Case directed therapeutic aquatic exercise in musculoskeletal diseases

Urs N. Gamper, PT, CH-Valens
International Congress 2016
Comprehensive Aquatic Therapy put into Practice
Santiago de Querétaro, October 31, 2016
Topics

- Characteristics of musculoskeletal diseases
- Assessments and measurements
- Attendant treatment in msk diseases
- Delayed and protective muscle activity
- Why water
- Actual evidence for aquatic exercises in msk diseases
- Characteristics of fascia's and how we can treat it’s with Bad Ragaz Ring Method®
Musculoskeletal diseases

specific
specific intervention like: Surgery, DMARD, Antibiotics

undifferentiated
Diagnostic challenge: Teamwork, Doctors, Therapists

non specific
non specific intervention like: Multidimensional approach
Chronic musculoskeletal diseases in aquatic therapy

- Low back pain
- Osteoarthritis
- Osteoporosis
- Rheumatoid Arthritis
- Spondylitis ankylosans
- Fibromyalgia
- Myofascial pain syndrome
Maintaining functional capacity over life course

Early life
Growth and development

Health problem

Disability threshold

Rehabilitation

Adult life
Maintaining highest possible level of function

Range of function in individuals

Rehabilitation and ensuring the quality of life

Older age
Maintaining independence and preventing disability

Source: Active Ageing: A Policy Framework, WHO, 2002
Integrated behavioural on neuromuscular explanation of activity limitations in musculoskeletal diseases

**Behavioural model**
- Pain during activity → Psychological distress
- Avoidance of activity

**Neuromuscular model**
- Muscle and soft tissue weakness
- Pain during activity
- Activity limitations
- Poor proprioception
- Laxity/Stiffness
- Accessory movement

Adapted from Dekker J: Springer 2014
International classification of functioning, disability and health (ICF) and aims of interventions in musculoskeletal-diseases

Reduction of symptoms
- Reduce pain
- Improve mobility
  - Joint / Nerves
  - Soft tissue
- Improve endurance
- Improve muscle force
- Improve postural control

Reduction of ADL limitations
- Improve mobility
  - Changing and maintaining body positions
  - Walking and moving
- Improve self care
- Improve domestic life
  - Household tasks
- Improve major life areas

Source: WHO http://apps.who.int/classifications/icfbrowser/
Rehab Cycle and outcome measurements

Measurements has to measure on:
- Body function
- Activity and Participation

Measurements must be:
- metric
- sensitive
- reliable

Pain neuroscience education (PNE)

The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review

13 RCT, PEDro Scala 7-10

Content of PNE:
- Neurophysiology of pain
- Nociception and nociceptive pathways
- Synapses and action potentials
- Spinal inhibition and facilitation
- Peripheral and central sensitization
- Plasticity of the nervous system
- Psychosocial factors and beliefs contributing to pain

- No reference of anatomic or patho-anatomic models
- No discussion of the emotional or behavioural aspects of pain
A key element of “teaching people about pain” appears to be the combination of education with active/movement strategies. A conceptual framework of kinesthetic education must be consistent with and reinforces pain neuroscience education. They also provide some specific guidance for integrating pain neuroscience education with exercise and movement in a more congruent manner, enhancing the effectiveness of specific movement approaches such as graded exposure techniques.

What is often overlooked, however, is the consistency between the messages of pain neuroscience education and those of other therapeutic interventions, including movement therapies. The addition of guided purposeful movement performed in a manner consistent with pain neuroscience education may be vital to the desired behavioral changes, and when inconsistent messages are delivered between education and movement interventions, outcomes may be adversely impacted.
Is there a role for transversus abdominis in lumbo-pelvic stability

Adapted from: Cresswell AG et al. Exp Brain Res. 1994;98:336-41
Back muscle dysfunction during remission from recurrent back pain

○ □ healthy people
★ ■ recurrent episodes unilateral low back pain
Gait parameters and muscle activation patterns after 3, 6, 12 month after total hip arthroplasty

Why Aquatic Therapy

Physical properties

Water is a new environment (Tasks)

Rules of exercise physiology

Pathophysiology

Patient needs
Physical properties

- Buoyancy
- Hydrostatic pressure
- Viscosity
- Waves
- Turbulences
- Temperature

Percentage of weight-bearing during partial immersion in the hydrotherapy pool

How can we influence muscular activity in the pool?

- Surface
- Body shape
- Radius
- Speed
- Turbulences
- Waves
- Flotation aid
- Depth
Water as a new Environment (new tasks)

- Problem solving strategy
  - Change in neuro-motor behaviour
  - Different compensation strategy (land/water)
  - Balance reactions (strategy and time)
- Increase of sensory input
- No risk to fall
Aquatic Therapy is recommended in several clinical Guidelines

- EULAR recommendations for the non-pharmacological core management of **hip and knee osteoarthritis**

- EULAR revised recommendations for the management of **fibromyalgia**

- 2010 update of the ASAS/EULAR recommendations for the management of **ankylosing spondylitis**

- An updated overview of clinical guidelines for the management of non-specific **low back pain** in primary care
Systematic Review

Aquatic exercise for the treatment of knee and hip osteoarthritis

13 RCs 1190 participants, mean duration OA 6.7 y, mean duration aquatic exercise 12 weeks (6-20)

Outcomes: Pain

Paracetamol SMD 0.18 (0.11-0.25), NSAR SMD 0.37 (0.26-0.49)
doi:10.1016/j.joca.2014.01.003.
Aquatic exercise for the treatment of knee and hip osteoarthritis

Disability

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Aquatic Mean</th>
<th>SD</th>
<th>Total</th>
<th>Control Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Std. Mean Difference IV, Random, 95% CI</th>
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<tbody>
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<tr>
<td>Foley 2003</td>
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<tr>
<td>Fransen 2007</td>
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<td>23.7</td>
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<td>49.8</td>
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<tr>
<td>Hale 2012</td>
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<tr>
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<td>9.6</td>
<td>20</td>
<td>5.3%</td>
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<td>Lund 2008</td>
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<td>27</td>
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<tr>
<td>Patrick 2001</td>
<td>0.03</td>
<td>0.55</td>
<td>101</td>
<td>1.13</td>
<td>0.67</td>
<td>121</td>
<td>18.6%</td>
<td>-0.32 [-0.59, 0.08]</td>
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<tr>
<td>Sterner-Victorin 2004</td>
<td>23.5</td>
<td>7.03</td>
<td>10</td>
<td>46</td>
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<td>1.2%</td>
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<tr>
<td>Wang 2006</td>
<td>0.0</td>
<td>0.4</td>
<td>21</td>
<td>1</td>
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<td>21</td>
<td>5.2%</td>
<td>-0.22 [-0.82, 0.39]</td>
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<tr>
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<td>20</td>
<td>-89.96</td>
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<td>26</td>
<td>6.1%</td>
<td>-0.40 [-0.95, 0.14]</td>
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</table>

Total 529 530 -0.32 (-0.47, -0.17)

QoL

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Aquatic Mean</th>
<th>SD</th>
<th>Total</th>
<th>Control Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Std. Mean Difference IV, Random, 95% CI</th>
</tr>
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<tbody>
<tr>
<td>Cochrane 2005</td>
<td>-48.02</td>
<td>24.78</td>
<td>159</td>
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<tr>
<td>Foley 2003</td>
<td>-49.4</td>
<td>20.04</td>
<td>35</td>
<td>-56.3</td>
<td>17.8</td>
<td>35</td>
<td>10.4%</td>
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<td>Fransen 2007</td>
<td>-45.15</td>
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<td>-0.45 [-0.88, -0.04]</td>
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<tr>
<td>Hale 2012</td>
<td>24.81</td>
<td>10.04</td>
<td>20</td>
<td>25.36</td>
<td>8.23</td>
<td>15</td>
<td>7.4%</td>
<td>-0.05 [-0.72, 0.51]</td>
</tr>
<tr>
<td>Himman 2007</td>
<td>0.43</td>
<td>0.2</td>
<td>36</td>
<td>0.5</td>
<td>0.2</td>
<td>35</td>
<td>10.0%</td>
<td>-0.35 [-0.82, 0.12]</td>
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<td>Lim 2010</td>
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<td>-42.65</td>
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<td>20</td>
<td>8.4%</td>
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<td>Lund 2008</td>
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<td>14.47</td>
<td>27</td>
<td>-43.1</td>
<td>11.05</td>
<td>27</td>
<td>9.4%</td>
<td>0.01 [0.53, 0.54]</td>
</tr>
<tr>
<td>Patrick 2001</td>
<td>0.81</td>
<td>0.07</td>
<td>101</td>
<td>0.6</td>
<td>0.08</td>
<td>121</td>
<td>14.9%</td>
<td>0.13 [0.13, 0.40]</td>
</tr>
<tr>
<td>Sterner-Victorin 2004</td>
<td>0.37</td>
<td>0.83</td>
<td>10</td>
<td>3</td>
<td>1.93</td>
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<td>3.3%</td>
<td>-1.81 [-3.00, -0.62]</td>
</tr>
<tr>
<td>Wang 2011</td>
<td>-73</td>
<td>12</td>
<td>26</td>
<td>-67.13</td>
<td>8.16</td>
<td>26</td>
<td>9.1%</td>
<td>-0.47 [-1.02, 0.08]</td>
</tr>
</tbody>
</table>

Total 493 478 -0.25 (-0.49, -0.01)
Effectiveness of aquatic exercises for musculoskeletal conditions

Pain: Aquatic exercise vs. no exercises

- OA: -0.31 (-0.5, -0.13)
- RA: 0.00 (-0.47, 0.47)
- FM: -1.02 (-1.65, -0.38)
- LBP: -0.74 (-1.68, 0.20)

Aquatic exercise vs. no exercise
Effectiveness of aquatic exercises for musculoskeletal conditions

Outcome Physical Function: aquatic vs. no exercises

<table>
<thead>
<tr>
<th></th>
<th>Aquatic exercise</th>
<th>No exercise</th>
<th>Std. Mean Difference IV, Random, 95% CI</th>
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<tbody>
<tr>
<td>OA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cochrane 2005</td>
<td>49.87 (24.05)</td>
<td>49.03 (22.48)</td>
<td>0.04 (-0.18, 0.26)</td>
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<tr>
<td>Foley 2003</td>
<td>-49.5 (25)</td>
<td>-54.4 (19.12)</td>
<td>0.02 (-0.22, 0.75)</td>
</tr>
<tr>
<td>Fransen 2007</td>
<td>-34.8 (23.7)</td>
<td>-49.9 (19)</td>
<td>0.69 (0.27, 1.10)</td>
</tr>
<tr>
<td>Hale 2012</td>
<td>-35.29 (13.1)</td>
<td>-38.62 (10.31)</td>
<td>0.11 (-0.56, 0.78)</td>
</tr>
<tr>
<td>Hinnman 2006</td>
<td>-35.18 (18.39)</td>
<td>-38.59 (21.94)</td>
<td>0.17 (-0.30, 0.63)</td>
</tr>
<tr>
<td>Patrick 2001</td>
<td>-31.1 (18.33)</td>
<td>-37.57 (22.37)</td>
<td>0.31 (0.05, 0.58)</td>
</tr>
<tr>
<td>Stener-Victorin 2004</td>
<td>-22.5 (7.03)</td>
<td>0</td>
<td>2.21 (0.88, 3.53)</td>
</tr>
<tr>
<td>Wang 2007</td>
<td>-30 (13.3)</td>
<td>-33.3 (16.67)</td>
<td>0.22 (-0.42, 0.85)</td>
</tr>
<tr>
<td>Wang 2011</td>
<td>78 (16)</td>
<td>69 (18)</td>
<td>0.40 (-0.14, 1.54)</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>452 (545)</td>
<td>454 (581)</td>
<td>0.32 (0.12, 0.51)</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>581</strong></td>
<td><strong>573</strong></td>
<td><strong>0.32 (0.13, 0.51)</strong></td>
</tr>
</tbody>
</table>

| OA             |                  |             |                                        |
| RA             |                  |             |                                        |
| Hall 1999      | -22.5 (21)       | -27 (19)    | 7.9% (0.22, 0.69)                      |
| Subtotal (95% CI) | 35 (35)        | 35 (35)     | 0.63 (0.20, 1.00)                      |

| FM             |                  |             |                                        |
| Munguia-Izquierdo 2008 | -25.1 (16.8) | 29 | 6.7% (0.43, 0.97)                      |
| Tomas-Carus 2007 | 55 (30)         | 17 (17)    | 5.0% (0.72, 1.42)                      |
| Tomas-Carus 2009 | 54.1 (19.8)     | 17 (17)    | 4.8% (0.91, 1.8)                       |
| Subtotal (95% CI) | 63 (57)        | 57 (18.5)  | 0.36 (-0.88, 0.16)                     |

| Osteoporosis   |                  |             |                                        |
|                |                  |             |                                        |

No exercises Aquatic exercises
The benefits of a high-intensity aquatic exercise program (HydrOS) for bone metabolism and bone mass of postmenopausal women

N=108, EG 64, CG 44,
CG normal physical status
EG High intense AE 24 weeks 3/w 50-60 min.
Intensity mod. Borg Scale 5-9

Femoral trochanter BMD

P1NP (Bone formation marker)
Early aquatic physical therapy improves function and does not increase risk of wound-related adverse events for adults after orthopaedic surgery

### Adverse effect

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Aquatic Events</th>
<th>Land Events</th>
<th>Total</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Brady 2008</td>
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<td>6</td>
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<tr>
<td>Hammer 2009</td>
<td>7</td>
<td>53</td>
<td>5</td>
<td>35.9%</td>
</tr>
<tr>
<td>Jakovljevic 2011</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>8.4%</td>
</tr>
<tr>
<td>McAvoy 2009</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>10.6%</td>
</tr>
<tr>
<td>Rahmann 2009</td>
<td>0</td>
<td>18</td>
<td>17</td>
<td>12.3%</td>
</tr>
<tr>
<td>Stockton + Mengersen</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tovin 1994</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Zamaroli 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total (95% CI)
- Total events: $\chi^2 = 0.37$ (P = 0.57)
- Test for overall effect: $Z = 2.45$ (P = 0.01)

### Effect of ADL

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Aquatic Mean</th>
<th>SD</th>
<th>Total</th>
<th>Land Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hammer 2009</td>
<td>-9.5</td>
<td>9</td>
<td>41</td>
<td>-11</td>
<td>11</td>
<td>11</td>
<td>37.2%</td>
<td>0.15 (-0.28, 0.57)</td>
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<tr>
<td>Jakovljevic 2011</td>
<td>27</td>
<td>8</td>
<td>12</td>
<td>27</td>
<td>9</td>
<td>12</td>
<td>10.5%</td>
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<tr>
<td>McAvoy 2009</td>
<td>75.3</td>
<td>16.7</td>
<td>15</td>
<td>68.3</td>
<td>13.6</td>
<td>15</td>
<td>12.8%</td>
<td>0.45 (-0.28, 1.17)</td>
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<tr>
<td>Rahmann 2009</td>
<td>-37</td>
<td>13.3</td>
<td>17</td>
<td>-43.3</td>
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<td>Stockton + Mengersen 2009</td>
<td>-18.4</td>
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<td>20</td>
<td>-20.6</td>
<td>7.1</td>
<td>22</td>
<td>18.2%</td>
<td>0.29 (-0.32, 0.90)</td>
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<td>Tovin 1994</td>
<td>92.2</td>
<td>4.31</td>
<td>10</td>
<td>82.4</td>
<td>12.36</td>
<td>9</td>
<td>7.1%</td>
<td>1.04 (0.06, 2.01)</td>
</tr>
</tbody>
</table>

Total (95% CI)
- 115 Aquatic
- 119 Land
- 0.33 (0.07, 0.58)

Start with Aquatic Therapy 4 days after surgery
Postoperative Rehabilitation of Patients with Shoulder Arthroplasty: A Review on the Standard of Care

Phase I - 1st day - 4th week post surgery
- passive ROM: Flex & Elev 130°, ER approx. 30°,
- from 3rd week on low intensive active-assisted ROM;
- isometrics, cryotherapy;
- 4-6 weeks immobilization in a sling;
- contra-indication: no weights, no active ROM, no lifting

Phase II - 4th-8th week post-surgery
- continue passive ROM up to 160° Elev & 60° ER;
- active-assisted ROM; ER & Flex depending on the pain, 120° Abd.;
- isometrical shoulder stabilisation, low intensive strengthening (triceps/biceps<2.5kg), easy ADLs:
- contra-indication: weight above 2.5 kg

Phase III - 2nd-3rd month post-surgery
- whole active ROM (depending on the pain)
- strengthening of rotator cuff, exercises with theraband

Ideal for individualized Aquatic Therapy
# Shoulder muscle activation during aquatic and dry land exercises in no impaired subjects


<table>
<thead>
<tr>
<th>Muscle</th>
<th>Test</th>
<th>30° /S</th>
<th>60° /S</th>
<th>90° /S</th>
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<tbody>
<tr>
<td>Supraspinatus</td>
<td>Land</td>
<td>16.68</td>
<td>17.46</td>
<td>22.79</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>3.93</td>
<td>5.71</td>
<td>27.32</td>
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<tr>
<td></td>
<td>p=.015</td>
<td>p=0.15</td>
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<tr>
<td>Infraspinatus</td>
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<td>11.10</td>
<td>10.76</td>
<td>15.03</td>
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<tr>
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<td>Water</td>
<td>2.28</td>
<td>2.89</td>
<td>21.06</td>
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<td></td>
<td>p=.0325</td>
<td>p=.0524</td>
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<tr>
<td>Subscapularis</td>
<td>Land</td>
<td>5.96</td>
<td>6.83</td>
<td>7.45</td>
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<tr>
<td></td>
<td>Water</td>
<td>1.49</td>
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<td>Anterior deltoideus</td>
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<td>15.88</td>
<td>18.82</td>
<td>22.09</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>3.61</td>
<td>4.49</td>
<td>32.83</td>
</tr>
<tr>
<td></td>
<td>p=.0047</td>
<td>p=.0273</td>
<td>p=.3273</td>
<td></td>
</tr>
</tbody>
</table>
Effects of aquatic resistance training on mobility limitation and lower-limb impairments after knee replacement

N=50, E 26 C 24 unilateral knee replacement, time since surgery: 9 month, 2/w 45 progressive aquatic exercises RPE 12-16, HydroBoots, 12 weeks, CG no intervention

<table>
<thead>
<tr>
<th>Variable</th>
<th>Aquatic Training Group</th>
<th>Control Group</th>
<th>Mean Difference† (95% CI)</th>
<th>ANCOVA P‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Posttrial</td>
<td>Baseline</td>
<td>Posttrial</td>
</tr>
<tr>
<td></td>
<td>n=23</td>
<td>Mean ± SD</td>
<td>n=23</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>KEP operated (W)</td>
<td>23</td>
<td>112.6±51.4</td>
<td>23</td>
<td>145.6±64.0</td>
</tr>
<tr>
<td>KEP nonoperated (W)</td>
<td>23</td>
<td>153.8±50.9</td>
<td>23</td>
<td>172.3±60.0</td>
</tr>
<tr>
<td>KFP operated (W)</td>
<td>23</td>
<td>99.8±49.4</td>
<td>23</td>
<td>136.9±60.0</td>
</tr>
<tr>
<td>KFP nonoperated (W)</td>
<td>24</td>
<td>130.2±44.1</td>
<td>24</td>
<td>144.2±53.6</td>
</tr>
<tr>
<td>CSA operated (cm²)</td>
<td>24</td>
<td>105.2±30.0</td>
<td>24</td>
<td>110.1±30.7</td>
</tr>
<tr>
<td>CSA nonoperated (cm²)</td>
<td>24</td>
<td>114.5±29.1</td>
<td>24</td>
<td>117.6±39.3</td>
</tr>
<tr>
<td>Maximal walking speed (m/s)</td>
<td>25</td>
<td>1.90±0.30</td>
<td>25</td>
<td>1.96±0.31</td>
</tr>
<tr>
<td>Habitual walking speed (m/s)</td>
<td>25</td>
<td>1.31±0.17</td>
<td>25</td>
<td>1.41±0.24</td>
</tr>
<tr>
<td>Stair ascending (s)</td>
<td>25</td>
<td>4.96±2.10</td>
<td>25</td>
<td>4.27±1.67</td>
</tr>
<tr>
<td>WOMAC total score (mm)</td>
<td>25</td>
<td>22.4±10.6</td>
<td>25</td>
<td>17.9±8.5</td>
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<tr>
<td>Pain score (mm)</td>
<td>25</td>
<td>16.8±10.6</td>
<td>25</td>
<td>13.0±8.7</td>
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<tr>
<td>Stiffness score (mm)</td>
<td>25</td>
<td>32.7±24.0</td>
<td>25</td>
<td>25.9±20.6</td>
</tr>
<tr>
<td>Physical functional difficulty score (mm)</td>
<td>25</td>
<td>22.6±11.7</td>
<td>25</td>
<td>18.5±9.4</td>
</tr>
</tbody>
</table>
Fascial treatment in the pool?
Sensory findings after stimulation of the thoracolumbar fascia with hypertonic saline suggest its contribution to low back pain


12 healthy subjects
Hypertonic saline 5.8%
Fascial adaptation to lifestyle

Plyometric training effects on Achilles tendon stiffness and dissipative properties


n=19, (EG 9, CG 10) 14 w/ 2/w 60 minutes
EG diff. jumping exercises
CG normal daily activity
Muscle-tendon-unit activity during counter-movement and no counter-movement


Oscillatory movement with recoil properties

Human Achilles tendon plasticity in response to cyclic strain: effect of rate and duration

* p=0.009
† p=0.081

14 weeks, 4/w, leg press 90% 1RM

Reference protocol
A 14 weeks, 4/w, leg press 90% 1RM)
B high strain rate 72 jumps
C long strain duration 1x

* p<0.008
‡ p=0.081

P=0.002

References
Loading of different facial components

Effect of fascia training on collagen turnover

Schleip R Ed. in Fascia in sport and movement, Handspring 2015
The pathogenesis of tendinopathy: balancing the response to loading

Magnusson SP et al. Nat Rev Rheumatol, 2010;6:262–68
doi:10.1038/nrrheum.2010.43

a) 36 km running
b) 1 h max. knee kicking
c) 10 times 10 repetition (70% 1 RM)
Fascial training

- Soft tissue stretching
- Rebound elasticity
  - Tendon: high load, 70% 1 RM oscillatory recoil like slow jumping
  - Intramuscular Fascia: low load, 30% 1 RM slow, dynamic, fluidly
- Fascial release
  - Manual techniques
- Fluid refinement
  - Free movements in all directions

Fascial training use BRRM®: soft tissue stretching
Fascial training use BRRM®: soft tissue stretching
Fascial training use BRRM®: rebounding elasticity
Fascial training use BRRM®: soft tissue stretching
Questions
and try it’s in the pool