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ORIGINAL ARTICLE

# Open-Label Randomized Clinical Trial to Assess the Effects of Preoperative Acupuncture in High Anxiety Patients Undergoing Total Knee or Hip Arthroplasty

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## Abstract

**Background:** Preoperative state anxiety is a known predisposing factor for enhanced postoperative pain and hindered recovery following total knee or hip replacement. Acupuncture administered preoperatively has been associated with reduced anxiety in surgical studies, yet evidence of its efficacy in the orthopedic surgical setting is limited.

**Objective:** This study investigated the effects of preoperative acupuncture on preoperative anxiety and pain and compared acute postoperative pain between acupuncture and control patient groups.

**Design:** Parallel-arm, open-label, randomized controlled trial.

**Setting:** Bone and Joint Institute, Hartford Hospital, Hartford, CT.

**Participants:** Sixty middle-aged and elderly men and women with clinically validated preoperative anxiety undergoing elective total hip or knee replacement.

**Intervention:** One-to-one randomization to preoperative acupuncture ( $n = 30$ ) or no acupuncture treatment ( $n = 30$ ) on the day of surgery.

**Coprimary outcomes:** Anxiety before and after preoperative acupuncture using the visual analog scale and postsurgical pain using the numeric pain scale.

**Secondary outcomes:** Incidence of acupuncture-related complications, pain before and after acupuncture, nausea and vomiting incidence, opioid consumption, anxiolytics and antiemetics use, and patient satisfaction.

**Results:** Patients reported lower anxiety and pain preoperatively following acupuncture compared with before treatment (both  $p < 0.001$ ). Postoperatively, the acupuncture group reported lower pain in the first 3 h than the control group, although this difference was not statistically significant. No significant differences in postoperative complications or patient satisfaction were observed between the study groups. Most patients were satisfied with the acupuncture treatment and reported a likelihood of considering preoperative acupuncture for future surgeries.

**Conclusions:** These preliminary findings support that preoperative acupuncture is a safe and effective means to reduce perioperative anxiety and pain in patients undergoing total hip or knee replacement surgery. Additional

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studies should be conducted to best determine the value of preoperative acupuncture in total hip or knee patients presenting with surgically related anxiety.

**Clinical Trial Registration:** ClinicalTrials.gov (10/31/2023, NCT06099223).

**Keywords:** preoperative acupuncture, total knee arthroplasty, total hip arthroplasty, anxiety, pain

## Introduction

Over three million patients with end-stage osteoarthritis or rheumatic arthritis have undergone total knee or hip arthroplasty (TKA or THA).<sup>1</sup> As the aging population increases and there is a greater desire to sustain mobility and quality of life, the numbers of total hip and knee joint replacement surgeries are expected to increase appreciably in coming years.<sup>2</sup> While both surgeries demonstrate high success in terms of survival, prostheses performance, and low revision rates, a significant proportion of patients experience preoperative anxiety, enhanced postoperative pain, and worse recovery outcomes.<sup>3–8</sup>

To address this challenge, there has been a significant shift in recent years toward incorporating nonpharmacologic treatments into multimodal perioperative analgesic care.<sup>9</sup> Among these strategies, acupuncture represents a versatile treatment modality that has demonstrated great success as an adjunct to standard analgesic care in the setting of THA and TKA. Intra- and postoperative auricular acupuncture has been correlated with significant reductions in opioid consumption<sup>10–14</sup> and prolonged time to first opioid use.<sup>13</sup> Existing literature has shown that acupuncture is an effective approach to treat acute postoperative pain and promote enhanced recovery following THA or TKA.<sup>13,15–18</sup>

While the benefits of intra- and postoperative acupuncture are well-documented, limited research is available on the value of acupuncture-mediated sedation before hip or knee joint replacement surgery, despite numerous studies demonstrating the utility of preoperative acupuncture for anxiety reduction in other types of surgeries.<sup>19,20</sup> At our institution, a prestudy analysis revealed that 21% of monthly THA and TKA patients exhibit preoperative anxiety, consistent with a range of 16%–25% reported in the literature.<sup>3,4</sup> Anxiety and preoperative pain are strongly correlated<sup>7</sup> and the most consistent predictor of postoperative pain is preoperative pain.<sup>21</sup>

Thus, perhaps the best method to improve surgical outcomes in THA and TKA is to target both preoperative anxiety and perioperative pain using preoperative acupuncture. This study, therefore, investigated the effects of preoperative acupuncture on preoperative anxiety and perioperative pain in patients with clinically validated preoperative anxiety who underwent elective THA or TKA, with a hypothesis that preoperative acupuncture would reduce preoperative anxiety and postoperative pain compared to control patients.

## Design and Interventions

### Study design

This parallel-arm, open-label, randomized controlled trial was conducted at the Bone and Joint Institute of Hartford Hospital from March 2022 to April 2023 and included 60 patients who underwent elective TKA or THA. The study was approved by Hartford HealthCare Institutional Review Board (IRB HHC-2021–0348) and performed in accordance with the 1964

Declaration of Helsinki and its later amendments. All study personnel underwent IRB training including completion of relevant Collaborative Institutional Training Initiative (CITI) program modules. This clinical trial has been registered on ClinicalTrials.gov (10/31/2023, NCT06099223).

### Study population

Men of age 18–85 years and women of age 52–85 years scheduled for elective TKA or THA surgery exhibiting anxiety according to the validated Amsterdam Preoperative Anxiety and Information Scale (APAIS-A-T >10, range 4–20, Table 1) were eligible. The APAIS-A-T is a modified survey with a similar validity to the State-Trait Anxiety Inventory that specifically quantifies preoperative anxiety using four questions pertaining to anesthesia and surgery-related anxiety; a minimum score of 11 is the most accurate cutoff to identify patients with anxiety.<sup>22</sup>

Patients were excluded if they met any of the following criteria: inability to give consent, infection at any acupuncture point, allergy to acupuncture needles, abnormal preoperative blood work (INR >1.5 or platelet count <70,000), presence of active ongoing coagulopathy and/or current use of anticoagulants, or pregnancy. Patients with uncontrolled diabetes (HbA1c ≥ 8.0%) were excluded, consistent with our institute's policy prohibiting these patients from undergoing THA or TKA due to heightened risk of infection. Women under 52 were excluded due to the potential conflict between our institute's standard timing for pregnancy tests on the day of surgery and the scheduled preoperative acupuncture session for the study, to avoid unwanted delays in the operating room schedule. Non-English-speaking patients and those receiving a revision THA or TKA were also excluded.

All potential patients were screened using the hospital's Electronic Privacy Information Center (EPIC) system. Eligible patients provided informed consent during their in-person preoperative appointments or virtually via a video or phone call with the study coordinator. During the consenting process, the patients were informed of the study details, benefits, risks, and enrollment process, with adequate time allotted to

TABLE 1. APAIS-A-T SURVEY

*Directions: for each of the questions below, please put a mark in ONE box corresponding with your answer*  
1: Not at all; 2: Somewhat; 3: Moderate; 4: Moderately high; 5: Extremely

Questions:	1	2	3	4	5
1. I am worried about the anesthetic					
2. The anesthetic is on my mind continually.					
3. I am worried about the procedure.					
4. The procedure is on my mind continually.					

APAIS-A-T, Amsterdam Preoperative Anxiety and Information Scale.

address questions and concerns. Written informed consents were obtained from all patients prior to study participation.

### Randomization

Patients were randomized 1:1 to receive a single session of preoperative manual acupuncture or no acupuncture (i.e. control) on the day of surgery. Software-based (Research Randomizer) simple randomization was used to generate the randomization sequence ( $n = 60$ ) by the study coordinator prior to enrollment. The randomization sequence was kept in a secure, password-protected electronic file accessible only to study coordinator; assignments were allocated sequentially by surgery date, then consent date as necessary. Following each acupuncture treatment allocation, a preoperative acupuncture session was scheduled and an acupuncturist was assigned according to the patient's surgery date and provider availability. Patients were made aware of their assigned study treatment by the coordinator on the day of surgery upon arrival to the preoperative suite.

### Intervention and procedures

In the preoperative suite, prior to any standard of care surgical preparation, all patients completed a visual analog scale (VAS; 0 [not at all anxious] to 100 [extremely anxious]) and a numeric pain scale (NPS; 0 [no pain] to 10 [worst possible pain]), administered by the study coordinator, to gauge pre-treatment anxiety and pain.

Thereafter, licensed, experienced medical acupuncturists met with acupuncture-randomized patients to administer the study intervention. Prior to all acupuncture treatments, the assigned acupuncturist conducted a preoperative medical assessment and chart review with each patient. All acupuncture-randomized patients received a combination of bilateral auricular acupuncture at the Shen men, Zero, Tranquilizer, and Master cerebral points and body acupuncture at the Pericardium 6 (PC6) wrist site (Fig. 1). Sterile, disposable acupuncture needles were carefully inserted at a shallow depth of the four auricular acupuncture points in each ear (36-gauge DBC Detox-5, length: 13 mm, diameter: 0.20 mm) and at the body point on each wrist (38-gauge SEIRIN-J-type, length: 30 mm, diameter: 0.18–0.20 mm), totaling 10 needles per patient. These needles were retained for ~20–30 min to attain *de qi* sensation, then discarded into a sharps container. Following the procedure, all acupuncture patients repeated the VAS and NPS scale assessments and proceeded to standard preoperative care and scheduled TKA or THA.

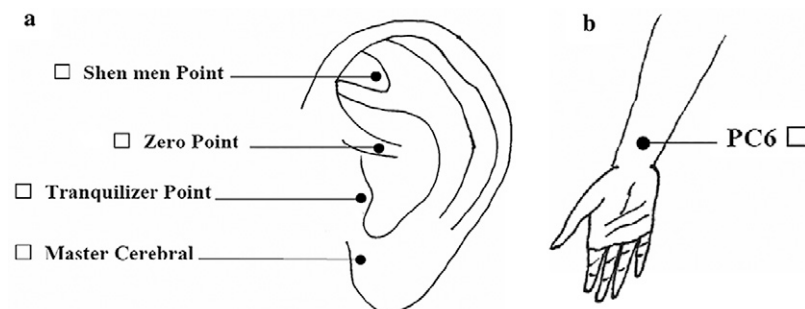
In contrast, control patients completed the baseline VAS and NPS assessments only once upon arrival to the preoperative suite, then proceeded immediately after to standard preoperative care and scheduled THA or TKA. Both surgeries were performed according to standard surgical practice under spinal and regional anesthesia. Following surgery, all patients received multimodal analgesic care per institutional protocol. All patients were monitored throughout hospitalization and followed for 30 postoperative days with a phone survey administered within the first 7 postoperative days.

### Outcomes

The first coprimary outcome was the change in self-reported preoperative VAS anxiety before and after acupuncture. The second coprimary outcome was the difference in NPS postoperative pain reported by acupuncture versus control patients at three time points (upon arrival to the postanesthesia care unit [PACU], at 1 h and at 3 h). Though not a primary outcomes, baseline preoperative state anxiety and pain were additionally compared between the acupuncture and control groups using the VAS and NPS assessments.

Several secondary outcome measures were additionally compared between the study groups. Incidence of postoperative nausea and/or vomiting (PONV) was assessed using the simplified PONV impact scale (0 [no nausea or vomiting] to 6 [continuous nausea and  $\geq 3$  vomit/dry-retching events]) at postoperative hours 1 and 3. The following data were additionally collected from EPIC and compared: 24-h postsurgical opioid consumption, reported as morphine milligram equivalents, anxiolytics and antiemetics use during hospital admission, and hospital length of stay. All patients completed a satisfaction questionnaire with scaled (0 [completely dissatisfied] to 10 [completely satisfied]) questions pertaining to their overall experience, as well as pain and anxiety management during their admission period. The questions were administered by phone within one week after discharge from the hospital. Acupuncture-treated patients completed a two-question multichoice survey to gauge satisfaction (“not at all” to “extremely”) with the acupuncture treatment and likelihood (“never” to “very likely”) of receiving acupuncture for future surgeries.

To evaluate the safety of preoperative acupuncture in THA and TKA, all incidences of acupuncture-related complications were reported throughout the study. All patients were monitored for adverse events throughout hospital admission and in the first 30 days following discharge. All adverse events were attributed and graded by severity with appropriate documentation and reporting to the IRB as necessary.



**FIG. 1.** Auricular (a) and body (b) acupuncture points used; PC6, Pericardium 6.

### Sample size

An initial sample size was calculated based on previous studies examining the use of acupuncture for the primary outcomes, pain, and anxiety.<sup>13,23</sup> Sample size calculations based on these studies required 22 (11 per group) for pain and only 8 (4 per group for paired samples design) for anxiety, accounting for 10% attrition. However, the follow-up time points were different than the current study and the population examined differed (i.e. dental anxiety) in one study.<sup>23</sup> Therefore, an interim statistical analysis was performed after the first 31 patients were enrolled (50% of feasible maximum enrollment total) to re-evaluate sample size.

For the coprimary outcome of pain, the interim sample size calculation indicated that a minimum of 26 patients per group was needed using a repeated measures design with two groups for a total of 52 patients. This design achieved 81% power to test factor B1 if a Geisser–Greenhouse Corrected F Test is used with a 5% significance level and the actual effect standard deviation is 0.255 (an effect size of 0.40319). Given an estimated attrition rate of 10%, a minimum sample size of 60 patients were included (30 per group).

For the coprimary outcome of anxiety, the difference in the response of anxiety score from pre- to postacupuncture was normally distributed with a standard deviation of 26.3. The difference in the mean anxiety score of matched pairs was 35.6. Therefore, a total of six pairs of patients was necessary to reject the null hypothesis that this response difference is zero with probability (power) 0.8, with a 5% significance level.

### Statistical analysis

All data were checked for normality of distribution. Patient demographic and clinical (including operative) characteristics were compared between groups using an independent samples *t*-test if continuous data were normally distributed, or Mann–Whitney U if not. A chi-square or Fisher's exact test (if cell counts were <5) was used to compare these characteristics between groups for categorical variables. All continuous variables were expressed as mean  $\pm$  standard deviation or median  $\pm$  interquartile range. Categorical variables were expressed as frequency (%). The coprimary outcome, self-reported postoperative pain was compared between patients that received acupuncture versus control patients using repeated measures analysis of covariance, adjusting for preoperative pain, updated Charlson Comorbidity Index, gender, history of acupuncture, and incidence of mental illness. The three time points evaluated for the repeated measures included PACU arrival, 1-h postoperation, and 3-h postoperation. Self-reported average pain was compared between groups at each individual time point using independent samples *t*-tests, adjusted using Bonferroni correction. Self-reported pain and the coprimary outcome, self-reported anxiety was compared before versus after acupuncture and between the acupuncture and control groups using paired samples *t*-test. Secondary outcomes for patient postoperative complications and patient satisfaction were compared between those who received acupuncture versus control using independent samples *t*-test or chi-square analysis. Statistical analysis was conducted using SPSS version 26.0. A *p*-value <0.05 was deemed statistically significant. The statistician performing the analysis was not blinded to study grouping, but did not participate in conducting clinical assessments.

## Results

### Participants

A total of 60 patients, 30 in each group, completed the study (Fig. 2). There were no significant differences in the baseline characteristics of acupuncture-treated patients versus those in the nonintervention control group (Table 2).

**Primary outcome.** Upon arrival to the preoperative area, prior to treatment, patients in the acupuncture and control groups reported similar anxiety ( $60.73 \pm 21.28$  vs.  $59.66 \pm 30.11$ , respectively;  $p = 0.870$ , 95% confidence interval [CI] = 12.48–14.63; Fig. 3, left) and pain ( $4.97 \pm 3.01$  vs.  $4.69 \pm 2.79$ , respectively;  $p = 0.72$ , 95% CI = 3.04–6.62; Fig. 3, right). Following the acupuncture intervention, patients who received acupuncture reported significantly less anxiety ( $60.73 \pm 21.28$  before vs.  $28.90 \pm 21.54$  after;  $p < 0.001$ , 95% CI = 23.56–40.10; Fig. 3, left) and pain ( $4.97 \pm 3.01$  before vs.  $2.90 \pm 6.62$  after;  $p < 0.001$ , 95% CI = 1.44–2.69; Fig. 3, right).

There were no significant differences in postoperative pain between patients in each study group in the PACU ( $0.47 \pm 1.36$  vs.  $1.38 \pm 2.83$ , respectively; 95% CI =  $-0.16$ – $2.30$ ,  $p = 0.087$ ), at postoperative hour 1 ( $1.67 \pm 2.22$  vs.  $2.45 \pm 3.15$ , respectively; 95% CI =  $-0.39$ – $2.51$ ,  $p = 0.147$ ), and at postoperative hour 3 ( $3.67 \pm 3.03$  vs.  $4.55 \pm 3.29$ , respectively; 95% CI =  $-0.26$ – $3.01$ ,  $p = 0.098$ , Fig. 4).

**Secondary outcomes.** There were no statistically significant differences in the incidence of postoperative complication, medication use, hospital length of stay, and 24-h postoperative opioid consumption. Per the phone survey results, patient satisfaction was similar between the two study groups (Table 3). Most patients were very satisfied with their overall care, as well as pain, and anxiety management. Within the acupuncture treatment group, a small portion of participants experienced minor immediate complications including local bleeding, discomfort, and pain (Table 4). Even so, most patients who received acupuncture were satisfied with the treatment and likely to consider acupuncture for future surgeries (73.4% and 83.3%, respectively).

### Discussion

Preoperative anxiety is common among patients scheduled to undergo total hip or knee arthroplasty and represents a significant antecedent to enhanced postoperative pain and poor recovery. Preoperative acupuncture has been successfully used to ameliorate anxiety in a variety of surgery types,<sup>19,20</sup> warranting this clinical investigation of its efficacy among patients undergoing THA or TKA presenting with preoperative anxiety.

Following a single, preoperative session of mixed auricular and body acupuncture, a significant reduction in patient-reported preoperative anxiety was observed. The effect occurred within 30 min of receiving the intervention, consistent with findings in previous studies that used similar acupuncture points to treat anxiety.<sup>23–28</sup> Though no specific acupuncture points were used to treat pain, reductions in pre- and postoperative pain were also reported following the acupuncture intervention. Anxiety state is known to influence pain; preoperative anxiety can cause psychological distress, resulting in an increased likelihood to somatize pain.<sup>29–31</sup>

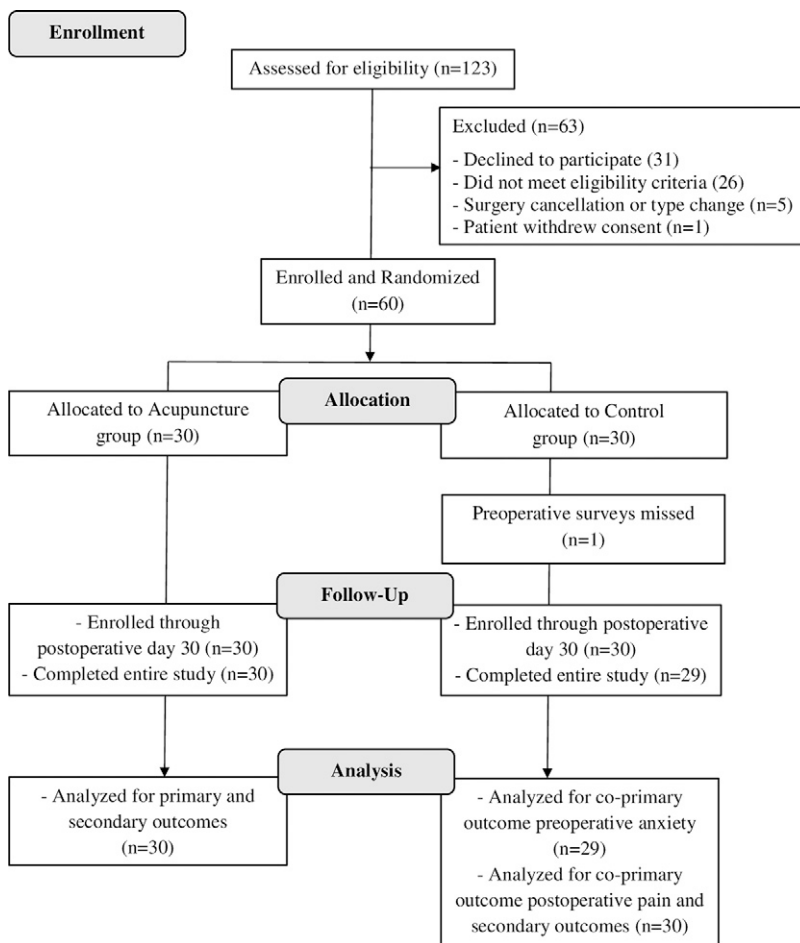


FIG. 2. Flow diagram of study patients.

Given that preoperative acupuncture can induce significant relaxation and has sedating properties,<sup>32,33</sup> it is plausible that the reduction in anxiety indirectly influenced the patients' perception of pain as well. Indeed, these findings align with the expected benefits of the acupuncture points used, according to Traditional Chinese medicine theory. Shen men calms or activates heart fire to alleviate anxiety and pain, while point Zero is said to move the mind, emotions, and body toward homeostatic balance.<sup>34</sup> The Master Cerebral point is influential in psycho-emotional and somatic disorders that accompany acute and chronic pain, and the Tranquilizer point produces a general sedation effect to relax the body.<sup>34-36</sup>

While there were no statistically significant differences in the secondary outcomes, the incidence of PONV was higher in control patients than in acupuncture-treated patients. This finding may reflect the use of the PC6 body acupuncture point, which was selected for its dual anti-anxiety<sup>37</sup> and anti-PONV<sup>38</sup> effects. Nonetheless, all study patients received midazolam before surgery and propofol sedation during surgery per institutional standard practice. Both medications have antiemetic properties,<sup>39-41</sup> potentially explaining the low incidence of PONV and why any discernable difference in PONV was statistically insignificant. At our institution, the expected length of stay for THA and TKA patients is about 1.25 days; it is standard practice to keep patients postoperatively for one night, followed by one to two physical therapy sessions. During this time, patients are given opioids, anxiolytics, and antiemetics at regular intervals. Both the relatively short inpatient stays and

medication administration protocols plausibly contributed to the lack of differences in secondary outcomes (Table 3).

Since this was the first acupuncture study performed at our institution, this study primarily assessed the impact of a single preoperative acupuncture session on anxiety, focusing on its influence in the first hours of recovery. Nevertheless, the 3-h assessment endpoint may have been too early to capture any difference, while institutional practices may have obscured potential effects on other outcomes. This study has other limitations. Most patients were white, non-Hispanic, older individuals, although this is consistent with demographic data from a recent large-scale epidemiological survey.<sup>42</sup> As per the survey, the prevalence of THA and TKA surgeries was evenly balanced among males and females; however, in our study, the patient population was predominately female. This may reflect the increased incidence of preoperative anxiety among women versus men.<sup>43</sup> In addition, this study was an open-label design that compared an acupuncture-treated group to a nonintervention control group. Similar studies have used sham acupuncture rather than nonintervention controls to mitigate bias. In this study, sham acupuncture was not performed given the relatively small surface area of the ear and concern for human error resulting in accidental stimulation.

Further research should aim to investigate the effect of multiple preoperative acupuncture sessions or a combination of pre- and postoperative acupuncture on anxiety and postsurgical recovery with more long-term follow-up. Future studies should also investigate the efficacy of preoperative acupuncture in a

TABLE 2. PATIENT DEMOGRAPHICS AND BASELINE CHARACTERISTICS

Variable	Acupuncture (n = 30)	Control (n = 30)	Total (n = 60)	$\chi^2$ , 95% CI, or U	p-Value
Age (years) mean $\pm$ SD	69.60 $\pm$ 9.71	67.63 $\pm$ 7.71	68.62 $\pm$ 8.75	-2.57, 6.50	0.39
Sex, n (%)				0.88	0.35
Female	22 (73.3)	25 (83.3)	47 (78.3)		
Male	8 (26.7)	5 (16.7)	13 (21.7)		
Ethnicity, n (%)				—	0.35
Hispanic	4 (13.3)	1 (3.3)	5 (8.3)		
Non-Hispanic	26 (86.7)	29 (96.7)	55 (91.7)		
Race, n (%)				4.75	0.09
Caucasian/White	26 (86.7)	24 (80.0)	50 (83.3)		
African American/ Black	0 (0.0)	4 (13.3)	4 (6.7)		
Other	4 (13.3)	2 (6.7)	6 (10.0)		
BMI (kg/m <sup>2</sup> ) mean $\pm$ SD	32.16 $\pm$ 5.31	30.44 $\pm$ 5.51	31.30 $\pm$ 5.44	-1.07, 4.52	0.22
CCI median, IQR	1.0, 2.0	0.0, 2.0	0.0, 5.0	U = 332.0	0.06
Hx mental illness <sup>a</sup> , n (%)	15 (50.0)	12 (40.0)	27 (45.0)	0.61	0.44
Anxiety	13 (43.3)	10 (33.3)	23 (38.3)	0.64	0.43
Bipolar disorder	0 (0.0)	1 (3.3)	1 (1.7)	—	1.00
Depression	8 (26.7)	6 (20.0)	14 (23.3)	0.37	0.54
Hx acupuncture, n (%)				1.93	0.17
Yes	12 (40.0)	7 (23.3)	19 (31.7)		
No	18 (60.0)	23 (76.7)	41 (68.3)		
APAIS Score (0–20) mean $\pm$ SD	13.27 $\pm$ 2.39	13.90 $\pm$ 2.56	13.58 $\pm$ 2.48	-1.92, 0.65	0.33
Surgery, n (%)				0.07	0.80
Total hip arthroplasty	15 (50.0)	16 (53.3)	31 (51.7)		
Total knee arthroplasty	15 (50.0)	31 (46.7)	29 (48.3)		

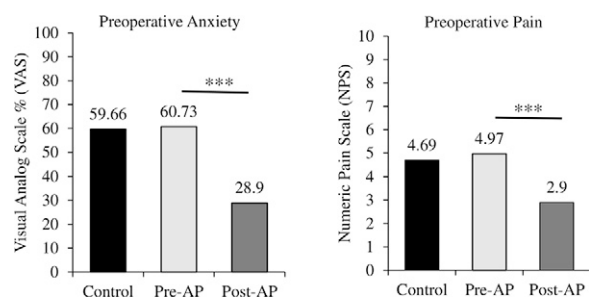
<sup>a</sup>A patient may have more than one diagnosis reflecting the differences in frequency between history of any mental illness versus the frequency of each specific diagnosis.

APAIS, Amsterdam Preoperative Anxiety and Information Scale; BMI, body mass index; CCI, Charlson Comorbidity Index; CI, confidence interval; VAS, Visual Analog Scale.

larger, more diverse patient population to enhance the reliability of findings. Future studies may also consider evaluating the efficacy of preoperative acupuncture on anxiety compared to a pharmacologic treatment such as benzodiazepines.

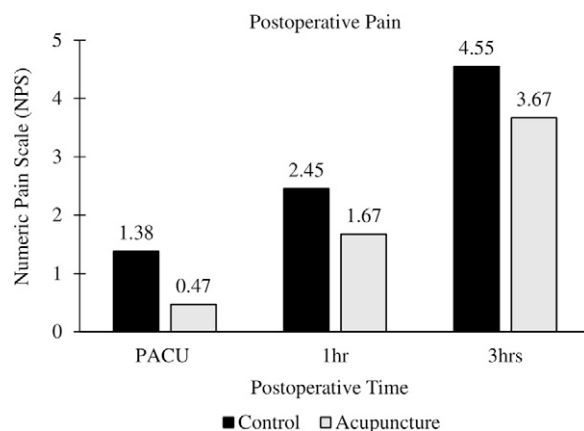
### Conclusions

Preoperative mixed auricular and body acupuncture was associated with increased relaxation and comfort prior to



**FIG. 3.** Presurgical self-reported anxiety and pain in the nonintervention control group and acupuncture-treated patients before and after treatment (AP). \*\*\* $p < 0.001$ .

surgery in a high-anxiety patient cohort that underwent THA or TKA. Compared to nonintervention controls, patients receiving preoperative acupuncture reported less pain in the first three postoperative hours with no differences in safety outcomes. Importantly, most patients receiving acupuncture



**FIG. 4.** Postsurgical self-reported pain in the postanesthesia care unit and at 1 and 3 postoperative hours.

TABLE 3. SECONDARY OUTCOMES

Variable	Acupuncture (n = 30)	Control (n = 30)	Total (n = 60)	$\chi^2$ , 95% CI, or U	p- Value
PONV, 1 h postoperative, n (%)				—	0.11
Yes	0 (0.0)	4 (13.3)	4 (6.7)		
No	30 (100.0)	26 (86.7)	56 (93.3)		
PONV, 3 h postoperative, n (%)				0.00	1.00
Yes	5 (16.7)	5 (16.7)	10 (16.7)		
No	25 (83.3)	25 (83.3)	50 (83.3)		
Antiemetic use median, IQR	0.0, 1.0	0.0, 1.0	0.0, 1.0	398.0	0.37
Midazolam dose (mg) mean $\pm$ SD	3.96 $\pm$ 1.73	4.21 $\pm$ 1.80	4.09 $\pm$ 1.76	-1.18, 0.70	0.61
Midazolam dose >2mg, n (%)	19 (63.3)	22 (73.3)	41 (68.3)	0.69	0.41
Length of stay (h) median, IQR	29.5, 3.5	29.0, 3.0	29.0, 3.8	390.5	0.38
Postoperative complications, n (%)				—	0.17
Yes	3 (10.0)	7 (23.3)	10 (16.7)		
No	27 (90.0)	23 (76.7)	50 (83.3)		
Postoperative opioids (MME), 0–24 h mean $\pm$ SD	45.51 $\pm$ 30.02	52.46 $\pm$ 30.92	48.99 $\pm$ 30.42	-22.70, 8.80	0.38
Patient satisfied? (9 or 10/10), n (%)					
Overall	21 (70.0)	24 (80.0)	45 (75.0)	0.80	0.37
Pain	19 (63.3)	20 (66.7)	39 (65.0)	0.07	0.79
Anxiety	21 (70.0)	19 (63.3)	40 (66.7)	0.30	0.58

Fisher's exact test used for categorical variables when cell frequency count <5.

CI, confidence interval; IQR, Interquartile Range. MME, morphine milligram equivalents; PONV, postoperative nausea and vomiting.

were very or extremely satisfied with the treatment and likely to consider acupuncture for future surgeries. These preliminary findings suggest that preoperative acupuncture may be a valuable nonpharmacologic tool to help mitigate preoperative anxiety and perioperative pain in patients undergoing total hip

or knee replacement. Further research investigating the short- and long-term analgesic and antianxiety effects of preoperative acupuncture is vital to determining its overall value in the setting of THA and TKA.

#### Authors' Contributions

P.K., E.T., and A.W. designed the study. D.N., D.W., M.S., and M.K. assisted in the identification of potential patient participants. S.V., E.T., A.W., and J.F. contributed to data collection. P.K., G.G., A.B., and E.S. performed the acupuncture intervention on patients. G.P. performed the data analysis and interpretation. S.V. and J.F. worked collaboratively on the first draft, and all authors supported the transition of the first draft to its approved final version.

#### Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### Author Disclosure Statement

No competing financial interests exist.

#### Consent for Publication

All authors gave their consent for publication.

TABLE 4. ACUPUNCTURE TREATMENT: COMPLICATION INCIDENCE AND PATIENT SATISFACTION

Variable	Frequency (n = 30)
Complication incidence, n (%)	
Local bleeding	9 (30.0)
Discomfort	3 (10.0)
Residual pain	1 (3.3)
Satisfaction, n (%)	
Extremely	14 (46.7)
Very	8 (26.7)
Somewhat	5 (16.7)
Not very	1 (3.3)
Not at all	2 (6.7)
Consider acupuncture for future surgeries, n (%)	
Very likely	19 (63.3)
Likely	6 (20.0)
Maybe	2 (6.7)
Never	3 (10.0)

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### References

1. Anonymous. The Ninth Annual Report of the AJRR on Hip and Knee Arthroplasty. 2022.
2. Singh JA, Yu S, Chen L, et al. Rates of total joint replacement in the United States: Future projections to 2020–2040 using the National Inpatient Sample. *J Rheumatol* 2019; 46(9):1134–1140; doi: 10.3899/jrheum.170990
3. Jung K-H, Park J-H, Ahn J-W, et al. Surgery-related anxiety on geriatric patients undergoing total knee arthroplasty: A retrospective observational study. *BMC Musculoskelet Disord* 2023;24(1):161; doi: 10.1186/s12891-023-06252-w
4. Lingard EA, Riddle DL. Impact of psychological distress on pain and function following knee arthroplasty. *J Bone Joint Surg Am* 2007;89(6):1161–1169; doi: 10.2106/JBJS.F.00914
5. Kahlenberg CA, Nwachukwu BU, McLawhorn AS, et al. Patient satisfaction after total knee replacement: A systematic review. *HSS J* 2018;14(2):192–201; doi: 10.1007/s11420-018-9614-8
6. Brander V, Gondek S, Martin E, et al. THE JOHN INSALL AWARD: Pain and depression influence outcome 5 years after knee replacement surgery. *Clin Orthop Relat Res* 2007;464:21–26; doi: 10.1097/BLO.0b013e318126c032
7. Rolfson O, Dahlberg LE, Nilsson J-å, et al. Variables determining outcome in total hip replacement surgery. *J Bone Joint Surg Br* 2009;91(2):157–161; doi: 10.1302/0301-620X.91B2.20765
8. Yang MMH, Hartley RL, Leung AA, et al. Preoperative predictors of poor acute postoperative pain control: A systematic review and meta-analysis. *BMJ Open* 2019;9(4):e025091; doi: 10.1136/bmjopen-2018-025091
9. Hyland SJ, Brockhaus KK, Vincent WR, et al. Perioperative pain management and opioid stewardship: A practical guide. *Healthcare (Basel)* 2021;9(3):333; doi: 10.3390/healthcare9030333
10. Wetzel B, Pavlovic D, Kuse R, et al. The effect of auricular acupuncture on fentanyl requirement during Hip Arthroplasty. *Clin J Pain* 2011;27(3):262–267; doi: 10.1097/AJP.0b013e3181fd516c
11. Usichenko TI, Dinse M, Lysenyuk VP, et al. Auricular acupuncture reduces intraoperative Fentanyl requirement during hip arthroplasty—A randomized double-blinded study. *Acupunct Electrother Res* 2006;31(3–4):213–221; doi: 10.3727/036012906815844265
12. Usichenko TI, Dinse M, Hermsen M, et al. Auricular acupuncture for pain relief after total hip arthroplasty—A randomized controlled study. *Pain* 2005;114(3):320–327; doi: 10.1016/j.pain.2004.08.021
13. Chen C-C, Yang C-C, Hu C-C, et al. Acupuncture for pain relief after total knee arthroplasty. *Reg Anesth Pain Med* 2015;40(1):31–36; doi: 10.1097/AAP.000000000000138
14. Cheng SI, Kelleher DC, DeMeo D, et al. Intraoperative acupuncture as part of a multimodal analgesic regimen to reduce opioid usage after total knee arthroplasty: A prospective cohort trial. *Med Acupunct* 2022;34(1):49–57; doi: 10.1089/acu.2021.0072
15. Crespin DJ, Griffin KH, Johnson JR, et al. Acupuncture provides short-term pain relief for patients in a total joint replacement program. *Pain Med* 2015;16(6):1195–1203; doi: 10.1111/pme.12685
16. Mikashima Y, Takagi T, Tomatsu T, et al. Efficacy of acupuncture during post-acute phase of rehabilitation after total knee arthroplasty. *J Tradit Chin Med* 2012;32(4):545–548; doi: 10.1016/S0254-6272(13)60068-0
17. Zhang Y, Zhang L, Lu M. Acupuncture combined with femoral nerve block for postoperative analgesia after total knee arthroplasty and functional rehabilitation: A randomized controlled trial. *Zhongguo Zhen Jiu* 2018;38(3):251–255.
18. Chen Z, Shen Z, Ye X, et al. Acupuncture for rehabilitation after total knee arthroplasty: A systematic review and meta-analysis of randomized controlled trials. *Front Med (Lausanne)* 2020;7:602564; doi: 10.3389/fmed.2020.602564
19. Bae H, Bae H, Min B-I, et al. Efficacy of acupuncture in reducing preoperative anxiety: A meta-analysis. *Evid Based Complement Alternat Med* 2014;2014:850367; doi: 10.1155/2014/850367
20. Tong Q, Liu R, Zhang K, et al. Can acupuncture therapy reduce preoperative anxiety? A systematic review and meta-analysis. *J Integr Med* 2021;19(1):20–28; doi: 10.1016/j.joim.2020.10.007
21. Lewis GN, Rice DA, McNair PJ, et al. Predictors of persistent pain after total knee arthroplasty: A systematic review and meta-analysis. *Br J Anaesth* 2015;114(4):551–561; doi: 10.1093/bja/aeu441
22. Moerman N, van Dam F, Muller MJ, et al. The Amsterdam Preoperative Anxiety and Information Scale (APAIS). *Anesth Analg* 1996;82(3):445–451.
23. Karst M, Winterhalter M, Munte S, et al. Auricular acupuncture for dental anxiety: A randomized controlled trial. *Anesth Analg* 2007;104(2):295–300; doi: 10.1213/01.ane.0000242531.12722.fd
24. Dellovo AG, Souza LMA, de Oliveira JS, et al. Effects of auriculotherapy and midazolam for anxiety control in patients submitted to third molar extraction. *Int J Oral Maxillofac Surg* 2019;48(5):669–674; doi: 10.1016/j.ijom.2018.10.014
25. Qu F, Zhang D, Chen L-T, et al. Auricular acupressure reduces anxiety levels and improves outcomes of *in vitro* fertilization: A prospective, randomized and controlled study. *Sci Rep* 2014;4(1):5028; doi: 10.1038/srep05028
26. Wu S, Liang J, Zhu X, et al. Comparing the treatment effectiveness of body acupuncture and auricular acupuncture in preoperative anxiety treatment. *J Res Med Sci* 2011;16(1):39–42.
27. Wang S-M, Peloquin C, Kain ZN. The use of auricular acupuncture to reduce preoperative anxiety. *Anesth Analg* 2001; 93(5):1178–1180; doi: 10.1097/00000539-200111000-00024
28. Wang S-M, Punjala M, Weiss D, et al. Acupuncture as an adjunct for sedation during Lithotripsy. *J Altern Complement Med* 2007;13(2):241–246; doi: 10.1089/acm.2006.6262
29. Stamenkovic DM, Rancic NK, Latas MB, et al. Preoperative anxiety and implications on postoperative recovery: What can we do to change our history. *Minerva Anestesiol* 2018; 84(11):1307–1317; doi: 10.23736/S0375-9393.18.12520-X
30. Hirschmann MT, Testa E, Amsler F, et al. The unhappy Total Knee Arthroplasty (TKA) patient: Higher WOMAC and lower KSS in depressed patients prior and after TKA. *Knee Surg Sports Traumatol Arthrosc* 2013;21(10):2405–2411; doi: 10.1007/s00167-013-2409-z
31. Rymaszevska J, Kiejna A, Hadryś T. Depression and anxiety in coronary artery bypass grafting patients. *Eur Psychiatry* 2003;18(4):155–160; doi: 10.1016/S0924-9338(03)00052-X
32. Ekblom A, Hansson P, Thomsson M, et al. Increased postoperative pain and consumption of analgesics following acupuncture. *Pain* 1991;44(3):241–247; doi: 10.1016/0304-3959(91)90092-C



33. Ulett G. Conditioned healing with electroacupuncture. *Alternative therapies in health and medicine. Altern Ther Health Med* 1996;2(5):56–60.
34. Helms JM, Walkowski SA, Elkiss M, et al. HMI auricular trauma protocol: An acupuncture approach for Trauma spectrum symptoms. *Deutsche Zeitschrift Für Akupunktur* 2012;55(4):5–8; doi: 10.1016/j.dza.2012.11.002
35. Sawyer RD. *Acupuncture: A comprehensive text*. By the Shanghai College of Traditional Medicine. Translated and edited by John O'Connor and Dan Bensky. Chicago: Eastland Press, 1981. xvi, 741 pp. Charts, Appendixes, Bibliographies, Indexes. \$55. *J Asian Stud* 1983;42(4):942–944; doi: 10.2307/2054805
36. Oleson T, Kroening R. A comparison of Chinese and Nogier acupuncture points. *Am J Acupunct* 1983;11(3):205–223.
37. Li C, Wang Y, Li B, et al. Effects of acupuncture at Neiguan in neural activity of related Brain regions: A resting-State fMRI study in anxiety. *Neuropsychiatr Dis Treat* 2022;18:1375–1384; doi: 10.2147/NDT.S368227
38. Lee A, Chan SK, Fan LT. Stimulation of the wrist acupuncture point PC6 for preventing postoperative nausea and vomiting. *Cochrane Database Syst Rev* 2015;2015(11):CD003281; doi: 10.1002/14651858.CD003281.pub4
39. Borgeat A, Stirnemann HR. Antiemetische Wirkung von Propofol. *Anaesthesist* 1998;47(11):918–924; doi: 10.1007/s001010050643
40. Sneyd JR, Carr A, Byrom WD, et al. A meta-analysis of nausea and vomiting following maintenance of anaesthesia with propofol or inhalational agents. *Eur J Anaesthesiol* 1998; 15(4):433–445; doi: 10.1046/j.1365-2346.1998.00319.x
41. Greene NH, Habib AS. Midazolam for anxiolysis and postoperative nausea and vomiting prophylaxis. *Anesth Analg* 2016; 122(3):590–592; doi: 10.1213/ANE.0000000000001128
42. Patel I, Nham F, Zalikha AK, et al. Epidemiology of total hip arthroplasty: Demographics, comorbidities and outcomes. *Arthroplasty* 2023;5(1):2; doi: 10.1186/s42836-022-00156-1
43. Geoffrion R, Koenig NA, Zheng M, et al. Preoperative depression and anxiety impact on inpatient surgery outcomes. *Annals of Surgery Open* 2021;2(1):e049; doi: 10.1097/AS9.0000000000000049

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