

CLINICAL OBSERVATION

Efficacy of acupuncture during post-acute phase of rehabilitation after total knee arthroplasty

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Abstract

OBJECTIVE: The purpose of this study was to determine whether acupuncture is effective in reducing pain and swelling around the knee and improving range of motion (ROM) during the post-acute phase of rehabilitation after total knee arthroplasty (TKA).

METHODS: Following TKA, 80 knees in 80 patients were randomly assigned to either an acupuncture treatment group (Group A) or a control group (Group C). In Group A, the complementary treatment of acupuncture was performed three times/week from postoperative day 7 until postoperative day 21. Outcome measures were: i) pain as assessed by a visual analog scale; ii) reduction of swelling around the knee as indicated by its circumference at the center of the patella; and iii) ROM of the affected knee.

RESULTS: Group A patients had significantly reduced pain and swelling around the knees and earlier recovery of ROM than did those in Group C.

CONCLUSION: Acupuncture provides effective treatment during the post-acute phase of rehabilitation after TKA with respect to pain relief, reduction of swelling around the knee, and early recovery of ROM.

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Key words: Acupuncture; Arthroplasty, replacement, knee; Range of motion, articular; Rehabilitation

INTRODUCTION

Patients who are free of knee pain after undergoing successful total knee arthroplasty (TKA) are more active than those with pain.¹ It is therefore important to pay attention not only to the surgery itself, but also to post-operative management.^{2,3} During the post-acute phase of rehabilitation after TKA, patients often complain of pain, aching and weakness around the knees.

Although several groups have reported that acupuncture is an effective complementary treatment for osteoarthritis (OA) of the knee with respect to pain relief and reduction of stiffness, few reports have clarified its efficacy during the post-acute phase of rehabilitation after TKA.⁴⁻⁸ Several reviews of randomized controlled trials have reported that acupuncture for OA of the knee is safe.^{9,10} It is therefore logical to ask whether acupuncture improves knee pain, swelling and range of motion (ROM) compared to usual postoperative care after TKA. The purpose of this study was to determine the efficacy of acupuncture during the post-acute phase of rehabilitation after TKA with respect to pain relief, reduction of swelling and ROM.

METHODS

Following unilateral cemented TKA surgery from Janu-

ary 2009 to December 2011 in our institutions, were randomly assigned to either an acupuncture treatment group (Group A) or a control group (Group C). Group C (control) consisted of 40 patients who received standard postoperative treatment during the initial period of rehabilitation after TKA. The 40 group A patients received complementary acupuncture combined with standard postoperative treatment. Group A comprised 10 men and 30 women with a mean age at surgery of 72 years [standard deviation (SD), 7 years]. Group C comprised 12 men and 28 women with a mean age at surgery of 73 years (SD, 5 years). The same acupuncture treatment team administered acupuncture to the operated knees in Group A three times/week from postoperative day (POD) 7 until POD 21 (i.e., on PODs 7, 10, 13, 15, 17 and 19). The acupuncture needles used were 40 gauge (0.16 mm) solid disposable filiform stainless steel needles (Seirin, Shizuoka, Japan). The depth of needle insertion varied with the thickness of the skin and subcutaneous fatty tissue at the site of the acupuncture points, but was usually 1-1.5 cm.¹¹ The acupuncturists left the needles in situ for 20 min-30 min. We assessed the therapeutic effects as optimal when the patient felt a momentary local sensation of heaviness or numbness, termed *de qi* in the classical acupuncture literature.¹² *De qi* must be distinguished from pain or discomfort due to needling.

The team used the following acupuncture points: stomach meridians (ST 31, 32, 38), one spleen meridian (SP 6), bladder meridians (BL-23, 25, 37, 57, 60), one kidney meridian (KI 3), gallbladder meridians (GB 31, 39, 40, 41, 42) and one liver meridian (LR 3) (Figure 1). All patients were Japanese and underwent TKA by the same surgeon (Y.M.) who used identical surgical instruments and the same types of TKA, namely Foundation™ PS Knee (DJO Surgical, Austin, TX, USA). Both groups underwent the same rehabilitation program. We used suction drainage and a foot pump for 24 h after surgery. Subsequently, the patients started ROM exercises twice a day using a continuous passive-motion machine, then started ambulating from POD 5 after surgery. All patients received continuous epidural anesthesia (0.2% ropivacaine 150 mL, 5% fentanyl 18 mL and physiological saline 32 mL) for 4 days after surgery, after which they received diclofenac sodium suppositories (50 mg/d) and loxoprofen (180 mg/d) for a further 17 days.

Outcome measures were: i) improvement in pain ac-

ording to the ratios of visual analog scale (VAS) scores on PODs 14 and 21 to that on POD 6; ii) improvement in swelling around the knee according to ratios of knee circumference (CAK) on PODs 14 and 21 to that on POD 6; and iii) time to achieve preoperative ROM (passive knee flexion angle).

We calculated improvement in swelling around the knee on POD 14 according to the following equation: (CAK on POD 14-CAK before surgery)/(CAK on POD 6-CAK before surgery). We calculated improvement in swelling around the knee on POD 21 according to a similar equation: (CAK on POD 21-CAK before surgery)/(CAK on POD 6-CAK before surgery). CAK was measured at the center of the patella.

We determined the passive knee flexion angle with a goniometer aligned to the mechanical sagittal axes of the thigh and shank (hip-knee-ankle angle).

The Takagi Hospital Institutional Review Board approved all study protocols and all patients gave informed consent prior to enrolment in the study. We used Student's *t*-test in the excel sheet (97-2003 Microsoft) for statistical comparisons, with the level of significance set at $P<0.05$.

RESULTS

Improvement in ratios of visual analog scale scores

The mean VAS pain score on POD 14 (after three acupuncture treatments in Group A) was 25 mm (SD, 3 mm; range, 21-32 mm) in Group A and 35 mm (SD, 13 mm; range, 32-41 mm) in Group C. On POD 6 it was 60 mm (SD, 6 mm; range, 48-67 mm) in Group A and 59 mm (SD, 5 mm; range, 48 mm-69 mm) in Group C (Figure 2). The improvement in ratio of VAS pain score on POD 14 to that on POD 6 was 0.42 (SD, 0.1) in Group A and 0.59 (SD, 0.1) in Group C. This difference was significant ($P<0.01$). However, there was no significant difference between the groups in VAS on POD 6 ($P=0.40$). The mean VAS pain score on POD 21 (after six acupuncture treatments in Group A) was 16 mm (SD, 5 mm; range, 12-28 mm) in Group A and 24 mm (SD, 3 mm; range, 20-35 mm) in Group C (Figure 2). The improvement in ratio of VAS pain score on POD 21 to that on POD 6 was 0.27 (SD, 0.1) in Group A and 0.41 (SD, 0.1) in Group C. This difference was signifi-



Figure 1 Acupuncture treatment. A: acupuncture treatment of the leg using Stomach meridians (ST 32,38), Spleen meridian (SP 6) and Gallbladder meridians (GB 31). B: Bladder meridians (BL 37) and Gallbladder meridians (GB 31). C: Bladder meridians (BL 57) and Gallbladder meridians (GB 39).

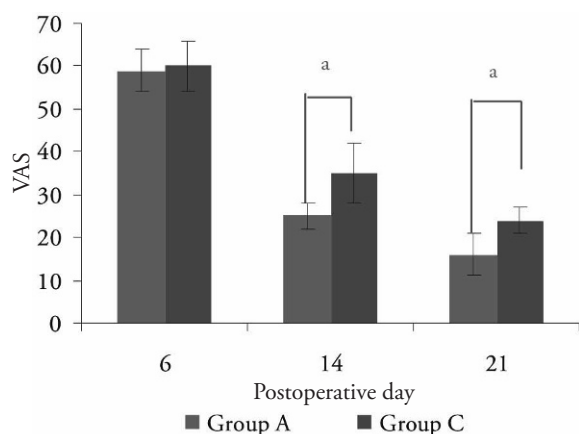


Figure 2 Visual analog scale results on days 14 and 21 after surgery. ^aSignificant difference between groups ($P < 0.01$).

Improvement in ratio of swelling around knee

The improvement in ratio of reduction of swelling around the knee on POD 14 as calculated above was 0.49 (SD, 0.1) in Group A and 0.61 (SD, 0.1) in Group C (Figure 3). This difference is significant ($P < 0.01$). The corresponding ratios on POD 21 were 0.30 (SD, 0.1) in Group A and 0.39 (SD, 0.1) in Group C (Figure 3), also a significant difference ($P < 0.01$).

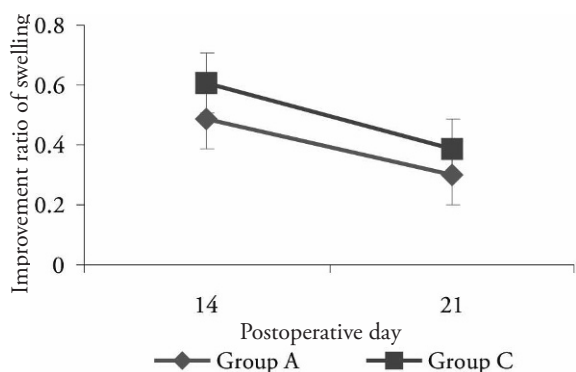


Figure 3 Improvement ratio of swelling around the knee at the center of the patella

Time to achieve preoperative range of motion

Mean ROM before surgery was 118.5° (SD, 10.0°; range, 0°-135°) in Group A and 120.8° (SD, 9.0°; range, 0°-137°) in Group C. This difference is not significant ($P = 0.33$). The mean time to achieve preoperative ROM was 15.2 days (SD, 1.4 days; range, 12 -18 days) in Group A and 20.9 days (SD, 3.2 days; range, 16 -26 days) in Group C. This difference is significant ($P < 0.01$).

We encountered no complications in either group.

DISCUSSION

Traditional Chinese acupuncture has a history of over 2500 years. Acupuncture has recently increased in popularity, becoming more widespread in some Western countries. This technique is now known as a form of complementary medicine that is effective in the treatment of many conditions and has fewer adverse effects than other modalities such as surgery or medications.¹³

The World Health Organization has published guidelines describing the efficacy of acupuncture in the cure or relief of 64 different symptoms and conditions.¹⁴ For example, acupuncture has been successful in cases of chronic pain, fatigue, nausea, arthritis, and digestive problems.¹⁵ Cohen et al. reported that acupuncture, alone or as an adjunct to pharmacotherapy, provides effective, safe and acceptable pain relief for patients with acute low back pain, migraine and ankle sprain.¹⁶

The strengths of the present study are that a single surgeon using the same instrumentation and surgical techniques treated all of a homogeneous group of patients. The number of patients was small, but sufficient to reveal significant differences for each variable assessed (VAS pain scores, reduction of swelling around the knee and time to achieve 90% of preoperative ROM). These results may not be generalizable to all knee arthroplasty patients.

The improvement in ratio of VAS pain score on POD 14 and POD 21 was significantly greater in Group A than Group C. Berman et al. studied patients with OA of the knee and reported that, according to Western Ontario and McMaster pain scores, an acupuncture group experienced significantly greater improvement in pain than did a placebo group.⁷ Scangdee et al. also reported that acupuncture is significantly more effective than placebo or diclofenac for symptomatic treatment of OA of the knee.⁵ Furthermore, a systematic review and meta-analysis of randomized controlled trials of adequate acupuncture showed that it is significantly superior to placebo in improving pain and function in patients with chronic knee pain.⁸

Many studies in animals and humans have demonstrated that acupuncture can stimulate multiple biological responses.¹⁸ From a neurophysiological perspective, needling may cause receptors to send neural impulses to the spinal cord to stimulate release of neurotransmitters that subsequently modulate functions in the brain as well as in the periphery.^{19,20} The best-known such mechanism is via endogenous opiates and their receptors. Early studies demonstrated the role that endogenous central nervous system opiates play in acupuncture-induced analgesia. Different kinds of endogenous opiates, such as β -endorphin, were reported as frequency-dependent factors in acupuncture. In the 1970s, acupuncture was regarded as a novel pain-killer. Naloxone, an opiate receptor antagonist, was shown to attenuate the analgesic actions of acupuncture in humans and mice; the release of a morphine-like substrate in the central nervous system was hypothesized as a possible mechanism.^{21,22} In the early 1980s, researchers purified β -endorphin and enkephalin and suggested that they have roles in the effects of acupuncture in humans and animals.^{23,24} Recent studies using positron emission tomography have shown that acupuncture treatment reduces thalamic asymmetry in patients with chronic pain.²⁵ Other studies using functional magnetic resonance imaging have pointed to relationships between

particular acupoints and visual-cortex activation.²⁵ Group A patients had significantly greater improvements than did Group C patients in swelling around the knee on PODs 14 and 21. Suzuki *et al.* reported that acupuncture treatment increases blood flow and oxygenation in peripheral areas and concluded that acupuncture is effective against lower limb ischemia.²⁶ Noguchi also reported that muscle blood flow in the hindlimbs of anesthetized rats improved after the acupuncture.²⁷ Jinsheng reported that acupuncture improves lower leg edema.²⁸ The present study shows that acupuncture reduces swelling around the knee during the post-acute phase of rehabilitation after TKA, suggesting that it improves blood flow to the muscles of the lower leg and circulation around the knee.

We found significant differences between the two groups in the time to achieve preoperative ROM. This is probably because pain and swelling around the knee improved sooner in patients in Group A than in those in Group C.

Acupuncture is effective treatment during the post-acute phase of rehabilitation after TKA with respect to pain relief, reduction of swelling around the knee and early recovery of ROM. Further study is required to confirm whether these findings can be generalized to all TKA patients and to provide more information on long-term effects.

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