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Aquatic Lumbar Stabilization Progressions

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Objectives

- Distinguish between global and local muscles and their role in spine stabilization exercise.
- List at least three key components to exercise for each of the three phases of spine stabilization.
- Outline at least three exercises to target specific and combined planes of movement

4

Objectives cont.

- Describe at least three therapeutic benefits for deep and shallow aquatic exercise in the treatment of lower back dysfunction.
- Identify at least one of the latest aquatic therapy research in treating patients with spinal dysfunction.

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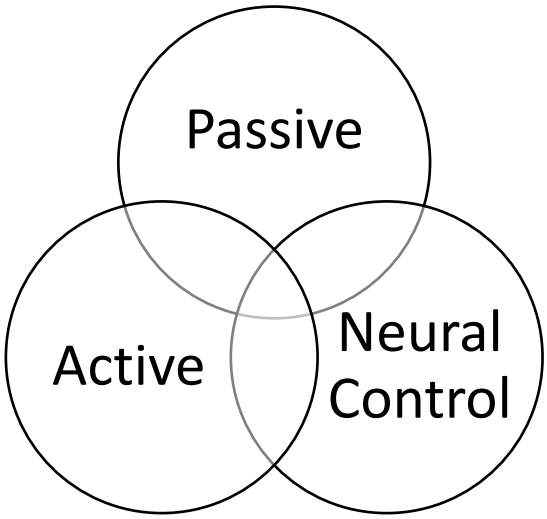
Panjabi's model

Spinal stability has 3 subsystems

1. Osteoligamentous (passive)
2. Muscle (active)
3. Nervous system (neural control)

Spinal stability within this model depends on proper functioning and interaction of all 3 subsystems



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Clinical Instability

Dysfunction in one or more of the subsystems leading to increase in the neutral zone

Characterized by pain, description of "back goes out"

May or may not have objective findings on radiological exam.

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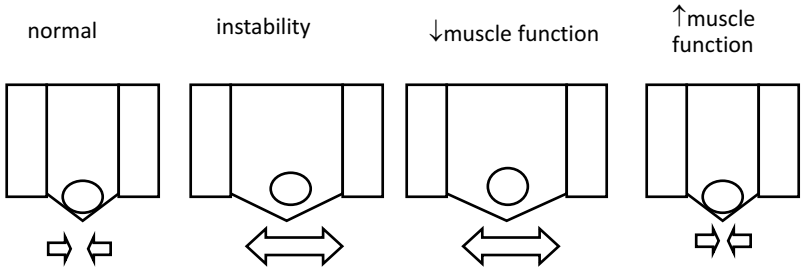
Neutral VS. Elastic Zone



Neutral zone = spinal motion produced with minimal internal resistance by passive structures
Elastic zone = motion produced against significant resistance from passive tissues

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Muscle Control

- **Types of muscle**
  - Related to their intended function
- **Timing of the muscles**
  - Relates to neural control
  - Pain leads to inhibition or spasm
  - Often needs to be retrained starting with cognitive awareness progressing to automatic activation

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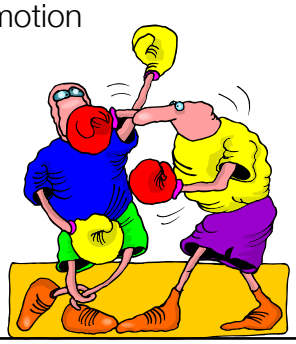
Big stupid vs. small stabilizing muscles

- Global
  - "Big stupid muscles"
  - Direction dependent
  - Non-continuous
  - Provide motion
- Local
  - Tonic
  - Low load (25% of max)
  - Without increased shear and compressive forces generated
  - Little change in muscle length



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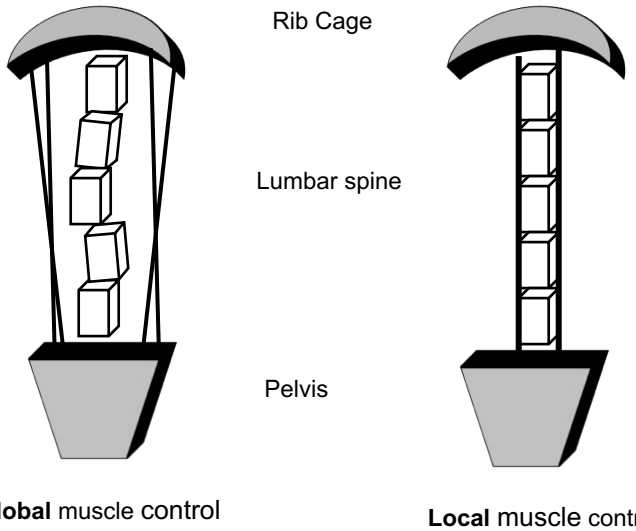

Global muscle control

Local muscle control

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Muscles

- Global
  - Obliques
  - Rectus abdominus
  - Erector spinae
  - Quadratus Lumborum
  - Hip flexors
  - Gluteals
  - Hamstrings
- Local Stabilizing
  - Transverse Abdominus
  - Multifidus
  - Pelvic floor
  - Diaphragm

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"Greatness lies not in being strong but in the right use of strength"

Henry Ward Beecher (1813-1887)

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Lumbar Stabilization

The ability to transfer loads and perform movements that are smooth and effortless.

Ability to disassociate movement of the extremities from the spine.

Requires muscle balance, strength, flexibility and motor control.

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Goals of Lumbar Stabilization

- Increase pt. Kinesthetic awareness
- Increase flexibility, strength, endurance and coordination
- Enhance function of extremities through strengthening of trunk musculature
- Facilitate function to control, prevent or eliminate symptoms
- Provide postural work to enhance balance and equilibrium
- Develop muscle synergy: internalized and automatic by patient
- Enhance patient compliance with good follow through by therapist

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Phases of Stabilization Exercise

Phase 1 = localized stabilization training
Phase 2 = generalized trunk stabilization
Phase 3= functional stabilization training

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Phase 1

- Patient education
- Finding pelvic neutral all positions
- ADIM various positions, quadruped 1st
- Multifidus isometrics
- Biofeedback

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How are you sitting?

- Are you stable?
- If I came behind you and pushed down on your shoulders would your low back give way?

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Finding Pelvic Neutral

"Just right"

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Belly Pull Ins

Facilitating the Transverse Abdominus

Use the exhale

Very effective in the quadruped position

- In the pool or if patient does not tolerate WB through wrists use wall push up position

Verbal Cues for ADIM (abdominal draw in maneuver)

- "Slowly and gently draw in your lower abdominals keeping your spine steady"
- "Hold the contraction while breathing normally"
- "It is important not to bend your spine while hollowing out your stomach"
- "should feel deep tension, not pushing out"
- "tighten abdominals without moving your back"

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Feedback with Aquatic Exercise

- Manual palpation
- Pool wall
- Cueing

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CONTINUED

Importance of the Multifidus

- Inhibition of muscle noted after 1st episode of LBP
- Recovery is not spontaneous
  - Specific ex. group v.s. general rehab
  - Sx. Resolved with both groups, however atrophy persisted in the general exercise group
  - 3yr f/u 75% recurrence rate with normal compared to 35% with stabilization group
    - Hides et al., 1996 & 2001

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Multifidus Activation

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Trunk Muscle Activity during Pool Stabilization Ex. (Bressel et al. 2012)

Rectus
- Abdominal bracing and ball push downs (highest)
- Alternating arms sagittal plane (lowest)

Lower abdominals
- Abdominal bracing and ball push downs (highest)
- Alternating arms sagittal & mediolateral pelvic tilts (lowest)

External oblique
- Abdominal bracing and ball rotations (highest)
- Alternating arms sagittal (lowest)

Multifidus
- Hip abduction, and ball rotations (highest)
- Alternating arms and abdominal hollowing (least)

Erector spinae
- Ball lateral push downs and abdominal bracing (highest)
- Pelvic tilts and abdominal hollowing (lowest)

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Clinical Pearls: Exercise Phase One

- Palpate multifidus watch for excessive paraspinal activity.
- Co-contraction with Transverse abdominus during ADIM

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Aquatic Exercise phase one: works “Balance”

Learning to obtain and maintain vertical and pelvic neutral without excessive compensatory movements with UE, head or feet.

Appropriate support, depth and use of equipment is essential for initial balance.

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Coordination

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Coordination

Sequencing of local muscles prior to global movement

Breathing

Starts in phase one and continues to be challenged in phase two (stability with mobility)

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Aspects of exercise affecting coordination

- Velocity
- Two or more movements in the same or different planes
- Upper and lower extremities moving together
- Moving distal to proximal
- Left/right alternating patterns
- Moving in different directions

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Phase 2

Basic
- Straight plane movement
- Frequent cueing
- Stable postures

Advanced
- Longer levers
- Transitional movement patterns
- Increase speed

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Phase 2 continued

Progress to uneven surfaces

Caution, ensure local muscle activation is adequate

Aerobic exercise should be introduced at this time

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Disassociation
"Divorce one motion from another"

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Supine & Prone




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Clinical Pearl

Power of Feedback

ADIM effective in facilitating disassociating lumbar erector spinae from gluteus maximus and medial hamstring with prone hip extension exercise. Using both is recommended for preventing anterior tilts during prone hip extension.

(Oh et al. 2007)

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Phase 2= Generalized Trunk Stabilization

- Abdominal bracing sequence
- Multifidus/ spine extension progression
- Prone or QP with ADIM
  - Arm reach to lift
  - Leg lift
  - Arm and leg lift
  - Add resistance (weights or bands)
  - Use of pillow or bolster under hips
- QL/ side plank
- Hip strengthening with spine in neutral
- Bridging progression
- Flexibility

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Multifidus and EMG Activity

(Callaghan et al. 1998)

Multifidus muscle size and CLBP

(Danneels et al. 2001)

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Horizontal Side Support
a.k.a. Side Plank

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Flexibility

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Flexibility builds from…..

A stable base is essential for the muscle to allow full range of motion and elongation. If balance is altered the range is shortened for safety.

The ability for a muscle to relax and allow elongation is related to coordination

45

Flexibility

Movement in a pain-free range

Balance/ pelvic neutral essential in the body's ability to move through full range.

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Muscle Activation &
Force Couples Controlling
Pelvic Alignment

Back extensors with
Hip flexor muscles
Create anterior pelvic
Rotation

Hamstrings and gluts with
Abdominal muscles =
posterior
Pelvic rotation

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The Right Way & the Wrong Way

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Deep Water Stretching

50

Size Does Matter!

51

Muscles are like springs

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Seated Knee extension

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Endurance

- Capacity of sustained effort over time
- Body and mind to function at peak efficiency for long periods
- Involves maintaining proper form which is a product of balance, coordination and flexibility

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Endurance

Maintaining alignment over prolonged period of time

Increasing cardiovascular challenges

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General Phase II exercise progression

- Stabilization with loading
- Stabilization with UE dissociation
- Stabilization with LE dissociation
- Stabilization with UE and LE dissociation combined
- Moving out of neutral

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Stabilization with loading




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Stabilization with UE dissociation

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Adding challenges…..

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Stabilization with LE dissociation

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Clinical Pearl for stability focus
Keeping your ducks in a row…

63

Stabilization with UE and LE dissociation combined

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Phase 2-3




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Phase 3

Functional

Sports/ work specific

Distracting exercises

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Speed vs Quickness

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Speed

Integrating local muscle control with increased activation of global muscle work.

Increases resistance and working towards strength.

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Strength

Balance of strength
Global and local

Agonist and antagonist

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Benefits of DEEP water exercise

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Shallow vs. Deep water running

Dowzer 1998

73

Literature Review: Effectiveness of Aquatic Vertical Traction on Lower Back pain and Associated Sciatica.

(Kaplan YK, Kaplan B (2016) *Journal of Aquatic Physical Therapy*. 24(1) pp.2-8)

- Conclusion: although research is limited, based on current evidence, it is **potentially beneficial to reduce pain** in patients with LBP.
- Kurutz and Bender concluded that aquatic vertical traction is a typical visco-elastic process with instant elastic and 20-minute long creeping phases. They recommend **10 min initial session, increased to 20 min**. (extending the treatment beyond 20 min was ineffective). Amount of elongation decreases with age.
- Use of armpit supports shifts the extension force to distal segments of the spine
- One investigation (Olah et al.) demonstrated significant reduction in pain measures but included exercise and iontophoresis in treatment with vertical tx.
- Consider the position of the applied weights (waist vs. ankle)
- Water temperature may play a role in that the one study that had 84 degree water temp failed to show any pain changes (one session 15 min., no weights used)

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Aquatic Vertical Traction

- 5 pound ankle weights/ suspended by noodles under arms
- 15 minutes hang in deep water well
- Increased spinal height
- Reduced pain
- Centralization of symptoms
  - Simmerman et al. 2011

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Vertical Position Stability

Stimulate function

Promote alignment and elongation of the spinal column

Individual must use their trunk muscles in order to control rotation.

Easier to initiate movement

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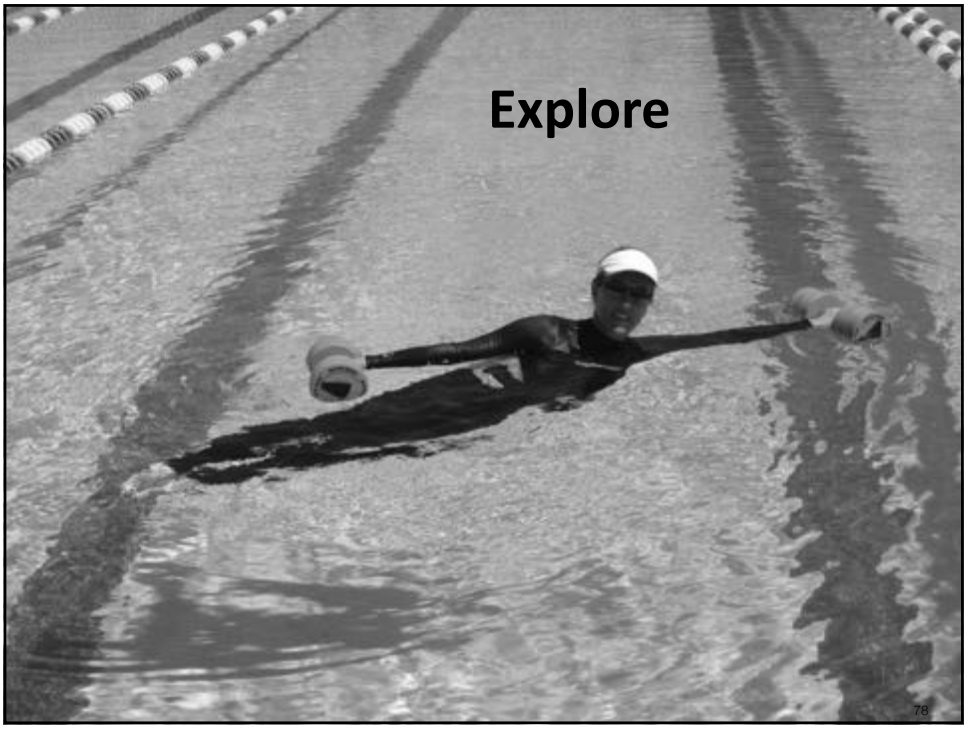

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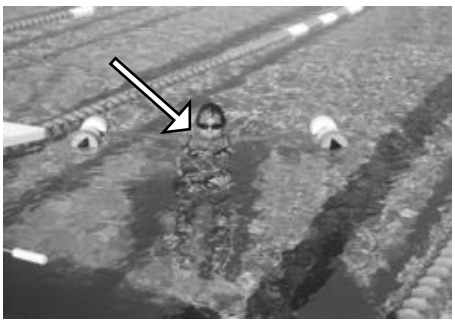
Deep Water Alignment



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What happens when there is inadequate floatation?

- Tension
- Breath holding
- Treading water
- Interference with desired movement patterns

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Floatation VS. Buoyancy Equipment

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CONTINUED

More belts and Vests

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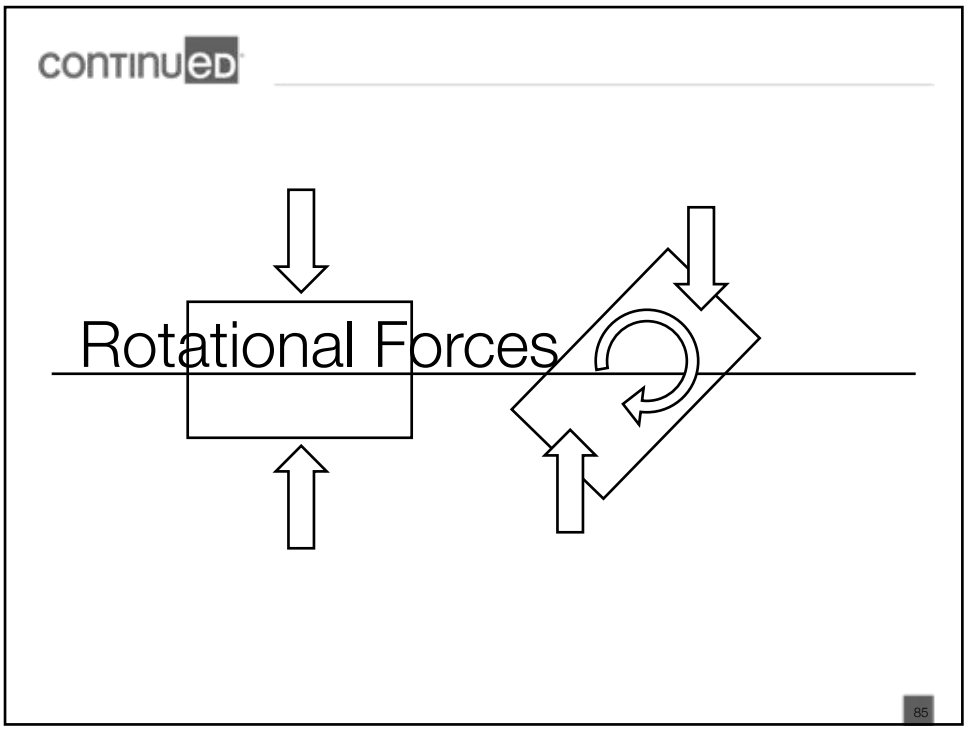

Sitting, kneeling and Standing

Noodles
Long bars/ barbells
Burdenko Boards
Wonder Boards
Subskate
Kickboards

87

Buoyancy Cuffs

88

Prone and Supine Recovery: Use physics

Change surface area and relative density: Bring knees and arms in toward body

Change COB and relative density: Exhale to assist in return to vertical

89

Watch the Head Position

90

Precautions to deep water

- Hydrophobia
- Instability, poor trunk control,
- Limited/ Absent proprioception
- Early post-op spinal fusion
- THA with hip precautions
- Multi-level fusion
- SI joint hypermobility
- ligamentous injuries

91

Gaining Specificity and Functionality in your exercise program!

92

Multiple Directions

Stimulate the neuromuscular system by reversing normal movement patterns

Correct or prevent muscle imbalances

Patterns are easier within the field of vision.

Moving backwards or sideways the body shifts to an internal kinesthetic awareness

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Effects of Aquatic Backwards Locomotion

- N= 30 (age 38.9 +/- 4.77), males with Hx of at least 11 months LBP prior to surgery
- Rx 1= PRE with MedX machine
- Rx 2= aquatic backward walking and jogging
- Control = no intervention
- Aquatic backwards locomotion is as beneficial as land based PRE for improving extension strength in patients after lumbar discectomy
  - Kim et. al (2010)

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Muscle Activation with Backward Walking

- Backward walking in water resulted in significantly higher muscle activity of the paraspinals (increased 61%), vastus medialis (increase 83%) and tibialis anterior (increase 47%) compared to walking forward in the water.

  Musumoto &Mercer 2008

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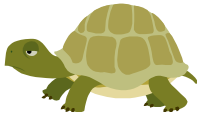
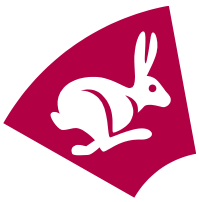
Vary the Speed

- SLOW
  - Learn and integrate the movement pattern
- MEDIUM
  - Develop flow
- FAST
  - Challenge systems





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Water and Land

Daily lives involve functioning on land

Land and water exercises are used to complement and build on each other

The same principles apply to land as they do in the water

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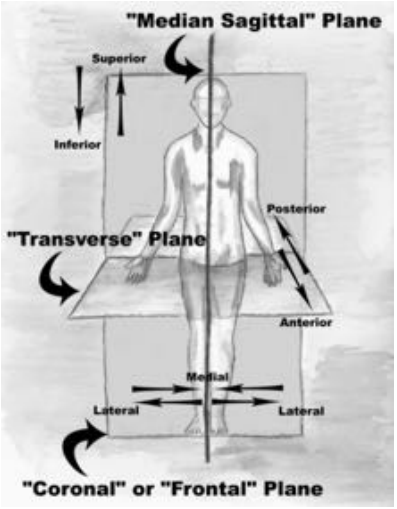
Progression and Planes



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Specificity in Exercise Prescription

- Direction and type of movement will determine plane of movement control challenged the most.
- Factors to consider with exercise
  - Unilateral vs. bilateral
  - Single plane vs. multiple plane
  - Types of resistance (buoyant vs. drag force)
  - Use and direction of manual perturbations or turbulence

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Sagital Plane

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CONTINUED

Transverse Plane

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CONTINUED

Frontal Plane

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Stability	
Pelvic neutral	Local Muscle activation

↓

Stability with Mobility	
Pelvic Neutral	Extremity movement

↓

Skill	
Move into and out of neutral	Multiple directions & planes of movement

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Importance of Cueing

- Improve performance
- Increases the value of the training
- Type of feedback for neuromuscular re-education
- Main types
  - Visual
  - Tactile
  - Verbal

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"Do" commands are more effective!

106

Practice does not make perfect, Perfect practice makes perfect!

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Aquatic Therapy Research

Spine specific

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Aquatic Spinal Stabilization Exercise & Patients with Symptomatic Lumbar Spinal Stenosis

N=6, 55-70 dx. lumbar stenosis

Outcomes= Roland-Morris disability questionnaire, pain rating scale before and after treadmill ambulation (neurogenic claudication)

Aquatic exercise 3x/ week x 6 weeks

Average decrease was 5 points on disability scale and 1.8 on pain scale

Kuck, Hasson, Olson, 2005

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Aquatic Lumbar stabilization and strengthening exercise on CLBP

6 subjects

12 week aquatic exercise (shallow and deep)

Avg. pain ↓ 71.6%

Functional outcome scores scores changed from severe to moderate disability

Winter & McCaulley-Callagy, 2002

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Aquatic Boot Camp for CLBP

- RTC, N=65 (age 20-50)
- Aquatic ex= 20 session, 5 times per week for 4 weeks, 60 minutes each
- Land ex= instruction verbal and written for HEP (no supervision just f/u phone call)
- Both groups had improvements in mobility (except for Schober test), pain disability and quality of life. However disability and quality of life measures were better in the aquatic group
- Dundar et al. Spine 2009

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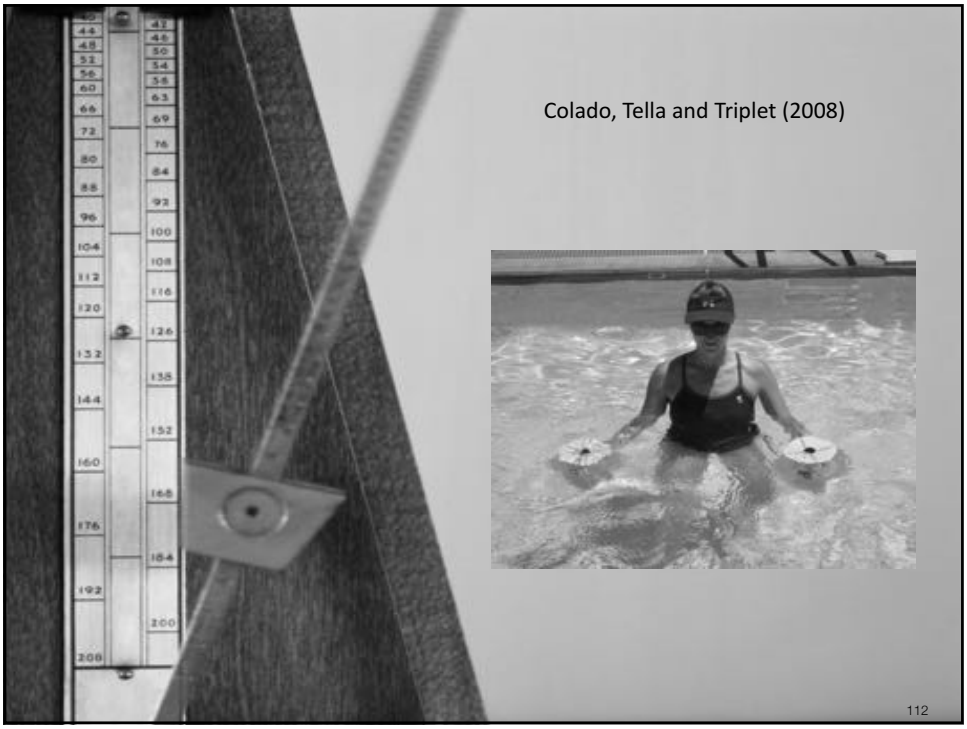

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Effects of Aquatic therapy on functional Mobility and Strength, fall risk and self-reported disability in individuals with LBP

(Johnson SR, Keyan Z, Rosario ER. (2016) *Journal of Aquatic Physical Therapy*. 24(1) pp. 22-29)

- Aquatic-based therapy can be effective treatment for individuals with LBP to improve functional mobility and strength, decrease fall risk and improve individual's self-reported disability.
- The researches suggested based on this study that patient's who present with pain levels above 5/10 and ODI scores of 45 and above would be good canidates for aquatic therapy.
- Outcome measures looked at with a trend fro improvement with aquatic group but not control was pain level, ODI, FABQ, 5 meter walk, sit to stand test and TUG.

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Frequency matters (Ariyoshi et al. 1999)

Twice or more a week was required to benefit from an aquatic exercise program for low-back pain

114

Systematic Review (Waller, Lambeck, Daly 2009)

Therapeutic aquatic exercise appears to be an effective treatment intervention for chronic and pregnancy-related low back pain.

115

A comparison of water-based and land-based core stability exercises in patients with lumbar disc herniation: a pilot study.

(Bayraktar 2015)

Authors concluded:

- An 8-week core stabilization program performed in water or on land decrease pain level and improve functional status in LDH patients.
- Both programs seem beneficial to increase health-related quality of life and static endurance of trunk muscles.
- Core stability exercises could be performed in water as well, no differences were found between methods due to environment.

116

The Effect of Water-Based Aerobic Training on the Dynamic Balance and Walking Speed of Obese Elderly Men with Low Back Pain (Irandoust, Taheri, Shavikloo 2018)

- 36 elderly aged persons (62.3±2.6 kg; 163.1±2.1 cm)with low back pain, body fat percentage higher than 35%, waist-hip ratio of over 95% and visceral fat above 100 cm2. (1/2 control and ½ aquatic exercise)
- Experimental group had a significant decrease in the test time of 10 m walking speed (p = 0.001), time up and go test (p = 0.001), as well as in obesity variables (p = 0.001) and back pain (p = 0.001) after four months; however, no significant reduction was observed in any of the test times and variables of obesity and low back pain in the control group.

117

A Pilot Study: Effects of Aquatic and Land Spinal Stabilization Training on the Management of Back Pain (Khair et al. 2014)

- There was a significant difference in the pain level between post-land and post-aquatic spinal stabilization training ($z = -2$, $p < 0.05$). The findings of this study indicated that aquatic spinal stabilization training and land spinal stabilization training decreases pain level and improves functional status, deep abdominal muscle function, and center of vertical force. Both aquatic and land spinal stabilization training demonstrated positive results in pain level, functional status, deep abdominal muscle function, and center of vertical force.

118

Aquatic Exercises in the Treatment of Low Back Pain: A Systematic Review of the Literature and Meta-Analysis of Eight Studies (Zhongji et al. 2018)

Conclusions Aquatic exercise can statistically significantly reduce pain and increase physical function in patients with low back pain. Further high-quality investigations on a larger scale are required to confirm the results.

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Thank You!

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