



Optimising Prosthetic Outcomes by Looking Above the Leg: Focusing on Flexion.

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Aims of the Optimising Outcomes Series...

- Provide practitioners with techniques to enable clients to gain improved functioning on their prosthesis.
- Facilitate communication between allied health professionals regarding training goals and techniques.



Clients in the Low to Moderate Activity Category



Primary Amputees

Elderly Amputees

K1 and K2 Classification

Transferring

Mobilising around the home

Using walking aids

How Amputation Affects Muscle Function:

- Some muscles are inhibited and become weak.

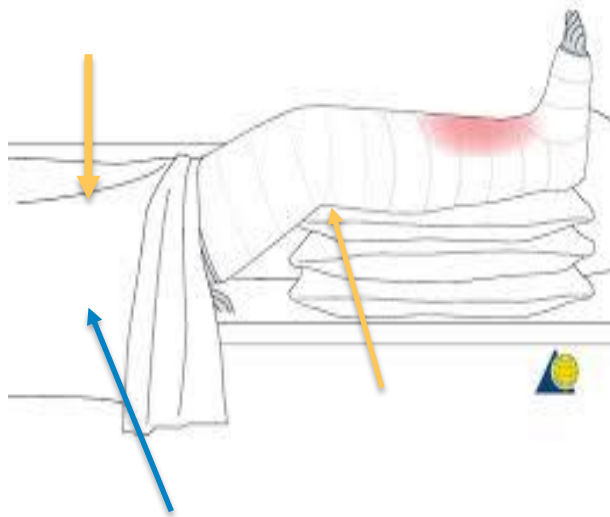
- Pain
- Surgery
- Positioning

- Some muscles are overactive and become tight.

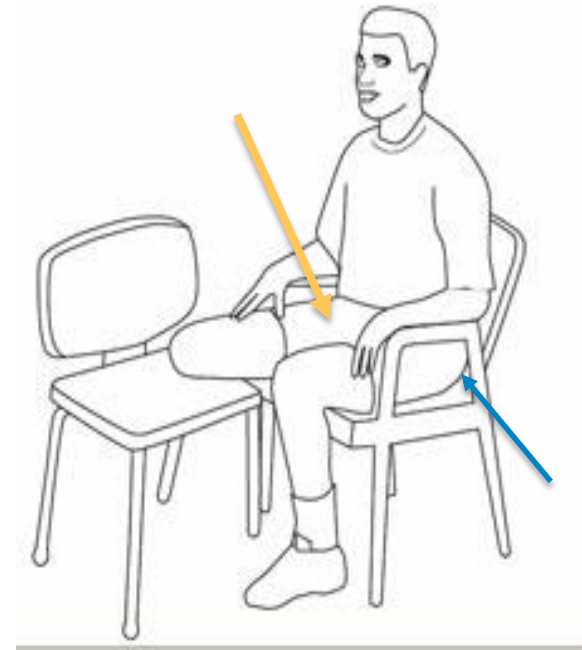
- Pain
- Positioning
- Adopted movement patterns

Prolonged positioning.

- **Positioning pre op**

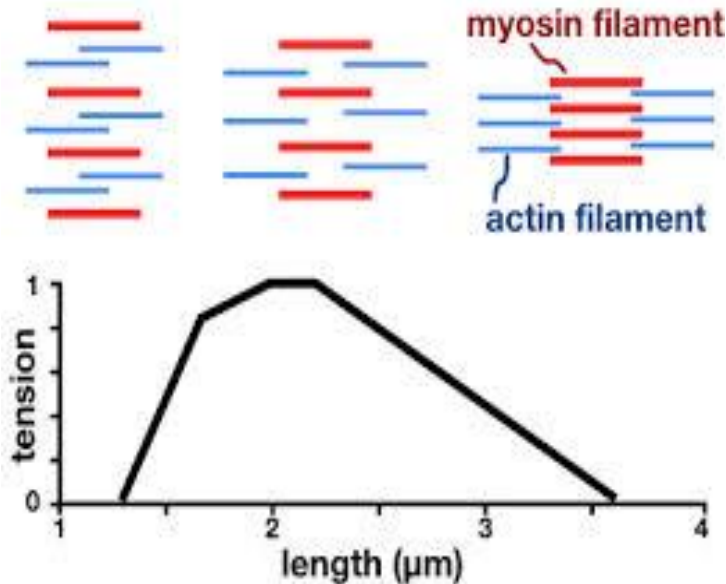


- **Positioning post op**



Prolonged positioning:

Greater difficulty generating tension in lengthened hip extensors:

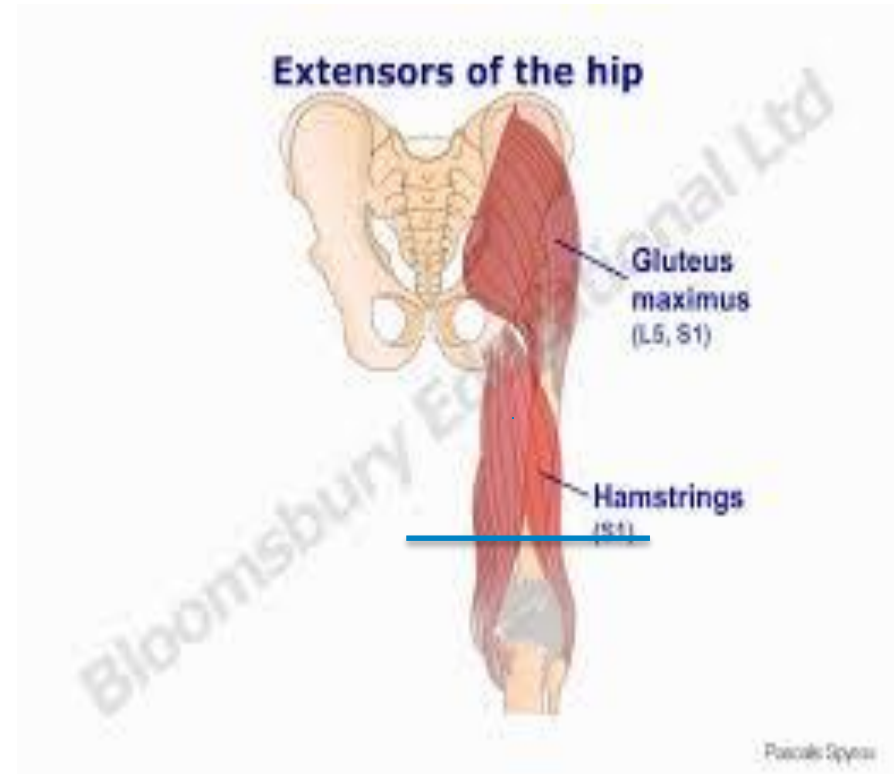
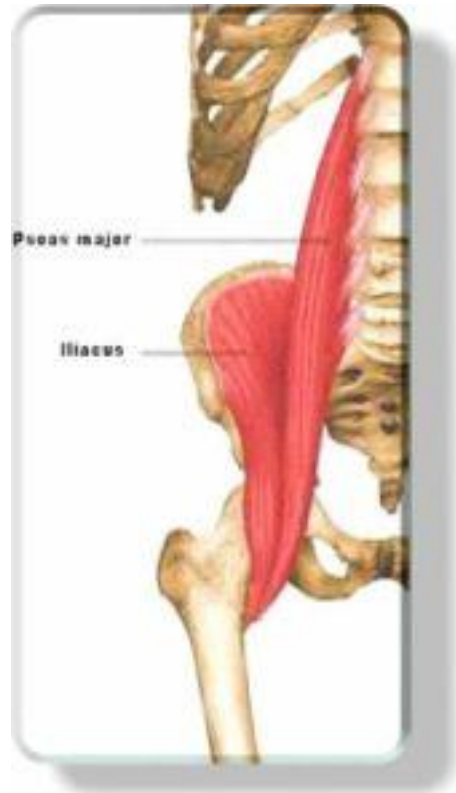


Tight hip flexors are recruited first:

- Less range available, less slack and earlier shortening.
- Greater afferent input via stretch receptors to spinal cord.
- Neuromuscular “strengthening” of the flexor pattern (neuroplasticity).

Amputation may affect muscle function by:

- **Surgically induced bias: cut vs uncut muscles.**



Amputation affects movement by affecting Core Stability.

Predisposition to Anterior pelvic tilt (sagittal plane) and hip flexion.

- T/F ↓ stabilisation of pelvis by hamstrings.
- Tight/overactive psoas.
- Weakened/lengthened abdominals.
- Weakened/lengthened gluteals.




Amputation may affect muscle function by:

- **Learned motor patterns**

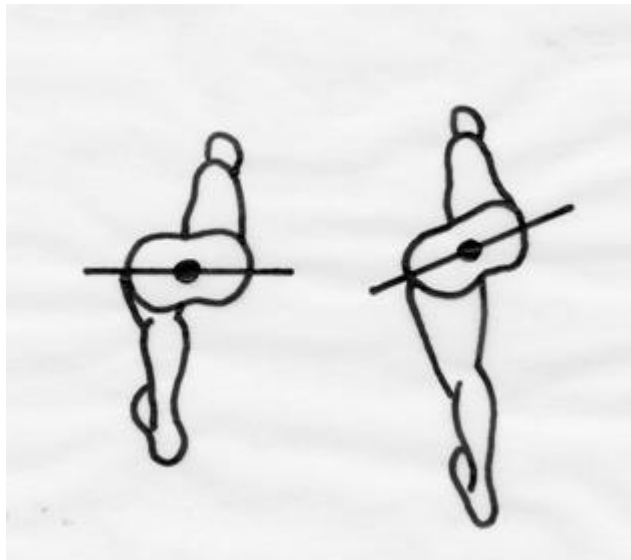
Movement = flexion



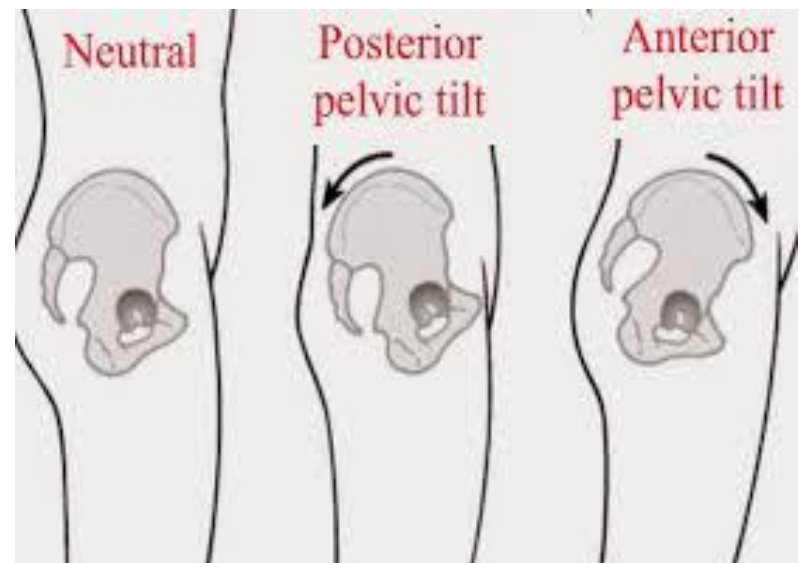
Muscle imbalances are created:

- Length related with associated joint restriction.  • Contractures
- Related to “**preferred activation**” patterns.  • Learned from movement experiences.
- Muscle imbalances will then be reflected in the gait pattern.  • Gait deviations

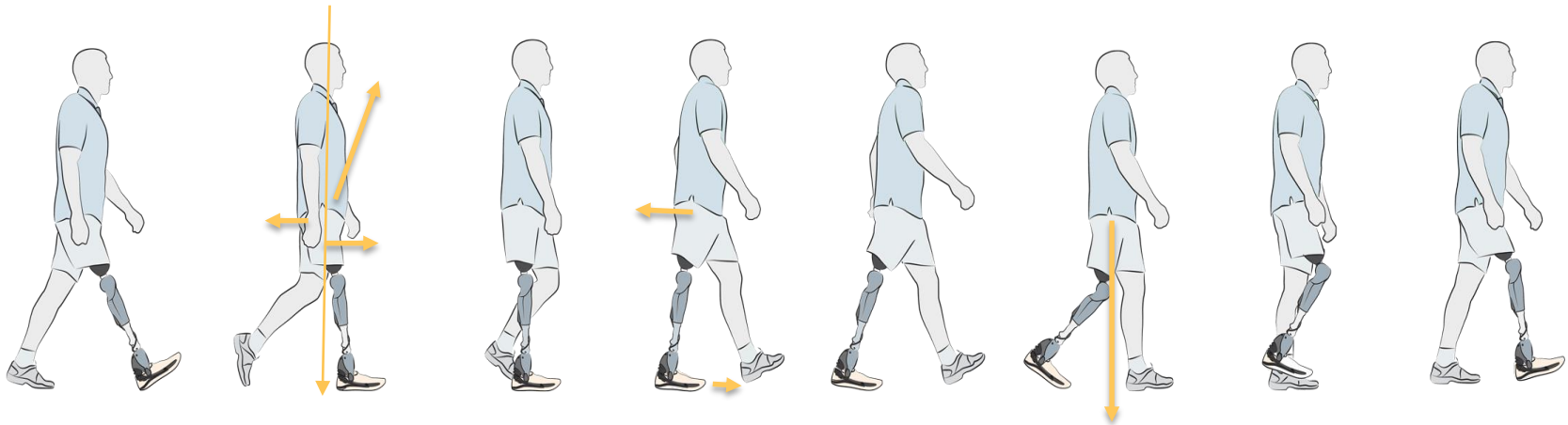
Pelvic Rotation in Transverse Plane.



Pelvic Tilt in Sagittal Plane

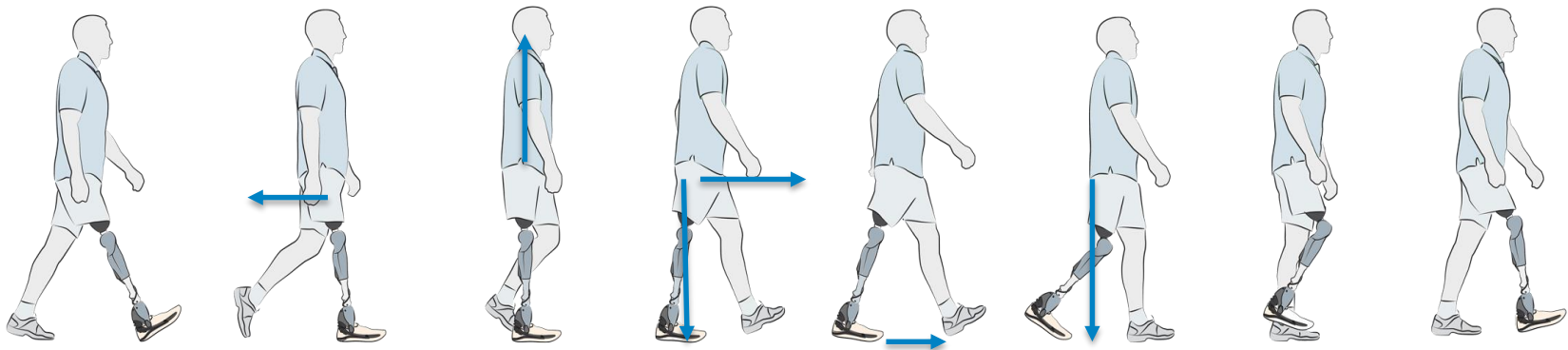


Prosthetic Stance: Inadequate hip extension and excessive posterior pelvic rotation(transverse plane).



- Hip Flexion and posterior pelvic rotation, trunk flexed forward causes compromised knee stability.
- Shortened step length with unaffected leg.
- Hip is low and posterior- prosthesis is 'lengthened'.
- Premature swing- difficulty breaking the knee joint.
- Results in difficulty clearing the prosthetic foot in swing.
- Patient may want the prosthesis shortened.

Prosthetic Stance- Adequate hip extension and anterior pelvic rotation.....



- **Generation of extension force by gluteals combined with:**
- **Erect trunk and core stability ensures knee stability.**
- **Hip on prosthetic side is high and forward.**
- **Ability to take equal step with intact leg.**
- **Knee joint breaks easily into swing.**
- **Foot clearance is achieved.**

Equal Limb Length

vs

Shortened Prosthetic Limb

- N=16
- All had some degree of hip E restriction on prosthetic side.

- N=27
- Greater degree of hip E restriction on prosthetic side

How Muscle Imbalances are reflected in Amputee Gait.



- Hip F throughout prosthetic stance phase and posterior rotation of pelvis.
- ↓ intact leg step length.
- “Dropping off” the prosthetic toe.
- Lengthened hip extensors are inhibited.

Where is the excess flexion coming from?

Anatomically Based



Performance Based



Hip ROM on the Amputated Side:

Hip flexor tightness will ↑
lumbar lordosis and
posterior rotation of pelvis
on the amputated side.

Adequate hip E ROM allows
the lumbar spine to remain
in a neutral position.



Assessing Passive Hip ROM (joint restriction)

Transtibial



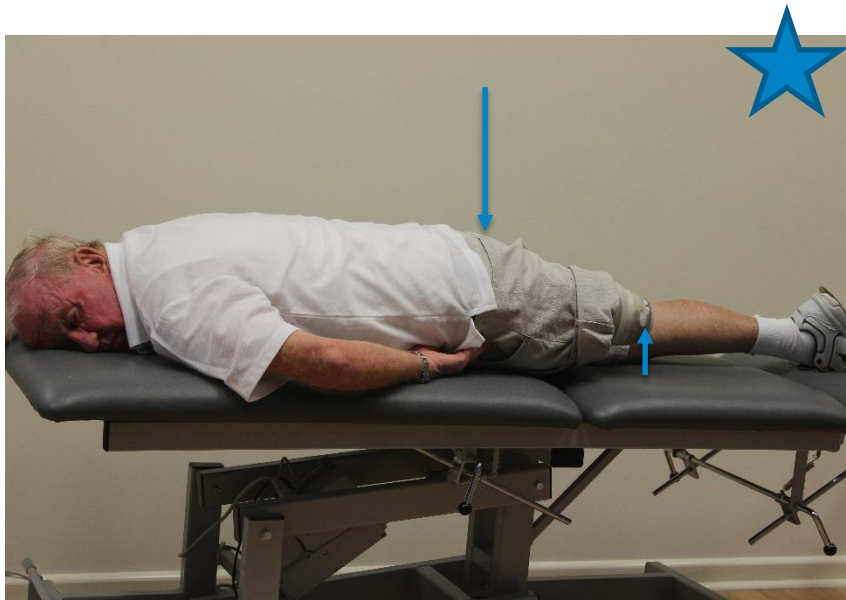
Transfemoral



Assessing Active Hip ROM (muscle strength through range)

Use the hip joint and control pelvis to isolate the gluteals.

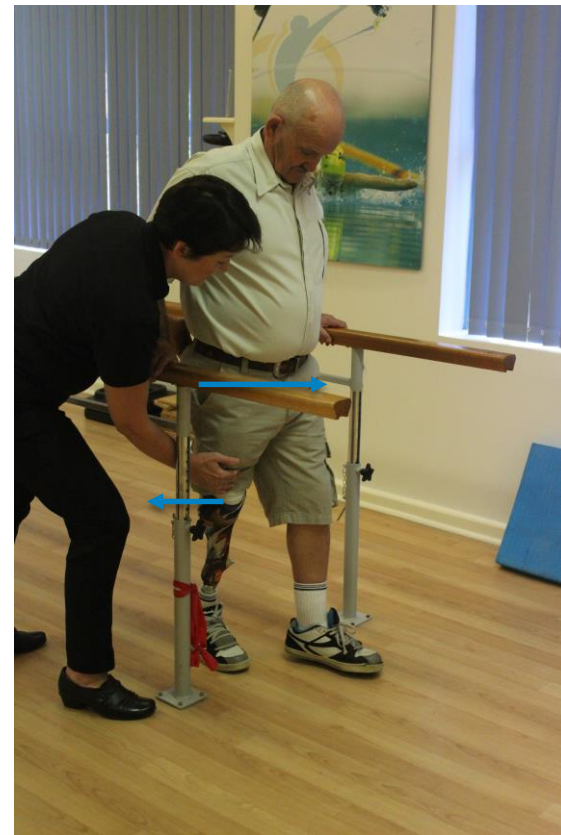
Not Lumbar Spine extensors



Trans tibial Amputee Flexed Gait Pattern:

Inability to contract gluteals and quads together

Retrain extending the hip and knee together.



Further extension training.

Reinforce the movement pattern



Achieving toe off



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Inner range quads, concentric/eccentric training.



For:

- “wobbly” knee during stance.
- Inability to control an energy returning foot.
- Controlling the knee during slope/stair descent .
- Progressing onto a foot with a stronger toe lever.

“Step-to” Gait



Avoid overstepping with the prosthesis into the frame.



Using Frames:

- Try stepping off into frame with intact leg.
- Frame should not encourage excessive trunk and hip flexion.
- Keep up ROM stretches and exercises for further progression from step-to-gait to a step through gait.

How the use of Aids influences Gait:

Sticks too far forward encourage trunk and hip flexion.



- Hip on the prosthetic side is low and posteriorly situated.
- Prosthesis is functionally lengthened.
- Difficulty breaking the knee for swing phase.
- Problems with toe clearance in swing phase.
- Patient may want the prosthesis shortened.

How the use of Aids influences gait:

Correct stick placement.



Extension of the trunk and hip encouraged.

- Weight can be transferred to the front of the foot.
- Mechanical advantage is achieved to break the knee easily for swing.
- High positioning of the hip facilitates toe clearance without needing to shorten prosthesis.
- Even step length can be achieved.

Implications for the Clinic: **Walking Out Flexion.**

Combination of:

- **Not** accommodating the full amount of hip flexion in the prosthesis.
- Postural re-education.
- Stretching program.
- Extension exercises.
- Gait Re-education to integrate the improved activation of the hip and core muscles into the gait pattern and correct use of aids.

Walking Out Flexion.

- Requires commitment.
- Reduce the socket flexion gradually to avoid back pain from lumber spine hyperextension.
- The longer the joint restriction is evident the harder it will be to resolve.

Safety needs to be trained...”The safest place for your prosthesis is underneath you.”

Commonly adopted posture to avoid weight bearing produces an:

Unstable Knee and flexed hip.

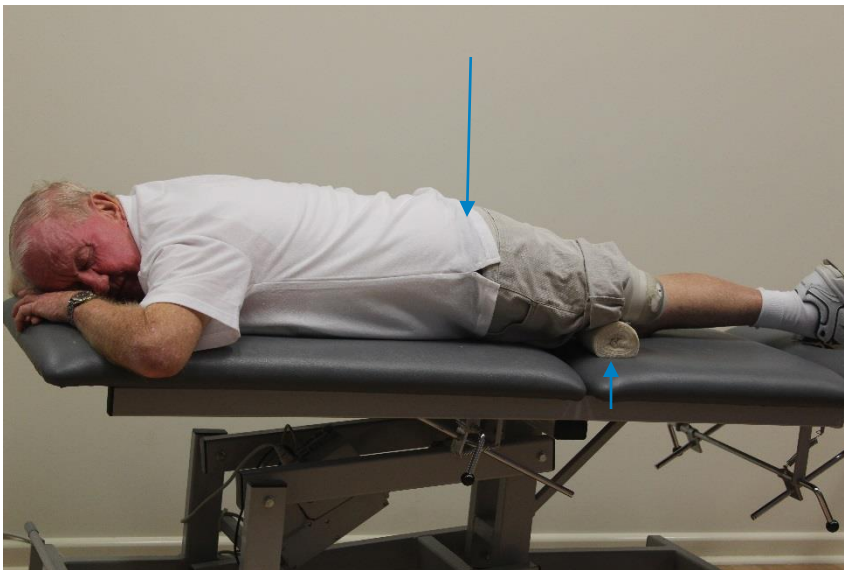


Reinforce correct foot placement and standing posture to produce a:

Stable knee and extended hip.



Hip Flexor Stretches: Beginner



- **Daily for 20 mins.**
- **Add extension exercises whilst pushing the ASIS into the bed.**
- **Do not allow the pelvis to come off the bed.**

Hip Flexor Stretches: Advanced.



- Kneel on the chair.
- With the abdominals activated to prevent excessive L/S extension- push the hip into extension.
- Always stretch after activity when the muscles are warm.

Progressive Hip Extensor Strengthening: 15 reps x3 sets x3 times per week.

This position allows more feedback in controlling unwanted lumbar spine and pelvis compensations.



More advanced, resistance is added, abdominals control pelvic tilt and rotation.



Putting it all together....Indicators of an optimal Gait Pattern.

- Even step lengths
- Extended hips
- Erect trunk



Putting it all together...Indicators of an optimal gait pattern.

- Using the Entire foot-achieving toe off.
- Even arm swing.
- Lateral trunk bending is minimised.





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