Osteoarthritis Year in Review: Outcome of Rehabilitation

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Abstract (297 words)

Purpose: This review highlights seminal publications of rehabilitation interventions for osteoarthritis (OA) since April 2012.

Methods: Medline in process, Embase, CINAHL and Cochrane data bases were searched from April 2012 through February 2013 for English language publications using key words osteoarthritis, rehabilitation, physiotherapy, physical therapy, and exercise. Rehabilitation intervention studies included randomized trials or systematic reviews/meta-analyses or pre-post studies. Pilot randomized trials, feasibility studies and studies of surgical interventions unless they included evaluation of a rehabilitation intervention were excluded.

Results: 25 studies were identified for inclusion and grouped thematically. The short-term benefits (i.e. to 3 months) of variable types and dosages of exercise were demonstrated for a number of outcomes including pain, stiffness, function, balance, biomarkers, and executive function and dual task performance (related to falling) in people with knee OA. Modalities such as 890-nm radiation, interferential current, short wave diathermy, ultrasound and neuromuscular functional electrical stimulation did not demonstrate benefit over sham controls in those with knee OA. Spa therapy improved pain over the period of treatment in those with knee and hand OA. Supervised self-management based on cognitive therapy principles resulted in improved outcomes for people with knee OA. Shock absorbing insoles compared to normal footwear minimally improved knee pain and but not function and did not decrease knee load. Neuromuscular and motor training improved function in those with total hip replacement. Accelerated weight-bearing and rehabilitation (8 versus 11 weeks) was demonstrated to be safe and effective at five years following matrix autologous chondrocyte implantation for cartilage defects in the knee.
Conclusions: Exercise remains a mainstay of conservative management although most studies report only short-term outcomes. Self-management strategies also are beneficial in knee OA. There seems to be a placebo effect with most trials of physical modalities although spa therapy demonstrated very short term effects.

Key words: osteoarthritis, hip, knee, rehabilitation, intervention, review
Introduction

Conservative, non-pharmacological interventions play a critical role in the management of the symptoms and disability of osteoarthritis (OA). The breadth of these interventions, many of which fall under the scope of practice of rehabilitation professionals, include but are not limited to physical modalities (thermal, athermal, light etc.), tissue manipulation, exercise prescription, education, bracing, insoles, and ambulatory aids. This review highlights seminal publications of rehabilitation interventions for osteoarthritis (OA) published since the last Osteoarthritis Research Society International conference in April 2012.

Methods:

Medline in process, Emsbase, CINAHL and Cochrane databases were searched from April 2012 through February 2013 using the search terms osteoarthritis, rehabilitation (exploded), physiotherapy, physical therapy, and exercise limited to human and English. Studies were included if the sample included individuals with OA, irrespective of severity, providing there was a rehabilitation intervention supervised by a health professional. Where studies included participants with ‘arthritis’, the study was included if the OA sample data were presented separately. Studies included meta-analyses, evidence-based clinical practice guidelines, randomized and non-randomized controlled trials and pre-post intervention designs. Narrative or qualitative reviews, pilot or randomized trials for the purposes of feasibility and studies of surgical interventions unless they included evaluation of a rehabilitation intervention were excluded, as were published abstracts and study protocols.

Publication titles and abstracts were reviewed for inclusion by both authors and discrepancies for inclusion were discussed and full papers reviewed prior to reaching agreement on inclusion or exclusion of these studies. All individual randomized trials reported in this
review were evaluated for quality using the PEDro criteria\textsuperscript{1,2} by both authors except where the original study authors reported study quality. In this latter case, the quality rating of the original authors is reported. All included papers were reviewed and abstracted fully by AMD with CM also reviewing results and the two authors agreeing on interpretation of the results. Finally, for ease of presentation, the authors grouped the papers thematically as presented below.

**Results and Discussion**

Of the 332 titles and abstracts reviewed, 25 published articles were identified for inclusion and are reviewed below with more detailed outcome data provided in Table 1. These studies included a meta-analysis of trials published until February 2012 representing the breadth of physiotherapy interventions for knee OA\textsuperscript{3}, a meta-analysis of shortwave diathermy knee OA\textsuperscript{4} and additional individual studies of rehabilitation interventions both as conservative management for OA or in the context of a surgical intervention published in the past year.

*Physical therapy interventions for knee OA: a meta-analysis*

Wang et al conducted a meta-analysis of interventions within the scope of physiotherapy practice for community-dwelling adults with knee OA\textsuperscript{3}. These authors included randomized trials published in the English literature between 1970 and February 29, 2012 and patient-reported outcomes of pain, disability and health-related quality of life were the primary endpoints evaluated. Eighty-four of 193 eligible RCTs met pooling criteria with an additional 123 RCTs not included in pooled analyses. These authors concluded that: 1) education programs had no statistically significant effect on pain relief; 2) proprioception exercise was moderately effective in reducing pain but not function or gait; 3) aerobic exercise improved pain (VAS) and disability but not psychological outcomes or health perceptions. Within 3 months, function as measured by the composite WOMAC score and gait speed improved significantly and the
improvement in gait but not function continued through 12 months. Of note, the pain effects at 3 months were greater for those with a physical therapist supervised program whereas improvements in the composite WOMAC score were greater in those in an unsupervised program; 4) aquatic exercise reduced disability but did not improve pain or quality of life; 5) strengthening exercises resulted in significant improvements in pain, composite WOMAC score and walking speed but not in EQ-5D or quality of life; 6) Tai Chi demonstrated improved composite WOMAC scores but not in pain; 7) massage similarly improved composite WOMAC scores; 8) orthotics had no effect on walking or composite WOMAC scores; 9) taping had no effect on pain, disability, composite WOMAC score or walking; 10) electrical stimulation demonstrated improved pain at 3 months follow-up but worsening at 6 months; global assessment and muscle strength also improved at 3 months; but, there was no effect on WOMAC composite score or walking; 11) pulsed electronic fields demonstrated no effect on pain or composite WOMAC scores; 12) therapeutic ultrasound reduced pain, improved composite WOMAC function scores and walking speed but did not result in significant changes in EQ-5D; and, 13) diathermy improved pain at 1 month but showed no difference at 3 months; additionally, there was no effect on EQ-5D, WOMAC composite or walking. With very few exceptions, the authors found that the level of evidence for all interventions was low due to risk of bias and imprecision due to follow-up and wide confidence intervals with pooled sample sizes under 400.

Wang et al also evaluated patient characteristics and outcome. High adherence to exercise interventions was associated with better outcomes. Age, sex, race, body mass index, comorbid conditions and knee alignment had variable impact such that there was inconclusive evidence of
the association of these factors with outcome. The impact of baseline OA severity on outcome varied depending on the intervention.

**Exercise**

The Ottawa Panel\(^5\) updated the evidence-based practice guidelines for aerobic walking programs for people with symptomatic knee OA over age 40 years. Overall, benefit was achieved in pain, quality of life and functional status (grade A, B C+ evidence) in the short-term (i.e. 3 months). Specific recommendations (Table 1) are made related to aerobic walking programs alone versus a normal daily activity control; walking program with strength training versus a patient education control; a walking program with a health education and behavioral component versus normal daily activities; a walking program with a multi-component exercises versus an education control; and, a walking program with a multi-component exercises and health education versus an education control.

Additionally, several authors evaluated different exercise protocols in the context of individual trials and, in each trial, there was demonstrated benefit with exercise. However, the quality of the studies was low with three of the five studies having PEDro scale scores of 6 and none exceeding a score of 8 of a total of 10 (Table 1). Chang et al found that the addition of graded elastic-band resistance exercises to physical modalities as compared to physical modality alone resulted in improved pain and functional outcomes in females with knee OA at 8 weeks follow-up\(^6\). Ebnezar and colleagues conducted a trial in which individuals with knee OA were randomized to two weeks of transcutaneous electrical stimulation (TENS) and ultrasound (US) with supervised yoga with an additional 10 weeks of unsupervised yoga versus TENS and US with supervised stretching and strengthening followed by unsupervised exercise\(^7\). While both groups improved by the end of 12 weeks, the yoga group showed improvements over the control
group in a number of outcomes (walking pain, disability, knee flexion, tenderness, swelling, crepitus, walking time). Hiyama found that a 4 week walking program under two conditions (walking alone and dual task or walking while counting backwards by 3s from 100) in combination with icing and range of motion and strengthening exercises in people with knee OA resulted in increased distance walked, improved Timed Up and Go and cognitive function as compared to a control group who iced and performed range of motion and strengthening exercises. In a study of a 12 week aquarobic exercise plus education intervention versus education alone in people with knee OA, Kim et al found that the intervention group had improved self-efficacy, pain, body weight, blood lipids and depression compared to the control group at the end of the intervention. In a randomized trial of squats plus vibration platform versus vibration platform alone versus usual activity control in people with knee OA, Simao et al found that individuals in both intervention groups had significant reductions in plasma concentrations of the inflammatory cytokines soluble tumor necrosis factor receptor 1 and 2 (TNFR1 and TNFR2), self-reported pain and increased in balance and walking speed and distance compared to the control group.

In a comprehensive evaluation of physiotherapy interventions for knee OA representing more than 40 years of published literature, the meta-analysis by Wang et al\textsuperscript{3} emphasizes the importance of exercise (particularly aerobic and proprioceptive exercises) in the management of knee OA. This is further supported by the Ottawa panel update of evidence-based walking programs as well as several trials of exercise published in the last year.\textsuperscript{6-10} The challenge with most of these studies, however, is that only relatively short-term outcomes are reported (e.g. 3 months) and the trials vary by type and dosage of exercise. There is an ongoing need for research
that evaluates the types and dosages of exercise with longer term outcomes that are most beneficial for the various subgroups of people with OA.

**Physical Modalities**

**Electro-therapeutic**

These interventions include a variety of modalities including laser, interferential current (IFC), short wave diathermy, therapeutic ultrasound, radiation and transcutaneous electrical nerve stimulation (TENS). The studies included one meta-analysis of short wave diathermy and 5 RCTs, all of which were of high quality with PEDro scores 9/10 (Table 1).

Alfredo et al demonstrated a significant improvement in WOMAC pain, function and total score in people with knee OA (KL grade 2-4) treated with low energy laser and exercise at 3 and 11 weeks post treatment compared to those treated with sham laser and exercise\textsuperscript{11}. The laser intervention included treatment with 3 joules at each of 9 points along the medial and later joint line, 3 times per week for three weeks (904 nm wavelength, 700 Hz). In a study of TENS versus TENS sham, IFC versus IFC sham or shortwave diathermy versus sham, Atamaz et al demonstrated that while all groups had improvements across a variety of outcomes following treatment, there were no statistically significant between group differences\textsuperscript{12}. There was no benefit in WOMAC pain or function or postural stability during or following treatment in a study by Hsieh et al evaluating light energy (radiation of 890 nm, 6.24 watts x 40 minutes for 6 treatments over 2 weeks) versus placebo in a study of people with knee OA, defined as Kellgren-Lawrence grade 2 or more \textsuperscript{13}. Laufer and Dar conducted a meta-analysis of short wave diathermy (high frequency electromagnetic energy of minimum 27.12 MHz) versus placebo, no treatment or diathermy plus an intervention such as exercise versus intervention (e.g. exercise) alone in people with knee OA\textsuperscript{4}. Inclusion criteria included good to excellent quality based on a
PEDro score of at least 6 of 10. Of the 7 eligible studies included in the analysis, treatment averaged 20 minutes and ranged from 6 to 24 treatments over 2 to 8 weeks respectively. Pooled analyses demonstrated a modest effect for thermal but not athermal diathermy in relieving pain and improving muscle strength. However, there was no benefit demonstrated for joint inflammation, activity, gait performance or quality of life. There was no benefit of therapeutic ultrasound compared to sham ultrasound in a double-blind randomized trial of people with bilateral knee OA, although significant within group differences were observed for both the active treatment and placebo groups for pain, WOMAC function, walking speed, Lequesne scores and anxiety and depression. Finally, Vance et al concluded that TENS had a strong placebo effect based on the results of their double-blind, randomized trial of people with knee OA. These authors found no between group differences for high frequency, low frequency and placebo TENS although there were within group differences for high and low frequency TENS on pain pressure thresholds and for all three groups for pain at rest and the Timed Up and Go test.

With the exception of one study using laser therapy, physical modalities did not show benefit over and above sham/placebo control. These findings were consistent across studies including Wang’s meta-analysis and that of Laufer who evaluated short-wave diathermy and the individual trials. Of note, these studies seem to indicate that there is a significant placebo effect as both the intervention and control groups had significant improvements pre to post treatment on many outcomes.

*Thermo-therapeutic*
Four trials evaluated the effect of heat and cold. All were of low quality based on the PEDro scale scores (Table 1).

Two authors evaluated superficial heat and cold in people with knee OA. Denegar re-evaluated randomized trial data to evaluate if the response to superficial heating and cooling differed between men and women\textsuperscript{15}. This within-subject randomized design had 5 treatment conditions: cold, warm, contrast (alternating warm and cold), superficial heat with an electric heating pad and a rest control. Overall, women had greater response to any of the active treatments based on Knee Injury and Osteoarthritis and Outcome Score (KOOS) pain and symptom subscale scores compared to men but there were no gender differences for activity or quality of life subscales. Within women, pain was significantly reduced with both cold and warm and symptoms were significantly reduced with cold, warm and contrast interventions. Gungen et al evaluated the effect of mud pack therapy versus hotpack on biomarkers, YKL-40 (also referred to as human cartilage glycoprotein-39\textsuperscript{18} and high-sensitivity C-reactive protein, in people with KL grade 3 or 4 bilateral knee OA and found no between group differences although there was a significant increase in YKL-40 in the hot pack group at 3 month follow-up\textsuperscript{16}. Secondary outcomes of pain, 15 meter walking time demonstrated within group but no between group differences; knee range of motion did not change; and, although there were no between group differences, WOMAC and Nottingham Health Profile scores demonstrated within group improvements, although not in all subscales.

Two randomized trials evaluated balneotherapy, often referred to as a form of hydrotherapy or spa therapy. Fioravanti et al evaluated the efficacy of balneotherapy versus ‘usual outpatient care’ in people with bilateral knee OA\textsuperscript{19}. The spa waters contained sulphate-bicarbonate-calcium and were heated to 38 degrees Celsius with participants receiving 12, 20
minute treatments over 2 weeks. With follow-up at 2 weeks and 3 months, the balneotherapy group had improved pain VAS, WOMAC pain, stiffness and function scores, SF-36 physical and mental component scores, Lesquense and AIMS at 2 weeks that persisted over time as compared to the control group. In another three-arm randomized single blind study, Horvath et al evaluated the effect of balneotherapy versus magnetotherapy for people with hand OA\textsuperscript{20}. All three groups received three weeks (three times per week) magnetic field therapy (60 Hz, 20 J x 15 minutes) to the hands with two of the groups also receiving full body submersion balneotherapy for 20 minutes five times a week for 3 weeks. The spa water was an alkaline sodium hydrogen carbonate soft water that also contained large amounts of fluoride heated to 36 degrees Celsius in one group and 38 degrees Celsius in the second group. In 59 of the 63 individuals randomized who completed more than 80% of the therapy, there was a significant improvement in a number of the outcomes studied including patients’ pain VAS in the 36 degree balneotherapy group and the physician global VAS in the 38 degree group compared to control at 3 weeks follow-up. At 13 week follow-up, both balneotherapy groups had improved pain based on patient and physician ratings compared to control. Of note, there was lasting improved pinch strength in the 38 degree balneotherapy group compared to control. The two balneotherapy groups had improved HAQ and SF-36 mental component scores, although this latter effect did not persist beyond 3 weeks follow-up. There were no significant differences between the two balneotherapy groups.

The effect of thermo-therapeutic interventions was variable with superficial heat or cold demonstrating no effect with the exception of women as compared to men achieving significant improvements\textsuperscript{15}. On the other hand, spa therapy appeared to demonstrate an effect\textsuperscript{19, 20}. These studies need to be interpreted with caution due to low study quality.

\textit{Self-management education program}
The Osteoarthritis of the Knee Self-management Program (OAK) is a disease-specific, 6 week program based on social cognitive theory. It is delivered by health professionals and, along with education, focuses on the participants developing SMART goals (i.e., specific, measurable, attainable, realistic, time-bound goals). In a randomized trial based in primary care, Coleman et al found the OAK program to be effective in reducing pain, improving function from baseline to 8 weeks and 6 months follow-up\textsuperscript{21}. Additionally, the proportion achieving a minimally clinically important improvement based on OARSI responder criteria was greater in the OAK group. Effectiveness of the intervention was also demonstrated in the SF-36 physical function, role-physical, bodily pain, vitality and social functioning domains as well as the timed-up-and-go test, hamstring strength and knee range of motion. Although this is a low quality study (PEDro score 6/10), these findings add to existing literature about the benefits of self-management\textsuperscript{21}.

**Biomechanical interventions: insoles, braces**

Three studies (one RCT and two pre-post designs) evaluated biomechanical interventions aimed at improving alignment in individuals with knee OA. In a double blinded cross-over trial in people with medial knee OA of a multi-modality intervention (valgus knee brace, customized neutral foot orthosis and shoes designed for motion control) versus control (neutral knee brace, unsupported foot orthosis and shoes with flexible midsole), Hunter et al found a small but statistically significant improvement in pain, but not function for those in the intervention group\textsuperscript{22}. Two pre-post studies of people with knee OA, one with shock absorbing insoles\textsuperscript{23} and the other with adjustable convex pods under the hind- and fore-foot\textsuperscript{24}, also showed improvements depending on the outcome evaluated (Table 1). Drexler reported statistically significant improvements in the WOMAC and SF-36 subscales following 3 months of wearing the individually calibrated adjustable heel pods and 56% of participants met OARSI responder
criteria. After 1 month of wearing the shock absorbing insoles, Turpin reported minimal changes in the knee adduction moment with the exception of the second half of stance phase. WOMAC pain and function scores and stair climb time demonstrated statistically significant improvements.

These individual studies of biomechanical interventions, including bracing and insoles, or insoles/shoe sole adjustments showed no or minimal benefit in reducing knee load (based on the surrogate knee adduction moment) and variable benefit on patient-reported pain and function. Taken together with the results of the meta-analysis results of Wang et al which included 7 RCTs of orthotics and demonstrated no benefit, there is little evidence supporting the use of these devices in people with knee OA.

Rehabilitation interventions in the context of surgery

Pre-surgical acupuncture in conjunction with exercise and education (weekly x 4 weeks then every two weeks x 4 weeks followed by monthly until surgery) demonstrated no benefit compared to exercise and education alone either pre- or post-surgery in a sample of individuals scheduled for total knee replacement (TKR) for OA. In post-hoc analysis, 6 of 28 and 1 of 28 individuals in the treatment and control groups respectively withdrew from the surgical list. At two years follow-up, none of the 6 in the treatment group had undergone TKR but the individual in the control group had bilateral TKR.

Bedeker et al found that the addition of yoga to conventional therapy did not provide benefit over and above conventional therapy following TKR.

Heiberg et al evaluated a 12 week group-based walking skills program focused on neuromuscular training and retraining of movement patterns (e.g. sit to stand, lunges, step up/step down, obstacle course, walking, etc.) instituted three months following total hip
replacement versus a control group advised to continue the exercises from their immediate post-operative rehabilitation. While both groups showed improvement from baseline (3 month post-surgery) to 5 months and one year post-surgery, the intervention group had superior outcomes on the six-minute walk test, stair climb test, figure-eight test, index of muscle function, Harris Hip Score and self-efficacy at 5 months post-surgery. There were no group differences on the Hip Injury and Osteoarthritis Outcome Scores (HOOS) subscale scores at 5 months or on any measures at 12 months.

Ebert et al reported the results to five-years following a randomized trial of accelerated weight-bearing and rehabilitation protocol (8 weeks) versus a standard protocol (11 weeks) following matrix-induced autologous chondrocyte implantation (MACI) to the medial or femoral condyle. As anticipated, there were improvements in all patient reported outcomes from pre-surgery to 5 years follow-up. Only the pain VAS demonstrated a significant improvement for the accelerated group as compared to standard care at five years; KOOS subscale scores and SF-36 domains demonstrated no difference. Between 2 and 5 years follow-up, there was a significant increase in the sport and recreation subscale of the KOOS and a significant decrease in active knee extension in the standard care group. Magnetic resonance imaging features scores demonstrated no difference between the two groups. The authors concluded that accelerated weight-bearing and rehabilitation was safe and effective at five years following MACI for cartilage defects in the knee.

In the context of surgery, the benefits of a neuromotor control based exercise program for people 3 months following THR are of interest, particularly given that care pathways adopted in many countries have limited rehabilitation to the first few weeks following surgery. Results of some research indicates that activity levels and walking change little following total joint
replacement\textsuperscript{29-31} and this study, therefore, raises questions about whether further targeted therapy and or education would improve patient outcome. Similarly, advancing our understanding of rehabilitation protocols is Ebert’s finding that weight-bearing and rehabilitation can be accelerated to 8 weeks in individuals undergoing MACI for cartilage defects\textsuperscript{28}. Safe and effective interventions that lessen the burden on the patient and system are critical in this time of limited health care resources.

**Summary and Conclusion**

In summary, the current research focusing on rehabilitation interventions most often addresses knee OA, with few studies on hip or hand OA. Based on the published literature from the previous year, exercise and education in the context of self-management continue to be supported as effective interventions for OA. Future research needs to focus on longer term outcomes and specifying the type and dosage of exercise.

**Contributions**

Davis: literature review, data abstraction, interpretation and drafting of manuscript

MacKay: literature review, confirmation of data abstraction, review of draft paper and approval of final manuscript

**Competing interests**

None

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Not applicable
References:


