

Multifactorial Management of Post Traumatic Hip Osteoarthritis in a Rural Veteran: Integrating sEMG-Biofeedback and Allostatic Load Monitoring

Venkata Nuthalapati

Physical Therapist, Amedisys Home Health, University of Montana, USA

Sushmita Bangari

Physical Therapist, Independent Consultant, India

Abstract:

This case study evaluates the clinical efficacy of the "Frontier Protocol," a novel, multi-domain intervention designed specifically for rural populations facing "functional stagnation" in orthopedic recovery due to limited specialist oversight. The subject, a 52-year-old male Veteran with advanced post-traumatic unilateral hip osteoarthritis (OA) following an intra-articular fracture and secondary chronic low back pain, presented with significant Trendelenburg gait and Gluteus Medius inhibition. To address the "Zip Code Barrier" inherent in rural healthcare, the patient was monitored using an integrated autonomic and neuromuscular framework. This included Heart Rate Variability (HRV) to assess allostatic load and physiological stress modulation, alongside surface electromyography (sEMG) sensors providing real-time, automated muscle activation feedback during home-based exercises. The intervention utilized an engineering-driven home framework consisting of three distinct phases: biochemical priming, force-use engineering, and remote oversight. Initially, the patient performed aerobic exercise at 60% VO₂ max to upregulate Brain-Derived Neurotrophic Factor (BDNF) before engaging in motor learning tasks. Simultaneously, household modifications were implemented to require hip abduction and weight-shifting for essential daily activities. Following the 8-week protocol, the patient demonstrated a 34% increase in Gluteus Medius peak contraction. Functional outcomes significantly improved, with the Harris Hip Score rising from 58 (Fair) to 82 (Good). Notably, a 15ms increase in RMSSD correlated with days of improved pain modulation, indicating stabilized autonomic function. These findings suggest that integrating neurological and environmental contexts—utilizing Trauma-Informed Kinesiology—can effectively bypass geographical barriers to specialist care. Orthopedic physical therapy achieves superior outcomes when accounting for the patient's total physiological and environmental landscape rather than focusing solely on isolated biomechanical deficits.

Keywords:

Allostatic Load, Biochemical Priming, Force-Use Engineering, Functional Stagnation, Gluteus Medius Inhibition, Harris Hip Score, Neuromuscular Re-education, Remote Oversight, sEMG-Biofeedback, Trauma-Informed Kinesiology.