KEY
To Shoulder Rehabilitation is:
- Dynamic, Caudal Glide
- Posterior Dominant Shoulder

Rotator Cuff Muscles create Dynamic Caudal Glide
Due to Oblique RTC fibers (Inferior Vector)

Dynamic Caudal Glide

"Dynamic Caudal Glide"
Rotator Cuff Muscles (SS, IS, TM) Perform As A Functional Dynamic Unit Depressing The Humerus Concomitantly With Shoulder Abduction, flexion and scaption.

Inman Force Couple.
Inman, et al. JBJS 26: 1-30, 1944

How do you measure GH/RTC musculature?

• In order to treat the patient and the GH/RTC joint, one must evaluate it first
How do you measure GH/RTC musculature?

- MMT
- [Reference to Riemann, BL, Davies, GJ, et.al. Hand-held dynamometer testing of the internal and external rotator musculature based on selected positions to establish normative data and unilateral ratios. JSES. 19:1175-1183, 2010]
- Isokinetics - 1984 - 1994 (4 Editions)

How do we do it?

- Since RTC strengthening is so important, how do we do it the right way!
- And why?

Shoulder Modified Neutral Position

30 Deg. / 30 Deg. / 30 Deg. Position
(Davies has recommended for 30 years)

- 30° abduction
- 30° forward flexion to the 30° Scaption position
- 30° diagonal tilt of the exercise relative to the transverse plane

30/30/30 position

- 30° abduction
  - Rationale:
  - Prevents the “wringing out” effect on the supraspinatus tendon
  - Facilitates the blood flow (nutrients, O2, etc.) to the tendon to help with the healing process
  - Protects the supraspinatus tendon during healing

Tendon’s Critical Zone
Hypovascular/Avascular
“Critical Zone”

Rathbun, JB, Mac Nab, I.
The Microvascular Pattern of the Rotator Cuff, J BJS (B): 540-553, August 1970

“Wringing out effect”
• With the arm in the adducted position, the humeral head compresses on the articular side of the supraspinatus tendon causing the “wringing out” effect.

“Wringing out effect”
• With the arm in the 90 abducted position, with weak SS, IS, TM (or pain/reflex inhibition) the deltoid overpowers the lower RTC muscles, causes superior translation and causes a compression on the bursal side of the supraspinatus tendon causing the “wringing out” effect.

30/30/30 position
• 30 abduction
  • Rationale:
    • Protects the supraspinatus tendon during the healing process

Shoulder Position
• Hatakeyama, Y, et.al.
  • Effect of arm elevation and rotation on the strain in the repaired rotator cuff tendon. A cadaveric study.
  • AJSM. 29:788-94, 2001

Shoulder Position
• The strain in all of the planes decreased significantly with the arm elevated more than 30 degrees.
**30/30/30 position**

- **30° scaption**
  - Rationale:
  - Functional arc of motion of the shoulder
  - Decreases stress on the anterior capsule to protect the anterior capsule & I GHL
  - Pre-stretches the IS & TM on the physiological length-tension curve to increase power

- **30° diagonal tilt** relative to the transverse plane
  - Rationale:
  - The diagonal plane places the muscle fibers (SS, IS, TM)
  - in the direct line of force for power
  - production

- **30/30° diagonal tilt** relative to the transverse plane
  - Rationale:
  - 30 years ago I listened to my patients and they taught me! (Engineer)
  - It’s more comfortable for the patient
  - Prevents iatrogenically creating stress (injury) to the posterior shoulder

---

**EMG Research on ER**

- Reinold, MM, et al.
- EMG analysis of the RTC and deltoid musculature during common shoulder ER exercises
- JOSPT. 34:385-394, 2004
- (Adduction increased ER EMG – overflow/irradiation effect)

**Research Study**

- J Biomech. 38:755-760, 2005

---

**Research Study**

- Experimental in-vivo study to test the potential changes of the subacromial space width (during muscular contractions) are caused by alterations of scapular kinematics and/ or GH translation.
- 12 healthy subjects
- Open MRI: 30, 60, 90, 120, 150° of arm elevation

**Research Study**

- Force of 15 N to cause isometric contraction of the GH abductors or adductors

**Research Study**

- Adducting muscle activity led to SS increase of the subacromial space width in all arm positions
Research Study
Force of 15 N to cause isometric contraction of the GH adductors.

Research Study
These data show that the subacromial space can be effectively widened by adducting muscle activity and by affecting the position of the humerus relative to the glenoid.
This effect may be employed for treatment of the impingement syndrome.

Summary of 13 reasons for 30/30/30 position

Rationale-30/30/30
30 Abduction:
1. Prevents “wringing out” effect
2. Increases blood flow - i.e., O2 & nutrients to the healing tendon
3. Protects the supraspinatus tendon during the healing

Rationale-30/30/30
30 Scaption:
4. Scaption is functional arc of motion of the arm
5. Protects anterior capsule (stress-shields ant. inf. capsule & IGHL)
6. Pre-stretches ER muscles and provides a better mechanical advantage based on the physiological length-tension curve
7. (Weakest muscle group in GH joint)

Rationale-30/30/30
30 Diagonal movement pattern:
7. Diagonal motion - direct line of contraction for lower RTC muscles to increase power (Anatomy & biomechanics)
8. Comfortable position for patient (Empirically based comment)*****

Rationale-30/30/30
Bolster under arm for adduction:
9. GH adduction to hold towel roll recruits EMG activity of ER (weakest muscle)
10. GH adduction to hold towel roll recruits EMG activity of ER (weakest muscle)
7. GH adduction to hold towel roll recruits EMG activity of ER (weakest muscle)
8. GH adduction increases the width of the subacromial space and protects tissues in sub-acromial space
9. GH adduction increases the width of the subacromial space and protects tissues in sub-acromial space

Rationale-30/30/30
Muscular strengthening exercises for ER force should also be encouraged to decrease subacromial pressures.
Which is the optimal exercise to strengthen supraspinatus?

- **Boettcher, CE, et.al. MSSE. 41:1979-1983, 2009**

> Because of force-couple relationship between supraspinatus + deltoid during elevation, it has been proposed that the optimal exercise to strengthen supraspinatus is one that would maximize supraspinatus activity while minimizing surrounding muscle activity, particularly the deltoid.

**Which is the optimal exercise to strengthen supraspinatus?**

- Compared surface and in-dwelling EMG:
  - 1. empty can position
  - 2. full can position
  - 3. prone elevation
  - 4. prone ER
  - 5. pendant ER

**Which is the optimal exercise to strengthen supraspinatus?**

- Compared surface and in-dwelling EMG:
  - 1. empty can position
  - 2. full can position
  - 3. prone elevation
  - 4. prone ER
  - 5. pendant ER

---

**Research**

- Gates, JJ, et.al.
- The supraspinatus, having distinct anterior and posterior subregions, is most commonly considered an abductor of the humerus, but it has also been shown to induce humeral rotation. In the scapular plane, the anterior subregion of the supraspinatus acts as both an internal and external rotator depending on the initial position of the humerus. The posterior subregions either acted as an external rotator or did not induce rotation. This study demonstrated a distinct functional difference between the anatomic subregions of the supraspinatus. This understanding will help to improve testing methods, development of repair strategies, and rehabilitation of the supraspinatus.

---

**Compendium Of Isokinetics, 1984**

Still one of my toughest questions?

- How do you progress a patient from the 30/30/30 position to the 90/90 position?
- What are the specific criteria to use to make sure the patient is ready to tolerate the stresses in the 90/90 position?

**Progression**

- 30/30 -> 90/90 position
- If a patient has a lower extremity "boo-boo" and they are limping, what do we normally do?
- Put them on crutches.
- Why not apply the same principle to the shoulder?
Progression

- 30/30 position
- 90/90 with Shoulder Horn - Provides support to the GH joint and supraspinatus which is in a shortened position (Transition-passive support)
- 90/90 position

Progression from 30/30/30 to 90/90 - We use a “crutch” for the shoulder

- 90/90 with Shoulder Horn - Provides support to the GH joint and supraspinatus which is in a shortened position (Transition-active support)

- Will now also have patient adduct the GH joint against the Shoulder Horn to “widen” the subacromial space.

Progression

- 90/90 position without support
- Progress to functional movement
- Patterns

Poster Dominate Shoulder

- Normal Unilateral
- Ratio:
  - IR/ER: 3:2
  - (Operational definition) Posterior Dominant Shoulder:
    - ER 10%
    - IR/ER: 4:3

Isolated Training & Correlation to Functional Performance

But that is really silly because no one functions in with an isolated movement!
YES. There is an "overflow" from isolated GH training to overhead performance.

Isolated Training & Correlation to Functional Performance
Ellenbecker, Davies, et al, AJSM, 1988
Mont, et al, AJSM, 1994
Treiber, et al, AJSM, 1998
Davies, et al., 2010

Functional Rehabilitation
- We all want to have the same end result, but the challenge and DEBATE lies in how we get there:

    **Isolated**

    **Integrated**

    **Functional**

Davies’ TOP 10 Exercises for Shoulder Complex Rehab
- TAS Exercises (Bis/Tris) - 2
- Scapulo-thoracic exercises - 4
- GH Exercises - 2 (2 overlap)
- RTC Exercises - 2 (with progressions)
- Functional Specificity exercises

“Specificity” Functional Exercises
- Dynamic stability
- Proprioceptive/kinesthetic training
- Neuromuscular reactive training
- Functional rehabilitation

Efficacy of Shoulder Rehabilitation and Training
- Effects of random versus blocked practice in upper extremity strengthening protocols on functional capacity and dynamic stability: a randomized controlled study

Research Design
- Control group: “Nothing”!
- Sham control group: intervention, but not the specifics of what you are really testing
- Experimental group: actual intervention as the independent variable

Efficacy of Shoulder Rehabilitation and Training
- Outcome measures:
  - Isokinetic testing (isolated joint testing)
  - Angular replication testing (proprioception performance)
  - CKC UE Stability testing (CKC function)
  - Underkoffler overhand softball throw (Multi-joint functional testing)
Efficacy of Shoulder Rehabilitation and Training

Prospective randomized controlled training study

- Power analysis: Subjects: 35
- Stratified by gender & randomly assigned to:
  - C Group: Blocked training program (18)
  - Exp Group: Random training program (17)
- Training Program

Training Methods:

- The subjects performed:
  - 1 set
  - 10 reps
  - 10 RM @ beginning and at 3 weeks to establish and adjust working weights - 60% MVC
  - Super set format
  - Rest intervals - 30-60 sec.
  - 2 times/week
  - 6 weeks
  - Progression - ACSM - 10%/week
  - Top 10 exercises

Efficacy of Shoulder Rehabilitation and Training

Subjects:

- Never did a push-up
- Never touched a ball
- Never threw a ball
- Never did a throwing motion
- During the isolated training program

Results:

- All subjects SS changes:
  - CKC UE Stability test (P=0.021) (95% CI = 8.6 to 86.1 in)
  - Underkoffler overhand softball throw for distance (P<0.001) (95% CI = 2.2-4.2 touches)

Conclusions:

- Using isolated exercises to "work" each link in the kinematic chain
- Leads to SS improvement in various functional tests (without ever doing the functional exercises)

"Holy Grail"

- So we know the "top 10 exercises" works with normals (power and functional performance)
- In a controlled clinical environment (to minimize the confounding variables)
- But.......
- Does it really work with patients with shoulder pain ????

Using "TOP 10" exercises to "work" each link in the kinematic chain with patients

(no other treatments)

Shoulder Complex Rehabilitation

Birke, C, ... Davies, GJ et al. A Pre-Post Testing Training Study on the Effects of Specific Shoulder Exercises for Symptomatic Subjects

Paper presented as poster presentation, APTA-CSM, Chicago, IL, USA, February, 2012
The purpose of this study was to determine the effect of a specific eight-week training program on pain, strength, and power measures in subjects with subacromial impingement.

Materials/Methods:

After testing, subjects were randomized to an experimental or control group:

The experimental group (n=12) completed eight shoulder exercises and two arm exercises designed to work all glenohumeral and scapulothoracic muscles as well as forearm and upper arm muscles. (TOP 10 Exercises)

The control group (n=9) completed ten lower extremity strengthening exercises.

Each group completed twice weekly supervised one-on-one exercise sessions for eight weeks after which pre-testing measures were repeated.

Results:

Using "TOP 10" exercises to "work" each link in the kinematic chain with patients (no other treatments): pain, strength, power, function.

Pre-post test:

- Demographics, VAS, DASH, AROM, isokinetic testing, seated shot put test

"Holy Grail Study"
Analogy:
When you build a house, you want a solid Foundation

Foundation (CORE) Exercises for all Shoulder Complex Rehab

- TAS Exercises (Bis/Tris) - 2
- Scapulo-thoracic exercises - 4
- GH Exercises - 2 (2 overlap)
- RTC Exercises - 2

Functional Exercises for TAS/Rehab/PE

Of course, We would never just do “each link in the kinematic chain”, but use that as the foundation so we do miss something and then do the functional stuff after the basics

Functional Neuromuscular Dynamic Stability

“Specificity” Functional Exercises

- Dynamic stability
- Proprioceptive/kinesthetic training
- Neuromuscular reactive training
- Functional rehabilitation

“Specificity” Functional Exercises

- Most of us treat our patients using “functional exercises” for the whole rehab program, however, few use isolated rehab first and then progress to “functional exercises/activities”

Neuromuscular Training for Rehabilitation of Sports

- Neuromuscular Dynamic Stability Training for Rehabilitation of Sports: Does it work?
- Ankle rehab - YES
- Knee rehab - YES
- Shoulder - NO STUDIES
  - (There is NO evidence for the efficacy of proprioceptive training/neuromuscular training on rehabilitation of the shoulder)


Neuromuscular Training for Rehabilitation of Sports

- Neuromuscular Dynamic Stability Training for Rehabilitation of Sports: Does it work?
- Shoulder
- Jerosch, J, et.al. Effect of a sensorimotor training program on patients with subacromial pain syndrome. Unfallchirurg. 105:16-43, 2002 (German)
- Naughton, J, et. al. Upper-body wobble-board training effects on the post-dislocation shoulder. Phys Ther Sport. 6:31-37, 2005

Does it really work? Outcome Studies....

Rehabilitation

Foundation

Top 10 Exercises

Functional

Specificity Exercises

Outcomes

JSR, 2003

Summary

Neuromuscular Training for Rehabilitation of Sports

- Neuromuscular Dynamic Stability Training for Rehabilitation of Sports: Does it work?
- Shoulder - NO STUDIES


BUT.....

How are the patient's Improving?

SO.....
The improvement must at least partly be due to:

(Isolated rehab of each link in the kinematic chain)

WOW,

SO it's not just about functional rehabilitation ......

Bottom Line

• Bottom line: Functional

• Bottom/Bottom Line:
  Function is made up of each link in the kinematic chain

Take Home message:

Isolation first to work each link in the kinematic chain, and then,
Functional Integration
(Specificity)

Summary
And
Conclusions

Treatment algorithm for therapeutic exercises for shoulder rehabilitation?

Thank You