Osteoarthritis Physiotherapy Protocol

An integrated exercise-based rehabilitation program using the Levitation Tri-Compartment Unloader knee brace for patients suffering from moderate to severe knee osteoarthritis and other conditions.

By Rachel Doucet MSc PT  | Nina Laroche MSc PT
About The Authors

Rachel Doucet MSc, PT

Rachel Doucet is a physiotherapist at Cleveland Clinic Canada. Rachel has been involved in the world of sports and physical activity for as long as she can remember. She decided to pursue this passion as a career and obtained her Bachelor of Science in Kinesiology from Dalhousie University in Halifax before going on to complete her Master’s in Physiotherapy. She has experience working with a multitude of injuries and issues such as sport injuries, acute/chronic injuries, post-op rehab, motor vehicle accidents and workplace injuries. Additionally, Rachel worked as a PSP (fitness trainer) for the Canadian Armed Forces giving her a background in strength and conditioning.

Rachel has provided care for numerous events, including the National Skate Championship, Elite Gymnastics, Major Bantam Hockey, ICE JAM, Judo Nova Scotia, Canada Games: Halifax, Canada Games: Judo Test Event, Special Olympics, NSSAF Track and Field Championships and the St. Mary’s University Women’s Rugby Team.

Nina Laroche MSc, PT

Nina graduated from Dalhousie University in 2010 with a Master’s Degree in Physiotherapy. She has worked primarily in outpatient care and private practice and has a keen interest in treatment of the neuro-musculoskeletal system. Nina works with people suffering from sports, motor vehicle, work-related, repetitive strain, and postural-related injuries, and arthritis. She has completed Levels A-D of the McKenzie Institute of Canada’s “Mechanical Diagnosis and Therapy” courses, which is a standardized and validated movement based assessment and treatment system for neck, low back and extremity pain. She also provides post-concussion syndrome and vestibular rehabilitation and is trained in acupuncture.

Acknowledgments

Karen Decker BSc, PT

Karen graciously provided consultation in the formulation of this rehabilitation protocol. With over 25 years of experience as a physiotherapist, several advanced diplomas, and numerous accolades including the involvement in three Olympic games – her expertise and guidance was invaluable.
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1.1 Knee Osteoarthritis and Bracing

Osteoarthritis (OA) is the most common cause of disability in older adults.¹ It is estimated that 130 million people suffer from OA worldwide and by the year 2050 over 40 million will be severely disabled.¹ Unfortunately, there is no known cure for OA. Affected patients often experience a poor quality of life because, in addition to significant pain, OA can cause reductions in strength, range of motion, joint stability, neuromuscular control and proprioception. As a result, osteoarthritis is often a barrier to a healthy and active lifestyle.²,³

Standard care for OA is a multidisciplinary effort consisting of (1) unloading the joint through activity modification, strengthening, knee bracing, and/or weight-loss (if appropriate); (2) pharmacological or injectable treatments (e.g., intra-articular hyaluronic acid or corticosteroid injections) and (3) in severe cases where conservative treatments are ineffective, joint replacement surgery.¹,⁴

Traditional unloader knee braces have been shown to be effective in reducing pain during activity in patients with uni-compartmental tibiofemoral OA.⁷ These devices use condylar unloading mechanisms that positively affect knee kinematics during weight bearing activities.⁵–¹⁰,¹¹ However, it is important to note that uni-compartmental tibiofemoral OA accounts for a small fraction of all knee OA cases. In fact, an Oxford University study by Duncan et al. demonstrated that out of 531 patients with radiographic OA, only (6%) had isolated tibiofemoral OA, (35%) had isolated patellofemoral OA, and (59%) had both patellofemoral and tibiofemoral OA.¹² As a result, traditional uni-compartment unloader braces do not fully address the majority of knee OA cases.

![Figure 1: Knee Compartments – PFC, LTFC, MTFC](image-url)
1.2 The Levitation®2 Tri-compartment Unloader

Levitation®2 is the world’s first tri-compartment unloader knee brace. Equipped with a patented spring loaded hinge, it is the only knee brace capable of simultaneously providing unloading to both tibiofemoral joint compartments as well as the patellofemoral joint. To achieve this, the spring loaded hinge supports body weight during knee flexion, effectively transferring weight away from the knee joint.23 In fact, independent research indicates that Spring Loaded braces can reduce contact forces in the knee by up to 64%.14 When the knee is extending, the spring loaded hinge provides dynamic extension assistance, allowing for increased mobility, neuromuscular retraining, and pain-free muscle strengthening.

Levitation braces feature adjustable levels of assistance that can be customized through the full range of motion (figure 4). This adjustability allows the therapist to control how much assistance the patient is getting and to reduce the assistance provided as rehabilitation progresses.

Figure 2: Levitation uses patented spring technology to simultaneously decrease pressure in all three compartments of the knee.

Figure 3: Levitation Features

- Ultra Durable Carbon Fiber
- Optional Pneumatic Condular Offloader
- Surefit™ Anti-slip Straps
- Light Weight
- Adjustable Force Output
- Spring Loaded Bionic Hinge

Low Power Mode
↓ Assisted ROM
↓ Strength Assistance

High Power Mode
↑ Assisted ROM
↑ Strength Assistance
Benefit Description

Reduces Joint Compression
• Levitation can simultaneously reduce tibiofemoral and patellofemoral contact forces by absorbing bodyweight into a patented spring-loaded hinge (thus effectively transferring weight away from the knee joint).\textsuperscript{13,24}

Reduces Pain
• Decreasing joint compression forces can result in a significant reduction in patient reported pain symptoms during and after weight bearing activities.\textsuperscript{3,5–11,17}
• Levitation may improve neuromuscular function by reducing the incidence of knee joint muscular co-contraction during walking, thereby reducing pain associated with walking.\textsuperscript{3,18,19}

Improves Strength
• Levitation augments the natural strength of the quadriceps when weight-bearing. The extension assist function can be used to assist neuromuscular rehabilitation by rewarding partial activation of the quadriceps with pain-free extension. As a result, the brain overcomes arthrogenic muscle inhibition (AMI) and increases neural drive to the quadriceps. Over time, this can result in pain-free mobility, strengthening and rehabilitation, which can lead to increased muscle strength.\textsuperscript{3,16,17}

Functional Stabilization
• The rigid hinged brace provides functional medial and lateral support to the knee.

Injury Prevention
• Levitation helps to prevent overloading and fatigue by assisting quadriceps function.\textsuperscript{3,21}
• The stabilization provided by the rigid brace and the pneumatic condyle pads are intended to improve knee control and stability during dynamic activities to help prevent injury.\textsuperscript{22}

Performance Enhancement
• Levitation functions to reduce wearer fatigue and enhance quadriceps function by transferring mechanical work to the brace, allowing longer periods of exercise, activities of daily living (ADL), work and sport.\textsuperscript{3,15}

Table 1: Levitation Brace Key Features

<table>
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<th>Description</th>
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  • Levitation may improve neuromuscular function by reducing the incidence of knee joint muscular co-contraction during walking, thereby reducing pain associated with walking.\textsuperscript{3,18,19} |
| Improves Strength        | • Levitation augments the natural strength of the quadriceps when weight-bearing. The extension assist function can be used to assist neuromuscular rehabilitation by rewarding partial activation of the quadriceps with pain-free extension. As a result, the brain overcomes arthrogenic muscle inhibition (AMI) and increases neural drive to the quadriceps. Over time, this can result in pain-free mobility, strengthening and rehabilitation, which can lead to increased muscle strength.\textsuperscript{3,16,17} |
| Functional Stabilization | • The rigid hinged brace provides functional medial and lateral support to the knee. |
| Injury Prevention        | • Levitation helps to prevent overloading and fatigue by assisting quadriceps function.\textsuperscript{3,21}  
  • The stabilization provided by the rigid brace and the pneumatic condyle pads are intended to improve knee control and stability during dynamic activities to help prevent injury.\textsuperscript{22} |
| Performance Enhancement  | • Levitation functions to reduce wearer fatigue and enhance quadriceps function by transferring mechanical work to the brace, allowing longer periods of exercise, activities of daily living (ADL), work and sport.\textsuperscript{3,15} |

Figure 4a: Levitation’s adjustable extension assist allows the maximum force output and unassisted range of motion to be adjusted to the needs of the patient.

Figure 4b: Levitation’s customizable force response allows the force response curve to be customized across the range of motion of the knee joint.
### Table 2: Levitation knee brace compared to traditional off-loading braces

<table>
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<th>Features</th>
<th>Levitation 2</th>
<th>Traditional Unloader Braces</th>
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<tbody>
<tr>
<td>Joint stabilization 23</td>
<td>✓</td>
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<tr>
<td>Varus-valgus joint alignment 23</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Medial/lateral tibiofemoral unloading 23</td>
<td>✓</td>
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<td>Patellofemoral unloading 24</td>
<td>✓</td>
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<tr>
<td>Tri-compartment unloading 24</td>
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<tr>
<td>Reduces effective body weight transferred through the knees 23</td>
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<tr>
<td>Knee extension assistance 23</td>
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<tr>
<td>Immediate pain reduction 25</td>
<td>✓</td>
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<td>Rapid functional improvement 25</td>
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### 1.3 Levitation Implementation

For rehabilitation purposes, the Levitation knee brace is to be used while doing physiotherapy exercises and during ADLs. For guidance on Levitation brace fitting, refer to the [Instruction Manual](#).

During rehabilitation, the Levitation knee brace is most commonly used in high power mode with the spring loaded mechanism engaged and torque settings adjusted according to the patient’s specific needs (see [Instruction Manual](#) and below for additional details). Alternatively, the spring loaded mechanism can be disengaged to have the brace function in low power mode. While in low power mode Levitation functions like a traditional unloader knee brace, providing lateral stability as well as optional medial and lateral unloading. Low power mode is most commonly used during the late stages of rehabilitation, and during activities where the patient does not require assistance to allow for continued strength and proprioceptive development.

Levitation is particularly helpful with closed kinetic chain (CKC) exercises and activities. The spring loaded hinge mechanism assists patients through their full range of motion (ROM) during both knee flexion and extension. Joint loading in the tibiofemoral compartment(s) can be attenuated further via the addition of an optional pneumatic [Offloader](#). It can be fitted to either side of the brace, provides improved joint alignment and additional medial or lateral unloading.
Levitation’s torque settings can be adjusted by the treating physiotherapist as the patient progresses through rehabilitation. To determine the appropriate setting, it is recommended that functional testing be completed in conjunction with subjective scales such as Visual Analogue Scale (VAS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC),22 or Knee Injury and Osteoarthritis Score (KOOS) to monitor the patient’s response (Appendix).

Testing should be completed initially with the brace set at full torque and then again with gradually reduced assistance, while monitoring reported pain symptoms and performance. The goal is to find the torque setting at which the brace provides the least amount of assistance required to help complete functional tasks while remaining below the patient’s pain threshold. Functional tests relevant to patient’s goals should be used and are not necessarily limited to those provided in this protocol (table 4).

Table 4: Functional Test Examples

<table>
<thead>
<tr>
<th>Population</th>
<th>Functional Tests</th>
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</thead>
<tbody>
<tr>
<td>Non-athlete or pre/post-operative</td>
<td>• 40 meter fast paced walk test 26</td>
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<td>• TUG 26</td>
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<tr>
<td></td>
<td>• Stair climb test 26</td>
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<td></td>
<td>• 6 minute walk test 26</td>
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<td></td>
<td>• Community balance test 27</td>
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<td></td>
<td>• 30 second chair test 27</td>
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<tr>
<td>Athlete or non-operative</td>
<td>• Shuttle run</td>
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<td></td>
<td>• Vertical jumping</td>
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<td></td>
<td>• Carioca test</td>
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<td></td>
<td>• Triple hop distance test 28</td>
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<tr>
<td></td>
<td>• Ladder drills</td>
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<tr>
<td></td>
<td>• Cutting on demand</td>
</tr>
<tr>
<td></td>
<td>• Lunging</td>
</tr>
</tbody>
</table>

*Warning*: Never use the brace in high power mode while driving.

Table 3: List of examples for when to use Levitation’s high and low power modes

<table>
<thead>
<tr>
<th>High Power Mode</th>
<th>Low Power Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early to mid stages of surgical rehabilitation</td>
<td>Late stage rehabilitation</td>
</tr>
<tr>
<td>Early to mid stages of post-injury rehabilitation</td>
<td>Return to play or occupational duties</td>
</tr>
<tr>
<td>Return to play or occupational duties</td>
<td>High risk work or play on unstable surfaces</td>
</tr>
<tr>
<td>Sit to stand, crouching, squatting and lunging</td>
<td>Stair climbing</td>
</tr>
<tr>
<td>Descending stairs</td>
<td>Driving*</td>
</tr>
</tbody>
</table>

See Appendix for outcome measures and print-outs.
2.0 Levitation OA Protocols

Caution

The Levitation OA protocol is a guide intended for clinicians treating patients who are dealing with various degrees of OA, related functional deficits, prepping for surgery, or have undergone surgery and are beginning recovery. Therefore, practitioners must use clinical reasoning when prescribing a rehabilitation program for their patients. This protocol is solely intended for use as a guideline to incorporate the Levitation knee brace into management and therapeutic exercise for persons with OA. Each treatment plan should be individualized according to the patient’s needs, pain levels, current mobility, functional status and goals. Patients should be informed not to “push through” any undue pain during exercise or complete any activities that do not feel comfortable or safe. Refer to pg. 20 for further details and recommendations regarding physical activity and OA.

Similarly, the timeline for each stage is not predetermined, but rather progress is made based on the achievement of goals listed in each stage and pain levels measured using WOMAC or VAS pain scales (Appendix). Beginning and ending stages will also vary depending on pain levels, ROM, strength, and function (some people will start at Stage 1 and others will begin elsewhere; some may reach the end stages and others may not). The goal is to maximize functional abilities while minimizing pain, thereby improving quality of life (QOL).
Levitation Exercise Protocol

Program Overview, Exercises & Guidelines

Table 5: Levitation Physiotherapy Protocol

<table>
<thead>
<tr>
<th>Stage</th>
<th>Goals &amp; Outcome Measures</th>
<th>Use of Levitation</th>
<th>Ongoing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brace Introduction, AROM, Swelling &amp; Pain Control</td>
<td>• Size &amp; customize Levitation knee brace • Focus on recruiting vastus medialis oblique • Monitor changes in reported pain with VAS or WOMAC (appendix) • Achieve AROM at knee: 0-90°, push for 100-135° knee flexion as able</td>
<td>• Achieve negative quadriceps lag test • Should be fitted and adjusted regularly by patient or therapist to accommodate changes in swelling, dressings, use of a compression sleeve, or removal of staples • After acclimatization period (see instructions) brace is recommended to be worn during weight-bearing &amp; functional activity • Extension assist to be adjusted to individual needs (see table 3 and figure 4) • Compression sleeve may be worn underneath • Customize brace settings as tolerated based on functional tests and subjective pain measures</td>
</tr>
<tr>
<td>2</td>
<td>Strength, Muscle Balance &amp; Proprioception</td>
<td>• Strive for full ROM and achieve 100% weight bearing, normal gait and functional body mechanics • Optimize body mechanics during ADLs • Increase muscle strength &amp; balance (core, lower kinetic chain) • 5/5 on all lower extremity Manual Muscle Tests (MMT) • Monitor pain symptoms during and after activity using VAS or WOMAC (appendix) • Regain balance – measure using standardized balance tests such as BERG • Gradually decrease Levitation force output while remaining below the patient's pain threshold • Increase range of motion during functional activities • Continued pain management modalities if needed • Education: Gradual exercise progression via reps, sets, time and load within pain tolerance</td>
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<tr>
<td>Stage</td>
<td>Goal &amp; Outcome Measures</td>
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<td>**1. **</td>
<td><strong>Brace Introduction, AROM, Swelling &amp; Pain Control</strong></td>
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<td><strong>2.</strong></td>
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<td>**3. **</td>
<td><strong>Strength, Balance &amp; Proprioception</strong></td>
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<td><strong>4.</strong></td>
<td><strong>Strength, Balance &amp; Proprioception</strong></td>
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<td><strong>5.</strong></td>
<td><strong>Strength, Balance &amp; Proprioception</strong></td>
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### General
- Customized brace settings as tolerated based on functional limitations and subjective pain measures.
- Gradually decrease Levitation force output while maintaining below the patient's pain threshold.
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- Gradually decrease Levitation force output while maintaining below the patient's pain threshold.

### Ongoing Management
- Education: Gradual exercise progression via reps, sets, time, and load within general patient education: pain tolerance.
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### Use of Levitation
- Cautions.
- Monitor pain symptoms during and after activity using VAS or WOMAC.
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<td>3</td>
<td><strong>Dynamic Activity &amp; Agility</strong></td>
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<td></td>
<td>- Minimize risk of re-injury</td>
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<td>- Pain and swelling are well managed</td>
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<td></td>
<td>- Continue pain-regarding ongoing use of the Levitation brace during specific activities (e.g., when to use low power mode vs. high power mode)</td>
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<td></td>
<td>- Counsel patient regarding pain symptoms during specific activities</td>
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<td></td>
<td>- Monitoring patients during activity, use VAS or WOMAC (appendix)</td>
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<td>- Monitor improvement in pain with VAS or WOMAC (appendix)</td>
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<td>- Encourage continuous pain-free home exercise</td>
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<td>- Decrease force output slowly (as patient's strength increases) while increasing unassisted range of motion</td>
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<td></td>
<td>- Education: Proper form and body mechanics is critical</td>
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<td>- Sets and reps: quality over quantity</td>
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<td>- General: Integrate preventative dynamic warm up (e.g., FIFA 11+)</td>
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<td>- Improve strength, flexibility, balance, endurance</td>
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<td>- Athlete: Sport specific training such as agility, power</td>
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<td>- 3-4 week</td>
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<td>- Patient is psychologically prepared to return to activity or sport</td>
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<td></td>
<td>- Counsel patient regarding ongoing use of the Levitation brace during specific activities (e.g., when to use low power mode vs. high power mode)</td>
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<td></td>
<td>- Ensure return to activity or sport is closely monitored</td>
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<td>- Ensure return to activity or sport is closely monitored</td>
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<td>- Continue pain-regarding ongoing use of the Levitation brace during specific activities</td>
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<td>- Monitoring patients during activity, use VAS or WOMAC (appendix)</td>
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<td></td>
<td>- Education: Proper form and body mechanics is critical</td>
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<td>- Sets and reps: quality over quantity</td>
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<td>- Athlete: Sport specific training such as agility, power</td>
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Stage 1: Brace Introduction, AROM, Swelling and Pain Control

- Initial recommended brace power setting for exercise is indicated below as:
  - Low Power Mode
  - High Power Mode
- Some exercises have the option to be augmented with EMS.
- Physiotherapists must use clinical reasoning to determine which exercises are appropriate for each patient and determine safe recommendations for sets and reps.

1. **Bike Half Rotations**
   - Start by moving the braced leg back and forth through the bottom half of pedal rotation.
   - Gradually work to achieve full revolution as tolerated.

Notes
- Bike settings: low resistance

2. **Glute Squeezes**
   - Lying in a comfortable supine position, squeeze glutes together.

Notes
- Hold contraction for 5-10 seconds.

3. **Heel Slides**
   - Begin lying supine with the braced leg straight and a towel under the heel.
   - Bend the knee and slide the heel towards the buttock as far as possible.
   - Hold a gentle stretch in this position and then slowly lower the leg back to a straightened position.

Notes
- For ROM exercise use the brace in low power mode.
- If torque assist is engaged, patient will receive resistance for the hamstrings while bending the knee. This can help with hamstring strengthening (if appropriate for the patient).

4. **Quad Set**
   - Begin lying supine with the braced leg straight.
   - Tighten the quadriceps muscles, pushing the back of the knee towards the bed as far as comfortably possible.

Notes
- High power mode is recommended. If tolerable, Physiotherapist can engage torque assist to help achieve full (pain free) knee extension.

5. **Ankle Pumps**
   - Lying supine on bed - move ankle up and down to encourage circulation in lower leg.

Notes
- Should be done frequently throughout the day.
Stage 2a: Strength, Muscle Balance & Proprioception

- Individualize/progress strengthening for core, hips and ankles.
- Stretch or foam roll any tight muscle groups.
- Begin gait re-training and functional body mechanics training.
- Begin low impact cardio (e.g. cycling and walking).
- Begin with open kinetic chain strengthening.

Optional – EMS can be used to target Vastus Medialis Oblique (VMO).

Suggested initial brace power setting for exercise indicated as:

- **Low**
- **High**

### 1. Straight Leg Raise

1. Begin lying supine with the non-injured knee flexed and the braced leg straight.
2. Tighten the quadriceps, and while maintaining an extended knee, lift the leg to the height of bent knee. Lower in a controlled manner.

### 2. Quad Over Roll

1. Begin lying supine with the back of the braced knee over a foam roller or alternative.
2. Contract the quadriceps and lift the lower leg off the bed to achieve full knee extension.
3. Hold for 2-5 seconds, then slowly lower heel back down.

#### Notes
- Exercise can be progressed by adding ankle weights.

### 3. Seated Leg Extension

1. Sitting on a chair on plinth, activate the quadriceps to straighten the knee into full extension.
2. Hold for 2-5 seconds and then slowly lower the leg to start position.

#### Notes
- For ROM exercise use the brace in **Low** low power mode.
- If torque assist is engaged **High** patient will receive resistance for the hamstrings while bending the knee. This can help with hamstring strengthening.
- Exercise can be progressed by adding resistance via ankle weights or theraband as tolerated.

If **High Power Mode** is recommended for an exercise – continue to monitor the patient’s pain and reduce torque as strength improves.
Stage 2b: Strength, Muscle Balance & Proprioception

- Begin progressive closed kinetic chain exercises (choose appropriate exercises based on your patient’s current functional abilities and goals (non-athlete/surgical vs. athlete/non-surgical).
- Ensure proper body mechanics, instruct on avoiding compensatory movements.

1. **Single Leg Stance**
   1. Begin by transferring body weight fully onto the braced leg.
   2. Maintain this single leg stance position while touching supports as needed.

   **Notes**
   - Stand next to sturdy object to use for support as needed.
   - Keep hips level and pointed forward, focus on a stationary object.

2. **Squat**
   1. Begin standing tall with feet hip width apart.
   2. Initiate movement by lowering hips back and squatting down, as if sitting in a chair.
   3. Stand back up to the start position squeezing the buttocks and pushing heels into ground.

   **Notes**
   - Ensure proper body mechanics, instruct on avoiding compensatory movements.

3. **Lunge**
   1. Begin upright with one foot in front, the other behind, in a long stance position.
   2. Initiate movement by lowering body down into a lunge position keeping equal weight through both feet.
   3. Press up through legs and rise back to the start position.
Stage 3a: Return To Work

1. **Bosu Single Leg Stance**
   1. Transfer body weight fully onto the braced leg with foot positioned in middle of bosu.
   2. Maintain this single leg stance position while trying not to touch supports or opposite foot to the floor.

   **Notes**
   - Stand next to sturdy object to use for support if needed.
   - Keep hips level and focus on a stationary object.

2. **Side Stepping & Tandem Walking**
   1. 10-15 steps at a time at a comfortable pace.

   **Notes**
   - If patient has issues achieving full pain free extension – engage high power mode.

3. **Sit to Stand**
   1. Begin sitting near the edge of the chair, knees bent and feet hip width apart.
   2. Initiate movement by hinging forward at the hips, squeeze buttocks and straighten knees – rising to a tall standing position.
   3. Slowly lower to a seated position as you push hips back towards the chair.

   **Notes**
   - Use a chair with armrests for support if needed.

4. **Walking**
   1. Movement should be at a comfortable pace ensuring proper lower body mechanics.

   **Notes**
   - If patient has issues achieving full pain free extension – engage high power mode.

5. **Lateral Step Up**
   1. Stand beside the step and position the foot of the braced leg fully onto the step.
   2. Transfer body weight onto the braced leg rising up onto the step.
   3. Lower down to start position in a controlled manner.

   **Notes**
   - Set up next to sturdy object to use for support if needed
   - Step height: half height of patient’s shin.

6. **Functional Lift**
   1. Squat down and grasp object, then push heels into floor and engage buttocks to lift.
   2. Slowly lower the object back down again by squatting.

   **Notes**
   - Maintain a neutral spine while lifting.
   - Exercise difficulty can be adjusted by changing the object’s weight or the ROM of lift.
Stage 3b: Return to Play

- Interval jogging or running can be included on flat terrain along with other sport specific training methods.
- Educate patient on proper body mechanics and avoidance of compensatory movement patterns during exercises.

1. **Single Leg Clock Exercise**
   1. Begin by transferring bodyweight fully onto braced leg and imagine standing in the center of a clock.
   2. Maintain this single leg stance position while extending opposite leg out as far as able without losing balance into the following directions.
   3. Return foot back to center between positions and try not to touch the foot down until you have completed all four excursions.

   **Notes**
   - Stand next to sturdy object to use for support as needed.

2. **Bosu Stability Squat**
   1. Begin positioned standing in good posture with feet hip width apart on the flat side of the BOSU.
   2. Initiate movement by lowering hips back and squatting down, as if sitting in a chair.
   3. Return to start position by squeezing the buttocks and pushing heels into the bosu.

   **Notes**
   - Stand next to sturdy object to use for support as needed.

3. **Front Step Up**
   1. Stand facing the step, position the foot of braced leg fully onto the step.
   2. Transfer body weight onto the braced leg rising up onto the step.
   3. Lower down to start position in a controlled manner.

   **Notes**
   - Exercise can be progressed by adding additional weight.
Stage 3b: Continued

4 **Bosu Split Squat**
   1. Begin with foot of the braced leg on the center of the bosu and the other foot behind in a long stance position.
   2. Initiate movement by lowering the body down into a lunge position keeping equal weight through both feet.

5 **Single Leg Squat**
   2. Initiate movement by bending at the hip, then bend knee slowly to lower your body towards the floor.
   3. Rise to start position by squeezing the buttocks and pushing heel into ground.
   **Notes**
   - Stand next to sturdy object to use for support as needed.

6 **Box Jump**
   2. Load into squat position and then jump forward landing with both feet on the step/box.
   3. Absorb the landing in a soft and controlled manner by squatting on the box.
   4. Stand and then carefully step back onto floor to return to start position.
   **Notes**
   - Exercise can be progressed by increasing the height of box/step as able.

7 **Agility Ladder**
   1. Physiotherapist can provide graduated agility ladder patterns based on patients abilities.
   **Notes**
   - Continue this pattern moving as quickly as possible while maintaining good body control until you reach the end of the ladder.
Stage 4: Full Return to ADLs or Sport

Ensure patient has passed functional testing relevant to their activity level.

- Non-athlete or post-operative: passes the Community Balance Test.
- Athlete or non-operative: passes functional test relevant to activity/sport.

Continue a regular (minimum: 3x/week) individualized flexibility/strength/dynamic exercise program during the return to physical activity phase.

Stage 5: Maintenance & Prevention

Continue a regular (minimum: 3x/week) individualized flexibility / strength / dynamic exercise program during the maintenance phase.

Perform regular knee injury prevention and proprioceptive warm up exercises before sport/activity (ex. FIFA 11+ Protocol).

FIFA 11+ Injury Prevention Manual
Considerations for Exercise with Osteoarthritis

- Proper footwear and consultation with a pedorthist is recommended.

- Exercise during time of day when pain is typically least severe or in conjunction with peak effectiveness of pain medications.

- Adequate warm up and cool down periods (5-10 mins) are critical for minimizing pain.

- Follow a program that minimizes pain (see Instruction Manual on adjusting the force output of Levitation to assist mobility below the pain threshold) while gradually progressing towards activity levels that provide greater health benefits. Monitor pain levels during exercise. If pain is increasing with activity, adjust the Levitation brace to a higher torque assist. If pain lowers or goes away continue – if not, reduce exercise intensity.

- Small amounts of discomfort in the muscles or joints during or immediately after exercise is common, and does not necessarily mean joints are being further damaged. If two hours after exercise pain is higher than it was prior to exercise, the duration or intensity should be reduced in future sessions.

- Avoid strenuous exercise during acute flare ups and periods of inflammation. However, it is important to gently move the joint through full ROM during this time.

- In the presence of mild joint swelling, incorporate a program of sub-maximal exercise to warm up before beginning prescribed exercise program. If there is joint effusion, the surrounding muscle cannot contract maximally due to reflex inhibition caused by joint distension. Submaximal exercises for 3-4 mins on a swollen joint decreases this inhibition mechanism. Extension assistance provided by Levitation can allow for continued strength training which can help decrease reflex inhibition and support quadriceps function.

- Moderate to severe joint effusion may require additional physical therapy intervention, such as EMS to increase quadriceps engagement.

- Exercise should stop if severe pain is experienced. In the case of significant pain and functional limitations, it is recommended any amount of physical activity that the patient is able to maintain comfortably is continued.

- ACSM FITT Exercise Guidelines for OA can be used as a general guide for exercise, while incorporating Levitation to increase tolerance.
ASCM FITT Guidelines

Frequency

- Aerobic exercise 3-5 days/week.
- Resistance exercise 2-3 days/week.
- Flexibility and range of motion exercises are essential and are recommended daily.

Intensity

- Light-moderate intensity physical activities are recommended because they are associated with lower risk of injury or pain aggravation compared to higher intensity physical activities.
- 40% - <60% oxygen consumption reserve (VO2R) or heart rate reserve (HRR) is appropriate.
- Very light intensity aerobic exercise is appropriate for individuals with arthritis who are deconditioned.
- Both light and higher intensity resistance exercise can improve function, pain, and strength among patients with rheumatoid arthritis and osteoarthritis.
- Patients with rheumatoid arthritis and considerable damage in weight-bearing joints should perform lower intensity resistance exercise or physical activity.

Time

- A goal of ≥150 min/week of aerobic exercise is recommended.
- When appropriate, have the patient start with short bouts of 10 minutes (or less if needed), according to the individual’s pain levels.

Type

- Aerobic exercises with low joint stress such as walking and cycling are appropriate.
- High-impact activities such as running, stair climbing, and those with stop and go actions are not recommended if limited by lower body arthritis.
- Resistance exercises should include all major muscles groups as recommended for healthy adults.
- Include flexibility exercise with range of motion exercises of all major muscle groups.
- Incorporate functional exercises (e.g. sit to stand and step ups as tolerated to improve neuromotor control and maintain ADLs).

*Progression of aerobic, resistance, and flexibility exercises should be gradual and individualized based on an individual’s pain and other symptoms.
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Active Range of Motion (AROM)</strong></td>
<td>The maximal range of motion a patient can move a joint through under their own muscular effort.</td>
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<tr>
<td><strong>Activity of Daily Living (ADL)</strong></td>
<td>Task(s) that a patient performs frequently throughout an average day (e.g. walking, stair climbing).</td>
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<tr>
<td><strong>Arthrogenic Muscle Inhibition (AMI)</strong></td>
<td>Neurological activation deficit of muscles involved in the articulation of the damaged joint.</td>
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<tr>
<td><strong>Berg Balance Tests (BERG)</strong></td>
<td>A series of scored balance tests that increase in complexity allowing for a holistic assessment of proprioceptive function.</td>
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<tr>
<td><strong>Closed Kinetic Chain (CKC)</strong></td>
<td>Motion or movement where the distal end of the limb (e.g. hand, foot) is fixed to an external surface.</td>
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<tr>
<td><strong>Electric Muscle Stimulation (EMS)</strong></td>
<td>Therapeutic stimulation of contractile muscle activity via an external electrical input.</td>
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<td><strong>Extension Assist</strong></td>
<td>A biomechanical intervention where knee extension strength is improved with the aid of an external device.</td>
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<tr>
<td><strong>Functional Test</strong></td>
<td>A physical assessment that attempts to replicate real world demands that a patient is likely to face.</td>
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<tr>
<td><strong>Manual Muscle Testing (MMT)</strong></td>
<td>Rudimentary strength testing administered by a therapist to assess joint function and muscle balance.</td>
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<tr>
<td><strong>Outcome Measure</strong></td>
<td>A subjective assessment where patient’s rate specific elements of their medical condition in a quantitative manner.</td>
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<tr>
<td><strong>Quality of Life (QOL)</strong></td>
<td>The degree of satisfaction one has in their day to day life.</td>
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<td><strong>Tri-compartment Unloading</strong></td>
<td>A biomechanical process where pressure is reduced simultaneously in all three compartments of the knee.</td>
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<tr>
<td><strong>Uni-compartment Unloading</strong></td>
<td>A biomechanical process where pressure is reduced in a single compartment of the knee.</td>
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4.0 References


APPENDIX

Forms & Outcomes Measures
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<td>4. Resting</td>
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<td>12. Lying in bed</td>
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**Western Ontario & McMaster Osteoarthritis Index Population Reference Values**

**WOMAC Index Average Pain Score**

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</table>

**WOMAC Index Average Stiffness Score**

<table>
<thead>
<tr>
<th>Percentile</th>
<th>50th</th>
<th>75th</th>
<th>90th</th>
<th>95th</th>
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</tr>
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**WOMAC Index Average Function Score**

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<td>6.01</td>
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## Visual Analogue Pain Scale (VAS)

### Instructions:

- To help people say how much pain they feel, we have drawn a scale (rather like a thermometer) on which no pain is marked 0 and the worst pain you can imagine is marked 100.

- We would like you to indicate on this scale the amount of pain in your knee today, in your opinion. Please do this by drawing a line across whichever point on the scale indicates the amount of pain in your knee today.

### Table

<table>
<thead>
<tr>
<th>Percentile</th>
<th>50th</th>
<th>75th</th>
<th>90th</th>
<th>95th</th>
<th>99th</th>
</tr>
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<tr>
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<tr>
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<td>3.3</td>
<td>5.8</td>
<td>7.2</td>
<td>9.0</td>
</tr>
</tbody>
</table>

### Diagram

- **Worst Pain Imaginable**
- **No Pain**
KNEE INJURY & OSTEOARTHRITIS OUTCOME SCORE (KOOS)

This survey asks for your perspective on your knee. This information will help us keep track of how you feel about your knee and how well you are able to perform your usual activities. Answer every question by ticking the appropriate box, only one box for each question. If you are unsure about how to answer a question, please give the best answer you can.

1. These questions should be answered thinking of your knee symptoms during the last week.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1. Do you have swelling in your knee?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S2. Do you feel grinding, hear clicking or any other type of noise when you move your knee?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S3. Does your knee catch or hang up when moving?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S4. Can you fully straighten your knee?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S5. Can you bend your knee fully?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

2. The following questions concern the amount of joint stiffness you have experienced during the last week in your knee. Stiffness is a sensation of restriction or slowness in the ease with which you move your knee joint.

<table>
<thead>
<tr>
<th>Question</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6. How severe is your knee joint stiffness after first awakening in the morning?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S7. How severe is your knee stiffness after sitting, lying or resting later in the day?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</table>

3. How often do you experience knee pain

<table>
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<th>Weekly</th>
<th>Daily</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1. How often do you experience knee pain</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tbody>
</table>

What amount of knee pain have you experienced during the last week during the following activities?

<table>
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<tr>
<th>Question</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2. Twisting/Pivoting on your knee</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P3. Straightening your knee fully</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P4. Bending your knee fully</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P5. Walking on a flat surface</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P6. Going up and down stairs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P7. At night while in bed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P8. Sitting or lying</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>P9. Standing upright</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
The following questions concern your **physical function**. By this we mean your ability to move around and to look after yourself. For each of the following activities please indicate the degree of difficulty you have experienced in the last week due to your knee.

<table>
<thead>
<tr>
<th>Question</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
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</thead>
<tbody>
<tr>
<td>A1. Descending stairs</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>A2. Ascending stairs</td>
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</tr>
<tr>
<td>A3. Rising from sitting</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A4. Standing</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A5. Bending to floor/pick up an object</td>
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</tr>
<tr>
<td>A6. Walking on flat surface</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A7. Getting in/out of car</td>
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</tr>
<tr>
<td>A8. Going shopping</td>
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<tr>
<td>A9. Putting socks/stockings on</td>
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<tr>
<td>A10. Rising from bed</td>
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<tr>
<td>A11. Taking off socks/stockings</td>
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<td>A12. Lying in bed (turning over/maintaining knee position)</td>
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<td>A13. Getting in/out of bath</td>
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<td>A14. Sitting</td>
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<td>A15. Getting on/off toilet</td>
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<td>A16. Heavy domestic duties</td>
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<td>A17. Light domestic duties</td>
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</table>

The following questions concern your **physical function** when being active on a higher level. The questions should be answered thinking of what degree of difficulty you have experienced during the last week due to your knee.

<table>
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<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
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<tbody>
<tr>
<td>S1. Squatting</td>
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<td>S3. Jumping</td>
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<tr>
<td>S4. Twisting</td>
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<td>S5. Kneeling</td>
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<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. How often are you aware of your knee problem?</td>
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<td></td>
</tr>
<tr>
<td>Q2. Have you modified your life style to avoid potentially damaging activities to your knee?</td>
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<tr>
<td>Q3. How much are you troubled with lack of confidence in your knee?</td>
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<tr>
<td>Q4. In general, how much difficulty do you have with your knee?</td>
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</table>
KNEE INJURY AND OSTEOARTHRITIS OUTCOME SCALE (KOOS) POPULATION REFERENCE VALUES*

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<th>Pain Females</th>
<th>Symptoms Males</th>
<th>Symptoms Females</th>
<th>ADL Males</th>
<th>ADL Females</th>
<th>Sport/Rec Males</th>
<th>Sport/Rec Females</th>
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<td>83.1</td>
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<tr>
<td>60-69 y</td>
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<td>95.2</td>
<td>93.9</td>
<td>91.9</td>
<td>90.0</td>
<td>96.9</td>
<td>96.9</td>
<td>91.3</td>
<td>89.4</td>
<td>88.8</td>
<td>87.6</td>
</tr>
</tbody>
</table>

KNEE INJURY AND OSTEOARTHRITIS OUTCOME SCALE (KOOS) SCORING CRITERIA*

<table>
<thead>
<tr>
<th>KOOS Category</th>
<th>Scoring Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>$100 - \frac{\text{Mean Score (P1 - P9)} \times 100}{4}$</td>
</tr>
<tr>
<td>Symptoms</td>
<td>$100 - \frac{\text{Mean Score (S1 - S7)} \times 100}{4}$</td>
</tr>
<tr>
<td>ADL</td>
<td>$100 - \frac{\text{Mean Score (A1 - A17)} \times 100}{4}$</td>
</tr>
<tr>
<td>Sport/Rec</td>
<td>$100 - \frac{\text{Mean Score (SP1 - SP5)} \times 100}{4}$</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>$100 - \frac{\text{Mean Score (Q1 - Q4)} \times 100}{4}$</td>
</tr>
</tbody>
</table>
