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Review article

Magnetic resonance therapy in the treatment of osteoarthritis: A scoping review

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ABSTRACT

Objectives: To primarily assess the existing literature about Magnetic Resonance Therapy (MRT) or Molecular Biophysical Stimulation Therapy (MBST) in the treatment of patients with osteoarthritis (OA). The scoping review question was: What has been reported about MRT or MBST concerning treatment of patients with OA?

Key findings: The applied treatment program consisted of one hour daily treatment for patients in all the included studies. In terms of duration of treatment, four studies suggested treatment for nine consecutive days, two for five days and one study reported treatment on weekdays for two weeks. Six of the studies investigated the effect of MRT on the knee and one study for finger, ankle, and hip, respectively. Consensus across studies was that MRT had a positive, almost always significant, effect. Six out of the seven studies had subjective outcome measurements such as pain, quality of life and joint function, which were measured through self-reported questionnaires. One study combined ultrasonography with Magnetic Resonance Imaging (MRI) to evaluate structural joint changes. This evaluation was performed by a radiologist. One study used objective measurement of cartilage thickness through a minimal distance algorithm. All tests used MBST-systems.

Conclusion: This scoping review showed that there seems to be a beneficial effect of MRT in the treatment of patients with OA in relation to improvement in pain, joint function, and quality of life. However, more robust research and further evaluation of MRT are needed.

Implications for practice: Treating patients diagnosed with OA with MRT for one hour for five to ten days seemed to improve pain, joint function, quality of life as well as regeneration of cartilage. However, limitations of the included studies in this scoping review, such as a general lack of control groups, low sample sizes, lack of control for confounding factors such as medication, calls for more robust research with stronger study designs.

Introduction

World Health Organization (WHO) classifies osteoarthritis (OA) as a disorder predominantly affecting the peripheral joints.[1] Globally, OA ranks among the 50 most common sequalae of diseases and injuries, affecting over 250 million people.[2] OA is a major cause of pain and disability and constitutes a considerable financial burden.[3] In Denmark, more than 30,000 people are affected by OA in a total population of 5.7 million people and total costs are estimated to be approximately 913 million EUR.[4]

Currently, there are no treatments able to counteract the structural progression of the disease. Current therapies are largely focused on controlling pain, maintaining or improving joint function to improve quality of life.[3] Physiotherapy and occupational therapy are examples of important elements in the treatment of OA[3] and appropriate pharmacological analgesia is a key platform in treatment of OA. Available treatment options have various effects and side effects, and several therapies are still subject to debate.[5] When non-pharmacological and pharmacological treatments fail to provide the desired effect, surgery can be an option. Total joint replacement is considered the definitive treatment of OA to reduce pain and restore function. However, this treatment is associated with adverse events such as deep venous thrombosis and infection. It is estimated that up to 25% of patients with OA are not suitable candidates for joint replacement.[5] Thus, new non-invasive and non-pharmacological therapies are warranted.

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A group of German researchers reported that patients suffering from joint pain often reported improvement when undergoing Magnetic Resonance Imaging (MRI). They found that the energy generated from the movement of protons had a regenerative effect on the surrounding tissue. The many different frequencies in an MRI scanner were refined to only those with a proven effect on the surrounding tissue. The pulsing magnetic waves passing energy from the movement of hydrogen atoms to damaged tissue in the joints became known as Magnetic Resonance Therapy (MRT).[6]

In 1999, the German company MedTec Medizintechnik GmbH developed therapeutic systems for nuclear magnetic resonance therapy and patented it as Molecular Biophysical Stimulation (MBST).[6] MBST uses the same physical principle as MRI/MRT, but with a much weaker electromagnetic field than in a typical MRI scanner. The magnetic power of main magnetic fields in MBST ranges from 0.4 to 2.35 mT, which is 10,000 times weaker than in MRI.[7] The MBST therapy system does not use magnetic spin technology to generate images, but rather to stimulate different processes in organic tissue at the molecular level.[8,9]

Numerous studies have been conducted on the use of MRT over the past 20 years, but evidence on the benefits has been conflicting. This scoping review follows the methodology developed by the Joanna Briggs Institute[10,11] and examines and outlines results of existing studies, to gain a better understanding of the benefits and limitations of the use of MRT in the treatment of OA. The scoping review question was: What has been reported about MRT or MBST concerning treatment of patients with OA?

Methods

Search strategy

A three-step search strategy was applied to search literature in appropriate databases. The first step used the index terms and words from titles and abstracts in the first selected articles to form further search terms. The introductory search terms were used to search the database PubMed in collaboration with a research librarian to identify more precise and extensive search terms that made it possible to identify all relevant studies. The second step used the identified keywords and index terms adjusted to each of the selected databases. Studies published from January 1999 to present in English, German, Swedish Norwegian and Danish languages were eligible for inclusion. The third step covered an assessment and screening of the reference lists of each of the selected full text articles for additional relevant literature.

Inclusion criteria

The inclusion criteria for this scoping review are summarized in Table 1.

Information databases

The following databases were included: PubMed, CINAHL, AMED, Cochrane and Embase.

The specific keywords in the databases were identified via the thesaurus: “Mesh”, “CINAHL headings” or “emtree” and others. Furthermore, a block search was conducted. An exemplary search is shown in Table 2.

Screening and selection

All identified citations were collated and uploaded into Mendeley Reference Manager (version 1.19.4) and duplicates were removed. Titles and abstracts were then screened by two independent reviewers observing the inclusion criteria. Studies that met or could potentially meet the inclusion criteria were retrieved in full. The full text of selected studies was retrieved and assessed in detail. Any disagreements between reviewers were resolved through discussion and consensus was achieved; if necessary, a third reviewer was involved.

Data extraction

From the included scientific articles, appropriate descriptive data were extracted and schematized in a data extraction instrument based on the methodology for scoping reviews by Jonna Briggs Institute.[10,11] The data extraction instrument was used in an iterative process to ensure that additional relevant data were included and was continually updated throughout the data extraction process.

Presentation of results

Each of the included studies is presented in a form that logically reflects the objectives of this scoping review. Data are presented and discussed in terms of overall concept/components related to MRT or MBST in OA. The results of this review are presented in a narrative form including tables and figures.

Results

Inclusion of studies

The database searches identified 321 studies. Additionally, six studies were retrieved through other sources as shown in Fig. 1. A total of 115 duplicates were removed and 160 studies not related to the objective of this review were excluded. Thus, 52 full text studies were assessed for eligibility, and 45 studies were excluded. Finally, the reference lists of the included studies were then screened for any potentially relevant materials. The final number of included

Table 1
Inclusion criteria.

Inclusion criteria	
Types of participants	The review included studies on adult patients diagnosed with OA according to established diagnostic criteria regardless of disease classification. The criteria applied were: International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) from WHO.[1]
Concept	The core concepts examined by the scoping review were firstly MRI scanners and different MBST devices used for MRT. Furthermore, different treatment programs (e.g. number of treatment days and treatment length per treatment) were examined.
Context	This review considered studies conducted in clinics or hospital settings.
Types of studies	This scoping review considered qualitative, quantitative, and mixed methods studies of any design or methodology. The scoping review also considered systematic reviews of treatment with MRT or MBST for patients with OA.
Types of outcomes	This scoping review included all types of outcome.

Table 2
Search strategy in MEDLINE (PubMed).

Block 1: Osteoarthritis	Block 2: MRT
Controlled Vocabulary:	**Controlled vocabulary**
"Osteoarthritis" [MesH]	
Free text (ti,ab)	**Free text (ti,ab):**
Osteoarthritis	Magnetotherapy
OA	"Biomagnetic therapy"
"Degenerative arthritis"	"Magnet therapy"
Arthrosis	"Magnet treatment"
"Degenerative joint disease"	"Magnetic field therapy"
"Osteo-arthritis"	"Magnetic treatment"
"Osteo-arthrosis"	Mrt
Osteoarthrosis	Mbst
"Primary osteoarthrosis"	"Magnetic resonance therapy"
	"Molecular biophysical stimulation therapy"

Block 1 and 2 combined with "AND":
((((((((((("Osteoarthritis"[Mesh]) OR Osteoarthritis[Title/Abstract]) OR OA[Title/Abstract]) OR "degenerative arthritis"[Title/Abstract]) OR "noninflammatory arthritis"[Title/Abstract]) OR arthrosis[Title/Abstract]) OR "degenerative joint disease"[Title/Abstract]) OR "osteo-arthritis"[Title/Abstract]) OR "osteo-arthrosis"[Title/Abstract]) OR osteoarthrosis[Title/Abstract]) OR "primary osteoarthritis"[Title/Abstract]) OR "rheumatoid arthrosis"[Title/Abstract])) AND ((((((((((magnetotherapy[Title/Abstract]) OR "biomagnetic therapy"[Title/Abstract]) OR "magnet therapy"[Title/Abstract]) OR "magnet treatment"[Title/Abstract]) OR "magnetic field therapy"[Title/Abstract]) OR "magnetic therapy"[Title/Abstract]) OR "magnetic treatment"[Title/Abstract]) OR mrt[Title/Abstract]) OR mbst[Title/Abstract]) OR "magnetic resonance therapy"[Title/Abstract]) OR "molecular biophysical stimulation therapy"[Title/Abstract])

studies was seven. The described searches were carried out in October 2018. An updated search was conducted in October 2019; no new relevant studies were identified.

Characteristics of included studies

Included studies were published over a 16-year period between 2000 and 2016. All seven studies included adult patients diagnosed with OA. One study was conducted in Turkey,[12] one in Austria and Germany[13] and five in Germany.[7,14–17] The study designs consisted of five descriptive cohort studies[7,13–16] and two randomized controlled trials (RCTs).[12,17] The sample sizes ranged from 14 to 4500 patients. The mean age of included patients ranged between 30 and 75 years. Six out of the seven studies[7,12,13,15–17] had subjective outcome measurements such as pain, quality of life and joint function. One study[12] used ultrasonography and MRI scans to evaluate structural joint changes; this evaluation was performed by a radiologist. Finally, one study used objective measurement of cartilage thickness through a minimal distance algorithm.[14]

The time points of measurement varied between studies. All studies had a baseline evaluation but differed otherwise regarding time points for both other and final evaluation. MBST nuclear magnetic applications from the MedTec Company, Wetzlar, Germany was used in all seven studies. It was unclear if some of the studies used the same model type, as three of the studies did not specify the exact model type.[7,13,15] The other four studies used different models: the MBST open system 350,[12] MBST 1-

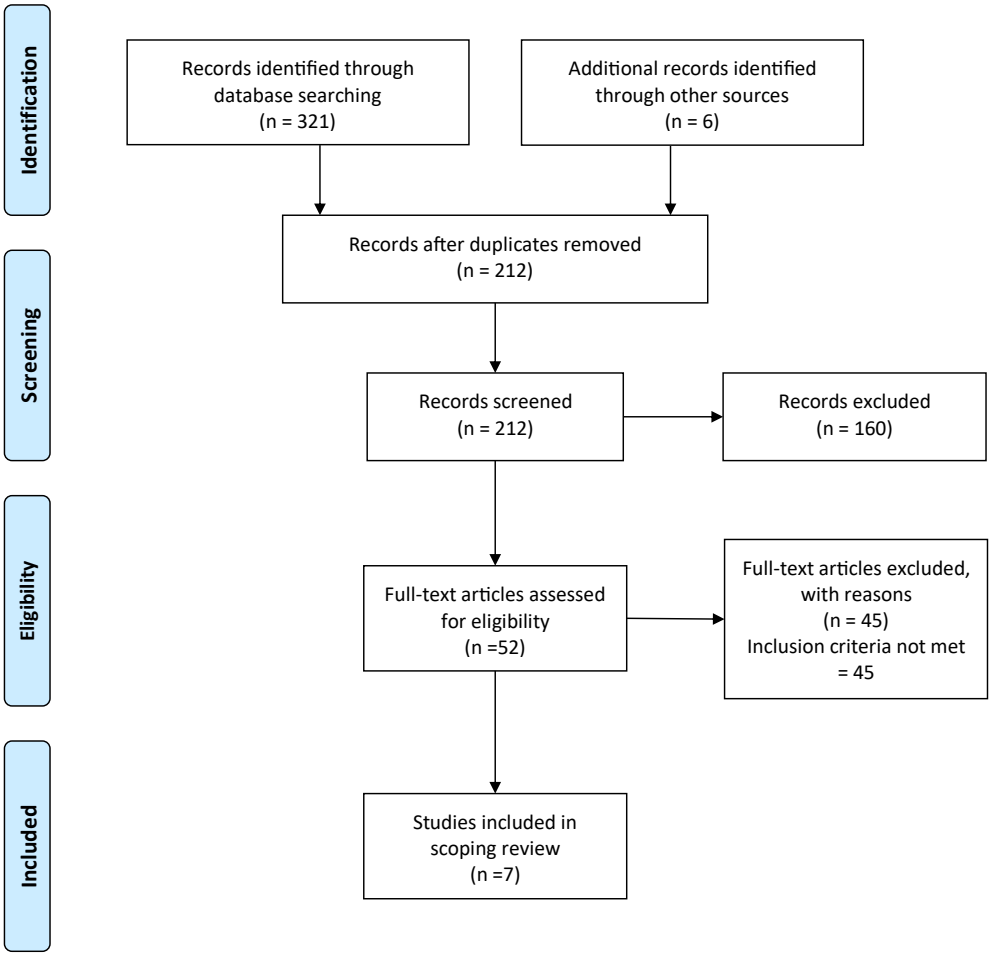

Figure 1. PRISMA flowchart of the study selection and inclusion process.

Table 3
Overview of study characteristics.

First author, year, and country	Population	Aim of the study	Study Design	Sample size	Time points of measurements
Froböse, 2000, Germany	Female patients with knee OA. Mean age 54.4 years.	To evaluate the effectiveness of MBST in respect to the regeneration of cartilage structures.	Descriptive cohort.	14 patients.	Baseline. **After treatment:** • 10 weeks after
Auerbach et al., 2003, Germany	Patients diagnosed with cartilage defects of knee joint. Mean age 48 years.	To evaluate the effectiveness of MBST in the treatment of osteoarthritis-related complaints of the knee.	Descriptive cohort.	59 patients.	Baseline. **After treatment:** • Directly after • 8 weeks • 6 months
Fagerer et al., 2007, Germany	Patients with knee OA. Mean age 51 years.	To evaluate the effectiveness of MRT for osteoarthritis of the knee with regards to pain and disability.	Descriptive cohort.	25 patients.	Baseline. **After treatment:** • Directly after • 6 months
Kullich et al., 2008, Germany	Patients with finger joint OA. Mean age 69 years.	To evaluate the effectiveness of MBST in the treatment of osteoarthritis of the finger joint.	RCT.	58 patients: 34 case 24 control	Baseline. **After treatment:** • Day 10 • 6 months
Levers et al., 2011, Germany	Patients with knee OA. 18 patients above 60 years old. 21 patients under 60 years old.	To evaluate the long-term effect of MBST regarding everyday activities and pain for patients with gonarthrosis.	Descriptive cohort.	39 patients.	Baseline. **After treatment:** • Directly after • 6 months • 1–2 years (9 patients) • 2–3 years (8 patients) • 3–4 years (13 patients)
Kullich et al., 2013, Austria and Germany	Patients OA of the Knee, hip, ankle, and low back pain. Mean age 62 years.	To gain the verified and testable evidence that nuclear magnetic resonance can positively and sustainably influence various degenerative rheumatic diseases.	Descriptive cohort.	4,500 patients: Knee: 2770 Hip: 673 Ankle: 420	Baseline. **After treatment:** • Directly after • 6–8 weeks • 6 months • 1 year
GÖKŞEN et al. 2016, Turkey.	Patients with knee OA. Between 30–75 years old.	To evaluate the efficacy of MRT on pain, physical functioning, and health related quality of life as well as on imaging properties of knee joint structures by using ultrasonography and MRI.	RCT.	97 patients: 49 case 48 control	Baseline. **After treatment:** • Directly after* • 12 weeks *Not US or MRI.

CELLREMAKE,[14] MBST KSRT 300.[16,17] The applied kHz frequency differed between 17 and 100 kHz.

The applied treatment program in all the included studies consisted of one hour of daily treatment. In four studies, treatment was provided for nine consecutive days,[7,13,14,17] in two studies for five days[15,16] and in one study, treatment was provided on weekdays for two consecutive weeks.[12] Some studies investigated several anatomical regions whereas some focused on a single region. Six of the studies investigated the effect of MRT on knee OA and one study investigated MRT on OA in the finger, ankle, and hip joint, respectively. Tables 3 and 4 provide an overview of study characteristics of included studies.

Review findings

The findings have been categorized according to the anatomical region of interest. The results from studies examining more than one anatomical region will be divided and presented accordingly. A general overview of the review findings can be found in Table 4.

Knee

The study by Froböse[14] evaluated the influence of MRT on OA of the knee. This study included 14 patients and evaluated the effect of MRT over a 10-week period. A general overview of the study showed that there was a distinct growth with respect to the cartilage structures after the treatment.

The study by Auerbach et al.[15] evaluated the effectiveness of MRT in the treatment of arthritis-related disorders of the knee. This study included 59 patients and evaluated the effect of MRT over a six-month period. The study found a statistically significant change in scores for all assessment criteria and thus a significant improvement in pain, joint stiffness, joint function, and quality of life.

The study by Fagerer et al.[16] evaluated the effectiveness of MRT for osteoarthritis of the knee. This study included 25 patients and

Table 4
Review findings.

First author, year, and country	Applied treatment system	Applied treatment program	Outcomes measured and their main points
Froböse, 2000, Germany	**MBST-system:** 1-CELLREMAKE. **Company:** MedTec Medizintechnik, Germany. **Frequency:** Not specified.	**Number of sessions:** 9 days on weekdays. **Session length:** 1 hour.	**Objective - Cartilage thickness (minimal distance algorithm, ECKSTEIN et al, 1998):** The results of the study show that there is distinct growth in respect to the cartilage structures 10 weeks after the treatment.
Auerbach et al., 2003, Germany.	**MBST-System:** not specified. **Company:** MedTec Medizintechnik, Germany. **Frequency:** Not specified.	**Number of sessions:** 5 days consecutive. **Session length:** 1 hour.	**Subjective - VAS, WOMAC, Lequesne index and Lysholm.** The patients experienced significant improvement with regards to pain, knee function and quality of life up to 6 months after treatment.
Fagerer et al., 2007, Germany.	**MBST-system:** KSRT 300. **Company:** MedTec Medizintechnik, Germany. **Frequency:** 100kHz.	**Number of sessions:** 5 days consecutive. **Session length:** 1 hour.	**Subjective - VAS and Lequesne index.** The patients experienced a clear improvement with regards to pain and knee function up to 6 months after treatment.
Kullich et al., 2008, Germany.	**MBST-system:** Closed MBST 300. **Company:** MedTec Medizintechnik, Germany. **Frequency:** 100kHz.	**Number of sessions:** 9 days consecutive. **Session length:** 1 hour.	**Subjective - VAS and QUABA.** **Case group:** The patients experienced significant improvement with regards to pain and hand function up to 6 months after treatment. **Control group:** The patients did not experience any improvement with regards to pain and hand function up to 6 months after treatment.
Levers et al., 2011, Germany.	**MBST-system:** Not specified. **Company:** MedTec Medizintechnik, Germany. **Frequency:** Not specified.	**Number of sessions:** 9 days on weekdays. **Session length:** 1 hour.	**Subjective - VAS and Lequesne index.** The patients experienced a clear improvement with regards to pain and knee function up to 4 years after treatment.
W. Kullich et al., 2013, Austria and Germany.	**MBST-system:** Not specified. **Company:** MedTec Medizintechnik, Germany. **Frequency:** 17–85 kHz.	**Number of sessions:** 9 days consecutive. **Session length:** 1 hour.	**Subjective - VAS, Lequesne index and Mazur.** **Knee:** The patients experienced a significant improvement with regards to pain and knee function up to one year after the treatment. **Hip:** The patients experienced a significant improvement with regards to pain up to one year after treatment. Clear improvement with regards to hip function was also found. **Ankle:** The patients experienced a significant improvement with regards to pain and ankle function up to one year after the treatment.
GÖKŞEN et al. 2016, Turkey.	**MBST-system:** Open system 350. **Company:** MedTec Medizintechnik, Germany. **Frequency:** 17–85 kHz.	**Number of sessions:** 10 days on weekdays. **Session length:** 1 hour.	**Subjective - MRI and US.** Imaging arm failed to show significant differences between groups* in terms of cartilage thickness on US and MR scores. *Case vs. control and treated knee vs. untreated knee. **Subjective - VAS, WOMAC and SF-36.** The case and control group experienced a significant improvement with regards to pain, knee function and quality of life up to 12 weeks after treatment. The differences in VAS, WOMAC and SF-36 were not significant between case and control group. Baseline parameters between case and control group were not significant.

evaluated the effect of MRT over a six-month period. The study found that pain intensity and pain frequency, measured by a visual analogue scale (VAS), could be clearly improved by the nuclear MRT. A general overview of the study showed that symptoms concerning pain, discomfort, and restricted movement in daily life, measured by the Lequesne index, were significantly improved after therapy. All changes, except for walking distance, were significant at day 1 and six months after treatment.

The study by Levers et al.[7] evaluated the long-term effect of MRT regarding everyday activities and pain in patients with OA. This study included 39 patients and evaluated the effect of MRT over a four-year period. A general overview of the study showed a shift of all levels to lower values and thus an improvement in general health. The study reported a significant improvement in general health up to three years after the treatment.

The study by Kullich et al.[13] tried to show verified and measurable evidence that MRT could positively and sustainably influence various degenerative rheumatic diseases, specifically in the knee, hip and ankle. This study included 4500 patients, where 2770 had OA of the knee and evaluated the effect of MRT over a one-year period. A general overview of the study showed that all types of pain measured were significantly reduced at all follow-ups. An improvement in knee function and walking distance, measured by the Lequesne index, was also found.

The study by Gökşen et al.[12] investigated patients with mild to moderate knee OA and evaluated the efficacy of MRT. This study included 97 patients, equally divided between a case and a control group. A general overview of the study showed that both groups improved significantly, but the average change from baseline in outcome parameters was similar in the case group compared with the control group after 14 days. These changes were also quite similar 12 weeks after treatment. With regard to ultrasonography and MRI measurements, the study failed to show significant differences between the groups in terms of cartilage thickness.

Hip

Kullich et al.[13] reported a clear improvement in pain and function maintained for up to one year after treatment. This cohort study included 4500 patients with a one-year-follow-up; 673 patients had OA of the hip.

Ankle

Kullich et al.[13] reported that a significant reduction in pain intensity under load as well as peak pain and pain at rest was attained as soon as the MRT therapy series was completed. A significant improvement in ankle function was also found. These findings were sustained after 12 months. This cohort study included 4500 patients with a one-year-follow-up; 420 patients had OA of the ankle.

Hand

Kullich et al.[17] evaluated the effectiveness of MRT in the treatment of patients with OA of the finger joint. This study from Germany included 70 patients, equally divided between a case and a control group. The study evaluated the effect of MRT over a six-month period. A general overview of the study showed a significant improvement in pain and hand function for the case group, which was retained after six months, whereas no improvement was found in the control group. The groups did not differ statistically at baseline. Furthermore, the study found that the control group experienced significant deterioration in pain and hand function after six months.

Discussion

Five of the seven included studies were identified as descriptive cohort studies by the authors of this scoping review, as the study design was not specified. Cohort studies by default are level II evidence and thus provide recommendations with a moderate degree of certainty, if only considering the study design.[18] Unfortunately, none of the cohorts included a control group. Two of the studies included in this scoping review stated that their study design was a double-blinded RCT. When looking across the cohort studies, there is consensus that MRT has a positive, almost always significant, effect. Interestingly, when looking at the results of the two RCT studies, the study by Kullich found a significant difference between the case and control group, whereas the study by Gökşen did not, since improvement regarding outcome parameters was found in both the case and control group. Importantly, six of the seven studies had a rather small sample size, ranging between 14 and 97 patients.

Self-reported pain measured by a VAS was commonly used with subcategories such as pain at rest, stress-induced pain, and peak pain. The studies seemed to agree that MRT should be regarded as a valuable approach to reduce pain in patients with OA. It should be noted that only one of the studies listed which questions were asked and measured by the VAS. Thus, knowing exactly how the studies defined e.g., pain at rest is unknown.

Different self-reported questionnaires to evaluate quality of life and joint function were used throughout the studies. The Lequesne index, WOMAC and SF-36 are examples of validated tools used. Generally, the studies agreed that MRT is an efficient approach to improve quality of life and joint function.

One study used diagnostic imaging to evaluate the effect of MRT. The study reported that no significant changes could be found regarding structural changes in cartilage thickness measured by radiologists using MRI and ultrasonography. This is interesting, because the study by Froböse reported that there was distinct growth of cartilage structures 10 days after MRT, and most of these measurements were highly significant. Both studies described comparable treatment programs. One of the reasons for this might be that the structural changes are relatively small and such small changes might be easy to miss when evaluated/measured subjectively (e.g., by use of electronic ruler), as in the study by Göksen et al., whereas Froböse made use of an objective algorithm. Though all studies included patients diagnosed with OA, only two of the seven studies had stage of the disease as a part of the inclusion criteria.[12,14] This is interesting, because the company behind MBST(MedTec) states that the stage of OA may influence therapy results.[19] Thus, to compare study samples, the progression of OA among the included patients should be equivalent. Only one study considered the effect of medication, such as Nonsteroidal Anti-Inflammatory drugs (NSAIDS).[12] This is also interesting, since the use of medication such as pain relievers is commonly used in the treatment of OA. If such medication is not taken into account, it might not be possible to make the distinction between whether a positive outcome might be attributable to MRT or the intake of medication.

Different demographic characteristics such as gender, age, BMI and sport activity level and their effect on MRT have been studied. Generally, there does not seem to be a gender-specific difference regarding the usefulness of MRT,[7,13] and BMI does not seem to affect the effectiveness of MRT.[13] One study evaluated the effect of sport

activity level such as swimming on the effect of MRT and found that a more positive effect could not be ascribed to this.[7] Moreover, a study reported that the treatment is considerably more effective in older patients, possibly because older people are typically retired and thus not exposed to the physical strains of a job.[7]

All studies included in this scoping review used MRT machines from MBST.[6] All studies had similar treatment programs and all patients were treated for sessions lasting one hour for 5–10 consecutive days. It would thus be reasonable to assume that such programs would have positive effects for patients with OA. Whether other treatment programs with longer treatment sessions or more treatment days would improve the effect of MRT for patients with OA remains unknown.

To our knowledge, this is the first scoping review on MRT in the treatment of OA. However, the following limitations should be considered.

Firstly, only seven studies were included. This low number of studies is likely a result of the research question focusing solely on in vivo patients diagnosed with OA. An additional number of studies might have been included if the research question had also covered in vitro studies. However, the aim of the review was to acquire knowledge as closely to clinical practice as possible, thus excluding in vitro and studies in animals. Furthermore, the devices used in studies included in this scoping review are from the German-based company MBST. Several of the studies included in this review were either written in German language or published in German journals. These studies were not found in the primary database search but through hand searching. This raises the question whether other relevant studies might have been found if the database search had been extended to also include German language research databases. The reason only seven studies have been published in the span of twenty years might also be that MRT is a relatively unknown field, or because the field is not progressing at pace.

Secondly, this scoping review only included studies in English, Danish, Swedish, Norwegian, and German language. Thus, relevant studies in other languages might have been missed. It should be considered if use of other/additional nomenclature and terminology in the search strategy might have identified other relevant articles.

Finally, considering the limitations of the included studies in this scoping review, any conclusion should be drawn cautiously regarding the effect of MRT on patients with OA, as the benefits reported in the included studies may be the results of other factors and may not truly reflect the direct benefits solely from the MRT treatment. It should also be noted that unlike a systematic review, scoping reviews do not tend to produce and report results that have been synthesized from multiple evidence sources following a formal process of methodological appraisal to determine the quality of the evidence.[10] The aim of this scoping review was to provide an overview and outline what had been reported about MRT in the treatment of patients with OA. Thus, a systematic assessment of methodological limitations or risk of bias of the evidence included within this scoping review was not performed. A systematic review approach might provide further insight into the limitations of the included studies.

Conclusion

Based on the included studies, there seems to be a beneficial effect associated with MRT in the treatment of patients with OA in relation to improvement in pain, joint function, and quality of life. However, more robust research and further evaluation of MRT should be conducted to eliminate all the confounding variables and the limitations of the current studies.

Recommendations for research

Even though the results of the studies included in this scoping review seem to point in the same direction, the low number of studies (7) with small sample sizes (14–97) in six of the studies calls for more research in this area. Furthermore, the general lack of control groups should encourage further research with stronger study designs. Future studies should preferably be designed as RCTs with both objective and subjective outcomes and focus on comparable groups of patients with OA.

Recommendations for practice

In the light of the research question and the studies included in this scoping review, treating patients diagnosed with OA with MRT for one hour for 5–10 consecutive days seemed to improve pain, joint function, quality of life as well as regeneration of cartilage. However, the low number of included studies as well as a general lack of control groups calls for more robust research with stronger study designs.

Conflict of interest statement

None.

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None.

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