

## THE CUFF

HUG  
Hôpitaux Universitaires de Genève



UNIVERSITÉ DE GENÈVE  
FACULTÉ DE MÉDECINE

Lädermann Alexandre

Service d'orthopédie et de traumatologie de l'appareil  
moteur

## Content

- Etiology
- History
- Pathologic conditions
- Treatment
- Rehabilitation



4 questions:

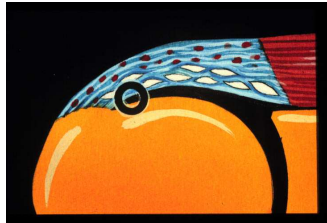
- Is it a cuff tear?
- Does the patient need an operation?
- At which moment?
- Which technique ?

## Pathogenesis of degeneration

- Duplay, 1872: péri-arthrite scapulo-humérale
- Meyer, 1931: « tears of the rotator cuff occurred secondary to attrition as a result of friction with the undersurface of the acromion »
- Codman, 1934: « critical zone, where most degenerative changes occur, as a portion of the rotator cuff located one centimeter medial to the insertion of the supraspinatus on the greater tuberosity »
- McLaughlin, 1951: « The anterior acromion was removed. The early result was good... »
- Neer, 1972: Subacromial impingement syndrome

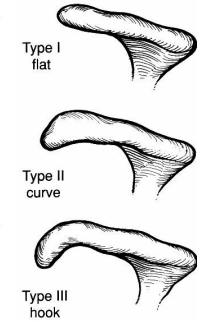
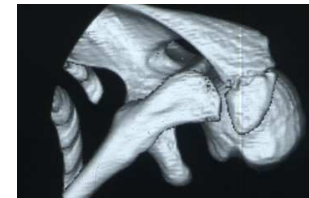
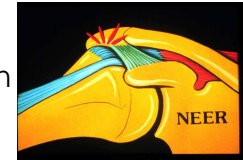
## Etiology

- Age related degeneration
- Vascular critical portion Codman



## Etiology

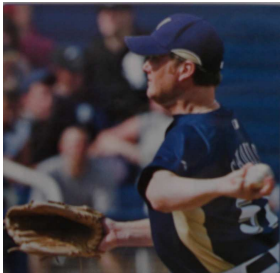
- Age related degeneration
- Vascular critical portion Codman
- Mechanical:  
External impingement Neer



Bigliani. Orthop. Trans 1986 and JBJS 2007

## Etiology

- Age related degeneration
- Vascular critical portion Codman
- Mechanical:  
External impingement Neer  
Internal impingement Walch, Gerber



## Etiology

- Age related degeneration
- Vascular critical portion Codman
- Mechanical:  
External impingement Neer  
Internal impingement Walch, Gerber
- Tension Overload
- Trauma (macro)



## Patient History

- Reason for visit
- Relevant history
  - Medications
  - Injections
  - Physical therapy
  - Surgery
  - Worker's compensation

## Patient History

- Reason for visit
- Relevant history
- Characterize pain
  - Location (post,ant,lat...)
  - Severity
  - Time of day
  - Precipitating activity
  - Effect on ADL's

## Assessment

- 1) Clinical exam
- 2) Radiographic
- 3) Isokinetic testing

important in decision for:

- Cuff repair
- Muscle tranfert
- Prosthesis
- Dysbalances (sports)

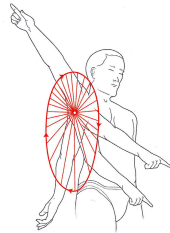
## Shoulder girdle muscles

- |                     |                       |
|---------------------|-----------------------|
| 1) Rotator cuff     | 6) Latissimus Dorsi   |
| ⊙ Supraspinatus     | 7) Trapezius          |
| ⊙ Infraspinatus     | 8) Teres major        |
| ⊙ Teres Minor       | 9) Levator Scapularis |
| ⊙ Subscapularis     | 10) Rhomboids         |
| 2) Pectoralis minor | 11) Coracobrachialis  |
| 3) Pectoralis major | 12) Serratus Anterior |
| 4) Biceps Brachii   | 13) Deltoid           |
| 5) Triceps          |                       |

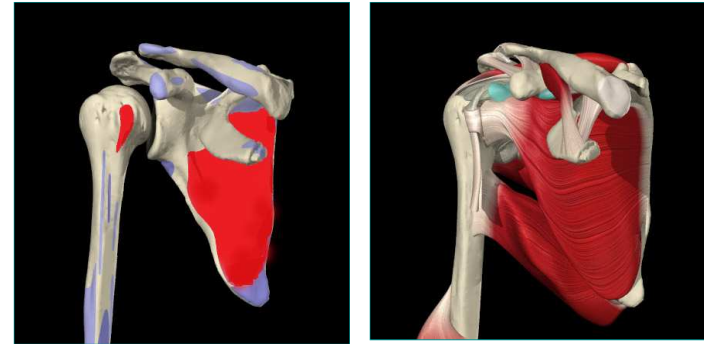
Known by the acronym S.I.T.S.

## Function

- The rotator cuff muscles are deep in location and serve as stabilizers of the GH joint.
- Permit movements of the shoulder:
  - Flexion
  - Extension
  - Abduction
  - Adduction
  - External rotation
  - Internal rotation



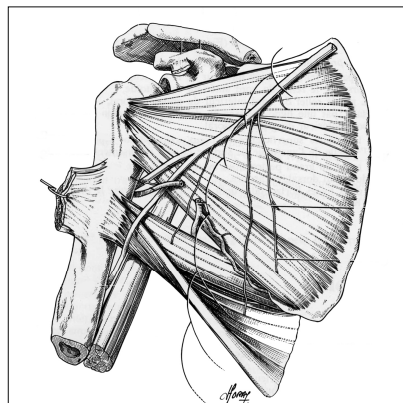
## Subscapularis



Origin: subscapular fossa of scapula  
Insertion: lesser tubercle of humerus

## Subscapularis

INNERVATION  
SUBSCAPULARIS NERVE



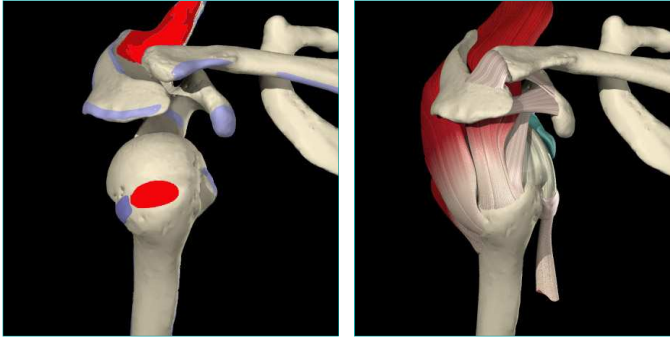
## Subscapularis

Most powerful muscle of the cuff (53%)

Action:

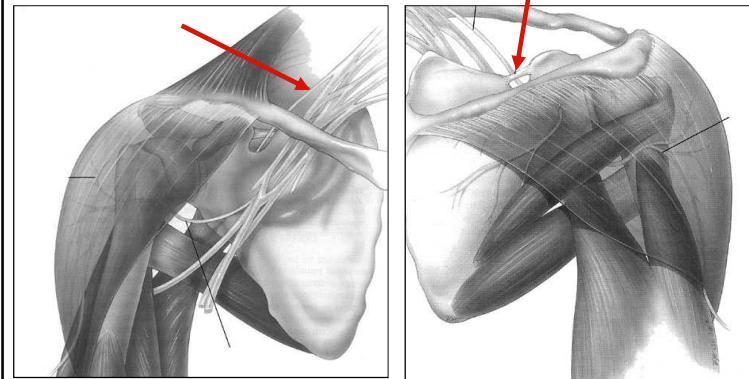
- Stabilizes the front of the shoulder
- Rotates the arm inward

## Supraspinatus



Origin: supraspinous fossa of scapula  
 Insertion: greater tubercle of humerus

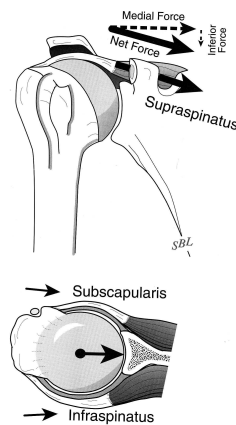
## Supraspinatus



INNERVATION: SUPRASCAPULARIS NERVE

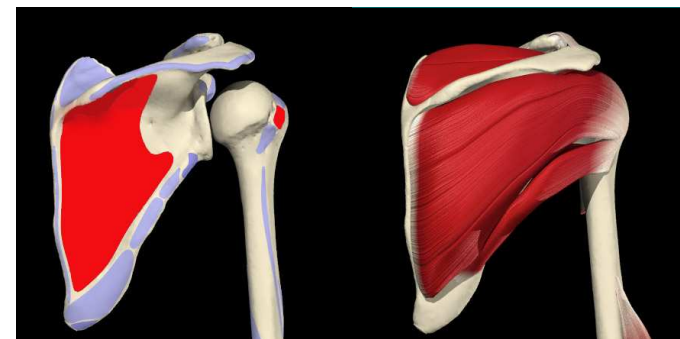
## Supraspinatus

- 14% strength of the cuff
- Action:
- Stabilizes the shoulder joint
  - Initiates the first 30-60 degrees of abduction at which point the deltoid takes over
  - Acts also either as an external or internal rotator, depending on the position of the humerus



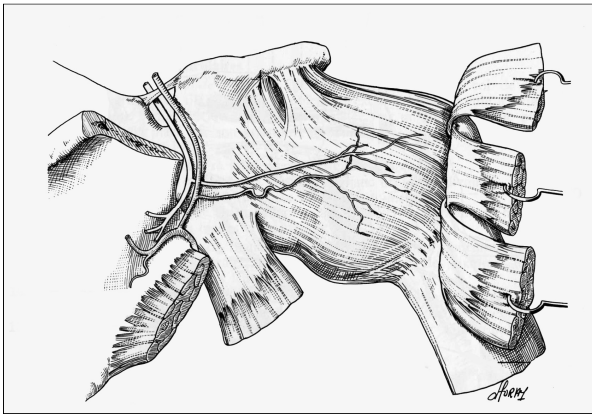
Favre JSES 2009 , Basset J Biomech 1990

## Infraspinatus



Origin: Infraspinous fossa of scapula  
 Insertion: greater tubercle of humerus

## Infraspinatus



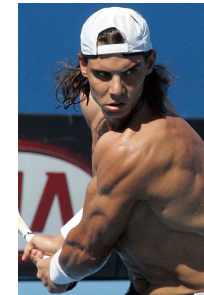
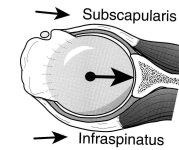
INNERVATION: SUPRASCAPULARIS NERVE

## Infraspinatus

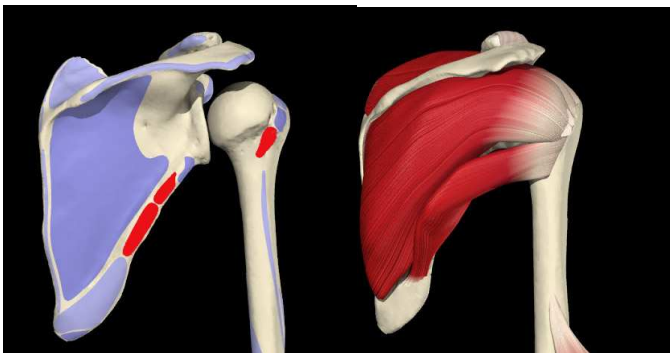
- 22% of strength of the cuff  
(60% force in ER)  
Colachis Arch Phys Med Rehab 1969

Action:

- Stabilizer of the back of the shoulder  
(antagonist of the subscapularis)
- Laterally rotates and adducts arm at shoulder joint (depressor of the humeral head)

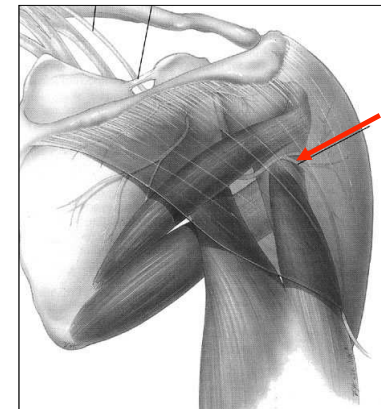


## Teres minor



Origin: Inferior lateral border of scapula  
Insertion: greater tubercle of humerus

## Teres minor



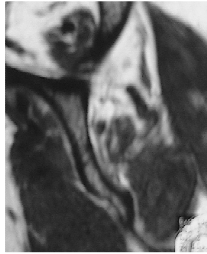
INNERVATION AXILLARY NERVE

## Teres minor

- Less powerful muscle of the cuff (40% force in ER)  
Colachis Arch Phys Med Rehab 1969

Action:

- External rotation in 90° of abduction
- Auxiliary stabilizer in normal condition due to its small cross-sectional area  
Favre JSES 2009
- Hypertrophy in case of deficit of infraspinatus



## Clinical examination

- Cervical spine
- Visual inspection
- Palpation
- Passive ROM
- Active ROM
- Cuff specific testing



## Visual Inspection

- Remove shirt
- Systematic
  - Deltoid
  - Supraspinatus
  - Infraspinatus



## Visual Inspection

- Remove shirt
- Systematic
  - Deltoid
  - Supraspinatus
  - Infrapinatus
  - Biceps
  - AC joint
  - Skin changes
  - Scars



## Palpation

- Comparative AC joint compression
- Crossed arm adduction if painful asymmetrically



## Passive ROM

- Supine position
- Compare both sides
- Forward elevation
- IR and ER at 90°
- ER at 0°





### Limited PROM

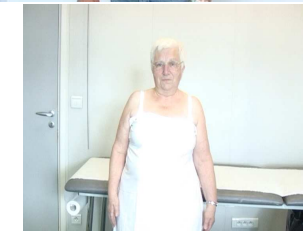
- Osteoarthritis
- Adhesive capsulitis

→ Stop exam !

- Painful
- Inaccurate
- Doesn't influence immediate treatment

### Active ROM

- Forward elevation
- Painful arc
- Pseudo-paralytic shoulder



### Loss of active forward elevation: Pseudoparalytic shoulder

- No pain
- Active elevation < 80°
- Complete passive ROM
- 2-3 affected tendons

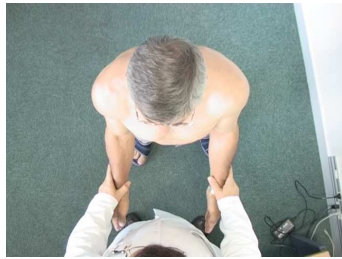
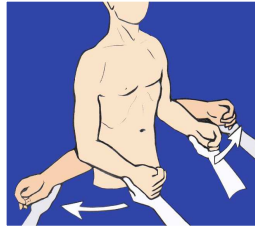


### Dynamic antero superior subluxation



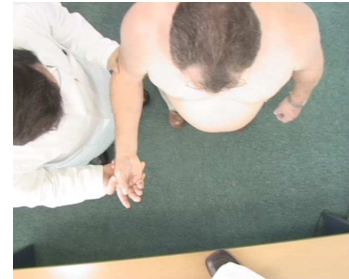
### Active ROM

- External rotation  
0° abduction



Increased ext rot  
if subscap rupture

### Deficit of active external rotation at 0° abduction



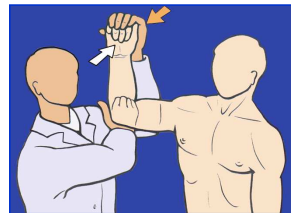
External rotation lag  
(HERTEL)



Dropping sign  
(NEER)

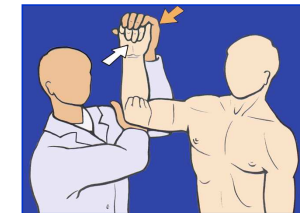
### Active ROM

- Patte
- External rotation  
90° abduction



### Active ROM

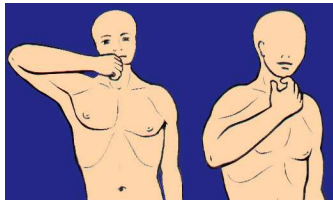
- External rotation  
90° abduction



Drop sign  
(Hertel)



## Loss of active external rotation at 90° abduction



Horn blower sign

## Active ROM

### • Internal rotation

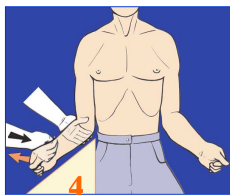
- Level reached by thumb
- Observe from behind
- Comparative



## Rotator Cuff Testing Infrapinatus

External rotation strength  
0° abd & 45° ER

(no ERL,  
no dropping sign)

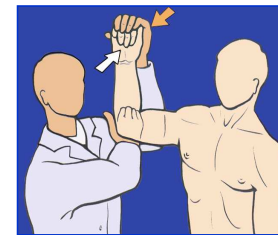


5°



## Rotator Cuff Testing Teres Minor

Strength in ER at  
90° Abd-90° ER  
(Only tested if  
infrapinatus is weak)



### Rotator Cuff Testing Teres Minor

Drop sign  
(Hertel)



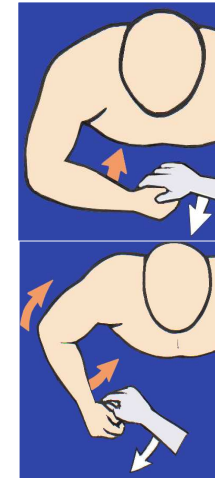
### Rotator Cuff Testing Subscapularis

Belly-press test

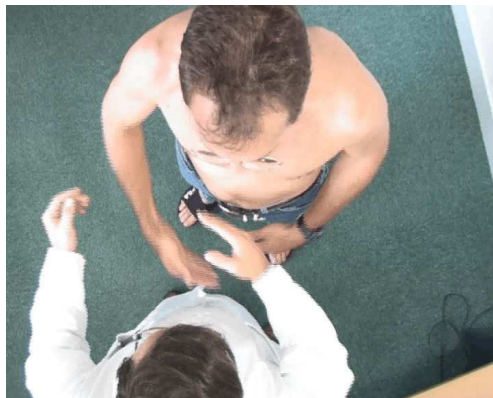


Normal

Subscapularis rupt.



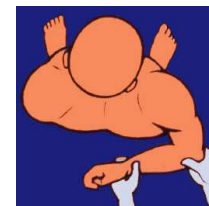
### Rotator Cuff Testing Subscapularis



Press belly test

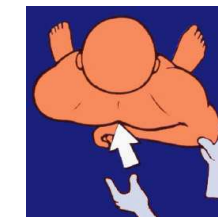
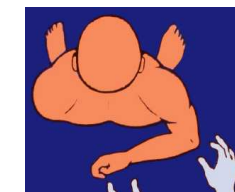
### Rotator Cuff Testing Subscapularis

Lift-off test



Normal

Subscapularis rupt.



### Rotator Cuff Testing Subscapularis



Lift-off test (Gerber) ± Internal lag sign

### Rotator Cuff Testing biceps

- Examine contour
- Look for signs of rupture

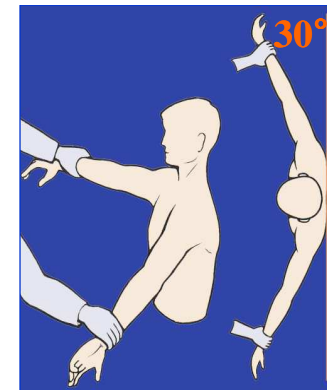


### Popeye sign



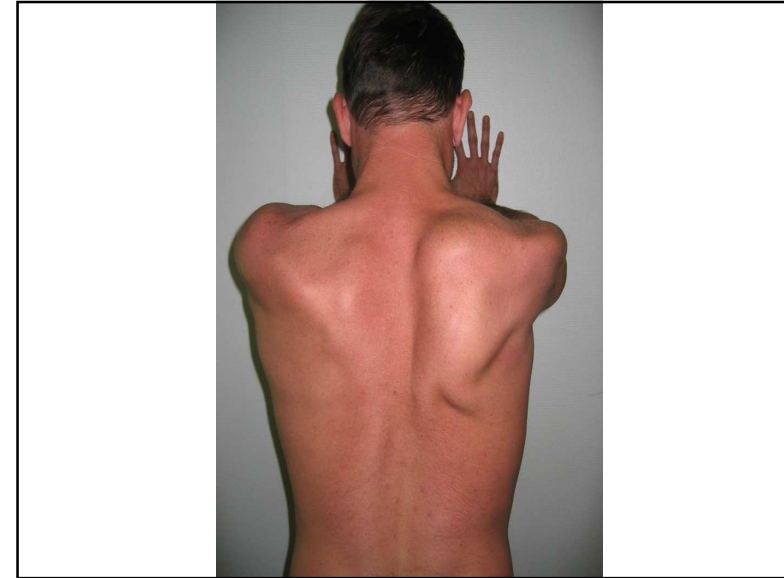
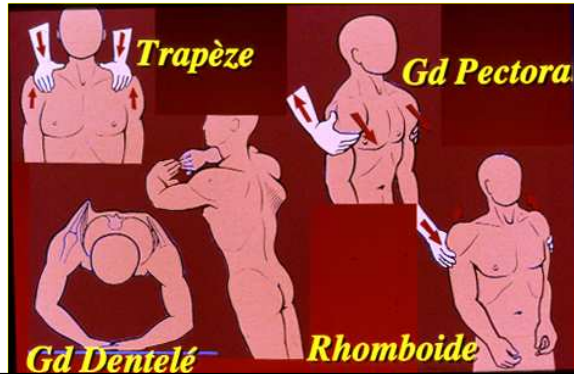
### Rotator Cuff Testing Supraspinatus

- Jobe's test
  - 90° abduction
  - 30° anterior flexion
  - Internal rotation



## Extrinsic Scapular Muscles

- Trapezius
- Rhomboid
- Serratus anterior



## Cervical Spine

- Do not overlook
- Palpation:
  - Levator scapulae
  - Trapezius
  - D4
  - C4-C5
- ROM



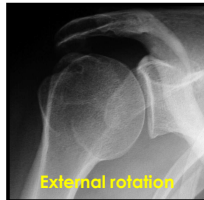
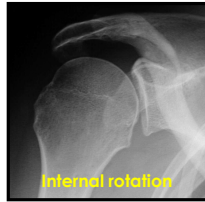
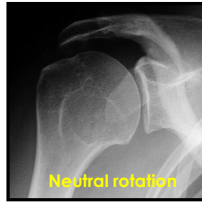
## Things Typically NOT Done systematically

- Abduction
  - Biceps tendonopathy tests (speed, yergarson, palm up)
  - SLAP Testing (O'Brien...)
  - Impingement signs/test (Neer, Hawkins, yocum)
  - Palpation of:
    - Greater and lesser tuberosities
    - Coracoid
    - Bicipital groove
- ... painful and not specific

## Imaging

### Standard X-ray examination

AP radiographs

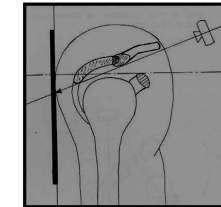
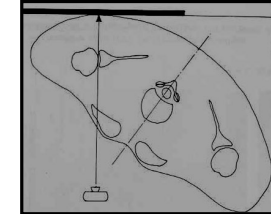
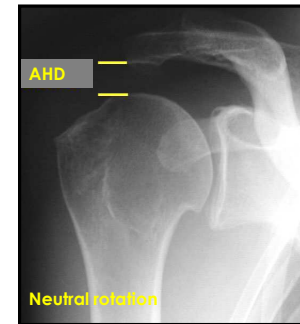


Supraspinatus outlet view

## Imaging

### Standard X-ray examination

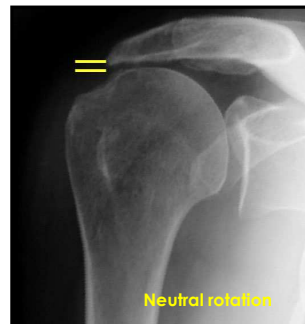
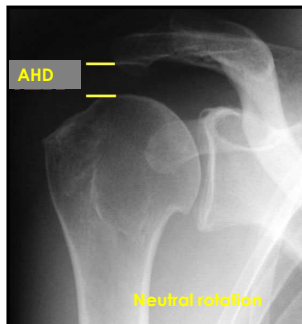
Acromiohumeral Distance



## Imaging

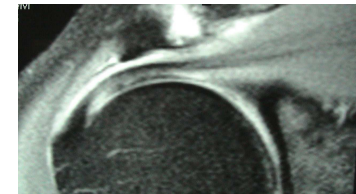
### Standard X-ray examination

Acromiohumeral Distance



## Secondary Imaging

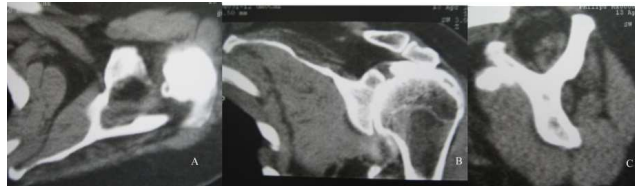
- Echo
- Arthro MRI
- Arthro CT
- (Infiltration test)



## Muscle: pathologic conditions

- Muscles of the rotator cuff undergo profound changes in response to tendon tear (or experimental tenotomy) reflected by fatty infiltration, muscle retraction and atrophy.

Goutallier CORR 1994, Fuchs JSES 1999,  
Meyer J Orthop Research 2004, Gerber JSES 2009



## Fatty infiltration

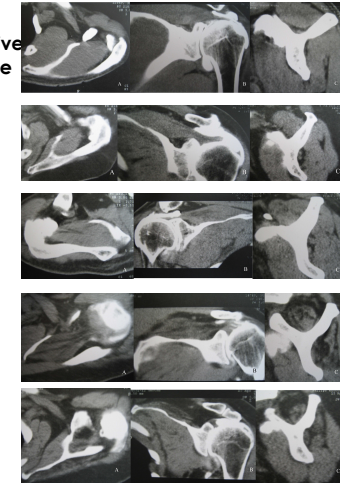
**Fatty infiltration of the rotator cuff musculature is a permanent and progressive consequence of rotator cuff tendon rupture**

Goutallier CORR 1994

**Fatty degeneration grading on CT scan**

Grade 0  
Grade 1  
Grade 2  
Grade 3  
Grade 4

No fatty deposits  
Some fatty streaks  
More muscle than fat  
As much muscle as fat  
Less muscle than fat



## Fatty infiltration

Reparable tears:

- Acromio-humeral distance (AP neutral rot)  $\geq 7$ mm

Weiner, JBJS, 1970

- Fatty infiltration  $\leq 2$  grade

Goutallier CORR 1994, Fuchs JSES 1999, Goutallier JSES 2003

- No osteoarthritis



## Fatty infiltration

- Architectural changes following alterations in muscle tension and pennation angles have been postulated as the cause of this fatty FI.

Meyer J Orthop Res 2004, Nakagaki JSES 1996

- FI > 2 decreased postoperative strength, shoulder mobility, tendon-bone healing

Goutallier 1998, Gladstone 2007

- FI may be halted but not reversed by successful tendon repair

Gerber JSES 2007

- Large tendon tears, longer delays after tendon rupture, and older patient : more severe and frequent FI

Gerber JBJS 2000, Mélis&Walch JSES 2009



## Fatty infiltration

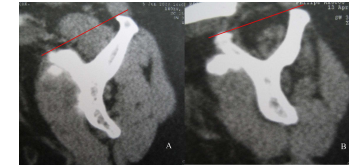
- Delays after tendon rupture
- Mean time to tendon rupture-intermediate FI:  
3 years for supraspinatus  
2.5 years for infraspinatus and the subscapularis
- Mean time to tendon rupture-severe FI:  
5 years supraspinatus  
4 years infraspinatus  
3 years subscapularis

Méris&Walch Orthop & Traumatol Surg Research 2009

## Muscular atrophy

- Tangent sign

Zanetti 1998



- Strongly correlated with stage of fatty infiltration of the supraspinatus ( $p < 0.0001$ )

Williams&Walch JSES 2009

- A positive Tangent sign was significantly related to the presence of grade 3-4 FI

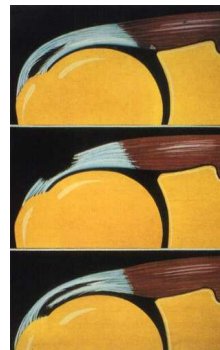
Williams&Walch JSES 2009

- There is a potential of muscle regeneration through continuous traction after tendon release

Frey J Orthop Res 2009

## Classification of tear

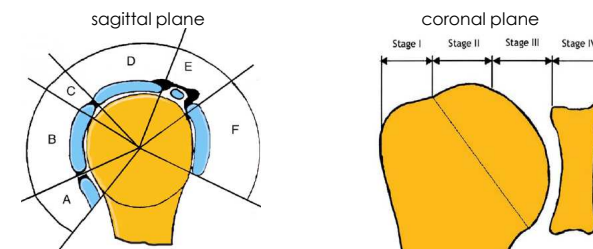
- Characterized by size, retraction and location
- Etiology
  - Not used! May be most important
- Size:
  - Massive tears  $\geq 2$  complete tendons (correlate more consistently with function, prognosis, and surgical outcome)
- Location
  - Articular, bursal, intrasubstance
- Degree
  - < 50 %, > 50 %



Gerber JBJS 2000

## Classification of tear

Location and retraction of the tear:



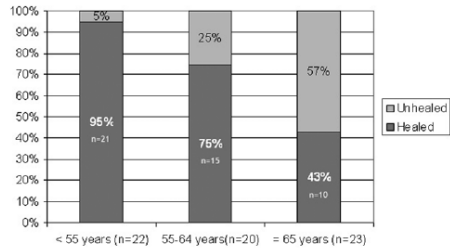
Most massive tears appear to follow 2 distinct anatomic patterns: posterosuperior or anterosuperior.

Warner&Gerber AAOS 1998



## Indication for surgery

### Pronostic factors of healing

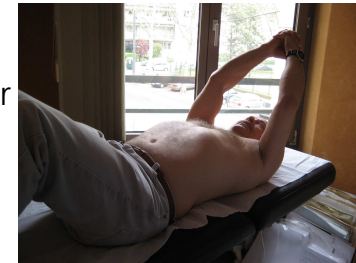


- 95% healing in patients < 55 years
- 75% healing in patients between 55-64 years
- 43% healing in patients > 65 years

Boileau P, JBJS 87-A, 2005

## Indication for surgery

- There is no emergency
- Relieve pain
- Avoid frozen shoulder
- Have an imaging



## Indication for surgery

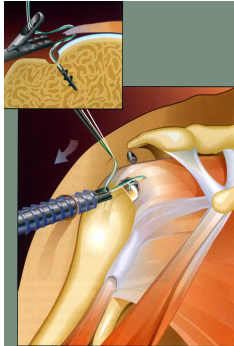
- <55 y/o need orthopaedic advice
- >55 depend of:
  - Symptomatology, effect on ADL's
  - Request of the patient, sports and professional activities



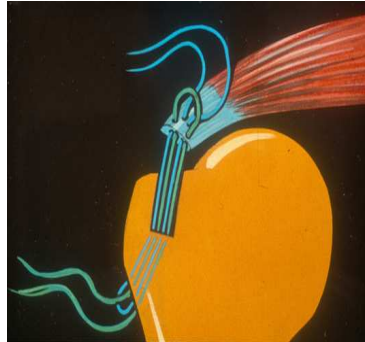
## Indication for surgery

- <55 y/o need orthopaedic advice
- >55 depend of:
  - Symptomatology, effect on ADL's
  - Request of the patient, sports and professional activities
  - Patient commorbidities (diabetes), smoke, previous infiltration, motivation
  - Type of lesion, muscle retraction or atrophy, fatty infiltration

## Arthroscopic

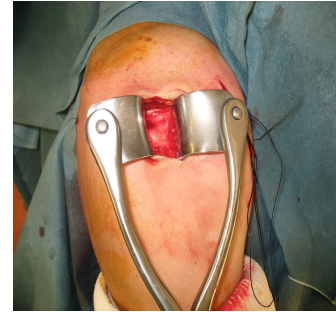


## Open



Same long term results  
Experience of surgeon

## Operative technique



## Operative technique

- General anesthesia



## Healing

- NSAID compromise healing
  - NSAID inhibit and compromise significantly tendon-to-bone healing (in rat)  
Cohen, Am J Sports Med, 2006
- Smoking and previous corticosteroids too!
- How strong is the repair (in sheep)?
  - 30% Normal at 6 weeks
  - 52% Normal at 3 months
  - 81% Normal at 6 months

Gerber C, JBJS 86-A, 2004

## Postoperative immobilisation

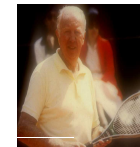


0 to 6 weeks: no activity

6 weeks: normal daily life

3-6 months: return to work,  
sport

9 months -1 year: the patient  
forgets his shoulder



## Postoperative rehabilitation



Passif D1



## Postoperative rehabilitation



Passif

Actif

Strengthening

