Intro: Arthrogenic muscle inhibition (AMI) is a known complication associated with anterior cruciate ligament reconstruction (ACLR). AMI typically affects quadriceps activation, causing gait impairments postoperatively. Previous work surrounding motor imagery and biofeedback has shown promise in alleviating AMI and improving functional recovery. This study aims to assess the efficacy of a novel electroencephalogram (EEG) biofeedback training protocol that integrates motor imagery and EEG biofeedback to improve postoperative outcomes for ACLR patients.

Methods: A preliminary exploratory comparison was performed between the first intervention subject and a matched control from an ongoing randomized, blinded clinical trial (Intervention: 29-year-old male, 86 kg; Control: 29-year-old female, 68kg). All participants followed a standardized postoperative physical therapy protocol, with the intervention group completing additional 20-minute EEG biofeedback sessions twice weekly for 8 weeks, starting at the first therapy visit. Training involves motor-imagery visualization with real-time EEG feedback to reinforce activation of motor pathways. Markerless motion capture recorded overground gait, bilateral squats, and forward lunges at 2, 4, and 6 months postoperatively, with outcome assessors blinded to group allocation. Knee flexion range of motion, peak knee flexion angles, and peak knee flexion moments were reported.

Results: Both patients demonstrated gains in stance-phase knee ROM over the follow-up period, though the intervention patient showed greater improvement. Stance-phase ROM more than doubled from 2 to 6 months (+7.2°), driven by increased early-stance flexion and improved mid-stance extension (+3.7°). The control patient showed smaller ROM gains (+2.9°) but similarly improved mid-stance extension by 6 months (+6.6°). First-peak knee flexion moments, however, diverged. By 6 months, the intervention patient increased from 0.13 to 0.29 %BW·m, indicating improved quadriceps loading, whereas the control patient decreased from 0.37 to 0.22 %BW·m, consistent with continued quadriceps avoidance.

Conclusion: Preliminary results suggest EEG biofeedback may enhance early quadriceps activation and stance-phase knee mechanics following ACLR. Overall, the intervention patient demonstrated more substantial gains in both ROM and flexion moment, suggesting improved quadriceps engagement and progression toward normative gait mechanics. Further data are needed to confirm these effects.