DUND

Protocol for Pre- & Post-Operative Monitoring in ACL Surgery

Traditionally, Gait analysis and balance assessments have been key tools for evaluating recovery following Anterior Cruciate Ligament (ACL) reconstruction, primarily during post-operative rehabilitation. However, emerging evidence supports the value of pre-operative interventions aimed at normalising gait and improving muscular function. Normal gait mechanics have been linked to enhance quadricep activation, which may mitigate the risk of Atherogenic muscle inhibition (AMI), a condition where neural inhibition leads to reduced muscle activation despite intact musculature, contributing to delayed recovery [1]. Similarly, reducing pre-operative joint stiffness, patients may also lower their risk of developing arthrofibrosis, a complication associated with excessive scar tissue formation [2]

The objective is to test the hypothesis that pre-operative gait normalisation can reduce the incidence of AMI and arthrofibrosis. This hypothesis is grounded in the relationship between gait mechanics, muscle activation, and joint mobility. Studies have demonstrated that quadriceps inhibition, a key feature of AMI, is exacerbated by poor preoperative neuromuscular control [3]. Furthermore, restoration of gait parameters prior to surgery is indicative of full ROM and reduced stiffness, both of which are protective against arthrofibrosis [4] [5].

The outlined protocol can easily be completed by patients at home, providing clinicians a patient-specific movement profile throughout the recovery process. The tests can be performed either with or without crutches, depending on the individual case, as determined by the clinician. It is suggested that the footwear surface types, and walking speeds be standardised to minimise confounding variables.

Timed Up and Go (TUG) Test

- Distance of 3 meters.
- Can assess baseline mobility, speed, dynamic balance, and symmetry.
- DANU measures Spatiotemporal parameters, Footstrike mechanics, and Centre of Pressure.

2-minute walk

- Assess endurance and functional capacity during walking, when continuously walking for 2 minutes on a flat surface.
- Can assess baseline mobility, speed, dynamic balance, total distance, and symmetry.
- DANU measures Spatiotemporal parameters, Footstrike mechanics, and Centre of Pressure.

Single Leg Stance Test

- Assess balance and stability, injured Vs. Non-injured leg.
- 30 seconds on each leg.
- DANU measures area of Ellipse, width & length of Ellipse, mediolateral range, anterior-posterior range, total displacement, and DANU stability index.

Double Leg Stance Test

- Assess balance and stability, injured Vs. Non-injured leg.
- 30 seconds in total.
- DANU measures area of Ellipse, width & length of Ellipse, mediolateral range, anterior-posterior range, total displacement, and DANU stability index.

Stair Walking Test

- Assess functional lower limb strength, mobility, and dynamic balance during common gait
- Aim for 8-10 steps, prohibited patients have the required number of steps.

DUND

- DANU measures spatiotemporal parameters, Footstrike mechanics, Centre of Pressure, and time to complete task.
- Can be both up and down the stairs, up to practitioner.

List of full metrics:

Gait:

- Spatiotemporal parameters:
 - o Stride Time
 - Contact Time
 - Swing Time
 - o Step Length
 - o Stride Length
 - o Gait Velocity
 - o Step Time
 - o Double Support Time
 - o Cadence
 - o Swing-Stance Ratio
 - o Step by Step Asymmetry % for each metric
- Centre of Pressure (CoP) Parameters:
 - o Video visualisation with CoP trajectory
 - Accumulation of Initial contacts, final contacts, and CoP trajectories for each step.
 - o CoP Velocity
 - Anterior-posterior range
 - o Mediolateral range
 - Length of gait line
- Other parameters:
 - Total load Accumulation of tibial accelerations throughout the session in all three axes.

DUND

- Overall limb dominance Determines how dominant a particular leg is (longer contact times implies more dominant action of that leg).
- $\circ~$ Duty Factor this is a ratio between contact time and stride time.
- Peak Tibial Acceleration

Balance Assessments:

- DANU stability index A score we have developed based on the metrics collected, where a 10 is considered perfectly stable with almost no movement and a 0 indicating high instability and a lot of movement.
- Area of Ellipse
- Width of Ellipse.
- Length of Ellipse.
- Mediolateral range
- Anterior-posterior range
- Total Displacement.

DANU Bibliography

- [1] J. T. Hopkins and C. Ingersoll, "Arthrogenic Muscle inhibition: A Limiting Factor in Joint Rehabilitation," *Journal of Sport Rehabilitation*, pp. 135-159, 2000.
- [2] K. D. Shelbourne and T. Gray, "Minimum 10-year results after anterior cruciate ligament reconstruction: how the loss of normal knee motion compounds other factors related to the development of osteoarthritis after surgery," Am J Sports Med., vol. 37, no. 3, pp. 471-480, 2009.
- [3] J. L. Hunnicutt, M. M. McLeod, H. S. Slone and C. M. Gregory, "Quadriceps Neuromuscular and Physical Function After Anterior Cruciate Ligament Reconstruction," *Journal of athletic training*, vol. 55, no. 3, pp. 238-245, 2020.
- [4] A. D. Kuo and J. M. Donelan, "Dynamic Principles of Gait and Their Clinical Implications," *Physical therapy*, vol. 90, no. 2, pp. 157-174, 2010.
- [5] N. J. Lemme, D. S. Yang, R. Talley-Bruns, D. Alsoof, A. H. Daniels, L. Petit and P. D. Fadale, "Risk Factors and Outcomes for Preoperative Stiffness Requiring Intervention Before Anterior Cruciate Ligament Reconstruction," *Orthopaedic Journal of Sports Medicine*, vol. 11, no. 7, 2023.