



Knee osteoarthritis pain in the elderly can be reduced by massage therapy, yoga and tai chi: A review



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ABSTRACT

Background and methods: This is a review of recently published research, both empirical studies and meta-analyses, on the effects of complementary therapies including massage therapy, yoga and tai chi on pain associated with knee osteoarthritis in the elderly.

Results: The massage therapy protocols have been effective in not only reducing pain but also in increasing range of motion, specifically when moderate pressure massage was used and when both the quadriceps and hamstrings were massaged. The yoga studies typically measured pain by the WOMAC. Most of those studies showed a clinically significant reduction in pain, especially the research that focused on poses (e.g. the Iyengar studies) as opposed to those that had integrated protocols (poses, breathing and meditation exercises). The tai chi studies also assessed pain by self-report on the WOMAC and showed significant reductions in pain. The tai chi studies were difficult to compare because of their highly variable protocols in terms of the frequency and duration of treatment.

Discussion: Larger, randomized control trials are needed on each of these therapies using more standardized protocols and more objective variables in addition to the self-reported WOMAC pain scale, for example, range-of-motion and observed range-of-motion pain. In addition, treatment comparison studies should be conducted so, for example, if the lower-cost yoga and tai chi were as effective as massage therapy, they might be used in combination with or as supplemental to massage therapy. Nonetheless, these therapies are at least reducing pain in knee osteoarthritis and they do not seem to have side effects.

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Knee osteoarthritis pain in the elderly can be reduced by massage therapy, yoga and tai chi.

Knee osteoarthritis affects some 80% of elderly people. Pharmaceuticals have been relatively effective for the treatment of knee osteoarthritis but often have undesirable side effects. Complementary therapies have also been effective in reducing knee pain but without side effects. This paper is a review of recent (this past decade) empirical studies and meta-analyses (that appeared on PUBMED) on complementary therapies that have reduced knee pain including massage therapy, yoga and tai chi.

1. Knee osteoarthritis

Knee osteoarthritis involves degeneration of the cartilage in the joint with pain in and around the joint as well as joint stiffness and restricted movements that ultimately lead to muscle weakness

[1]. The pain experience of knee osteoarthritis is apparently due to activation of sensory pain fibers in the arthritic joint and to weakening of the surrounding muscles.

Knee osteoarthritis is reputedly the most common joint disease in the elderly and the largest cause of functional disability with some 80% of people over 65 years of age showing radiological symptoms of osteoarthritis [2]. In the U.S. alone, reportedly 27 million people are affected by knee osteoarthritis with associated treatment costs of \$185.5 billion per year [3]. The incidence has supposedly doubled in women and tripled in men over the last 20 years [4]. Leading risk factors for osteoarthritis aside from age and genetics include female gender and obesity as well as excessive sports or occupational stress [5].

The main focus of treatment has been to relieve pain, to restore function and to slow the progression of the disease. The treatments have been classified as pharmacological, non-pharmacological and surgical or combinations of these [2]. Anti-inflammatory drugs as well as non-opioid analgesics have been prescribed for the

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reduction of inflammation and pain [1]. Although these have effectively reduced the inflammation and pain, they have led to undesirable side effects in long-term follow-up studies including, for example, heart failure and hypertension [6]. Because of these potential adverse side effects, the American College of Rheumatology has advised the use of non-pharmacological therapies including physical therapy and exercise [7]. With joint pain and limited mobility, however, most individuals with knee osteoarthritis do not participate in regular physical activity [7]. These epidemiological data highlight the need for complementary/integrative therapies such as massage therapy and lower-impact physical exercise such as yoga and tai chi. The following sections of this paper are reviews of research on these therapies.

2. Massage therapy for knee osteoarthritis

Research on the effects of massage therapy on knee osteoarthritis pain has been limited, although the results have consistently suggested that the pain from that condition can be reduced by massage therapy. The pain, however, has typically been self-reported on visual analogue pain scales (e.g. happy to sad faces or 0–100 thermometer scales) and on the Western Ontario and McMaster Universities Arthritis Index (WOMAC) [8–11] with all the limitations of self-report studies. In this research, more objective observation measures such as range of motion (ROM)-related pain were not taken. ROM was not measured in two of the four studies [8,9]. In the first of these, pain was measured on a 10-point Likert scale, and pain decreased even though, according to the authors of that study, only the patient's healthy foot, hands and upper parts of the shoulders were massaged "shallowly" for 20 min each day of their hospitalization [8].

In the other two WOMAC studies, ROM was measured but did not change [10,11]. In one of these studies a self-massage protocol was used [10]. This raises the possibility that the pressure being applied was not sufficient (moderate pressure massage being key to positive effects). This would be especially true if the participants were not instructed to use moderate pressure and given that they would not be inclined themselves to apply pressure to the area around the painful joint. In the second study, pain and stiffness were reduced, and increased function was noted on the self-report WOMAC scale, but the ROM results were negative [11]. This could be related not only to the use of low pressure massage but also to the massage not being focused on the affected leg [11]. Only 50% of the hour-long massages were applied to the affected leg, and the massage protocol, again, may have lacked sufficient pressure to increase ROM.

A comparison between Thai massage and Swedish massage for a sample of older people with knee osteoarthritis further supported the need for moderate pressure [9]. In that study, the group who received Thai massage (which typically involves more pressure than Swedish massage) reported a greater reduction in pain on the WOMAC than the group who received Swedish massage.

Based on these mixed findings, we recently conducted a knee osteoarthritis massage study in which moderate pressure massage was applied to the affected leg by massage therapists [12]. Because earlier research was only focused on the quadriceps muscles, we designed a massage therapy protocol that was focused on the hamstrings as well as the quadriceps muscles, thinking that both sets of muscles were involved in ROM (flexion and extension of the knee). And the assessments not only included self-reported pain, but also ROM and ROM-related pain. Moderate pressure massage therapy (moving the skin) was used inasmuch as it has been noted to be more effective than light pressure massage (light stroking) with adults with hand pain [13], upper arm and shoulder pain [14] and neck arthritis pain [15]. For example, in the study on adults

with arthritis in their upper limbs, the moderate pressure massage group versus the light pressure massage group had less pain and greater grip strength following the first and last sessions.

By the end of the one-month treatment period the moderate pressure group was reporting and showing less ROM-related pain behavior (e.g., grimacing), and greater range of motion. Further, the massage in our study was focused on the quadriceps muscle inasmuch as researchers have reported a relationship between quadriceps weakness, increased pain and altered walking patterns [9]. But, the hamstrings were also massaged given that the previous studies [10,11] failed to find ROM increases when focusing only on the quadriceps. The results of this study on increased ROM and decreased self-reported pain as well as decreased ROM-related pain are consistent with those we have previously reported, i.e. changes in ROM and pain following moderate pressure massage in adults with arthritis of the upper limbs [14] and in the neck [15]. Other researchers have noted a reduction in knee osteoarthritis pain following massage, but only by self-report (WOMAC), not by direct observation of ROM-related pain [10,11]. In one of the few studies on massage for adults with knee osteoarthritis, for example, pain and stiffness were reduced and functionality was increased [10]. However, no ROM changes resulted from this self-massage study, possibly because it was a self-massage study and because it is not clear that moderate pressure massage was applied. As we have noted in our earlier studies, moderate pressure is necessary for positive changes to occur [13–15]. The positive effects in our self-massage studies may have derived from moderate pressure being applied and/or the combination of therapist massage (once a week) and the participants' self-massage (once a day).

Another potential interpretation for the inconsistent findings between the increased ROM we noted and the lack of change in ROM following massage reported by the other group is that their knee self-massage was focused solely on the quadriceps muscle group [10]. The authors of that self-massage study suggested that despite the earlier research on joint cartilage degeneration as the key factor in knee arthritis, the more recent research had noted that quadriceps muscle weakness that affects joint loading and proprioceptive deficits contributed to knee arthritis [10]. Others have also found relationships between weak quadriceps muscles and increased pain and limited walking [9]. That was the rationale for their self-massage protocol focusing on the quadriceps muscle [10]. However, the findings from our study suggest that it may be necessary to massage both the hamstrings and the quadriceps muscles to achieve increased ROM, especially since the hamstring muscles are noted to work together to flex the knee (12).

Our results may be inconsistent with those of Perlman et al. [11] for different reasons. They again found changes on the WOMAC self-report scale on pain, but no changes in ROM even though their massages were longer (30–60 min), more frequent (two to three times weekly) and for a longer study period (8 weeks) than ours. As already mentioned, their Swedish massages may have lacked sufficient pressure, and, as already mentioned, the lower limbs were only massaged 50% of the sessions. Their results were inconsistent with ours in that they only observed reduced pain after 5 weeks of 60-minute massages two or three times weekly (as opposed to their lower dose group receiving only 30-minute massages two or three times weekly) [11]. One possible explanation for the positive effects following the shorter and less frequent massages in our study (20 min weekly for 4 weeks) is our use of moderate pressure massage [12], although it is not clear what pressure was used in their study [11]. Cross-study comparisons are difficult because of the different massage protocols and the various outcome measures used, i.e. self-report pain scales in their study [11] and the more directly observed ROM-related pain measures in our study.

Combining therapist-delivered massage with daily self-

massages has been effective now in at least three studies and suggests that this may be a more cost-effective therapy for individuals with arthritis pain and one that may have more sustainability [13–15]. The data from our knee osteoarthritis study also highlight the importance of designing massage therapy protocols that target muscle groups affected by the joint movements and then assessing those specific range of motion measures and the ROM-associated pain.

3. Potential underlying mechanisms for massage therapy alleviating knee osteoarthritis pain

The underlying mechanism for the relief of knee osteoarthritis pain and the increase in ROM is not clear. We have reported elsewhere that moderate pressure massage is accompanied by decreased heart rate, suggesting a relaxed state [16]. We have also noted that the stimulation of pressure receptors results in increased serotonin (the body's natural pain suppressor) which may be the primary underlying mechanism for pain relief [16]. A related possibility is the substance P decreases (substance P causing pain) that we have documented following massage therapy in fibromyalgia patients when they are experiencing more deep/restorative sleep following massage [16]. Further research is needed to explore the potential underlying mechanisms for the reduction of knee osteoarthritis pain and other pain syndromes following massage therapy. In addition, the moderate pressure massage protocol needs to be replicated in a more representative sample than the medical school employees we have assessed.

The clinical implications of these data include the effective use of moderate pressure massage [16] and massaging both the hamstrings and quadriceps to achieve better knee ROM and the reduction of knee ROM-related pain. The addition of self-massage on the days between massage therapy sessions might lead to even greater therapy effects, as has been noted in our earlier studies on arthritis of other joints (13–15).

4. Yoga therapy for knee osteoarthritis

Osteoarthritis of the knee has also been treated by yoga. Yoga has mostly been used as a loosening and strengthening form of exercise with young adults. However, interest in yoga is growing among older adults [17]. Yoga, like massage therapy, may be effective in pain management because of the stimulation of pressure receptors, in turn, increasing vagal activity and serotonin and slowing the production of cortisol and substance P [16].

Yoga studies on knee osteoarthritis have varied on many dimensions including the different types of yoga practiced as well as the differing length of sessions, and the frequency and duration of the treatment. Several of the studies have used an integrative program of yoga consisting of not only physical poses (asanas) but also breathing (pranayama) and meditation exercises which further confounds the question of which aspect/protocol of yoga is effective. In one of these studies a 40% reduction in pain followed one week of yoga in a camp setting [18]. And, an assessment on the 15th day revealed a 34% reduction in resting pain and a 69% decrease in morning stiffness. These decreases were significantly greater than the decreases noted for the randomized control group.

These studies were not only confounded by the different types of yoga (the poses, breathing and meditation exercises) being combined but also by their being preceded by a standard treatment for yoga e.g. transcutaneous electrical stimulation and ultrasound or physiotherapy. In a study that used physical poses alone (Iyengar standing yoga poses that are each held for a minute or so), a 47% decrease in pain occurred [19]. That study may have yielded a greater reduction in pain because the treatment period was 8

weeks as opposed to 2 weeks, although the yoga sessions in this case were not preceded by a standard treatment like physiotherapy. In another Iyengar yoga study EMG biofeedback was used prior to the yoga sessions [20]. The group who received EMG biofeedback followed by yoga versus the EMG biofeedback alone group reported a greater decrease in pain (57 vs. 38% on a visual analogue pain scale and 59 vs. 34% on the WOMAC scale).

In a meta-analysis, 18 studies on older adults (greater than age 60) met the criteria for a meta-analysis [21]. The meta-analysis revealed that yoga benefits exceeded those of conventional exercise interventions for strength, sleep and depression, although the effect sizes were modest and the methodological quality of the studies was mixed. Their conclusion that yoga was more effective than conventional exercise for osteoarthritis may have related to greater compliance by the participants in the more gentle exercise-yoga studies versus the more rigorous conventional exercise protocols. In addition, this meta-analysis was not limited to patients with knee osteoarthritis and the studies that were included in the meta-analysis were of mixed quality and yielded only modest effects.

The underlying mechanisms for yoga effects are not clear, although some have suggested hormonal and neurotransmitter changes, better posture and improved muscle tonus as well as a lessening of depression and anxiety [22]. The significant variety of yoga styles and the different outcome measures have made it difficult to interpret results across studies. Nonetheless, the meta-analysis studies, the reviews of the literature and the empirical studies just reviewed converge to suggest that yoga can be an effective complementary therapy for reducing knee osteoarthritis pain.

5. Potential underlying mechanisms for yoga reducing pain

The mechanism that has been most frequently used to explain massage therapy effects on pain syndromes, the Gate Control theory [16] might also pertain to yoga inasmuch as yoga is a form of self-massage, as in limbs rubbing against limbs and against the floor and stimulating pressure receptors. According to the Gate Control theory, pain stimulates shorter and less myelinated (or less insulated) nerve fibers so that the pain signal takes longer to reach the brain than the pressure signal which is carried by nerve fibers that are more insulated and longer and therefore able to transmit the stimulus faster. The message from the pressure stimulation reaches the brain prior to the pain message and “closes the gate” to the pain stimulus. This metaphor for the electrical and biochemical changes that likely occur has been commonly used in explaining the effect of grabbing your crazy bone when it has been bumped.

Another theory that is commonly referenced is the deep sleep theory. In deep sleep, less substance P is emitted and therefore less pain occurs because substance P causes pain. As already mentioned, we directly tested the “enhanced deep sleep leading to less substance P” theory in our study on fibromyalgia [16]. Following a period of massage therapy, more time was spent in deep sleep, and lower levels of substance P were noted in the saliva samples taken.

Still another theory is that less pain results from increased serotonin levels [16], serotonin being the body's natural anti-pain chemical. Serotonin, in turn, decreases cortisol and depression which are also important effects of yoga. And, serotonin decreases substance P and other pain-causing chemicals, highlighting the complex interaction between yoga effects on biochemistry. Future yoga studies might use multiple physiological and biochemical measures to enhance our understanding of the mechanisms underlying the pain reduction effects of yoga.

6. Tai chi for knee osteoarthritis

Tai chi is a Chinese martial art/exercise that combines many poses that are made very slowly and smoothly in a continuous, circular movement. Tai chi has most notably been used for enhancing balance and muscle strength in the elderly, although it has rarely been used for older adults with knee osteoarthritis (see Ref. [23] for a review). Typically, the control group has been a stretching, an awareness education, or a muscle relaxation group, and the Tai Chi groups have usually shown better performance than the control groups on all of the measures assessed.

In one study, kinematic analysis suggested that the Tai Chi practitioners used a more cautious walking strategy, including slower gait and shorter and slower steps than the control group [24]. The more complex gait involved in Tai Chi would also contribute to greater balance. Compared with normal gait, elders during Tai Chi had significantly larger knee and hip flexions and longer co-activation of most leg muscle pairs and greater activation of the leg muscles [25]. In another study, faster reflex reaction time was noted in the hamstrings and gastrocnemius muscles and a longer balance time on a tilt board [26]. Among swimmers/runners, the elderly people who regularly practiced Tai Chi not only showed better proprioception at the ankle and knee joints than sedentary controls, but also better ankle kinesthesia than swimmers/runners who did not practice tai chi [27]. In a review of 24 studies, Tai Chi had beneficial effects on balance and postural impairments, especially those associated with aging including improved balance and dynamic stability, increased musculoskeletal strength and flexibility, improved performance on activities of daily living, reduced fear of falling, and general improvements in psychological well-being. In still another study, increased muscle strength followed Tai Chi including the strength of the knee extensors and flexors [28]. The control group had less strength than the jogging group and less strength than the Tai Chi group.

More recently Tai Chi has also been studied for pain relief in older adults with knee osteoarthritis [29,30]. In one elaborate study involving gait kinematics, tai chi training was provided for 1 h twice a week for 6 weeks [31]. After 6 weeks of the tai chi exercise the stride length, the stride frequency and the gait speed increased significantly and knee pain was decreased. Unfortunately, this trial did not have a control or treatment comparison group.

In another knee osteoarthritis study, the 12-form Sun tai chi for arthritis [32] was adapted for elders with knee osteoarthritis [33]. In this randomized trial on a 20-week tai chi program for the elderly, several assessments were made including the WOMAC, the Get-up-to-go test, the Sit-to-stand test and the Geriatric Depression scale. The WOMAC was used to measure subjective pain, physical functioning and stiffness. The Get-up-to-go (GTG) measure assessed the speed in getting up to standing from an arm chair and walking as fast as possible for 50-feet and returning to the chair to sit down. The Sit-to-stand (STS) test has the participants cross their arms across their chest and rise to standing 5 times. The attention control group participated in health education, culture-related and other social activities for the same 20-week period.

On the primary variable, the WOMAC pain scale, the tai chi group score was significantly lower than the control group score starting at 9 weeks, suggesting that an 8-week trial was required to show a significantly greater reduction of pain. The scores on the WOMAC physical function and stiffness subscales also decreased more for the tai chi than the attention control group. Although the tai chi group also showed greater improvement on the GTG and the STS measures, the differences only tended to be significant. While an attention control group was included in this study, that condition did not include any physical activity, suggesting that it was not a good comparison group. In addition, having two sessions per

week for 20 weeks suggests that this was not a cost-effective intervention. Based on the group differences at 9 weeks, it would appear that this program could be provided for only 8 weeks for it to be successful.

The authors noted that this 12-form SUN style tai chi program has been endorsed by the American Arthritis Foundation and that it would be expected to be good for arthritic knee pain because the weight-bearing involved in tai chi could strengthen the leg muscles including the quadriceps and the hamstrings. It could re-establish the normal mechanics of the joint. When the joint is stabilized pain should be reduced because the stress and strain on the joint where the pain receptors are located are reduced.

Recent reviews of the literature further support the effectiveness of tai chi for patients with knee osteoarthritis. One of these research reviews yielded 74 studies, but 57 of them did not meet the inclusion criteria and 11 of them did not meet the exclusion criteria, leaving only 6 studies for analyses [34]. As in the previous studies, tai chi was noted to reduce pain and improve physical function in patients with knee osteoarthritis.

In a systematic review and meta-analysis, 5 randomized control trials met inclusion criteria [35]. The meta-analysis showed moderate evidence for short-term effectiveness of tai chi for reducing pain and stiffness and increasing physical function. These authors concluded, as have most of the authors of the research already summarized, that more quality randomized controlled trials are needed to replicate these results.

Another more rigorous meta-analysis identified 7 randomized controlled trials that met criteria [36]. This time the Jadad scale was used. This scale is the most rigorous criterion for meta-analysis and includes items that rate randomization, blinding and drop-out/withdrawals to determine the quality of the studies. Standard mean differences (changes) were 45% for pain, 31% for stiffness and 61% for physical function. The authors noted that an average change of 32.2–36.4% in the outcomes was greater than the minimum clinically important difference. As in most of the studies already reviewed, these authors only analyzed WOMAC scores. They found that most studies lacked objective outcome measures such as exercise performance and muscle strength which would be more reliable and robust evidence for the effects of tai chi on knee osteoarthritis. Nonetheless, they found no adverse effects of tai chi and relatively high adherence in most studies. They also pointed out the cost-effectiveness features such as the low cost of sessions given that no special setting was required and multiple benefits for the body, suggesting that tai chi might be considered a good alternative to other forms of exercise for knee osteoarthritis.

In all of these studies there may have been an overestimation of the treatment effects since the samples have been relatively small. Another limitation is that the duration of the tai chi sessions has been highly variable as have the targeted samples. For examples, the samples have had different durations of osteoarthritis as well as different ethnic and cultural backgrounds and wide variability in the treatment protocols on several dimensions including the type of tai chi form, the length of the form and the duration of the treatment period.

One of the real advantages of Tai Chi is that it is a simple, convenient workplace intervention that may promote musculoskeletal health without special equipment [37]. For example, in a workplace study, female computer users participated in two 50 min Tai Chi classes per week for 12 consecutive weeks. Positive results included reduced heart rate and waist circumference and increased grip strength. The Tai Chi program improved musculoskeletal fitness as well as psychological well-being.

Although Tai Chi has improved balance, gait and strength, some studies have the limitations of a small sample size or a limited number of variables. The reviews have also shown that Tai Chi

participants have improved performance on activities of daily living as well as general psychological well-being [38,39]. Unfortunately, Tai Chi has not yet been compared with similar forms of movement therapy such as yoga.

7. Limitations of these complementary studies

Although many limitations of the literature on massage therapy, yoga and tai chi with knee osteoarthritis have already been mentioned, they are briefly summarized here. Many of the massage therapy studies that showed lesser effects did not use moderate pressure and/or did not include the hamstrings in their massage protocols. The yoga studies were frequently confounded by the several types of yoga that were integrated in the protocols (poses, breathing and meditation), making it difficult to determine the real treatment effects. The yoga studies also typically focused on pain as measured by the WOMAC, a self-report measure that might not be as reliable as more objective measures such as observed ROM-related pain. The tai chi studies also primarily focused on pain as self-reported on the WOMAC. The tai chi studies were also difficult to compare because of their highly variable protocols in terms of frequency and duration of treatment.

8. Future directions

Larger, randomized control trials are needed on each of these therapies using more standardized protocols and more objective variables in addition to the self-reported WOMAC pain scale, for example, range-of-motion and observed range-of-motion pain. Further, treatment comparison studies should be conducted. So, for example, if the lower-cost yoga and tai chi were as effective as massage therapy, they might be used in combination with or as supplemental to massage therapy. Nonetheless, the studies thus far suggest that these therapies are at least reducing pain in knee osteoarthritis and they do not seem to have undesirable side effects. In addition, for most of the studies, the reduction in pain was clinically significant and compliance/adherence rates were high, suggesting that these therapies may be pursued by older adults with knee osteoarthritis even without being prescribed. Even though most of the studies focused exclusively on pain measures, undoubtedly other positive effects that have been reported for other conditions also happen for knee osteoarthritis following massage therapy, yoga and tai chi.

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