Electrogastrography and Personalized Transcutaneous Electrical Nerve Stimulation for Noninvasive, Low-Cost Diagnosis and Treatment of Gastroparesis

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Gastroparesis, characterized by slowed or absent gastric contractions, affects 1.8% of the population, presents with severe nausea, abdominal pain, a high mortality rate, and incurs high treatment costs. Diagnostic and treatment challenges are significant, as current methods are costly and ineffective. This study introduces an approach that combines transcutaneous monitoring of gastric contractions using an electrogastrogram (EGG) with personalized transcutaneous electrical nerve stimulation (TENS) to diagnose and treat gastroparesis. A dual-model approach customizes TENS parameters based on individual body mass indices (BMIs) for optimal gastric contraction stimulation, specifically targeting the PC6 forearm acupoint to enhance gastric motility. Using computational modeling, a COMSOL Multiphysics finite element model simulates the distribution of current in tissue following stimulation, and a NEURON Simulation Environment model assesses nerve activation based on this extracellular current distribution. Optimal parameters are the minimal intensity settings that activate 100% of nerve axons. To ensure precise adherence to model-identified parameters despite physiological fluctuations, the stimulation delivery device is optimized to incorporate a real-time feedback loop, dynamically adjusting these parameters based on skin conductance sensor data. The overall stimulation method was evaluated in an in vivo study with six participants. After treatment, as evidenced by EGG, gastric contraction frequency immediately rose by an average of 43.38% ($p<0.01$). Remarkably, a 36.63% increase in baseline contraction frequency was maintained 48 hours post-treatment ($p<0.01$). At $1123.49 this method offers an affordable, effective alternative for gastroparesis management.