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Use of Innovative Technologies in the Treatment of Osteoarthritis: Combined Action of High Frequency Neuromodulation and Intra-articular SARC Infiltration

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Abstract

Osteoarthritis (OA) remains a prevalent, debilitating condition that affects millions worldwide, primarily the elderly. Conventional treatments often fail to alleviate symptoms, leading to diminished quality of life for patients who are not candidates for joint replacement surgery. This study examines the efficacy of combining Pulsed High Frequency (PHF) neuromodulation therapy and Autologous Cytokine-Rich Serum (SARC) infiltration as an innovative, non-invasive treatment for OA. Eighteen patients with OA unresponsive to conventional therapies participated in this study, undergoing a single session of PHF neuromodulation and SARC infiltration. Results demonstrated a significant reduction in pain, as assessed by the Visual Analog Scale (VAS), and an improvement in joint mobility across various joints, including the knee, hip, and shoulder. These outcomes were sustained at a six-month follow-up, with approximately 80% of patients reporting a reduction in pain by at least 50%. Findings indicate that the PHF+SARC approach may offer a promising alternative for patients with refractory OA, providing long-term symptom relief and functional improvement with minimal intervention.

Keywords: Osteoarthritis, Pulsed High Frequency Neuromodulation, Autologous Cytokine-Rich Serum, Pain Management, Joint Mobility, Intra-articular SARC, Chronic Pain

Introduction

Osteoarthritis (OA) is the most common progressive musculoskeletal condition that can affect joints. Because of the higher prevalence of asymptomatic OA, it is approximated that 250 million people all over the world suffer from OA. OA causes an annual economic burden of at least USD 89.1 billion—which is between 1% and 2.5% of the gross domestic product in high-income countries, with knee and hip joint replacements as the majority of that cost. Furthermore, after low-back pain, osteoarthritis is the second leading musculoskeletal disorder in Disability Adjusted Life Years (DALYs) calculation in the elderly population. Studies have shown that there is a connection between OA and a slightly increased risk of developing cardiovascular and atherosclerosis-related diseases. As a leading cause of depressive episodes, chronic pain causes a vicious cycle in which pain limits physical activity and physical inactivity contributes to greater knee pain and weight gain. As a chronic disease with pain as the dominant symptom, pain management and lifestyle changes are insufficient, and OA remains challenging to treat. Joint replacement surgery is the only option left in end-stage disease to increase the quality of life in cases where conventional symptomatic treatment did not work. Patients suffering from OA in major joints such as the knee, hip, or shoulder often experience diminishing treatment options when conventional therapies (including anesthetic and corticosteroid infiltrations, or platelet-rich plasma (PRP) infiltrations) fail. For those who are not candidates for joint replacement surgery, alternative treatments are limited [1].

Pathogenesis – Osteoarthritis as a Whole Joint Disease

The approach to OA changed a lot throughout history. At first, it was thought that OA is a disease of cartilage. Later, the perception was replaced by an idea that subchondral bone is also affected, but today it is known that all the tissues in or around the

joint are influenced by the disease, leading to the concept of OA as a whole joint disease.

Articular Cartilage

Articular cartilage (AC) is avascular, alymphatic, and aneural tissue with chondrocytes as the only cell type in the cartilage tissue. Besides chondrocytes, AC is formed by the extracellular matrix (ECM), which is composed of water (more than 70%) and organic components such as type II collagen, aggrecan, other proteoglycans (decorin, biglycan, and fibromodulin), collagens (types III, VI, IX, XI, etc., collagens), glycosaminoglycans and glycoproteins. In early-stage OA, when macroscopic joint changes are not yet seen, the cartilage matrix goes through changes with the help of degrading enzymes. Perturbed equilibrium between anabolic and catabolic processes leads to the progression of OA and further structural changes [2]. The main mediators of cartilage metabolism are cytokines, discussed below. By initiating inflammatory processes and inducing a catabolic state of the cartilage, early surface changes seen as fibrillations extend distally, forming deep fissures, leading to cartilage delamination uncovering the calcified cartilage and the subchondral bone.

Subchondral Bone

Even though progressive cartilage damage and its eventual loss were the most mentioned features of the OA in the past, it is now well accepted that subchondral bone alterations and synovial inflammation also influence all other structures in the joint. Their structural changes are important disease characteristics, confirming that OA is a whole joint disease.

With the initiated increased bone turnover and neovascularization of subchondral bone, newly formed vessels together with nerves infiltrate the bone, invade the overlying cartilage tissue, making a communication channel for the exchange of biologic factors. This process is another mechanism that causes pain in OA [4, 3].

Synovium

The synovial membrane, together with synovial fluid, makes the synovium. Synovial fluid plays a crucial role in cartilage nutrition. The avascular cartilage uses the synovial fluid as a source of nutrients, but also as a reservoir for its degrading products. Synovitis is recognized as an important feature in patients with OA and has been associated both with symptoms and with structural progression. The inflammation in OA causes synovia to proliferate and induces the infiltration of T and B lymphocytes as well as mast cells. In addition, synovitis causes the extensive production of proteolytic enzymes, causing cartilage damage, while cartilage matrix catabolism produces molecules that propagate synovial inflammation [5, 6].

Cytokines Involved in OA Signalization

Our understanding of OA pathogenesis is incomplete without cytokines. Today, we know that OA is not merely a condition that develops from inappropriate loading forces on weight-bearing joints and repetitive stress, but a disease in which an underlying immune response dictates the degradation of cartilage, bone remodeling and typical symptoms such as swelling, pain and stiffness [4]. The main signaling molecules of the immune response in OA are cytokines. Based on their effect on the metabolism in the surrounding tissue, they are commonly divided into two distinct subgroups: inflammatory and anti-inflammatory. The main inflammatory cytokines are: IL-1β, TNF-α, IL-6, IL-8, IL-17 and the main anti- inflammatory cytokines are: IL-1Ra, IL-4, IL-10 and IL-13.

PHF and SARC

Pulsed High Frequency (PHF) therapy has emerged as a potential solution for these patients. The PHF mechanism generates an approximately constant electric field, which promotes a neuromodulatory effect, leading to alterations in gene expression, particularly of c-fos, a proto-oncogene implicated in inflammation. PHF therapy also inhibits the proliferation of pro-inflammatory cytokines such as interleukins. The therapy is administered through a commercially available PHF generator system, KROMED. In conjunction with PHF, the use of Autologous Cytokine-Rich Serum (SARC) presents another promising option. SARC, produced from the patient's own blood, contains a serum rich in anti-inflammatory cytokines and growth factors but is devoid of cellular components such as platelets and fibrinogen. The serum is produced using the Qrem Cytokine system and is administered via intra-articular infiltration [7, 9].

Purpose

The aim of this study was to determine the efficacy of the combined use of PHF neuromodulation and SARC in reducing pain and improving joint mobility in patients with refractory osteoarthritis, specifically evaluating the percentage of patients who achieved significant improvements in these parameters one-month post-treatment.

Methods

This study involved 18 patients with knee, hip, or shoulder osteoarthritis who had been unresponsive to conventional treatments over the preceding six months. The primary measures of efficacy were pain levels, assessed using the Visual Analog Scale (VAS), and joint mobility. Baseline data were collected during the initial visit, and subsequent follow-ups were conducted. For the purposes of this article, the results at six months post- treatment are presented. Data from three patients who did not complete the six-month follow-up were excluded from the analysis.

Results

Of the 21 patients initially enrolled, data from 18 patients were analyzed at the six-month follow-up. Patients who underwent combined PHF+SARC treatment exhibited significant reductions in pain, as measured by VAS, and sustained improvements in joint mobility. Specifically, 70% of patients with knee OA, 100% with hip OA, and 67% with shoulder OA reported at least a 50% reduction in pain following a single treatment session. These improvements were sustained over the six-month follow-up period.

Conclusions

The combination of PHF neuromodulation and SARC infiltration appears to provide significant clinical benefits for patients with osteoarthritis refractory to conventional therapies. Approximately 80% of treated patients showed improvements in pain and joint mobility, with at least a 50% reduction in pain observed in the majority of patients one-month post-treatment. The findings suggest that this combined approach may be a viable thera-

peutic option for patients with refractory osteoarthritis, offering long-term benefits with a single treatment session. Further studies with larger sample sizes and longer follow-up periods are warranted to validate these results.

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