscular facilitation (PNF)

**REFERENCES**