

Supplementary File 4 – Proximal rehabilitation combined with quadriceps rehabilitation compared to quadriceps rehabilitation alone study characteristics

| <b>Author</b>   | <b>Intervention</b>   | <b>Control</b>   | <b>Variables measured</b>   | <b>Follow up</b> |
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| <b><i>Proximal rehabilitation &amp; Quadriceps rehabilitation v Quadriceps rehabilitation</i></b> |   |  |   |                  |
| Ismail et al. <a href="#">39</a>  | <p>Closed Kinetic Chain and proximal exercise group (n = 16)</p> <ul style="list-style-type: none"> <li>• 18 supervised sessions</li> <li>• Static stretching hamstrings, iliotibial band, gastrocnemius, quadriceps 3x30sec</li> <li>• Mini wall squat with ball between knees 0°-40°, 6sec hold x10repetitions</li> <li>• Forward step up on 8inch step, 6sec hold x10repetitions</li> <li>• Lateral step up on 8inch step, 6sec hold x10repetitions</li> <li>• Terminal knee extension with resistance banding 0-30°, 6sec hold in full extension</li> <li>• Proximal abduction in sidelying with ankle weight*, 6sec hold,</li> </ul> | <p>Closed Kinetic Chain exercise group (n = 16)</p> <ul style="list-style-type: none"> <li>• 18 supervised sessions</li> <li>• Static stretching hamstrings, iliotibial band, gastrocnemius, quadriceps 3x30sec</li> <li>• Mini wall squat with ball between knees 0°-40°, 6sec hold x10repetitions</li> <li>• Forward step up on 8inch step, 6sec hold x10repetitions</li> <li>• Lateral step up on 8inch step, 6sec hold x10repetitions</li> <li>• Terminal knee extension with resistance banding 0-30°, 6sec hold in full extension</li> </ul> | <ul style="list-style-type: none"> <li>• Pain</li> <li>• VAS (0-10)</li> <li>• Kujala Score (0-100)</li> <li>• Strength</li> <li>• Isokinetic (60°/s) peak force/body mass index <ul style="list-style-type: none"> <li>▪ Centric proximal abduction</li> <li>▪ Eccentric proximal abduction</li> <li>▪ Centric proximal external rotation</li> <li>▪ Eccentric proximal external rotation</li> </ul> </li> </ul> | 6 weeks          |

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|                                  | <p>2x10repetitions</p> <ul style="list-style-type: none"> <li>Proximal external rotation in sitting with ankle weight*, 6sec hold, 2x10repetitions</li> </ul> <p>*load, 60% 10 repetition maximum</p>   |  |   |   |
| Fukuda et al. <a href="#">23</a> | <p>Knee and proximal exercise group (KHE) (n = 28)</p> <ul style="list-style-type: none"> <li>12 supervised sessions (nil at home)</li> <li>Therapist assisted stretching hamstrings, plantar flexors, quadriceps and ilitibial band 3x30s</li> <li>Seated knee extension 90°-45°, 3x10repetitions*</li> <li>Leg press 0°-45°, 3x10repetitions*</li> <li>Squatting 0°-45°, 3x10repetitions*</li> <li>Single-leg calf raises, 3x10repetitions*</li> <li>Prone knee flexion (maintaining patella off table) 3x10repetitions*</li> <li>Proximal abduction with weights (sidelying) 3x10repetitions*</li> </ul> | <p>Knee exercise group (KE) (n = 26)</p> <ul style="list-style-type: none"> <li>12 supervised sessions (nil at home)</li> <li>Therapist assisted stretching hamstrings, plantar flexors, quadriceps and ilitibial band 3x30s</li> <li>Seated knee extension 90°-45°, 3x10repetitions*</li> <li>Leg press 0°-45°, 3x10repetitions*</li> <li>Squatting 0°-45°, 3x10repetitions*</li> <li>Single-leg calf raises, 3x10repetitions*</li> <li>Prone knee flexion (maintaining patella off table) 3x10repetitions*</li> <li>*load, 70% of 1 pain free repetition maximum</li> </ul> <p>†maximum resistance that enables 10 repetitions</p> | <ul style="list-style-type: none"> <li>Pain <ul style="list-style-type: none"> <li>NPRS ascending stairs</li> <li>NPRS descending stairs</li> </ul> </li> <li>Function <ul style="list-style-type: none"> <li>LEFS (0-80)</li> <li>AKPS (0-100)</li> <li>Single-limb hop test (cm)</li> </ul> </li> </ul> | <p>3 months, 6 months &amp; 12 months</p> |

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|                                 | <ul style="list-style-type: none"> <li>• Proximal abduction against elastic band (standing)<br/>3x10repetitions†</li> <li>• Proximal external rotation against elastic band (sitting)<br/>3x10repetitions†</li> <li>• Proximal extension (machine)<br/>3x10repetitions*</li> <li>• *load, 70% of 1 pain free repetition maximum</li> </ul> <p>†maximum resistance that enables 10 repetitions</p>   |   |  |                             |
| Dolak et al. <a href="#">24</a> | <p>4 weeks initial proximal abduction and external rotation rehabilitation followed by 4 weeks weight bearing exercises (n=17)</p> <ul style="list-style-type: none"> <li>• Exercise completed 3xper week (1 supervised, 2 at home)</li> <li>• Seated hamstring stretch, standing quadriceps stretch and standing wall stretch for triceps surae for 3x30sec prior to rehabilitation</li> <li>• Progression made on an individual basis by the</li> </ul> | <p>4 weeks initial quadriceps rehabilitation followed by 4 weeks weight bearing exercises (n=16)</p> <ul style="list-style-type: none"> <li>• Exercise completed 3xper week (1 supervised, 2 at home)</li> <li>• Seated hamstring stretch, standing quadriceps stretch and standing wall stretch for triceps surae for 3x30sec prior to rehabilitation</li> <li>• Progression made on an individual basis by the treating clinician within</li> </ul> | <ul style="list-style-type: none"> <li>• Pain</li> <li>• VAS</li> <li>• Function</li> <li>• LEFS</li> <li>• Strength</li> <li>• Isometric proximal abduction strength</li> <li>• Isometric proximal external rotation strength</li> <li>• Isometric knee extension strength</li> </ul> | 4 weeks, 8 weeks & 3 months |

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|  | <p>treating clinician within protocol limits</p> <ul style="list-style-type: none"> <li>• Side-lying proximal abduction/external rotation +/- 3-7% of body weight 3x10repetitions</li> <li>• Standing proximal abduction +/- 3-7% body weight 3x10repetitions</li> <li>• Seated proximal external rotation +/- 3-7% body weight 3x10repetitions</li> <li>• Quadruped hydrant +/-3% body weight 3x10repetitions</li> <li>• Single leg balance with front pull/diagonal pull/on airex pad/airex pad and diagonal pull 3x30sec</li> <li>• Wall slides with resistance/single leg mini squats/lunges to 20.3cm step/lunges to a 10cm step 3x10repetitions</li> <li>• Lateral step down 10cm step/15.25cm step/ 15.25cm step with resistance/20.3cm step 3x10repetitions</li> <li>• 2 leg calf raises/single leg calf raises/off step/on airex pad 3x10repetitions</li> </ul> | <p>protocol limits</p> <ul style="list-style-type: none"> <li>• Quad sets</li> <li>• Short arc quads +/- 3-7% body weight</li> <li>• Straight leg raises +/- 3-7% body weight</li> <li>• Terminal knee extension with 3-7% body weight</li> <li>• Single leg balance with front pull/diagonal pull/on airex pad/airex pad and diagonal pull 3x30sec</li> <li>• Wall slides with resistance/single leg mini squats/lunges to 20.3cm step/lunges to a 10cm step</li> <li>• Lateral step down 10cm step/15.25cm step/ 15.25cm step with resistance/20.3cm step</li> <li>• 2 leg calf raises/single leg calf raises/off Painstep/on airex pad</li> </ul> |  |  |
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| <p>Fukuda et al. <a href="#">38</a></p> | <p>Knee and proximal exercise group (KHE) (n = 23)</p> <ul style="list-style-type: none"> <li>• 12 supervised sessions (nil at home)</li> <li>• Therapist assisted stretching hamstrings, plantar flexors, quadriceps and ilitibial band 3x30s</li> <li>• Iliopsoas rehabilitation in non-weight bearing, 3x10repetitions*</li> <li>• Seated knee extension 90°-45°, 3x10repetitions*</li> <li>• Leg press 0°-45°, 3x10repetitions*</li> <li>• Squatting 0°-45°, 3x10repetitions*</li> <li>• Proximal abduction against elastic band (standing) 3x10repetitions†</li> <li>• Proximal abduction with weights (sidelying) 3x10repetitions*</li> <li>• Proximal external rotation against elastic band (sitting) 3x10repetitions†</li> <li>• Side-stepping against</li> </ul> | <p>Knee exercise group (KE) (n = 22)</p> <ul style="list-style-type: none"> <li>• 12 supervised sessions (nil at home)</li> <li>• Therapist assisted stretching hamstrings, plantar flexors, quadriceps and ilitibial band 3x30s</li> <li>• Iliopsoas rehabilitation in non-weight bearing, 3x10repetitions*</li> <li>• Seated knee extension 90°-45°, 3x10repetitions*</li> <li>• Leg press 0°-45°, 3x10repetitions*</li> <li>• Squatting 0°-45°, 3x10repetitions*</li> <li>• *load, 70% of 1 pain free repetition maximum</li> </ul> <p>†maximum resistance that enables 10 repetitions</p> | <ul style="list-style-type: none"> <li>• Pain</li> <li>• NPRS ascending stairs</li> <li>• NPRS descending stairs</li> <li>• Function</li> <li>• LEFS (0-80)</li> <li>• AKPS (0-100)</li> <li>• Single-limb hop test (cm)</li> </ul> | <p>4 weeks</p> |
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|                                       | <ul style="list-style-type: none"> <li>elastic band 3x1minute</li> <li>*load, 70% of 1 pain free repetition maximum</li> </ul> <p>†maximum resistance that enables 10 repetitions</p>  |   |  |         |
| Razeghi et al.<br><a href="#">37</a>  | <p>Proximal &amp; knee rehabilitation exercise programme (n=16)</p> <ul style="list-style-type: none"> <li>Programme not explicitly described</li> <li>“Progressive resistive exercises for the proximal muscles”</li> <li>“Terminal and 90° to 50° resistive knee extension and mini squats for the quadriceps”</li> <li>“The McQueen progressive resistive technique was applied to increase exercise resistance”</li> </ul> | <p>Knee rehabilitation exercise programme (n=16)</p> <ul style="list-style-type: none"> <li>Programme not explicitly described</li> <li>“Terminal and 90° to 50° resistive knee extension and mini squats for the quadriceps”</li> <li>“The McQueen progressive resistive technique was applied to increase exercise resistance”</li> </ul> | <p>In case and control group:</p> <ul style="list-style-type: none"> <li>Pain</li> <li>VAS</li> <li>Successful/unsuccessful outcome</li> <li>Strength</li> <li>Knee extension strength</li> </ul> <p>In success /unsuccess groups only</p> <ul style="list-style-type: none"> <li>Strength <ul style="list-style-type: none"> <li>Proximal flexion strength</li> <li>Proximal extension strength</li> <li>Proximal abductor strength</li> <li>Proximal adductor strength</li> <li>Proximal internal rotation strength</li> <li>Proximal external rotation strength</li> <li>Knee extension strength</li> </ul> </li> </ul> | 4 weeks |
| Nakagawa et al.<br><a href="#">40</a> | <p>Proximal and Knee Exercise Group (n = 7)</p> <ul style="list-style-type: none"> <li>All exercises performed in addition to the knee exercise group exercises</li> <li>Once per week supervised, 4 times per week independently at</li> </ul>  | <p>Knee Exercise Group (n = 7)</p> <ul style="list-style-type: none"> <li>Once per week supervised, 4 times per week independently at home</li> <li>Stretches (all exercise sessions) 3 repetitions/30-second hold. Sitting</li> </ul>  | <ul style="list-style-type: none"> <li>Pain <ul style="list-style-type: none"> <li>VAS – usual, worst, stair ascent and decent, squatting and prolonged sitting</li> </ul> </li> <li>Gluteal Electromyography <ul style="list-style-type: none"> <li>Max Voluntary Isometric Contraction (MVIC)</li> <li>Eccentric Contraction (EC)</li> <li>EC expressed as % of MVIC</li> </ul> </li> </ul>  | 6 weeks |

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|  | <p>home</p> <p>Weeks 1 and 2 exercises; 2 sets of 15 repetitions/ 10-second hold</p> <ul style="list-style-type: none"> <li>• Transversus abdominus muscle contraction in the quadruped position</li> <li>• Isometric combined proximal abduction–lateral rotation in side-lying with the proximals and knees slightly flexed elastic resistance</li> <li>• Side-lying isometric proximal abduction with extended knee</li> <li>• Isometric combined proximal abduction–lateral rotation in the quadruped position</li> </ul> <p>Weeks 3 and 4 exercises; 2 sets of 15 repetitions/ 10-second hold or 3 sets of 10 repetitions</p> <ul style="list-style-type: none"> <li>• Pelvic drop exercise on a 20-cm step Upper extremity extension of the contralateral arm with elastic resistance performed in a single-leg stance</li> <li>• Rotation of the body in the</li> </ul> | <p>hamstring stretch. Sitting patellar mobilization. Standing quadriceps, calf and iliotibial band stretch.</p> <p>Weeks 1 and 2 exercises; 2-4 sets of 10 repetitions/ 10-second hold</p> <ul style="list-style-type: none"> <li>• Isometric quadriceps contractions while sitting with 90° of knee flexion</li> <li>• Straight-leg raise in supine</li> <li>• Mini squats to 40° of knee flexion</li> </ul> <p>Weeks 3 and 4 exercises; 3 sets of 10 repetitions</p> <ul style="list-style-type: none"> <li>• Wall slides (0–60° of knee flexion)</li> <li>• Steps-up and steps-down from a 20-cm step</li> <li>• Forward lunges (0–45° of knee flexion)</li> </ul> <p>Weeks 5 and 6 exercises, as for weeks 3 and 4 plus; 3 sets of 30-second hold each exercise</p> <ul style="list-style-type: none"> <li>• Balance exercises: unilateral stance on the floor and on an air-filled disc, with opened and closed eyes</li> <li>• Progressive walking or</li> </ul> | <ul style="list-style-type: none"> <li>• Eccentric Isokinetic Peak Torque <ul style="list-style-type: none"> <li>• Knee extensor</li> <li>• Proximal abductor</li> <li>• Proximal lateral rotator</li> </ul> </li> </ul> |  |
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|                                     | <p>direction of the contralateral side, holding an elastic resistance with the ipsilateral arm while maintaining the lower extremity static</p> <p>Weeks 5 and 6 exercises, as for weeks 3 and 4b</p> <ul style="list-style-type: none"> <li>• Additional elastic resistance around the affected leg in the forward lunges to encourage lateral rotation and abduction of the proximal</li> </ul>   | running programme  |   |         |
| Avraham F et al. <a href="#">41</a> | <p>Proximal and quadriceps rehabilitation exercises (n = 10)</p> <p>Two treatment sessions/week in clinic, 4 sessions independently at home</p> <ul style="list-style-type: none"> <li>• 3 minutes Straight leg raises</li> <li>• 3 minutes Single leg squats</li> <li>• 3 minutes ITB stretches</li> <li>• 3 minutes hamstring stretches</li> <li>• 3 minutes proximal external rotators rehabilitation</li> <li>• 15minutes TENS</li> </ul> | <p>Quadriceps rehabilitation exercises (n = 10)</p> <p>Two treatment sessions/wk in clinic, 4 sessions independently at home</p> <ul style="list-style-type: none"> <li>• 7.5 minutes straight leg raises</li> <li>• 7.5 minutes single leg squats</li> <li>• 15 minutes TENS</li> </ul> | <ul style="list-style-type: none"> <li>• Pain</li> <li>• VAS (0-10)</li> <li>• Function</li> <li>• Patellofemoral evaluation scale (0-100)</li> </ul> | 3 weeks |



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| VAS – Visual analogue scale; NPRS – Numeric pain rating scale; LEFS – Lower extremity functional score; AKPS – Anterior knee pain score;<br>TENS – Transcutaneous electrical nerve stimulation; ITB – Iliotibial band |  |  |  |  |