Neurofeedback Visualization Training Through a Brain Computer Interface to Optimize Muscle Activation Following Femoroacetabular Impingement Hip Arthroscopy

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BACKGROUND

- **Femoroacetabular impingement (FAI)** is a condition involving abnormal contact between the femoral head and acetabulum, often requiring arthroscopic intervention.
- Postoperative patients frequently experience **muscle weakness** due to changes in motor cortex and corticospinal tract function.
- A key barrier to recovery is **arthrogenic muscle inhibition (AMI)** a neural phenomenon that prevents voluntary activation of affected muscle groups despite full structural healing.
- Standard rehabilitation may be limited in addressing these **neuroplastic changes**.
- **Neurofeedback Visualization Training (NFVT)**, via a non-invasive brain-computer interface (BCI), may help bypass this inhibition and promote motor reactivation.

PURPOSE

This study evaluates whether NFVT using BCI can improve muscle activation following FAI hip arthroscopy.

Investigate the effects of NFVT on:
➔ Strength recovery

➔ Neuromuscular control

➔ Functional movement mechanics

➔ Determine if NFVT can accelerate rehabilitation and mitigate AMI in FAI patients.

METHODS

- Study Design: IRB-approved, randomized, single-masked, controlled trial.
- NFVT protocol: EEG-based visualization of hip-focused rehab movements with real-time neurofeedback to activate the motor cortex.
- Primary outcomes:

➔ Hip flexor/extensor and abductor/adductor strength via isometric/isokinetic testing (e.g. Biodex).

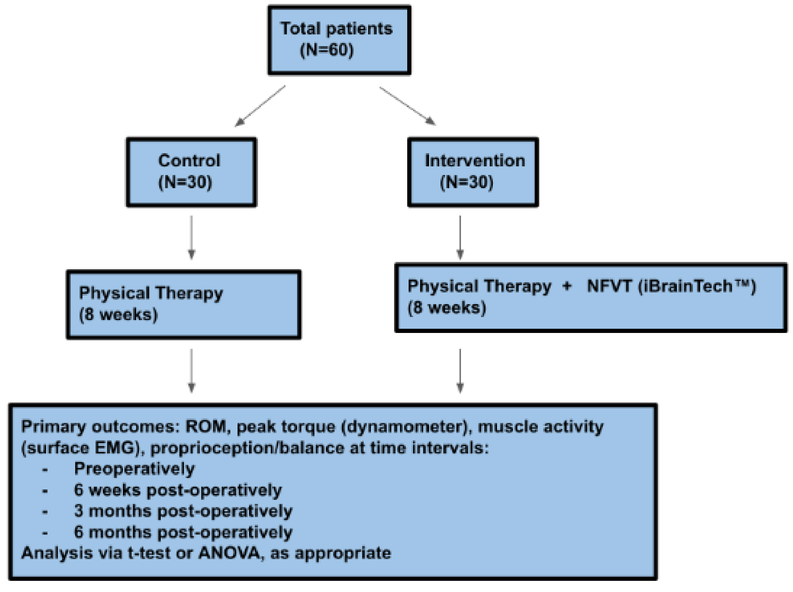
➔ Muscle activation via surface EMG during controlled movements.

➔ 3D motion analysis of gait, squat, lunge, and single-leg tasks at 700 Hz.

- Secondary outcomes:

➔ PROMs (e.g. HOS, iHOT, TSK-11) at baseline, 8w, 16w, 6mo, 12mo, 24mo

➔ Psychosocial data: socioeconomic status, area deprivation index, grit score



RESULTS

- Patient enrollment will begin in April 2025.
- Preliminary outcomes will be presented as patients reach postoperative milestones.
- Hypothesis: NFVT will result in:

➔ Earlier recovery of muscle activation

➔ Higher EMG activity

➔ Greater strength restoration

➔ Enhanced functional biomechanics

DISCUSSION

- **FAI patients often struggle with regaining neuromuscular control due to AMI.**
- **NFVT may serve as a breakthrough adjunct to traditional PT by retraining the brain-muscle connection.**
- **If effective, NFVT could:**

➔ **Enhance rehab time**

➔ **Improve long-term hip function**

➔ **Reduce risk of compensatory movement patterns**

➔ **Understanding and targeting AMI could transform postoperative protocols in hip preservation surgery.**