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● *Original Contribution*

THE EFFECT OF THERAPEUTIC ULTRASOUND ON PAIN AND PHYSICAL FUNCTION IN PATIENTS WITH KNEE OSTEOARTHRITIS

TUĞBA YEĞIN,* LALE ALTAN,*† and MELIHA KASAPOĞLU AKSOY*

*Department of Physical Medicine and Rehabilitation, BursaYüksek Ihtisas Training and Research Hospital, Bursa, Turkey; and
†Department of Physical Medicine and Rehabilitation, Uludağ University Medicine Faculty, Bursa, Turkey

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Abstract—Osteoartritis (OA) is one of the most frequent causes of pain, loss of function and disability in adults. The prevalence of OA is expected to increase substantially in the future. Knee OA is the most common subset of OA. Therapeutic ultrasound (US) is one of several physical therapy modalities suggested for the management of pain and loss of function due to OA. The purpose of our study was to investigate the efficacy of US therapy in reducing pain and functional loss and improving the quality of life in patients with knee OA in comparison to sham US therapy. The study involved 62 patients. The patients were randomly divided into two groups. The patients in group 1 (n = 30) were administered 1 W/cm^2, 1 MHz continuous US, and the patients in group 2 (n = 32) were administered sham US. The US treatment was applied for 8 min to each knee, 16 min in total, 5 d a wk, for a total of 10 sessions during 2 wk. The patients were evaluated immediately after treatment and 1 mo after therapy according to the visual analog scale (VAS), night pain, range of motion, morning stiffness, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Lequesne and Short Form-36 (SF-36) scales and 6 min walking distance. Improvement in pain and joint functions was observed in both groups according to the evaluation immediately after treatment and at 1 mo after the therapy. According to the evaluation results immediately after treatment, there was significant improvement in all pain scales (VAS, WOMAC, Lequesne, SF-36), morning stiffness and 6 min walking distance in patients receiving real US treatment ($p < 0.05$), but only in some pain scales (VAS, WOMAC) and functions in the group receiving sham US ($p < 0.05$). Significantly better improvement was observed in some pain scales (SF-36), functions (WOMAC, SF-36) and 6 min walking distance in the real US group. At 1 mo after therapy, no significant difference was observed between groups except for improvement in night pain in the real US group. In conclusion, US therapy has been found to be effective in reducing pain and improving physical function in the short term, but this positive effect was not persistent in the long term. However, we believe that the results of our study may contribute to ongoing research for the treatment of patients with knee OA, and further systematic investigation on larger patient populations may delineate the role of US in knee OA treatment. (E-mail: melihakasapoglu@hotmail.com) Published by Elsevier Inc. on behalf of World Federation for Ultrasound in Medicine & Biology.

Key Words: **Therapeutic ultrasound, Knee osteoarthritis, Physical function.**

INTRODUCTION

Osteoarthritis (OA) is a non-inflammatory, chronic and degenerative joint disease that is characterized by destruction of cartilage, osteophyte formation and subchondral sclerosis, which shows progressive involvement of synovial, diarthrodial and particularly load-bearing joints (Di Cesare and Abromson 2005).

Knee OA is the most common type of OA, and its prevalence is directly proportional to the age of the population (Andrianakos et al. 2003; Felson et al. 2000). In a study performed in United States, it has been shown that knee OA affects 28% of adults older than 45 y and 37% of adults older than 65 y (Dillon et al. 2006; Jordan et al. 2007). The goal of knee OA therapy is to alleviate pain and minimize secondary functional insufficiency by improving joint range of motion. Therefore, medical treatment modalities using non-pharmaceutical approaches have been described and various surgical procedures are performed in patients who do not benefit from such treatments.

Ultrasound (US), which is a frequently used physical therapy agent, has been accepted as an effective treatment

Address correspondence to: Meliha Kasapoğlu Aksoy, Bursa Yüksek İhtisas Training and Research Hospital, Department of Physical Medicine and Rehabilitation, Yildirim, Bursa 16800, Turkey. E-mail: melihakasapoglu@hotmail.com

agent in knee OA since it has been shown to increase blood flow, metabolic activity and tissue recovery and to reduce pain and inflammation via high-frequency sound waves that generate thermal and mechanic effects in soft tissues (Baker et al. 2001). In a recent Cochrane review published in 2010, it has been reported that US therapy may have positive effects on reducing knee pain and enhancing knee functionality in knee OA patients. However, it has also been emphasized that the level of evidence was low for the efficiency of US and well-designed and high-quality studies were required for further delineation of the subject (Rutjes et al. 2010). Therapeutic US has been used at 1 Mhz frequency in the current clinical practice and in several studies (Ozgönenel et al. 2009; Zhang et al. 2015). The intensity of US has been set between 0.8–2.5 W/cm^2 in most clinical trials and 1 W/cm^2 is usually accepted as the tolerable dose at which patients feel a mild warmth but no pain (Knight et al. 2001; Robertson and Baker 2001).

In the present study, our purpose was to investigate the effect of continuous US therapy (1 W/cm^2, 1 MHz) for 16 min versus sham US on pain, functional impairment and quality of life in patients with knee OA.

MATERIALS AND METHODS

A total of 65 patients, who were admitted to Physical Medicine and Rehabilitation Outpatient Clinic between March 2015 and September 2015 with complaints of knee pain and diagnosis of knee OA according to the criteria of the American College of Rheumatology, were included in the study.

The study was approved by the local ethical committee on April 15, 2015, according to the World Medical Association Declaration of Helsinki. We received informed consent from each participant in our study. Patients were included in the study according to the following criteria: (i) to be diagnosed with primary knee OA according to ARA criteria; (ii) to be between 40 and 70 y of age; and (iii) to have evidence of minimum Stage 2 knee OA in the X-rays taken during the last 12 mo according to the Kellgren-Lawrence Grading Scale.

Exclusion criteria for the study were as follows: (i) severe knee trauma in the last 6 mo; (ii) previous surgical operation on the knee; (iii) administration of intra-articular steroid and/or hyaluronate injection in the last 6 mo; (iv) physical therapy for knee in the last 3 mo; (v) existence of acute synovitis; (vi) neurologic deficit in lower extremity; (vii) inflammatory disease; (viii) impaired health condition (cardiac failure, advanced asthma, cancer).

Sixty-five patients were divided into two groups randomly. In group 1 (n = 32), US was applied to both knees for a total of 10 sessions for 2 wk using a BTL-4000 Premium US device (BTL Industries, Stevenage, Hertfordshire, UK) with a 5-cm^2 1-MHz probe. US was applied continuously in a circular movement (1 W/cm^2, 1 MHz) using gel for a total of 8 min to each knee while patients were in the supine position and their knees were flexed at 90°. The application was performed on the superomedial and lateral knee regions, covering an area of 25 cm^2. In group 2 (n = 33), sham US was applied to both knees for the same duration and with the same frequency as in group 1 by holding the device in switched off mode and covering its display panel. The use of any analgesics except paracetamol was avoided during the treatment and until the end of the first mo following completion of US treatment.

Evaluation parameters

Patients were evaluated three times by an independent researcher before, immediately after and 1 mo after the treatment. The efficacy of the treatment was evaluated according to the following parameters:

1. Pain: The visual analogue scale (VAS) was used for evaluating pain (0 = no pain; 10 = most severe pain) (Altman and Lozada 2008). The patients were also asked about the presence of night pain.
2. Morning stiffness: The presence and duration of morning stiffness were analyzed.
3. WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index): Disease-specific WOMAC is a health status index widely used in patients with knee OA. The validity and reliability of its Turkish version has previously been documented (Tüzün et al. 2005). The form consists of three subscales (pain, stiffness and physical function) and 24 questions. Higher WOMAC scores indicate increased pain and stiffness, and deterioration in physical functions (Peat et al. 2001). Severity of pain during the last 24 h is questioned for the subscale of pain. Two questions about joint stiffness are asked after the symptom of joint stiffness is clearly defined in the form. Difficulty in performing 17 different activities related to the affected joints during the last 24 h is questioned to document the status of physical function. The maximum scores for pain, stiffness and physical function were 50, 20 and 170, respectively, amounting to a total score of 240.
4. Lequesne scale: The Lequesne scale is specific for evaluation of pain, maximum walking distance and the daily activities of patients with OA. The validity and reliability of the Lequesne questionnaire in Turkish society has been reported previously by Aydemir (2005). The level of pain and functional impairment are interpreted as mild to moderate