W109. Capsule-Preserving Hydraulic Distension for Adhesive Capsulitis

Thursday, November 13, 2014
11:30 am–1 pm
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Contents

• Introduction and overviews (10 min): Sun Chung
• How to place a needle into the shoulder joint under ultrasound guidance (10 min): Sun Chung
• How to measure and interpret pressure-volume profiles (10 min): Keewon Kim
• Case Discussions (10 min): Keewon Kim
• Hands-on teaching (45 min): Chung, Kim, Chaiyoung Lim, SangJun Park, and Kyu Jin Lee
  – achieving the best ultrasound view to place a needle
  – placing a needle in to a dummy joint
  – measuring pressure-volume profiles
  – estimating high pressure without measuring
• Questions and Answers (5 min)
Introduction and Overviews

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Hydraulic Distension for Adhesive Capsulitis (AC)

- Chronic fibrovascular hyperplasia
- Biopsied 22 Froz Shoulders (durations 3-36mo) : chronic inflammatory response with fibroblastic proliferation (Hand 2007)

Tonino 2009, JAAOS
Treatment Options for AC

- Surgery
- Distension arthrography
- Manipulation under anesthesia
- Steroid injection
- Physical therapy / passive stretch
- Conservative Observation

Graph: Relative stiffness/pain over time (months)

A, B, C

Chambler 2003 JBJSb
Manipulation Under Anesthesia (MUA)

- Codman: “Manipulation yielded few miracles, a good vacation under pleasant circumstances seemed more desirable.”
- Sir Charnley: pain relief for 10 weeks after manipulation of 35 frozen shoulder patients without any harm, ER before abduction to avoid dislocation.

Castellarin 2004, APMR
MUA

- **Loew 2005 JSES**
- MUA of 30 Frozen Shoulders
- 4 iatrogenic SLAP
- 3 fresh PTT of Supraspinatus tend
- 4 ant. Labral detach (1 with osteochondral inj)
- 2 MGHL tears

*Figure 3* Arthroscopic finding of ventral labrum and capsule tear with osteochondral involvement seen in zone 2 after manipulation under general anesthesia (right shoulder, dorsal approach).
Treatment Options for AC

- Surgery
- Distension arthrography
  - Manipulation under anesthesia
  - Steroid injection
  - Physical therapy w passive stretch
  - Conservative Observation

• Arthrographic Hydraulic Distension
• Arthrographic Distension
• Distension arthrography
• Hydraulic Distension
• Hydraulic Dilatation
Arthrographic Hydraulic Distension

• 1965 Andren and Lundberg
• 31 reports have been published.
• Including one double blind randomized controlled study (2004 Buchbinder ARD) reporting definite short-term efficacy.
• **Widely used?**
Arthrographic Hydraulic Distension

• Not widely used in clinical settings, Why?
• No standardized protocols
  – How much fluid should be infused? **From 2ml to 150ml!**
  – How high pressure should be developed in the capsule?
  **Pressure was measured in only 1 AC patient!**
Arthrographic Hydraulic Distension

- **No standardized protocols in more than 31 reports, Why?**
- Because most of them had a belief that distension and “rupturing” the capsule would release the tightened, contracted capsule!!

Gradually increases. The procedure is continued until the capsule ruptures, as a rule, in the wall of the subscapular bursa. Sometimes rupture occurs early, but then the result is usually less favourable. During the injection the typical shoulder pain, often radiating down the arm or to the neck, is frequently reproduced and disappears on return of the fluid into the syringe.

*Andren and Lundberg, 1965 Acta Orthop Scandinav*
Rupture the Capsule to Treat?

- Rupture sites (Gavant 1994 J Vasc Interv Radiol): 8 Subscapular recess, 6 SASD bursa, 2 Long biceps sheath

The capsule was thinnest (< 1 mm) where it had no attachments: (1) posteroinferiorly, along the margins of the glenoid and in portions with no tendon insertions and (2) inferiorly, adjacent to the glenoid and where it was continuous with bursal sacs between the glenohumeral ligaments.

*Clark 1990 CORR*
Rupture versus Preserve the Capsule??

Contracted & Stiff

Distension

How can we do this?

Capsule Rupturing

Capsule Preserving
Can we stop infusion just before the rupture in order to give a prolonged stretch to the contracted capsule?
Can we stop infusion just before the rupture in order to give a prolonged stretch to the contracted capsule?

$V_{ph3}: 5.03 \pm 3.18 \text{ml} (2.33 - 10.99)$
Would Capsule Preserving Hydraulic Distension Be Better than Rupturing HD?

Kim et al 2011, JOR
How about repeated HDs? Would they give further effects?

Koh 2012 PM R
How about repeated HDs? Would they give further effects?

Koh 2012 PM R
How about repeated HDs? Would they give further effects?
Summary

• HD is a treatment for moderate to severe AC.
• Pressure-monitoring enables capsule preserving HD, offering better outcomes and repeated distensions.
• Requirements
  – Place a needle tip well into the capsule without being obstructed by soft tissues
  – Understand and interpret pressure-volume curves
  – Understand how to implement in clinical practice
How To Place a Needle into the Shoulder Joint under Ultrasound Guidance

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Glenohumeral Joint Intra-articular Injection

- Position yourself to view both the injection site and monitor at the same time
- Put the probe just below and parallel to the scapular spine
Glenohumeral Joint Intra-articular Injection

Move away from the central tendon of infra-spinatus
Glenohumeral Joint Intra-articular Injection

Make the target at left 1/3
Glenohumeral Joint Intra-articular Injection

Make the capsular line (target) flat
Glenohumeral Joint Intra-articular Injection

Make the capsular line (target) brighter
Glenohumeral Joint Intra-articular Injection

Hold a needle facing the bevel toward yourself. Stick the needle 5mm-15mm from the margin of the probe.

Remember that the needle has a tendency to move to the opposite side of the bevel when it advances.
Glenohumeral Joint Intra-articular Injection

Aim at the joint space

Starting point

Too painful
Stuck into cartilage
Needle Placement

Must see this: the needle penetrates the capsule!!!
Fluid Infusion
Signs of Successful Placement
Signs of Failure
Summary

• Positions: patients, injectionist, shoulder and probe
• Sonographic Views: central tendon of IS, capsule, labrum, humeral head
• Needle insertion: inserting angle and point, retrieving lost needle, piercing the capsule
• Confirming success: increase of fluid in the capsule and recess
How to Measure and Interpret Pressure-Volume profiles

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Decoding P-V Curves!

• Understanding Phases
• When to Stop Infusion
• Other Biomechanical Properties
Understanding Phases

Typical P-V Profile during Hydraulic Distension

(11:12:48, 691.3 mmHg)
Stress-Strain Curve in Biological Tissue

1\textsuperscript{st} phase: Toe region

2\textsuperscript{nd} phase: Linear region - Elastic deformation

3\textsuperscript{rd} phase: Failure region - Plastic deformation

Rupture!!
Typical P-V Profile during Hydraulic Distension
P-V Curves Are Not Always Typical.
5 Types of P-V Curves

- Tri-Phasic, Non-Rupture
- Tri-Phasic, Rupture
- Bi-Phasic, Non-Rupture
- Bi-Phasic, Rupture
- Mono-phasic

Which is Better?
Keewon Kim, JOURNAL OF ORTHOPAEDIC RESEARCH, 2011
Better Not to Rupture the Capsule!
Pre-Rupture Signs in P-V Curve

Appearance of the 3rd phase
- Volume of the 3rd phase
  - $5.03 \pm 3.18$ mL

High IA pressure
- Variable
- $>700$ mmHg
When to Stop Infusion

- Appearance of the 3rd phase
- High IA pressure (>700 mmHg)
- When patients ask to stop
Other Biomechanical Properties

- Slope of the Second Phase

Capsule Stiffness
Slope & ROM

The slope of phase $\parallel$ vs. sum of ROMs

$R^2 = 0.1213$
Slope & Pain VAS

The slope of phase II vs. VAS score

$R^2 = 0.1478$
Volume

- Total Volume Infused

Capsule Capacity

(11:12:48, 691.3 mmHg)
Biomechanical Interpretation

• Phase
  – Deformation state of the Capsule

• Slope
  – Stiffness of the Capsule

• Volume
  – Capacity of the Capsule
What if Pressure does not Increase?

- Tri-Phasic, Non-Rupture
- Tri-Phasic, Rupture
- Bi-Phasic, Non-Rupture
- Bi-Phasic, Rupture
- Mono-phasic
Case Discussions

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[1] F/50YO, Lt. shoulder pain (2MA)

- ROM: 105-120-45-T1-T7  (Abd–flex–ER-ER-IR)

  up to phase 3, 
  end pr. 305.2mmHg at 33.7ml, 
  EqPr 80.0mmHg

1 month after HD
ROM: 120 – 150 – 60 – T2 – T6
Pain: nearly resolved

- ROM: 45-90-20-head-S1 (Abd–flex–ER-IR)

up to phase 3, end pr. 439.7mmHg at 19.5ml, EqPr 160.8mmHg

1 month after HD
ROM: 75 – 135 – 45 - C7 - T11
Pain: 25% remains
Compliant vs. Stiff capsule

- Freezing phase
- Frozen phase
Discussion 1

• Observing P-V profiles during IHD enables **capsule-preserving** provides HD as well as **Biomechanical Evaluation.**

Up to phase 2
End pr.>700mmHg at 23.0ml

Up to phase 2
End pr.>700mmHg at 26.5ml,

Up to phase 3,
end pr. 613.5 mmHg at 28ml,

Discussion 2

• Capsule-Preserving HD enables repeated IHDs with additional benefit.
[4] F/78YO, Rt Shoulder Pain (1MA)

- Slip down, 1MA
  - right shoulder pain developed
  - Motion pain >> resting pain

- ROM: 58-135-60-C7-L2

- Neer +
- Empty can +-
- Belly press ++
- Lift off +
HD, flat-pressure profile
Pre-IHD

Subscap

Subscap

Subscap

Subscap
Post-HD

- Leakage shown to the subcoracoid bursa and through the anterior capsule.
[5] M/56YO, lt. shoulder pain (1YA)

• ROM: 95-115-38-T2-L2
• Empty can (-)
• Spurling (+)

• Hydraulic Distension Hx (+)
HD #1, flat phase profile, end pr. 240mmHg at 61.8ml
[5] M/56YO, lt. shoulder pain (1YA)
Global Fibroplasia

Localized ligamentous contracture

Hi Pressure PSS

Lo Pressure PSS
Discussion 4
Flat-Pressure PV Profile

Full-Thickness RC Tear

Localized ligamentous contracture

Leakage shown to the subcoracoid bursa and through the anterior capsule.

Low Pressure PSS
Summary

• Interpretation of P-V profiles
  – Phase (elastic/plastic deformation)
  – Slope (capsule stiffness)
  – Volume (capsule capacity)
Summary

• IHD outcome is better with the capsule preserved

• When to stop infusion
  • Appearance of the 3rd phase
  • High IA pressure (>700 mmHg)
    – When patients ask to stop
Summary

• Clinical Application of IHD
  – Better Efficacy + Biomech. Evaluation
  – Repeated IHDs with additional benefit
Thank you for attention