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## Acupuncture and Osteoarthritis of the Knee:

### A Review of Randomized, Controlled Trials

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### Abstract

Osteoarthritis of the knee is a major cause of disability among adults. Treatment is focused on symptom management, with nonpharmacologic therapies being the preferred first line of treatment. Acupuncture is considered a potentially useful treatment for osteoarthritis. The objective of this article is to review the English-language articles, indexed in MEDLINE or CINAHL, describing randomized, controlled trials of the effects of needle or electroacupuncture on knee osteoarthritis. Ten trials representing 1456 participants met the inclusion criteria and were analyzed. These studies provide evidence that acupuncture is an effective treatment for pain and physical dysfunction associated with osteoarthritis of the knee.

### Keywords

acupuncture; CAM; electroacupuncture; knee; osteoarthritis

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Osteoarthritis is the most common form of arthritis,<sup>1</sup> affecting 80% of those aged 65 or older.<sup>2</sup> It is the eighth leading cause of disability globally,<sup>3</sup> with the knee joint most frequently associated with disability.<sup>4</sup> After adjusting for age, sex, and comorbidity, knee osteoarthritis is responsible for a higher percentage of disability than any other medical condition for the following activities: stair climbing, walking a mile, and housekeeping.<sup>5</sup>

A recent meta-analysis found greater prevalence, incidence, and severity of knee osteoarthritis in women than men.<sup>6</sup> According to US National Health and Nutrition Examination Survey I<sup>7</sup> data, among those aged 65 to 74 years, women were twice as likely as men to have knee osteoarthritis.

The prevalence of osteoarthritis of the knee increases with age.<sup>4,8</sup> The Framingham Osteoarthritis study<sup>4</sup> found the prevalence of radiographic osteoarthritis of the knee in those younger than 70 years was 27.4%, those aged between 70 and 79 years was 34.1%, and those 80 years and older was 43.7%. This trend was statistically significant ( $P < 0.001$ ). Given this fact, the already considerable impact of this disease will become even greater with the aging of the population.

No cure for osteoarthritis currently exists. Treatment focuses on managing the pain and dysfunction associated with the disease. Guidelines for the medical management of knee osteoarthritis were established by the American College of Rheumatology (ACR) in 1995<sup>9</sup> and the European League Against Rheumatism in 2000.<sup>10</sup> Both of these guidelines address

nonpharmacologic and pharmacologic management of symptoms. Nonpharmacologic therapies are the preferred first line course of treatment.<sup>9</sup>

Nonpharmacologic modalities mentioned in the guidelines include patient education, physical therapy, occupational therapy, and exercise programs. The 2000 update of the ACR recommendations also mentioned acupuncture as a therapeutic approach under investigation.<sup>11</sup>

Acupuncture is a system of healthcare, which has been practiced for more than 3000 years.<sup>12</sup> It is a routine part of the practice of medicine in China, Japan, and Korea,<sup>12</sup> each nation having its own distinct tradition of practice.<sup>13</sup> French, British, and American versions of acupuncture have also developed but are not in common use.<sup>13</sup>

Classical acupuncture is based on the theory that vital energy, called qi, flows through the body along pathways called meridians. There are specific points along these meridians, called acupuncture points, or acupoints, at which the qi may be accessed. Inserting needles into these points permits the practitioner to restore harmony to the system by rebalancing the flow of qi.<sup>14</sup>

In the Western medical model, acupuncture is thought to relieve pain through the gate-control mechanism or through the release of neurochemicals.<sup>15</sup> Pomeranz and Berman<sup>16</sup> describe the possible neural mechanisms of acupuncture analgesia as follows: small diameter muscle afferents are stimulated, sending impulses to the spinal cord, which then activates 3 centers (spinal cord, midbrain, and pituitary) to release neurochemicals (endorphins and monoamines) that block pain messages. They discuss 17 different lines of research in support of endorphins being involved in acupuncture pain relief. While acknowledging that there is some debate, Pomeranz and German conclude that the evidence supporting the endorphin hypothesis is overpowering. The authors assert on the basis of supporting evidence from several studies, that midbrain monoamines (serotonin and norepinephrine) are also involved in acupuncture analgesia; however, the role of the pituitary is less clear.<sup>16</sup>

Identifying possible mechanisms of action that fit within the paradigm of Western medicine has helped to make acupuncture more acceptable in the United States. In 1996, the Food and Drug Administration reclassified acupuncture needles from Class III (investigational use) to Class II (general acupuncture use).<sup>17</sup> In 1997, National Institutes of Health consensus panel on acupuncture concluded that there was evidence of the usefulness of acupuncture to treat postoperative and chemotherapy nausea and vomiting in adults, as well as postoperative dental pain. In addition, the panel stated that acupuncture might be useful as an adjunct or alternative treatment for osteoarthritis.<sup>18</sup>

When the ACR Recommendations for the Medical Management of Osteoarthritis of the Hip and Knee<sup>11</sup> were updated in 2000, a recommendation about acupuncture was deferred because of a lack of sham-controlled trials, although the guidelines note that an NIH-funded, randomized, sham-controlled study was underway. Since that time, the results of that study, and some others, have been published. This article reviews the randomized, controlled trials using acupuncture for the treatment of the symptoms of osteoarthritis of the knee.

## Methods

### Approach to literature search

A MEDLINE search (1966 to April 2006) was conducted as follows: (1) explode “acupuncture” or explode “acupuncture analgesia” or explode “acupuncture therapy” or explode “acupuncture points” or “acupuncture.mp” (search as key word) (10,214 hits); (2) explode “osteoarthritis” or

explode “osteoarthritis, knee” or “osteoarthritis.mp”(search as key word) (30,749 hits); (3) explode “Knee” or explode “knee joint” or “knee.mp” (search as key word) (61,793 hits). Combining these 3 searches together (1, 2, and 3) yielded 68 citations.

CINAHL (1982–2005) was also searched as follows: (1) explode “acupuncture” or explode “acupuncture analgesia” or explode “acupuncture anesthesia” or explode “acupuncture points” or “acupuncture.mp” (search as key word) (3158 hits); (2) explode “osteoarthritis” or “osteoarthritis.mp” (search as key word) (2858 hits); (3) explode “Knee” or explode “knee joint” or “knee.mp” (search as key word) (8248 hits). Combining these 3 searches together (1, 2, and 3) resulted in 47 citations.

Titles, abstracts, and publication types of the 115 citations were scanned to determine which of these articles were applicable for this review. Bibliographies from retrieved articles were searched for relevant studies that might have been missed by the database searches.

### Criteria for inclusion and exclusion

English-language articles were included if the articles described randomized, controlled trials of the effects of needle or electroacupuncture (EA) on symptoms of osteoarthritis of the knee. Articles were excluded if they described case studies, unblinded, nonrandomized, or noncontrolled trials; used types of acupuncture other than needle or EA (such as bee venom acupuncture); studied types of arthritis other than osteoarthritis (such as rheumatoid); studied joints other than the knee; or were unavailable in English.

### Results from the trials

A total of 10 trials representing 1456 participants met the inclusion criteria and were analyzed in this review (Table 1).

**Participants**—The number of participants in the studies ranged from 24<sup>19</sup> to 570.<sup>20</sup> The mean age reported in 8 of the 10 studies was in the 1960s.<sup>20–27</sup> The mean ages for the remaining studies were 58.1 and 85 years, respectively.<sup>19,28</sup> All participants in all studies had been diagnosed with osteoarthritis of the knee through radiographic evidence<sup>20–28</sup> and/or according to ACR criteria.<sup>19,23,24,27</sup>

**Groups**—To be eligible for inclusion in this review, a study had to have a true acupuncture group and a control group. Six of the studies compared true acupuncture to a sham acupuncture control group<sup>20,22,24,26–28</sup>; 3 used a wait-list control,<sup>21,25,27</sup> 2 used an education control,<sup>19,20</sup> and 1 used a standard care control.<sup>23</sup> Three studies included additional treatment groups as follows: a transcutaneous electrical nerve stimulation (TENS) treatment group,<sup>19</sup> TENS group and ice massage group,<sup>28</sup> and diclofenac (a non-steroidal anti-inflammatory drug), EA plus diclofenac, and placebo tablet plus placebo EA groups.<sup>24</sup>

**Types of acupuncture treatment**—The types of true acupuncture included needling without any electrical stimulation,<sup>21,22,27</sup> conduction of electricity through all the needles (EA),<sup>19,24,28</sup> and needle acupuncture supplemented with EA of a subset of the needles.<sup>20,23,25,26</sup> Sham acupuncture included superficial needling of nonacupuncture points,<sup>22,27</sup> patch electrodes without needles or current,<sup>24,28</sup> tapping of knee points with needle guiding tube (knees were blocked from patients view), plus needle insertion in visible abdominal nonacupoints,<sup>20</sup> and needle in adhesive cylinder, no penetration, no electric current.<sup>26</sup>

The same 4 acupuncture points were stimulated in at least half of the studies: ST-35,<sup>19–24,28</sup> ST-36,<sup>20,21,23,25,26</sup> SP-9, and GB-34.<sup>20,22,23,25,26,28</sup> Seven other points were used in at least 2 of the studies: ST-34,<sup>21,28</sup> SP-6,<sup>20,23,26</sup> LI-4,<sup>21,25,26</sup> GB-39,<sup>20,23</sup> BL-60,<sup>20,23</sup> KI-3,<sup>20,23,26</sup>

and Xiyan.<sup>20,23–25</sup> One study did not dictate that specific points be used for each visit but permitted the acupuncturist to choose from a list of approved acupoints.<sup>27</sup>

Half of the studies stimulated at least 8 acupuncture points per session.<sup>20,23,25–27</sup> Each of the other studies treated a different number of acupoints each session: 6,<sup>21</sup> 5,<sup>22</sup> 4,<sup>28</sup> 3,<sup>24</sup> and 2.<sup>19</sup>

A treatment period of 4 weeks or less, with the total number of sessions ranging from 6 to 12, was used in 5 of the studies.<sup>19,21,22,24,28</sup> The treatment period of the other studies varied from 5 to 26 weeks for as few as 10 to as many as 23 sessions.<sup>20,23,25–27</sup>

In half of the studies, the authors reported that the acupuncture treatments were administered by trained professionals,<sup>20,22,24,26,27</sup> whereas the remaining 5 studies did not address the qualifications of the person(s) administering the treatment.<sup>19,21,23,25,28</sup> In 2 of the studies,<sup>24,28</sup> the acupuncturist did not seek the *de qi* sensation, a feeling of heaviness or numbness that confirms, upon needle placement, that the needle is in the correct site.

**Design**—One study was described as double-blinded,<sup>22</sup> and the remaining 9 studies used a single-blind design.<sup>19–21,23–28</sup> Participants were blinded to group assignment in those studies comparing true acupuncture to sham acupuncture. For studies using a wait-list or education control group comparison, participants could not be blinded; but in all cases, the assessors were blinded to group assignment.

**Outcomes measured in the trials**—The outcomes of interest in this review are those recommended by the Outcome Measures in Rheumatology and Arthritis Clinical Trials guidelines<sup>29</sup> and the Osteoarthritis Research Society task force on clinical trials<sup>30</sup> as *core*, or primary, outcomes for osteoarthritis trials: pain, physical function, and patient global assessment.

All studies had pain in common as an outcome measure. Some measured pain using a visual analog scale,<sup>21,24–26</sup> whereas other studies used numeric formats such as a numeric rating scale,<sup>19</sup> pain dolorimetry,<sup>22</sup> a pain intensity scale,<sup>28</sup> or the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain subscale.<sup>20,23,24,27</sup> Six studies measured physical function using the WOMAC function subscale<sup>20,22,23,26,27</sup> and/or the Algofunctional Index.<sup>23,24</sup> Three of the randomized, controlled trials included a patient global assessment,<sup>20,24,25</sup> making these the only studies to incorporate the 3 Outcome Measures in Rheumatology and Arthritis Clinical Trials core set clinical measures.

Noncore set outcome measures used in the studies included quality-of-life measures,<sup>20,26,27</sup> physician global assessment,<sup>24,25</sup> examination-based measures, such as joint range-of-motion,<sup>19,28</sup> and performance-based measures, such as walk times.<sup>19–21,24,28</sup>

**Findings within the trials**—Pain was the only outcome reported by all the studies; therefore, it is the focus of this section. In 8 of the 10 studies, the acupuncture group experienced statistically significant pain reduction in comparison with the control group.<sup>20,21,23–28</sup> One of these studies also found that the reduction in pain was significantly greater for the acupuncture group versus the drug treatment (diclofenac) group.<sup>24</sup> One study did not report on the difference between groups over time but instead reported a statistically significant difference in pretreatment versus posttreatment pain in both the EA and TENS groups but not in the control group.<sup>19</sup> Only 1 study found that the between-group difference over time was not statistically significant; however, a statistically significant difference in the pretreatment and posttreatment pain scores of both the true acupuncture and sham acupuncture groups was reported.<sup>22</sup> This study was also the only study that found no statistically significant difference between the groups over time on the physical function outcome, but, as with pain, the

prefindings or postfindings were significant.<sup>22</sup> Each of the other 5 studies found a statistically significant improvement in physical function in the acupuncture group versus the control group.<sup>20,23,24,26,27</sup>

Of the 3 trials that included a patient global assessment, only 1 reported a significantly greater improvement in the acupuncture group than the control group.<sup>20</sup> One study did not state whether or not the difference was significant,<sup>25</sup> and the third reported there was no statistically significant difference between the groups over time.<sup>24</sup>

## Discussion

On the basis of the findings of the 10 randomized, controlled trials identified by this review, there is evidence that acupuncture is an effective treatment of pain and physical dysfunction associated with osteoarthritis of the knee. There is not sufficient evidence to indicate whether or not acupuncture affects other factors associated with knee arthritis.

All 10 of the studies measured pain, and 6 of these also measured physical function. Only 1 of the 6 studies determined that the difference between treatment group and control group was not statistically significant for either of these 2 outcomes. The negative study findings in this 1 study should be considered with caution because the researchers used a flawed sham treatment. The sham involved needling “nonacupoints.” The supposed nonacupoints were in close proximity to real acupoints and the needling elicited the *de qi* sensation in 11 of the 20 controls, suggesting that the controls may have been active treatment cases. In fact, when the researchers reanalyzed the data, using *de qi* rather than treatment as the group factor, significant group  $\times$  time interactions were found for pain.

The other 9 studies concluded that acupuncture was effective. One of these studies<sup>19</sup> reported positive findings for the treatment groups but did not compare the treatment to the control group; the remaining studies found that the acupuncture group experienced significantly greater improvements in pain and physical function than the control group.<sup>20,21,23-28</sup> Although all of these trials are supportive of the effectiveness of acupuncture, an argument could be made that the results of the 4 studies that did not include a sham acupuncture group<sup>19,21,23,25</sup> offer weak evidence because the results of these 4 studies may be due to a placebo effect.

The strongest evidence comes from the sham-controlled trials,<sup>20,24,26,27</sup> as this design controls for the placebo effect (one study<sup>28</sup> that used a placebo group is not included here because it was a TENS placebo and not a sham acupuncture group). The sham-controlled studies had other strengths as well. These 4 studies were among the largest, having 97,26 193,24 294,27 and 570<sup>20</sup> participants. These studies used qualified acupuncturists and gave the most treatments (12 sessions<sup>24,26,27</sup> or 23 sessions<sup>20</sup>).

On the basis of the findings of the studies reviewed, acupuncture should be considered a viable adjunct or alternative treatment of knee pain and dysfunction associated with osteoarthritis of the knee for the thousands of individuals across the country who are suffering from symptoms of this chronic disease.

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Table 1

Acupuncture studies

Author	Participants	Groups	Outcomes	Findings
Christensen et al <sup>21</sup>	29 patients waiting for arthroplasty (short-term study)	Needle acupuncture (Group A) 2×/wk for 3 wk (wk 1–3) Wait list control (Group B) No treatment during wk 1–9 Treated wk 9–11	Pain VAS HSS knee scale 50-m walk time 20-step climb time	A vs B = +; A + B = + A vs B = +; A + B = + A vs B = +; A + B = + A vs B = +; A + B = +
Takeda et al <sup>22</sup>	40 subjects with grade I–IV knee OA	Needle acupuncture (Group A) 3×/wk for 3 wk Sham acupuncture (Group B) Same schedule as real acupuncture	MPQ pain rating index WOMAC Pain threshold dolorimeter	A vs B = – A vs B = – all A vs B = – (Pre vs post = + for both Tx and sham, all outcomes)
Yurtkuran et al <sup>28</sup>	100 patients with knee pain from OA 25 per group	TENS 5 d/wk for 2 wk; 20 min/session Same schedule for all treatment groups EA Ice massage Placebo	Present pain intensity Stiffness 50-ft walk time Quadriceps strength Active knee flexion	All Tx vs Placebo are + All Tx vs Placebo are + All Tx vs Placebo are + All Tx vs Placebo are + All Tx vs Placebo are +
Berman et al <sup>23</sup>	73 patients with symptomatic knee OA 58 completed study	Needle acupuncture Biweekly for 8 weeks Standard care control	WOMAC Algofunctional Index	A vs B = + pain function total A vs B = +
Sangdee et al <sup>24</sup>	193 patients with knee OA 186 completed study	EA (Group A) 3×/wk for 4 wk Diclofenac (Group C) 1 tablet 3×/d for 4 wk EA plus Diclofenac (A2) Same as treatment Placebo tablet plus placebo EA (Group B) Same as treatment	Amount of rescue analgesic 50-ft walk time Pain VAS WOMAC Algofunctional Index Patient's opinion of change Doctor's opinion of change	AI vs A2 vs B vs C = – AI vs A2 vs B vs C = – AI vs B = +; AI vs C = + A2 vs B = + pain AI vs B = + AI vs A2 vs B vs C = – AI vs B = +
Ng et al <sup>19</sup>	24 residents of Care & Attention Homes with knee OA	EA (Group A) 8 sessions on alternate days w/in 2 wk TENS (Group C) Similar to EA Education on OA knee care control (B)	Pain NRS Passive ROM Timed Up-and-Go test	Pre vs post = + for A and C All groups – Pre vs post = + for A and C
Berman et al <sup>20</sup>	570 patients with knee OA	Needle acupuncture (Group A) 2×/wk for 8 wk, 1×/wk for 2 wk, 1×/2wk for 4 wk, 1×/mo for 12 wk Sham acupuncture control (Group B) Same schedule as true acupuncture Education control Six 2-h group sessions on OA management	WOMAC pain scale* WOMAC function scale* SF-36 Physical health Patient global assessment 6-min walk distance	A vs B = + A vs B = + A vs B = – A vs B = + All –
Tukmachi et al <sup>25</sup>	30 patients with >6 mo hx of knee OA 29 were analyzed	Needle acupuncture alone (Group A) 2×/wk for 5 wk Acupuncture + remained on OA meds A2 Same schedule as above	Pain VAS* WOMAC pain, stiffness Patient global assessment Doctor global assessment	AI vs B = +; A2 vs B = + AI vs B = +; A2 vs B = + Not stated if stat significant Not stated if stat significant



Author	Participants	Groups	Outcomes	Findings
Vas et al <sup>26</sup>	97 patients with knee OA 89 completed the study	Wait list control (Group B) Remained on OA meds for first 5 wk Needle acupuncture plus diclofenac (A) 1x/wk for 12 wk Sham acupuncture + diclofenac control (B) Same schedule	WOMAC* Pain VAS PQLC	A vs B = + all scales A vs B = + A vs B = + for physical and psychological functioning
Witt et al <sup>27</sup>	294 patients with chronic knee OA	Needle acupuncture (Group A) 12 sessions over 8 wk Minimal acupuncture sham (Group B) Superficial needling, nonacupoints Wait list control (Group C)	WOMAC* Disability (PDI) SF-36 Physical health SF-36 Mental health Pain affective (SES) Pain sensoric (SES) Depression (ADS) Days with limited function	A vs B = +; A vs C = + all A vs B = +; A vs C = + A vs B = +; A vs C = + A vs B = -; A vs C = + A vs B = -; A vs C = + A vs B = -; A vs C = + A vs B = -; A vs C = + A vs B = -; A vs C = - A vs B = -; A vs C = - A vs B = -; A vs C = +

\* indicates Primary outcome; ADS, Allgemeine Depressionsskala; EA, electroacupuncture; PDI, Pain Disability Index; HSS, Hospital for Special Surgery; MPQ, McGill Pain Questionnaire; NRS, Numeric Rating Scale; PQLC, Profile of Quality of Life in the chronically ill; ROM, range of motion; SES, Schmerzempfindungs-Skala; SF-36, short form-36; VAS, Visual Analog Scale; WOMAC, Western Ontario and McMaster University Osteoarthritis Index; OA, Osteoarthritis; TENS, transcutaneous electrical nerve stimulation; +, statistically significant; -, not statistically significant; A vs B, Group A compared with Group B; A + B, Groups A and B combined when wait-list control group crosses over to treatment.