Does Abnormality in Scapular Motion Increase the Risk of Shoulder Impingement Syndrome: An Evidence Based Review

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THE PROBLEM

- Shoulder impingement syndrome
  - common musculoskeletal condition
- Several contributing factors for impingement syndrome (SIS):
  - bony abnormality, rotator cuff insufficiency, posterior capsule tightness, glenohumeral instability and scapular motion disorder
- Scapular motion disorder
  - potential source of mechanical dysfunction causing shoulder impingement syndrome

THE PROBLEM

- **Important questions**:

  - Whether the abnormal scapular motion contributes to the etiology of SIS?

  - Whether restoring normal scapular motion prior to shoulder symptoms could prevent SIS?

  - Whether correction of scapular motion post onset of SIS symptoms could facilitate relief of pain and return of function?

SIGNIFICANCE OF THE PROBLEM

- Impingement syndrome accounts for almost half of the total shoulder patient population.

- Impingement syndrome:
  - acute or chronic
  - chronic impingement is difficult to treat

- Identify potential risk factors
  - poor scapulo-thoracic motion or postural alignment
  - helpful tool to address both prevention and treatment

RELEVANCE TO PT

- Conservative treatment
  - exercises to improve function of rotator cuff muscles and scapular muscles.
- Specific contribution of scapula to SIS is not known.
- Research/evidence support for the importance of correcting Scapular mal-alignment and kinematics could be helpful:
  - To evaluate and diagnose SIS
  - To know how much emphasis should be given to Scapular kinematics
  - In developing an educational program for prevention of SIS
  - Early identification of patients at risk of developing SIS

PRIMARY QUESTION

Does abnormality in scapular motion increase the risk of shoulder impingement syndrome?

This is a background question

HYPOTHESIS

- H_0: There is no significant correlation between abnormal scapular motion and the: a) prevalence and b) incidence of shoulder impingement syndrome.

- H_1: There is a significant correlation between abnormal scapular motion and the: a) prevalence and b) incidence of shoulder impingement syndrome.

EXPECTED FINDINGS

- Able to find epidemiological, prevalence and incidence literature evidence to support a significant, positive correlation between presence of abnormal scapular motion and prevalence and incidence of impingement syndrome.

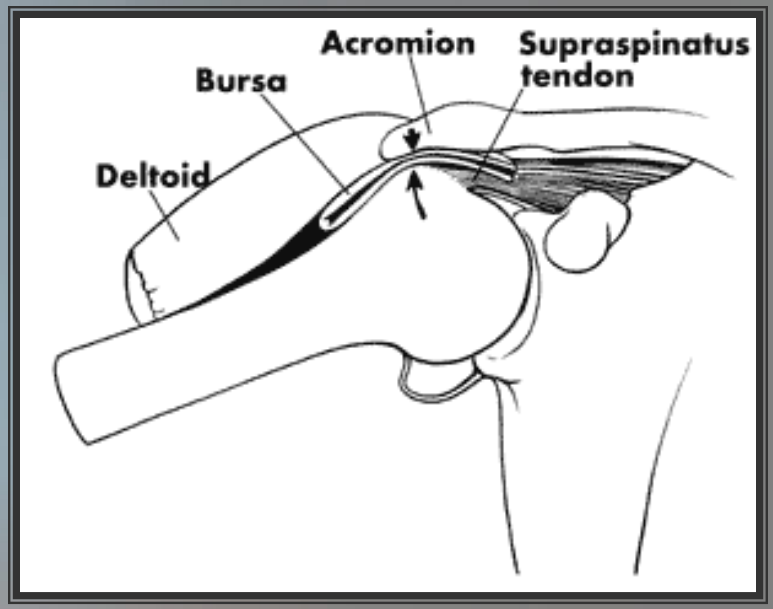
THEORETICAL CONSTRUCT

Shoulder and Scapula:

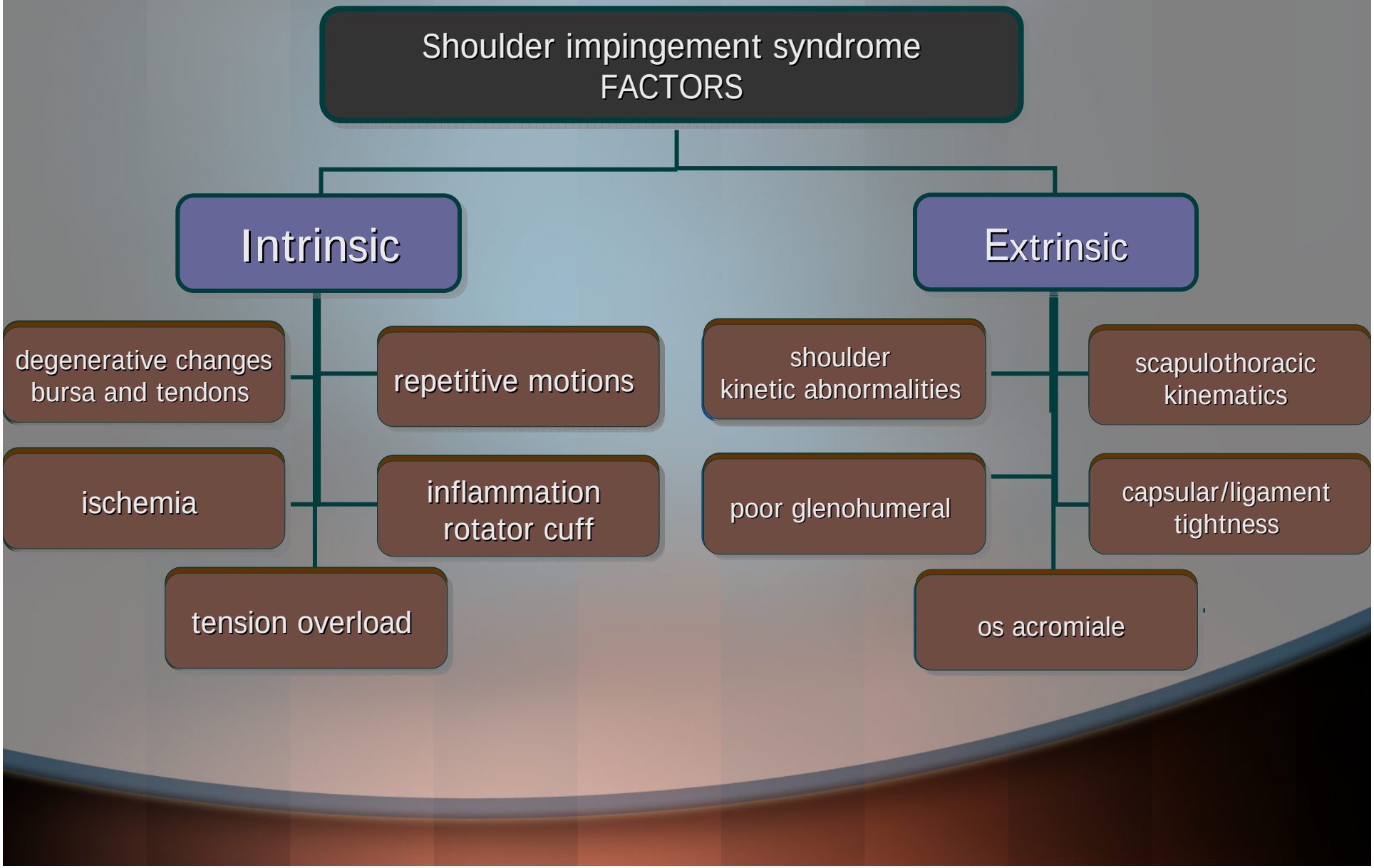
- Altered scapulothoracic motion affects the function of shoulder joint
  - approximately 1 degree of scapulothoracic motion for every 2 degrees of glenohumeral elevation during flexion/abduction
- Rotator cuff muscles
  - dynamic stabilizers
  - originates from the scapula
  - any abnormality in scapular motion must put the RC muscles at disadvantage

BACKGROUND

- What is Shoulder impingement syndrome?
  - Definition
    - “pain with overhead movements”
  - Shoulder girdle anatomy
    - Humerus, Acromion, Clavicle,
    - Rotator cuff muscles and tendons
    - Subacromial bursa
  - Pathophysiology
    - Entrapment of structures such as bursa, rotator cuff tendons, ligaments in sub-acromial space



BACKGROUND

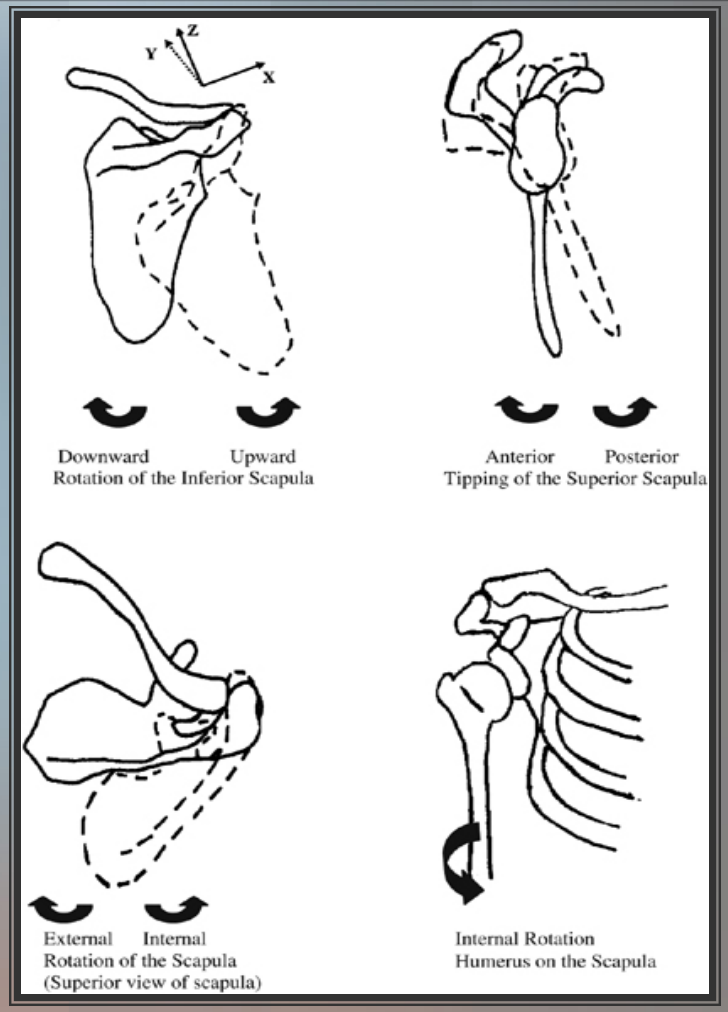

Shoulder impingement syndrome
FACTORS
Intrinsic
Extrinsic
degenerative changes
bursa and tendons
repetitive motions
ischemia
inflammation
rotator cuff
tension overload
shoulder
kinetic abnormalities
scapulothoracic
kinematics
poor glenohumeral
capsular/ligament
tightness
os acromiale

BACKGROUND

- What is the prevalence of shoulder Impingement syndrome?
  - 16% to 21% of the entire patient population
  - 44% to 65% of shoulder pain complaints, seen by physicians, are diagnosed as shoulder impingement syndrome
  - 10% of the total patients referred to physical therapy are for shoulder impingement syndrome

BACKGROUND

- What are normal scapular motions?
- What are abnormal scapular motions?
  - Any alterations in normal motion
- No data available on prevalence and incidence of abnormal scapular motions.



BACKGROUND

- What are the factors influencing prevalence and incidence of abnormal scapular motion :
  - Age
  - Gender
  - Posture
  - Activity related (overhead sport, swimming etc)
  - Occupation

BACKGROUND

What is the usual conservative treatment for

- Impingement syndrome:
  - Theraputic exercises, manual therapy, postural re-education, ultrasound, laser, acupuncture
- Abnormal scapular kinematics:
  - Stretching and strengthening of scapular muscles
  - Postural re-education of cervical and thoracic spine

SEARCH METHODS

- PubMed
- Medline
- Cochrane
- PEDro
- MeSH
- scholar.google

SEARCH METHODS: KEYWORDS

- “scapular kinematics”
- “kyphosis”
- “scapular posture”
- “shoulder posture”
- “impingement syndrome”
- “subacrominal impingement syndrome”
- “subacromial”
- “scapula and impingement syndrome”

DATA ANALYSIS: EVIDENCE BASED STATASTICS

- Sensitivity: a/a+b
- Specificity: d/b+d
- Positive predictive value: a/a+b
- Negative predictive value: d/c+d
- Likelihood ratio positive: sensitivity/ (1-specificity)
- Likelihood ratio negative: (1-sensitivity)/specificity
- Pre-test probability (prevalence): a+c/a+b+c+d
- Pre-test odds: prevalence/ (1-prevalence)
- Post-test odds +: pre-test odds x LR+
- Post-test odds-: pre-test odds x LR-
- Post-test probability: post-test odds/ (post-test odds +1)

INCLUSIVE/EXCLUSIVE CRITERIA

- Subjects:
  - Experimental and control group
  - Experimental group positive for shoulder impingement syndrome
  - Some form of scapular kinematic measurement
- Level of Evidence:
  - Level I-III
- Research Published: 1990-2008

STUDY FINDINGS

- Number of studies appropriate for secondary questions:18
- Number of studies appropriate for primary question: 12
- Number of studies that met all criteria to answer primary question: 8

DESCRIPTION OF STUDIES

#	Author/yr	Year	Type of study	Control	Level
1	Lukasiewicz et al	1999	Retrospective	yes	III
2	Ludewig et al	2000	Retrospective	yes	III
3	Hebert et al	2002	Retrospective	yes	III
4	Endo et al	2000	Retrospective	yes	III
5	Laudner et al	2006	Retrospective	yes	III
6	Borstad et al	2002	Retrospective	yes	III
7	Warner et al	1992	Retrospective	yes	III
8	McClure et al	2006	Retrospective	yes	III

DESCRIPTION OF STUDIES

#	Author/yr	Year	Type of study	Level
1	Michener et al	2003	Systematic review of studies on factors affecting SIS, no statistics	II
2	Roy et al	2007	Retrospective experimental study with control. Data not good for calculations	III

Results: Lukasiewicz et al 1999

Subjects # (Mean age)	Healthy: 20 (34 years) SIS: 17 (45 years)
Method	3- Dimensional electromechanical digitizing
Posterior Scapular tilt angle	angle between a vector passing through C7 and T7 and the inferior angle and root of spine of scapula
Arm level	maximum
Mean (SD) Degrees	SIS: 25 (8) Control: 34.5 (8)
Findings	Lack of posterior tilt and excessive superior translation is SIS group

Results: McClure et al 2006

Subject # (Mean age)	Healthy: 45 (43 years) SIS: 45 (45 years)
Method	3-Dimensional electromagnetic motion analysis system- 3 SPACE FASTRAK*
Scapular tilt angle	Scapula receiver with pins inserted in lateral scapula spine
Arm level	scapular plane elevation at 90º
Mean (SD) Degrees	SIS: 5 (1.5) Control: 3.5 (1)
Findings	Greater posterior tilt and greater clavicular retraction

Results: Borstad et al 2002

Subject # (Mean age)	Healthy: 26 (39 years) SIS: 26 (39 years)
Method	3- Dimensional scapular attributes using Motion capturing system
Scapular tilt angle	scapular X axis from root of the spine of the scapula to AC joint
Arm level	scapular plane (concentric/eccentric)
Mean (SD) Degrees	SIS: -13.5 (6.38) Control: -9.31 (7.26)
Findings	Significant increase in anterior tilt in SIS group at higher arm elevation levels

Results: Ludewig et al 2000

Subject # (Mean age)	Healthy: 26 (39 years) SIS: 26 (39 years)
Method	3-Dimensional electromagnetic motion analysis system FASTRAK
Scapular tilt angle	Sensor placed on the bony surface of acromial process
Arm level	90^{o} of arm elevation
Mean (SD) Degrees	SIS: -11 (3.5) Control: -8 (4.5)
Findings	Decreased posterior tilt and decreased serratus anterior muscle function in SIS

Results: Hebert et al 2002

Subject # (Mean age)	Healthy: 39 (34 years) SIS: 41 (44 years)
Method	3- Dimensional scapular attitudes using motion analysis system
Scapular tilt angle	Anterior scapular tilting measured in sagittal plane; scapular Y axis
Arm level	90^{o} of shoulder abduction
Mean (SD) Degrees	SIS: 14.1 (4.5) Control: 17.7 (5.6)
Findings	Less anterior scapular tilt in SIS group

Results: Endo et al 2001

Subject # (Mean age)	Healthy: 27 (57 years) SIS: 27 (57 years)
Method	Digital X-rays of shoulder at several angles
Scapular tilt measure	Referential line to measure scapular upward rotation angle (SURA) i.e angle of tilt at 90 degrees shoulder abduction
Arm level	90^{o} of shoulder abduction
Mean (SD) Degrees	SIS: 40.7 (8.7) Control: 44.3 (7.2)
Findings	Reduction in scapular rotation in SIS group

Results: Laudner et al 2006

Subject # (Mean age)	Healthy: 11 (21 years) SIS: 11 (22 years)
Method	Electromagnetic tracking device
Scapular tilt angle	Receiver on the acromion of scapula
Arm level	90º of humeral elevation
Mean (SD) Degrees	SIS: –2.5 (6.4) Control: -8.1 (10.0)
Findings	Increased SC elevation and scapular posterior tilt position in SIS group

Results: Warner et al 1992

Subject # (Mean age)	Healthy: 22 (27 years) SIS: 7 (28 years)
Method	Moire´ topography to assess asymmetry
Scapular motion	Degree of asymmetry measured as increased topography
Arm level	90^{o} arm elevation
Mean (SD) Degrees	SIS: 6/7 Control:18%
Findings	Asymmetric scapular kinematics in SIS

Results: Roy et al 2007

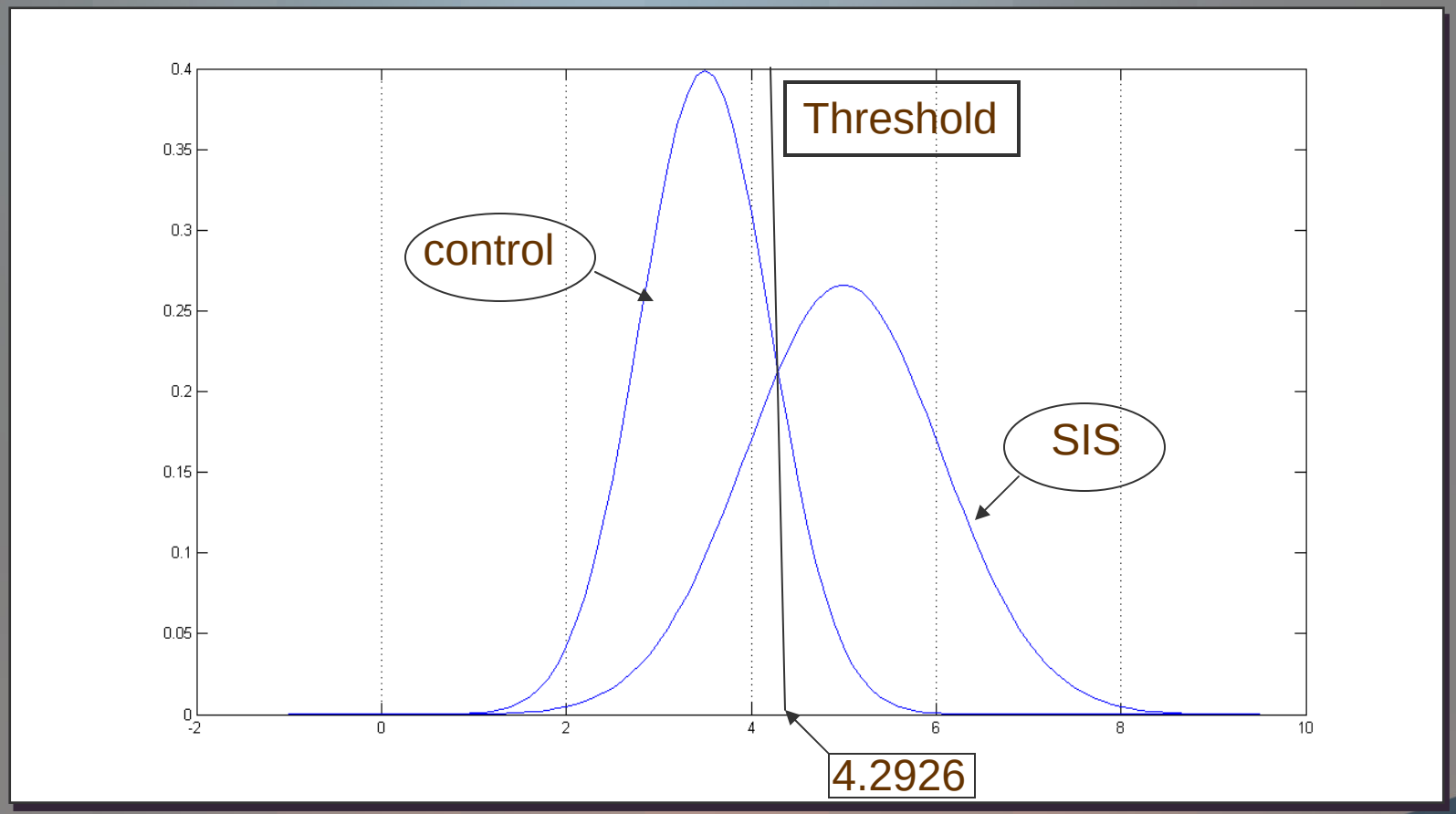
Subject # (Mean age)	Healthy: 30 (37 years) SIS: 8 (46 years)
Method	3-Dimensional scapular attitudes using optotrak probing system
Scapular tilt angle	Scapula coordinate system: z axis as scapular tipping motion
Arm level	Dynamic scapular motion 90º of abduction.
95% CI(SEM)	SIS: 1.3º to 4.0º Control:1.7º to 2.9º Unable to ran Gaussian
Findings	Mild reduction in posterior tilt at 90 degrees of abduction

DATA ANALYSIS

- Mean and standard deviation of scapular motion for control and experimental groups:
- Example: McClure et al 2006
  - SIS: 5 (1.5)
  - Control: 3.5 (1)

GAUSSIAN: Determining the Threshold

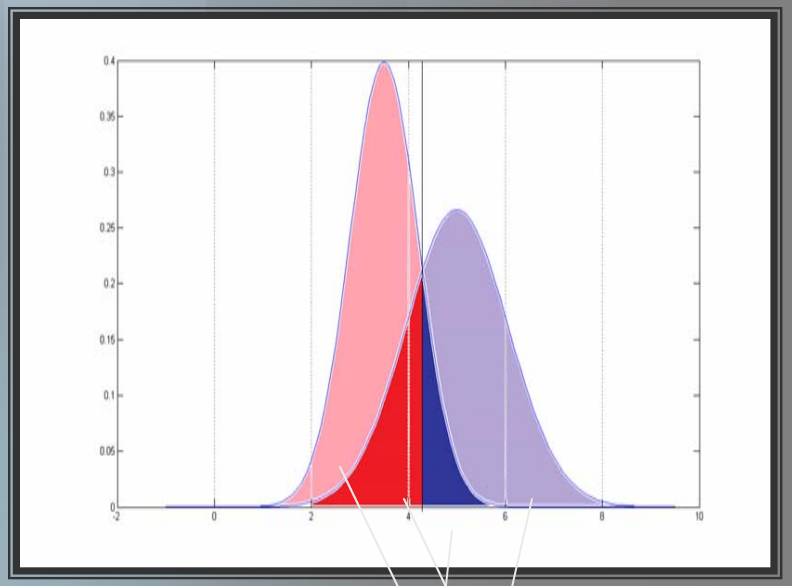
Example: McClure et al 2006



DATA ANALYSIS:

- Converting the Gaussian graph to 2X2 table.

- Example: McClure et al 2006
  - SIS: 5 (1.5)
  - Control: 3.5 (1)

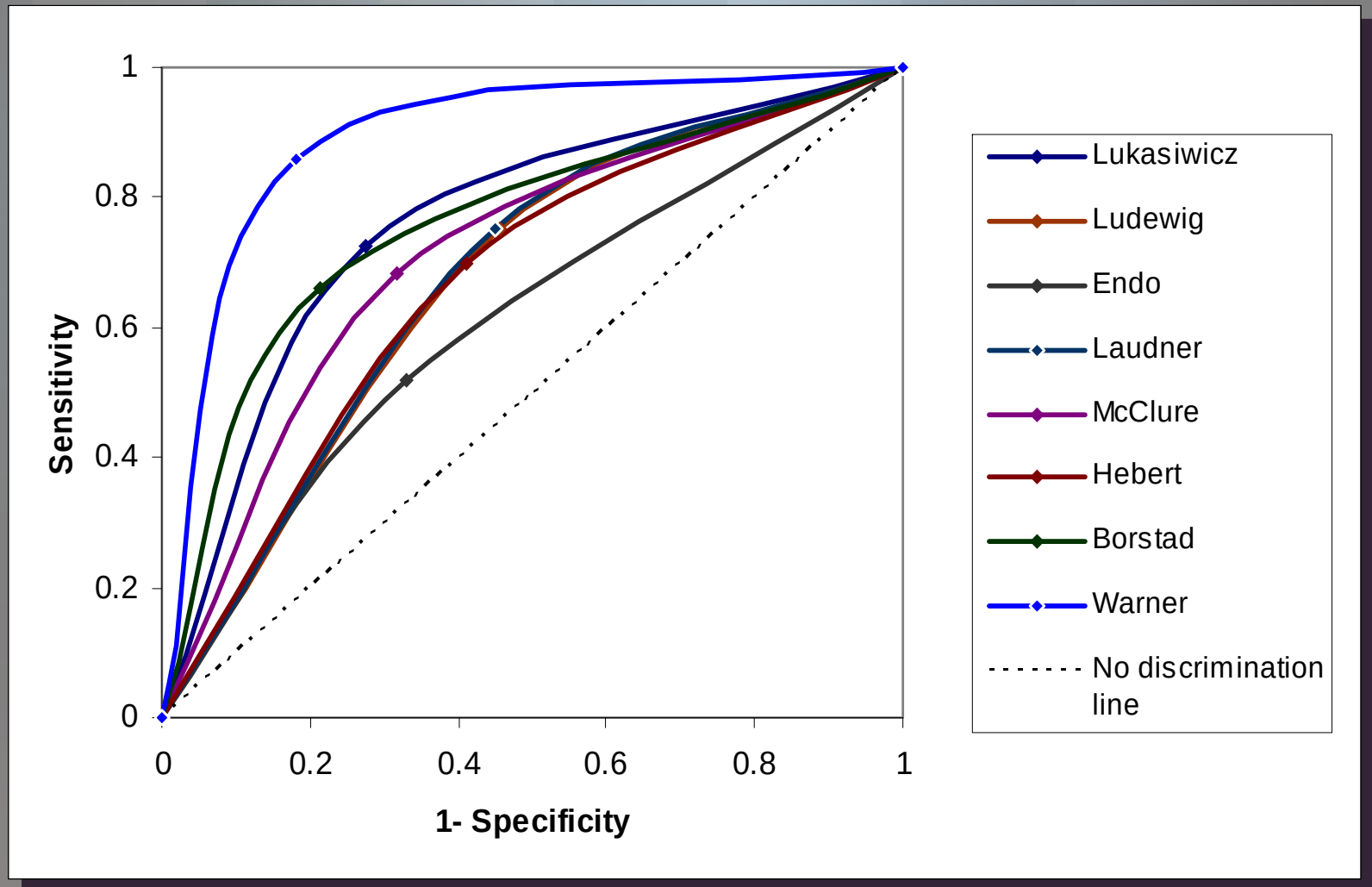


	SIS	No SIS
% positive		
% negative		

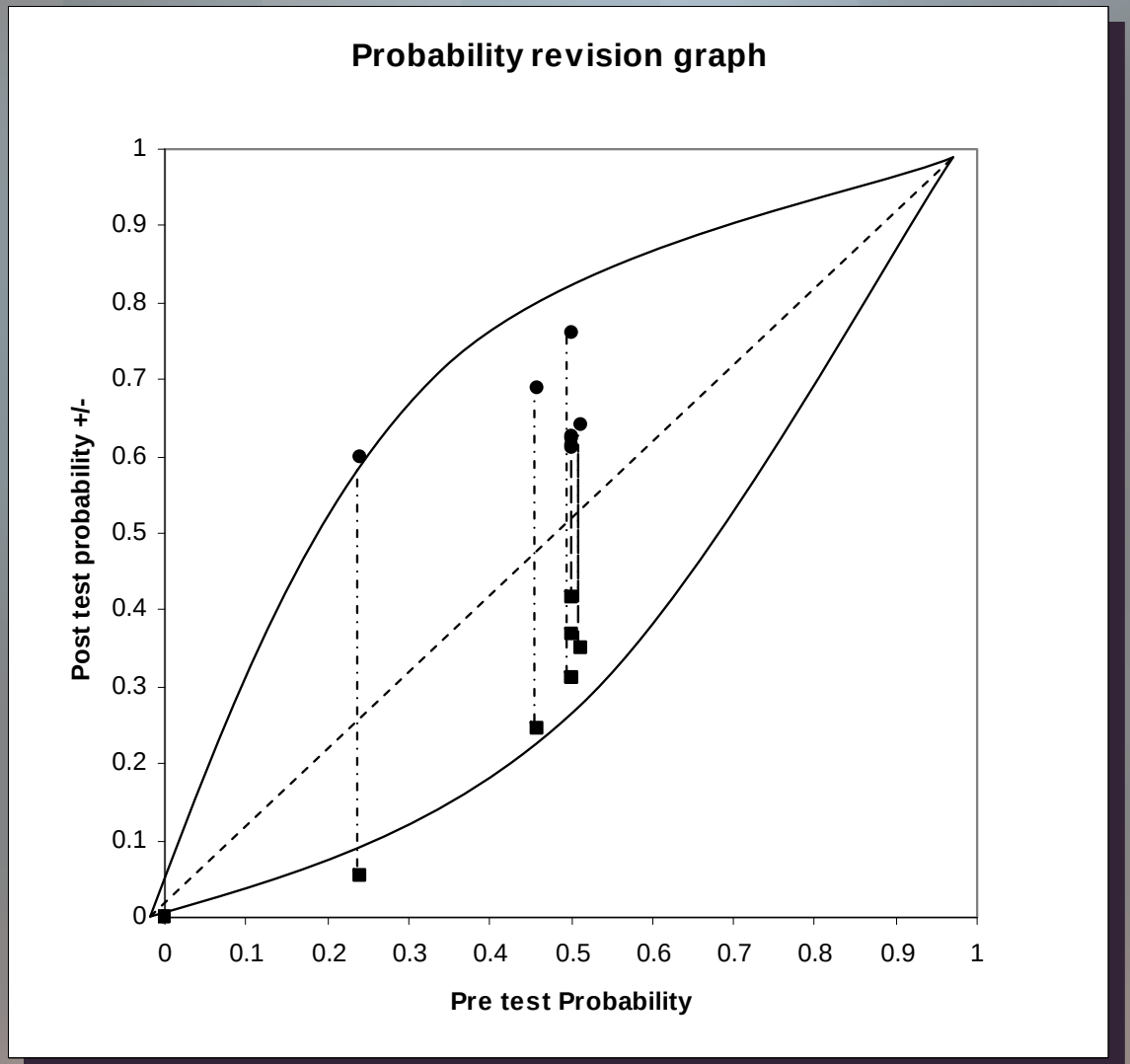
CALCULATION

No	Author	Sensitivity	Specificity	LR+	LR-	Pretest probability	Post test probability +
1	Lukasiewicz	0.7237	0.7237	2.6192	0.3817	0.4594	0.6900
2	Ludewig	0.7522	0.5445	1.6513	0.4550	0.5	0.6228
3	Laudner	0.7516	0.5497	1.6691	0.4518	0.5	0.6253
4	McClure	0.6814	0.786	3.1841	0.4053	0.5	0.7115
5	Borstad	0.6616	0.5835	1.5884	0.5799	0.5	0.6136
6	Endo	0.5204	0.6693	1.5736	0.7165	0.5	0.6114
7	Hebert	0.6982	0.5893	1.7000	0.5121	0.5125	0.6412
8	Warner	0.8571	0.8181	4.7142	0.1746	0.2413	0.6

ROC


1
0.8
0.6
0.4
0.2
0
Sensitivity
0
0.2
0.4
0.6
0.8
1
1- Specificity
Lukasiwicz
Ludewig
Endo
Laudner
McClure
Hebert
Borstad
Warner
No discrimination line

Probability Revision Graph



Accept or Reject H0

There is no significant correlation between abnormal scapular motion and the: a) prevalence and b) incidence of shoulder impingement syndrome:

- Limited evidence to reject null hypothesis
- All the studies shows weak correlation:
  - LR+ between 1-4
  - LR- greater than 0.3
- Post test probability:
  - Between 60-70%

DISCUSSION: Limitations of the research

- No RCT or Systemic reviews
- Only 9 Grade III evidence
- Small sample size
- Not enough data available for EBM calculation
- Only mean and standard deviation available
- Limitation with Gaussian method:
  - Assumption: behavior of the population is Gaussian

DISCUSSION: Research Gaps

- Different methods to measure scapular motion
  - Sensors, digitizing, imaging…
- Lack of consistency with scapular motion terminology
- Different movements and range
  - Abduction/ elevation/ flexion
  - 70 to 180 degrees
- Ambiguous outcome:
  - 4 studies found decreased posterior tilt
  - 3 studies found increased posterior tilt
  - 2 studies found change in tilt

Summary of Outcomes

No.	Author	Result
1	Lukasiewicz	Lack of posterior tilt
2	Ludewig	Decrease posterior tilt
3	Borstad	Increase anterior tilt
4	Roy	Mild reduction in posterior tilt
5	Laudner	Increase posterior tilt *
6	McClure	Greater Posterior tilt *
7	Hebert	Less anterior tilt *
8	Endo	Reduction in rotation
9	Warner	Asymmetric scapular kinematics

Implications for practice

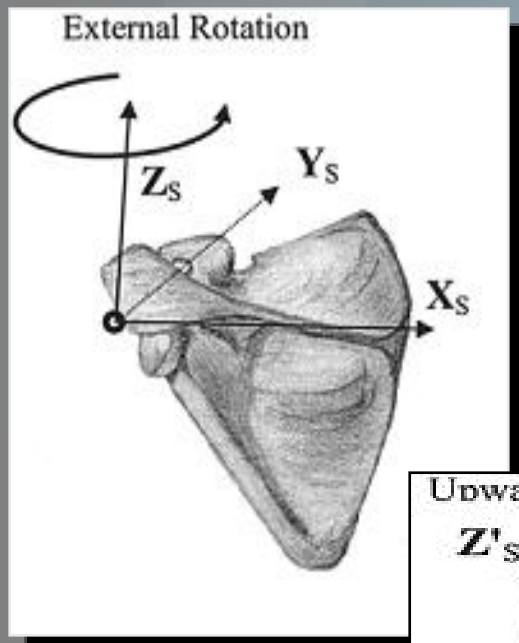
- Weak recommendation: measure scapular kinematics for shoulder and cervical patients.
- May be helpful to make differential diagnosis (eg. Elbow pain originating from shoulder).
- Scapular motion to screen
  - scapular tilt

Clinical Implication

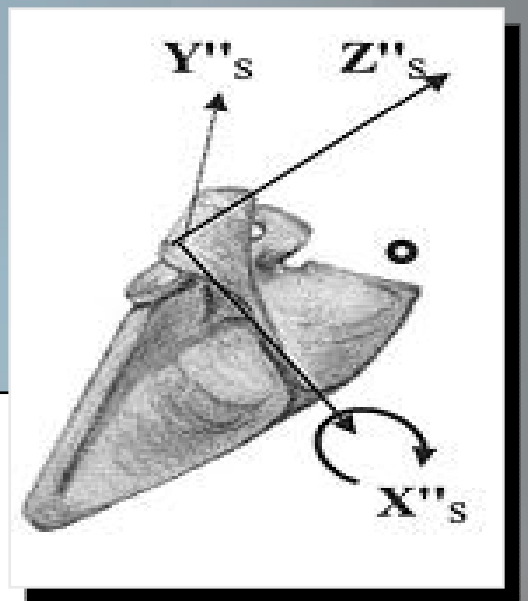
- How to measure Scapular Tilt:
  - Difficult to measure clinically
  - Observation
  - Other method: X-rays lateral view
  - Prone: AC joint distance from the table

Clinical Implication: scapula motion

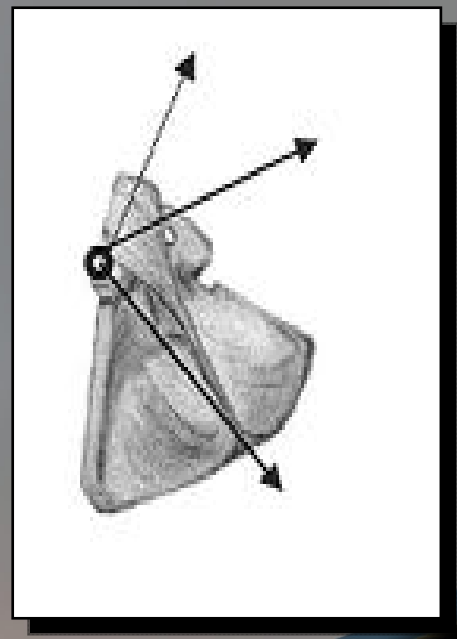
External rotation

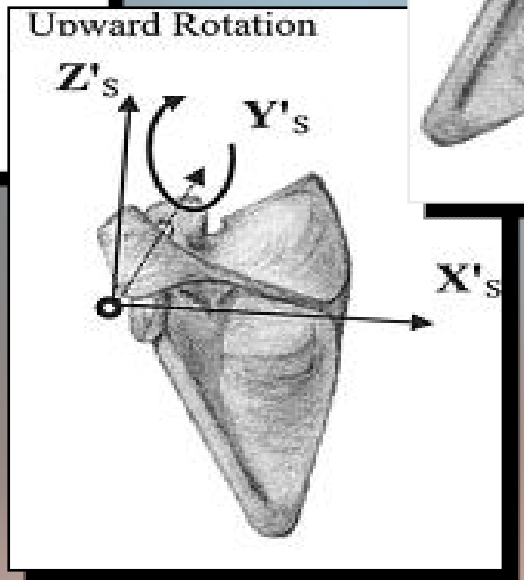


Posterior tilt



Final Position



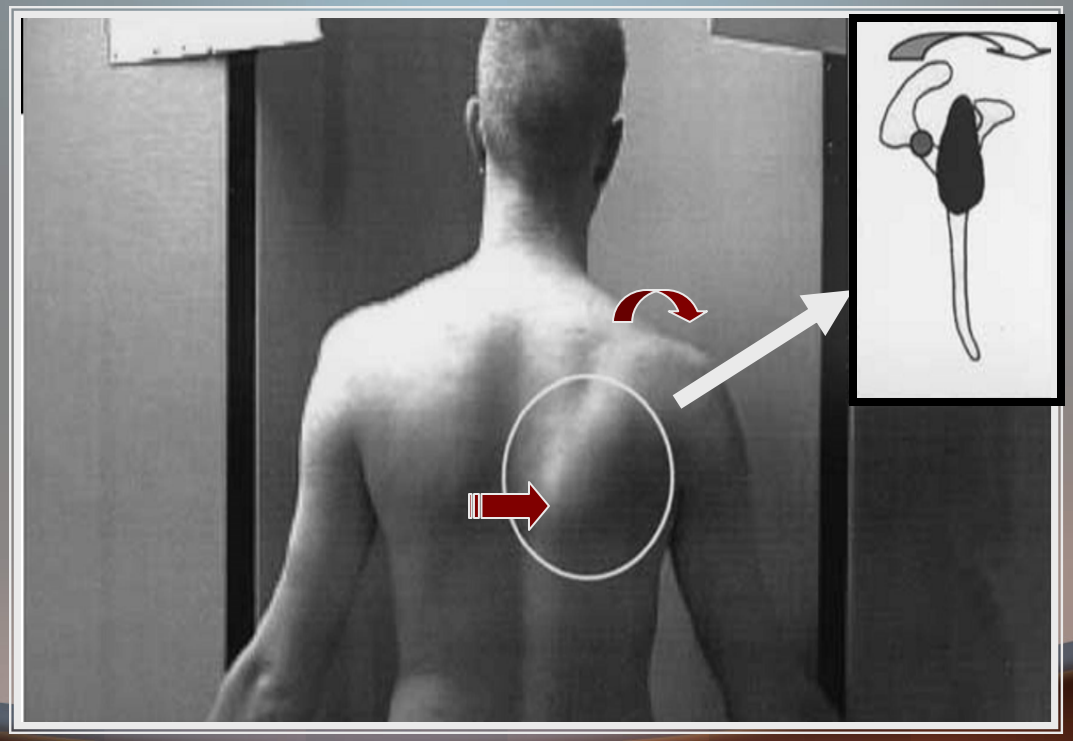


Upward rotation

Clinical Implication: Measure scapular tilt

Kibler ’02: Inferior angle (type I) indicating anterior tilt:

- At rest… “inferior medial scapular border may be prominent dorsally”
- During arm motion…“inferior angle tilts dorsally, acromion tilts ventrally over the top of the thorax”



DISCUSSION: Future Research

- More level I / II data
- Prevalence studies to determine the prevalence and incidence of abnormal scapular kinematics
- Studies to identify the factors affecting abnormal scapular motion

DISCUSSION: Proposed next study

- A large population study measuring:
  - Scapular kinematics with and without SIS
- Prevalence study identifying:
  - Population with SIS who also have abnormal scapular kinematics.
  - Populations with abnormal scapular kinematics who develops SIS

Conclusion

- Unable to make strong conclusion
- Some change in scapular kinematics (tilt angle) in patients with SIS.
- Unable to identify it as a risk factor due to lack of evidence.

Thank You!

Questions and/or Comments?