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Arzt & Praxis VerlagsgmbH
1180 Vienna - Hasenauerstraße 23
Tel. +43(0)1 479 05 78
office@arztundpraxis.at
www.arztundpraxis.at

Nuclear magnetic resonance as a new treatment option for osteoarthritis of the knee

Mag. N. Fagerer, Univ.Doz. Dr. W. Kullich

Mag. Nicola Fagerer, Univ.Doz. Dr. Werner Kullich
Ludwig Boltzmann Institut für Rehabilitation interner Erkrankungen [Ludwig Boltzmann Institute for the Rehabilitation of Internal Medicine Conditions], Thorerstraße 26, 5760 Saalfelden,
lbirehab@aon.at

Nuclear magnetic resonance as a new treatment option for osteoarthritis of the knee

Osteoarthritis of the knee is a degenerative disease of the knee joint that causes chronic pain and deterioration of joint function, with increasing stiffness of the joint. Nuclear magnetic resonance is a novel form of therapy for osteoarthritis which has its origins in diagnostic magnetic resonance imaging.

Within the context of post-marketing surveillance with follow-up after 6 months, the therapeutic application of nuclear magnetic resonance was investigated in 32 patients with osteoarthritis of the knee and long-term symptoms.

In order to document treatment outcome, a 10-point Visual Analogue Scale for pain (VAS), a specially-created score for frequency of pain, as well as the Lequesne index for knee disease were used before and immediately after therapy, and after a period of 6 months. Pain intensity and pain frequency were clearly improved as the result of the Nuclear Magnetic Resonance Therapy. Symptoms relating to pain and discomfort, and restricted movement in everyday life, as measured using the Lequesne index, were also markedly improved after treatment. The therapy appears to have a particularly good effect in patients with severe osteoarthritic knee pain. In some cases, the results of the treatment were still recognisable after 6 months, however there was a trend for the effect to diminish.

In addition to cartilage regeneration, the mechanisms triggered by the Nuclear Magnetic Resonance Therapy and the resulting rapid short-term improvement in symptoms should be investigated further.

Introduction

Osteoarthritis is the most common joint disease around the world and is the cause of chronic pain, often with significant restriction in mobility. The risk of contracting the disease increases with age, however arthritic changes can be present even at a young age, without being clinically symptomatic [1]. Osteoarthritis of the knee is the most common form of osteoarthritis. It is a degenerative disease of the knee joint caused by increasing destruction of articular cartilage, also involving the joint capsule, and the bones and muscles of the joint. Due to its elasticity, it is the role of the articular cartilage to absorb pressure during movement and stress and to ensure that the bones involved can move with minimal frictional resistance [2]. Adult cartilage consists of chondrocytes embedded in an extracellular matrix which consists of approximately 65-80% water and 20-35% solids. Even small variations in the composition of the cartilage can affect its function [3].

Due to the high prevalence of osteoarthritis of the knee, it is necessary to develop complementary treatment options in addition to surgical and medical treatments, in order to achieve a reduction in pain and an improvement in functional joint mechanics, as well as to delay the progression of the osteoarthritis [4]. In recent years, a special form of magnetic resonance technology has been developed; this is a therapy based on the nuclear magnetic resonance. This procedure differs fundamentally from magnetic field concepts. The mechanism of action is based on that of the well-known diagnostic magnetic resonance imaging systems [5]. The nuclear magnetic resonance of hydrogen protons means that the hydrogen nuclei absorb energy. When the direction of the field is changed, this energy is released into the surrounding tissue as resonance. Previously published works [6] indicate that this ion dynamics has a stimulating affect on proliferation in cartilage and bone. It has been demonstrated that nuclear magnetic resonance can markedly increase cartilage volume and cartilage thickness in osteoarthritis of the knee [7].

Clinical and radiological methods make it possible to perform a detailed assessment of the damage to the joint. However, a simple objective assessment of the degree of impairment and documentation of treatment results are difficult.

In order to assess and document osteoarthritis of the knee, it is most common to use validated questionnaires, for example

the Lequesne questionnaire for knee diseases [8].

We believed that it was of interest to assess the clinical effect of the novel Nuclear Magnetic Resonance Therapy for osteoarthritis of the knee in terms of impairment (Lequesne index) and pain (Visual Analogue Scale) on our own patient population.

Patients and method

Patients

Within the framework of post-marketing surveillance, the therapeutic use of Nuclear Magnetic Resonance Therapy (NMRT) in patients with osteoarthritis of the knee was investigated in an open-label clinical trial with follow up after 6 months. The study included 32 patients with painful osteoarthritis of the knee (15 men and 17 women), aged from 25 to 82 years (mean age: 51.4 ± 15.4 years). Due to drop-outs as the result of poor compliance, 25 cases could be included in the evaluation in accordance with the protocol after 6 months. Only patients with confirmed osteoarthritis of the knee and long-term symptoms were used for observation.

The exclusion criteria were as follows: malignant disease, bacterial disease, primary inflammatory rheumatic disease, such as rheumatoid arthritis, HIV-positive patients, cardiovascular disease, cardiac arrhythmias, patients with pacemakers, status post implantation of an ICD, insulin pump or total hip/knee replacement, alcohol abuse and pregnancy and lactation.

Treatment

Before the nuclear magnetic resonance therapy, the patients received in-depth information and gave their personal consent to participation in the study. The treatment parameters for osteoarthritis of the knee were entered into the control unit of the Nuclear Magnetic Resonance Therapy device (Multibiosignal Nuclear Magnetic Resonance Therapy System – MBST®, KSRT 300, 21460313, from MedTec Medizintechnik GesmgH, Wetzlar, Germany) at the start of the treatment using a computer chip card.

In this way, the precise dose of the nuclear magnetic resonance field reached the parts of the body to be treated. Treatment of the osteoarthritis of the knee was administered in the form of a series of sessions in the nuclear magnetic resonance coil on 5 consecutive days, with each session lasting one hour. The principle of this system is based on the generation of dynamic nuclear magnetic resonance field with a frequency of 100kHz. A transfer of energy from the alternating electromagnetic field of the treatment device to the cartilage stimulates the protons. These protons enter a higher energy state, and when they return back to their original state they release this energy into the cartilage cells. These then receive the missing information required for synthesis, with the aim of inducing cartilage regeneration.

Documentation

Before and directly after the 5-day Nuclear Magnetic Resonance Therapy, and again 6 months after the treatment, the pain symptoms were recorded using a 10-point Visual Analogue Scale (VAS) for a) peak pain, b) pain during movement, and c) pain at rest. Frequency of pain was recorded using a 10-point score (0 = never, 1 = 1x/3 months, 2 = 1x/month, 3 = 2x/month, 4 = 1x/week, 5 = 4x/week, 6 = 1x/day, 7 = 3x/day, 8 = more than 3x/day, 9 = more than 12 hours per day, 10 = constant pain), whereby a distinction was made between peak pain, pain during exertion and pain at rest. In order to assess the limitations experienced in everyday life as a result of the osteoarthritis of the knee, the German version of the Lequesne index for knee diseases [8] was also used. This contains 9 detailed questions about the three areas 1) symptoms (pain/discomfort), 2) walking distance, and 3) impairment of physical function (day-to-day activities).

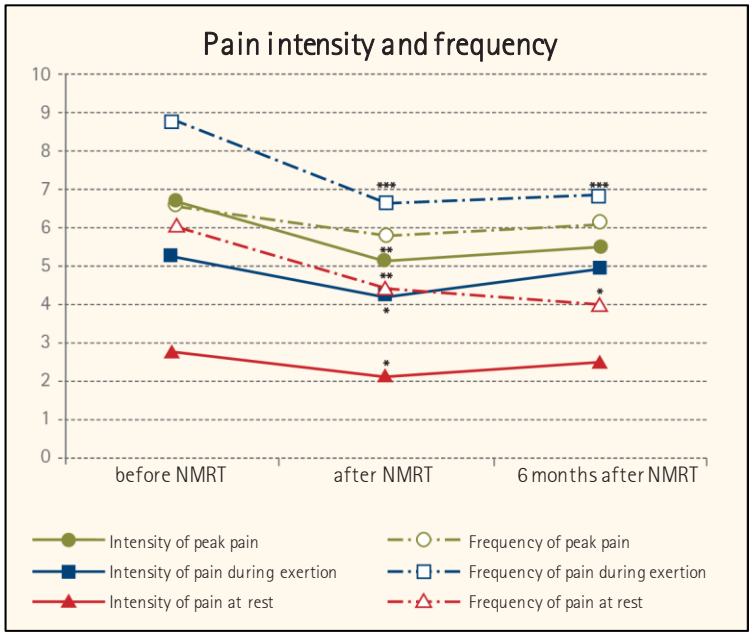

Fig. 1: Nuclear Magnetic Resonance Therapy – Intensity and frequency of osteoarthritic knee pain, divided into peak pain, pain on exertion and pain at rest. (Significance compared to baseline: * p < 0.05 ** p < 0.01, *** p < 0.001)

Statistics

The program packages Microsoft Office Excel 2003 and SYSTAT 9.0 Statistics for Windows (SPSS Inc., USA) were used for electronic collection and statistical analysis of the data. The following test procedures were used: descriptive statistics, Wilcoxon rank order test, Kruskal-Wallis test, Pearson correlation analysis.

Results

Following the Nuclear Magnetic Resonance Therapy there was a marked improvement in pain, as measured using the 10-point VAS. The changes were statistically significant for all types of pain, namely during exertion ($p < 0.02$), peak pain ($p < 0.002$), and pain at rest ($p < 0.05$) (Fig. 1).

A comparison between patients with severe and mild knee pain revealed that only those patients with more intense pain (pain on exertion > 5, peak pain > 7) experienced a significant improvement. In patients with severe peak pain at baseline, the treatment success was still statistically evident at 6 months after treatment. Frequency of pain (Fig. 1) on exertion and at rest also decreased significantly after therapy ($p < 0.0005$ and < 0.005). Pain on exertion and at rest were also still significantly improved after 6 months ($p < 0.001$ and < 0.02).

The total score for the Lequesne index for knee diseases (Fig. 2) showed a significant improvement after the Nuclear Magnetic Resonance Therapy ($p < 0.0003$). In particular, the Lequesne parameters "symptoms", describing pain and discomfort, and "impairment of physical function", which includes day-to-day activities, saw significant improvements ($p < 0.001$ and $p < 0.0005$). Only the parameter "walking distance" remained

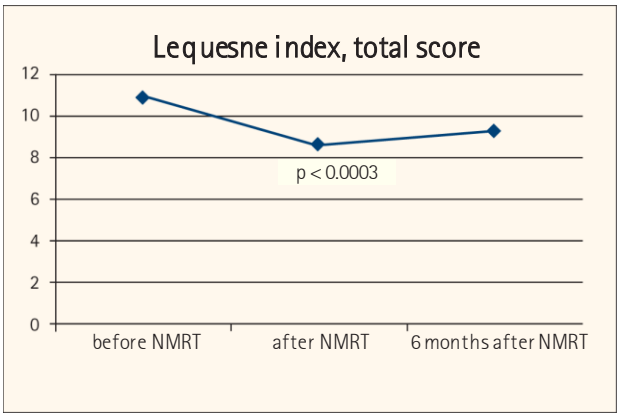

Fig. 2: Significant improvement in the total score for the Lequesne index for knee diseases as the result of the use of Nuclear Magnetic Resonance Therapy. (p = significance as compared to baseline)

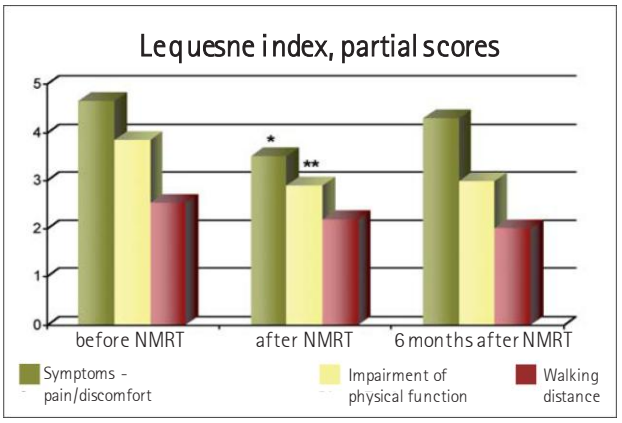

Fig. 3: Improvement in the Lequesne index for knee diseases with regard to pain and discomfort and/or loss of function during MBST Nuclear Magnetic Resonance Therapy (significance as compared to baseline: * = p < 0.001; ** = p < 0.0005).

unchanged (Fig. 3). Patients with severe pain on exertion and peak pain still had a marked improvement in day-to-day activities after 6 months, but the improvement was not statistically significant due to the low number of patients.

Discussion

A reduction in pain intensity as a result of the use of Nuclear Magnetic Resonance Therapy has been observed in some previous studies, including in patients with chronic low back pain [9]. As in the present study on patients with osteoarthritis of the knee, in which there was a clear tendency for the effect to diminish after 6 months, long-term effects in terms of pain reduction were also observed several months after the use of nuclear magnetic resonance for low back pain. The results indicate that a refresher of the positive effect might be beneficial after several months. The frequency of pain during movements placing stress on the knee was reduced from 12 hours per day to 1-3 times per day after 6 months as a result of the Nuclear Magnetic Resonance Therapy, resulting in a significant improvement in quality of life. At the end of the observations, daily pain at rest was now only being experienced 1x per week.

The Lequesne index is a self-assessment instrument, and it is the most suitable for the routine recording of treatment effects in patients with osteoarthritis of the knee [10]. An improvement in the parameter "symptoms" means a reduction in pain and discomfort during movements that place stress on the knee and/or a reduction in pain at rest. "Impairment of physical function" includes everyday activities such as "climbing stairs", "squatting" and "walking on uneven ground". These parameters also improved following the Nuclear Magnetic Resonance Therapy in our study. Cartilage degeneration in osteoarthritis of the knee also means a reduction in chondrocytes. These are of great importance for the structure of the extracellular matrix, the main constituent of articular cartilage, as they represent the only living element of the cartilage. In this context, it is worth mentioning the evidence of increased proliferation of chondrocytes and osteoblasts in vitro following Nuclear Magnetic Resonance Therapy [6]. Following the application of Nuclear Magnetic Resonance Therapy in patients with osteoarthritis of the knee, Froböse et al. [7] were able to demonstrate a marked growth in knee joint cartilage in nearly all parameters (cartilage thickness, cartilage volume, cartilage surface). This is explained by the activation of intact/divisible cartilage cells and increased collagen synthesis following Nuclear Magnetic Resonance Therapy. Furthermore, in an animal model with cruciate ligament resection and subsequent development a osteoarthritis of the knee, it was possible to demonstrate that the formation of osteophytes can be significantly reduced by Nuclear Magnetic Resonance Therapy [11].

Regeneration of the articular cartilage is a long-term process, and although this explains the improvements in arthritis-induced impairment as measured by the Lequesne index, the demonstrated clear short-term improvement in pain as measured by the VAS must be due to other mechanisms that can be triggered by the nuclear magnetic resonance.

As a result of the changes in the energy levels of protons and the influence of the electrical activity in cells via corresponding receptors, Nuclear Magnetic Resonance Therapy may influence the sensation of pain directly. Research in this area would be very helpful to explain the effects of Nuclear Magnetic Resonance Therapy on a symptomatic level.

Further investigation is also warranted with regard to the extent that Nuclear Magnetic Resonance Therapy can be optimised in terms of treatment duration and sequence of therapy, in order to achieve long-term success.

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