

Intraoperative Acupuncture for Posttonsillectomy Pain: A Randomized, Double-Blind, Placebo-Controlled Trial

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Objectives/Hypothesis: To evaluate the effect of intraoperative acupuncture on posttonsillectomy pain in the pediatric population.

Study Design: Prospective, double-blind, randomized, placebo-controlled trial.

Methods: Patients aged 3 to 12 years undergoing tonsillectomy were recruited at a tertiary children's hospital between February 2011 and May 2012. Participants were block-randomized to receive acupuncture or sham acupuncture during anesthesia for tonsillectomy. Surgeons, staff, and parents were blinded from treatment. Tonsillectomy was performed by one of two surgeons using a standard technique (monopolar cautery), and a single anesthetic protocol was followed. Study endpoints included time spent in the postanesthesia care unit, the amount of opioids administered in the perioperative period, and pain measures and presence of nausea/vomiting from postoperative home surveys.

Results: Fifty-nine children aged 3 to 12 years were randomized to receive acupuncture (n = 30) or sham acupuncture (n = 29). No significant demographic differences were noted between the two cohorts. Perioperative data were recorded for all patients; 73% of patients later returned home surveys. There were no significant differences in the amount of opioid medications administered or total postanesthesia care unit time between the two cohorts. Home surveys of patients but not of parents revealed significant improvements in pain control in the acupuncture treatment-group postoperatively ($P = 0.0065$ and 0.051 , respectively), and oral intake improved significantly earlier in the acupuncture treatment group ($P = 0.01$). No adverse effects of acupuncture were reported.

Conclusions: This study demonstrates that intraoperative acupuncture is feasible, well tolerated, and results in improved pain and earlier return of diet postoperatively.

Key Words: Acupuncture, tonsillectomy, pain, analgesia.

Level of Evidence: 1b.

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INTRODUCTION

Tonsillectomy is one of the most commonly performed surgical procedures in the United States, with an estimated 737,000 patients undergoing the operation each year.¹ The procedure is accompanied by significant morbidity such as postoperative bleeding, pain, nausea, vomiting, poor oral intake, and dehydration. Poor oral intake caused by pain can limit oral administration of analgesic medications and further complicates pain control. A large body of literature describes strategies

designed to properly manage postoperative pain after tonsillectomy,^{2–5} with an emphasis on drug combinations such as acetaminophen, nonsteroid antiinflammatory drugs (NSAIDs), and opioids. Although such regimens can be effective and are at present the mainstay approach in the pediatric population, the use of opioid medications can precipitate or exacerbate nausea, vomiting, respiratory suppression, and—as seen in some well publicized cases—can result in death.⁶

The use of perioperative acupuncture as an adjunct to reduce nausea and vomiting and improve postoperative pain has been increasingly explored as possible alternative analgesics. A recent Cochrane systematic review of 40 trials concluded that P6 acupoint (neiguan) stimulation was effective in reducing postoperative nausea and vomiting (PONV).⁷ The positive effect of acupuncture on PONV has also been shown in a study on pediatric posttonsillectomy patients.⁸ Its ability to improve pain control after tonsillectomy has been studied in adults; however, this study employed only postprocedure inpatient acupuncture that was timed with NSAID administration.⁹

In our hospital, acupuncture has been used for over 20 years on the pediatric pain service as an adjunctive therapy for decreasing pain and treating nausea in both acute and chronic painful conditions. We hypothesized

Additional Supporting Information may be found in the online version of this article.

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that intraoperative acupuncture would also decrease postoperative pain and nausea in pediatric patients undergoing tonsillectomy.

MATERIALS AND METHODS

Patient Recruitment

Children scheduled to undergo tonsillectomy at Lucile Packard Children's Hospital Stanford, a tertiary children's hospital in Palo Alto, California, were recruited to participate in the study. Inclusion criteria were being of American Society of Anesthesiologists physical status of 1 or 2, age 3 to 12 years on the day of surgery, and having diagnoses of obstructive sleep apnea, chronic tonsillitis, or tonsillar hypertrophy as indications for tonsillectomy. Patients receiving concurrent adenoidectomy or tympanostomy tubes were included, but patients undergoing any additional procedures were excluded. Moreover, patients with a history of chronic opioid use, body mass index of greater than 30, previous adverse reaction to opioid medications, or developmental delay were excluded. The sample size needed for powered analysis could not be calculated given the absence of any previously published data on pediatric acupuncture for posttonsillectomy pain. However, previous studies on perioperative surgical pain suggested a mean difference of 35% between treatment and control groups.¹⁰ Based on this estimate, a sample size of 27 in each group was estimated to allow detection of a 0.05 level of significance and a power of 80%. Allowing for dropouts, we planned to enroll a total of 60 children. Informed consent was obtained; and when appropriate, children were asked to assent verbally or in writing. All study forms and surveys were available in English and Spanish. All protocols were approved by the Stanford University School of Medicine Institutional Review Board.

Block randomization (every 10 patients; <http://www.randomization.com>) was performed prior to study initiation. The randomization was generated by author G.J.T., the patients were recruited by authors A.G.C. and A.H.M., the acupuncture/sham was performed by J.S. and B.G. As patients were recruited, they were sequentially assigned to receive acupuncture or sham acupuncture accordingly. The acupuncturists were informed of the results of randomization for the participants the morning of surgery. The surgeons (A.G.C. and A.H.M.) were blinded to the randomization, as were the patients, parents, and the postanesthesia care unit (PACU) nursing staff.

Anesthesia

The perioperative protocol included a standard oral premedication of 0.5 mg/kg of midazolam. Anesthesia was induced by inhalation induction with sevoflurane and nitrous oxide. The patients were orotracheally intubated after intravenous administration of 2 to 4 mg/kg of propofol, 3 mcg/kg of hydromorphone, and 0.5 mg/kg of dexamethasone. Additional hydromorphone was administered as needed and titrated to a respiratory rate of >20 in the operating room. In the PACU, opioids were administered per protocol: fentanyl 0.5 mcg/kg for mild pain; hydromorphone 1 mcg/kg for moderate or severe pain. To convert fentanyl units to hydromorphone units, micrograms of fentanyl were multiplied by a conversion factor of 5 to yield micrograms of hydromorphone.¹¹ Postoperatively, the patients were discharged home on a protocol of alternating acetaminophen and ibuprofen. No postoperative opioids were prescribed for use at home.

Acupuncture was performed by one of two American Academy of Medical Acupuncture board-certified acupuncturists (J.S. or B.G.). Streitberger needles, blunt control needles that collapse

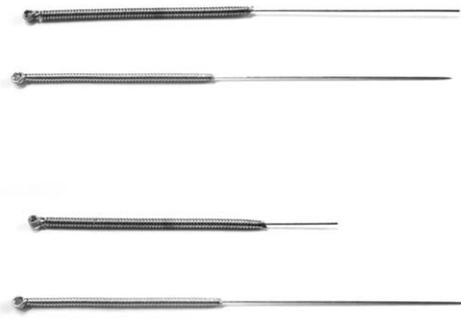


Fig. 1. Streitberger needles are shown above the standard acupuncture needles. Streitberger needles are blunt control needles that collapse into the handle of the acupuncture needle and do not penetrate the skin.

into the handle of the acupuncture needle and do not penetrate the skin (Fig. 1), were used for patients who were randomized to sham acupuncture. All of the needles were placed through specially designed needle holders to allow for blinding of the surgeons and other staff. Seirin junior acupuncture tacks (or control stickers without tacks) were placed in four ear acupuncture points after the body points were needled. All needles were removed at the conclusion of surgery.

Electroacupuncture at alternating frequencies of 4 and 100 Hertz using a Pantheon stimulator from point LI4 (hegu) to ST36 (zusanli), P6 (neiguan) to SJ5 (waiguan), and at KI6 (zhaohai) (Fig. 2). These points were chosen for their analgesic properties (ST36), relationship to analgesia at throat and head and neck (LI4, KI6), and antiemetic properties (P6). Alternating frequencies were chosen to optimize the release of endogenous endorphins, enkephalins, and dynorphins. Acupuncture needles were also placed at HT7 (shenmen) at the wrist crease on the ulnar side of the flexor carpi ulnaris tendon bilaterally without stimulation to decrease postoperative agitation.¹² The needles were placed to a depth at which a *fascial grab* (deqi) was perceived by the practitioners, at approximately 0.5 to 1 cm. Seirin junior tacks were placed at auricular points HT7, master cerebral, cingulate gyrus, and tonsil for the duration of the surgery.

Surgery

Extracapsular tonsillectomy was performed on all patients with monopolar electrocautery set at 15 W. Suction cautery was set at 30 W for targeted hemostasis. Adenoid removal, when performed concurrently, was performed with suction cautery at a setting of 30 W.

Endpoint Analysis

A survey form was completed by the PACU nurse. Vital signs, pain scores, presence of nausea and/or vomiting, pain medication administration, and total amount of time in the PACU were recorded. The nurse recorded any perceived adverse outcomes from acupuncture. In the present study, no adverse events were observed.

The parents/guardian were given a home questionnaire to record pain scores, as perceived by the parent and also by the child (Wong Baker Pain FACES Scale; Oklahoma City, OK).¹³ This survey was based on a posttonsillectomy survey previously published.³ The child's oral intake as a percentage of usual intake and postoperative events such as nausea and vomiting were also recorded. These were recorded twice a day through

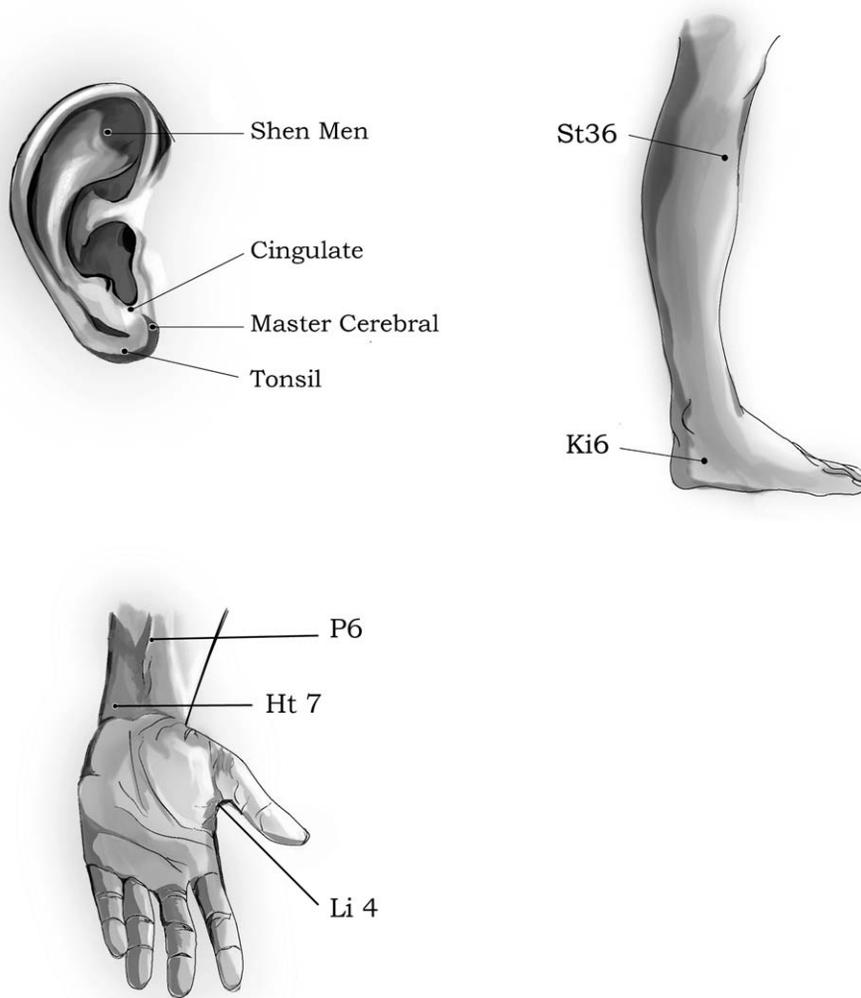


Fig. 2. Acupoints used on the pinna, forearm, hand, and leg.

the third postoperative day, and completed surveys were returned to the otolaryngology service at the child's postoperative visit. Postoperatively, parents were instructed to administer alternating weight-based dosing of acetaminophen and ibuprofen around the clock, regardless of the patient's pain status; this is our standard posttonsillectomy pain management protocol.

Our endpoints were time spent in the PACU and opioids administered in the perioperative period (operating room and PACU), as well as pain measures and the presence of nausea/vomiting from the postoperative home survey. Repeated measures analysis of variance (rANOVA) was used to compare longitudinal outcomes between two groups. The Greenhouse-Geisser correction was applied to account for potential nonhomogeneity of variations, that is, the violation of the sphericity assumption.¹⁴ Statistical significance was set at a *P* value of less than or equal to 0.05. Statistical analysis was performed using Stata 13.1 (StataCorp, College Station, TX). No changes were made to the study protocol after trial commencement.

RESULTS

Fifty-nine children were enrolled in the study between February 2011 and May 2012. Of these, 29 were randomized to the control group and 30 to the acu-

puncture group. PACU data points were collected on all patients. Postoperative home surveys were obtained from 43 patients (73%), 20 in the control group and 23 in the acupuncture group (Fig. 3). There were no significant differences in subject demographics between the two groups (Table I).

The amount of opioid medications administered was standardized to hydromorphone mcg/kg units. There were no significant differences in the amount of intravenous opioids administered between the two groups in the operating room or in the PACU (*P* = 0.38 and 0.76, respectively) (Fig. 4). Total time spent in the PACU was also not significantly different between the two groups (*P* = 0.51) (Fig. 5). Vital sign measurements were not significantly different between the two groups. Five patients in each group experienced PONV in the PACU.

Data from the home surveys demonstrated a significant difference in postoperative pain between the acupuncture and control groups, as reported by the patients survey (*P* = 0.0065), and only a trend toward improvement in the parents survey (*P* = 0.051). The treatment-time interaction was significant for both parent- and patient-reported data (*P* = 0.0085 and *P* = 0.043),

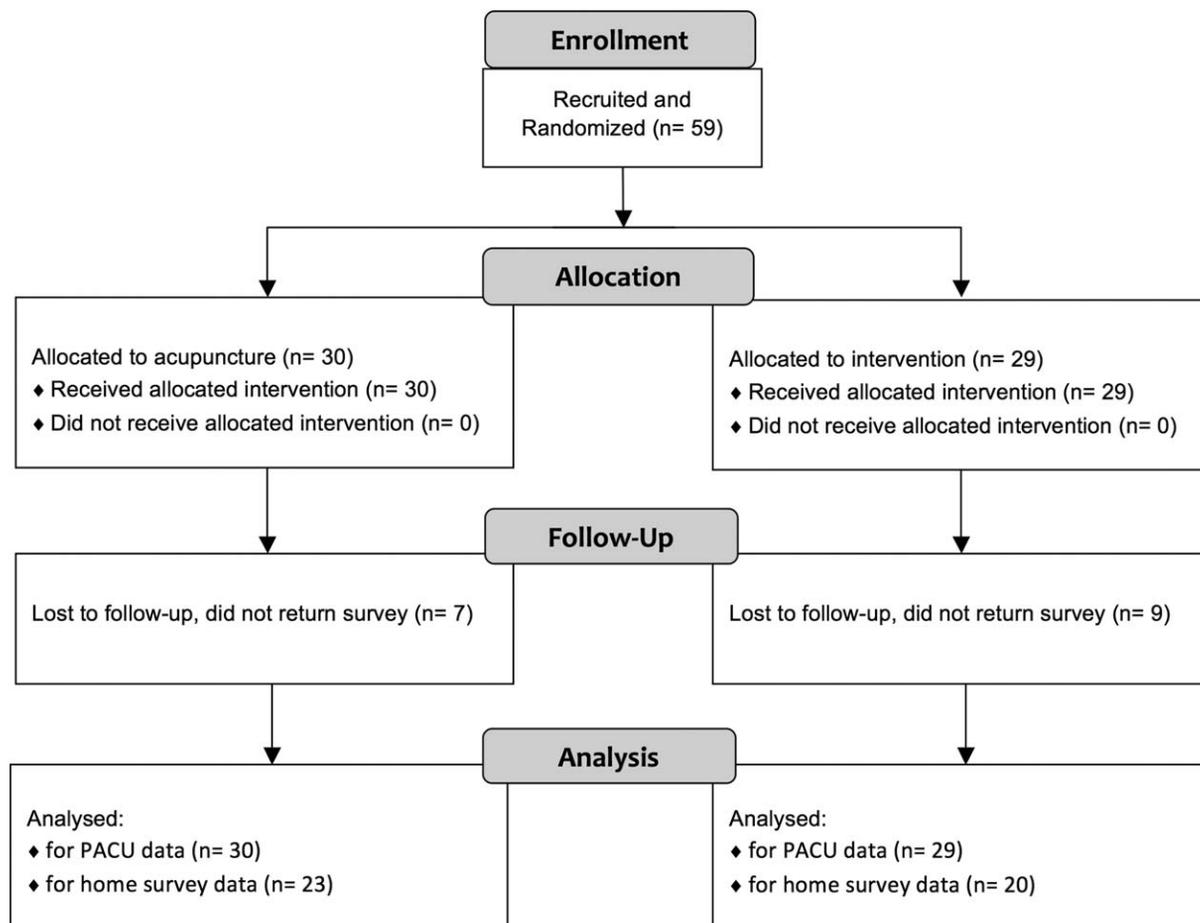


Fig. 3. Participant flow diagram. PACU = postanesthesia care unit.

implying that the effect of acupuncture on pain control changed over time. After correction for nonhomogeneity in group variations, the treatment-time interaction remained significant for the parent-reported data ($P = 0.039$) but not for patient-reported data ($P = 0.098$). Considering the presence of time-treatment interactions, additional tests were performed to evaluate the treatment effect at specific time points. From patient-reported data, the acupuncture-treated group experienced significantly less pain at time points of 24 and 36 hours ($P = 0.049$ and 0.01), but not at 12 and 48 hours or later time points ($P = 0.48$ and 0.095) (Fig. 6). From the parent-reported data, the difference was only statistically significant at 36 hours ($P = 0.02$) (Fig. 6).

In parallel, we examined the effects of time on our data set and found that time was also a significant variable for both parent- and patient-reported data ($P = 0.0003$ and $P = 0.0038$, rANOVA). Time remained significant with correction for nonhomogeneity in group variations for both parent- ($P = 0.0070$) and patient-reported data ($P = 0.026$). When compared to pain reported at the postoperative 12-hour time point, patient-reported data showed that the acupuncture-treated cohort had significantly less pain from 36 through 84 hours ($P = 0.003$ – 0.036), except at the 60-hour time point ($P = 0.157$). This contrasts the control

cohort, which had significantly less pain starting at a later time point of 84 to 96 hours ($P = 0.022$ and 0.001). The parent-reported data showed a similar trend, with the acupuncture cohort having significantly less pain at 36 and 48 hours ($P = 0.011$ and 0.005), whereas the control cohort exhibited significantly less pain starting at 72 to 96 hours ($P = 0.009$, $P = 0.009$, $P < 0.001$). Together, these analyses suggest that the acupuncture cohort

TABLE I.
Demographical Data for the Acupuncture and Control Groups.

	Acupuncture	Control	P Value
n =	30	29	–
Age, mean	6.98	6.67	0.68
Female	9	16	0.07
Male	21	13	
English	25	25	1.00
Spanish	5	4	
Surgeon 1	13	10	0.6
Surgeon 2	17	19	
OSA	26	27	1.00
Tonsillitis	4	5	

OSA = obstructive sleep apnea.

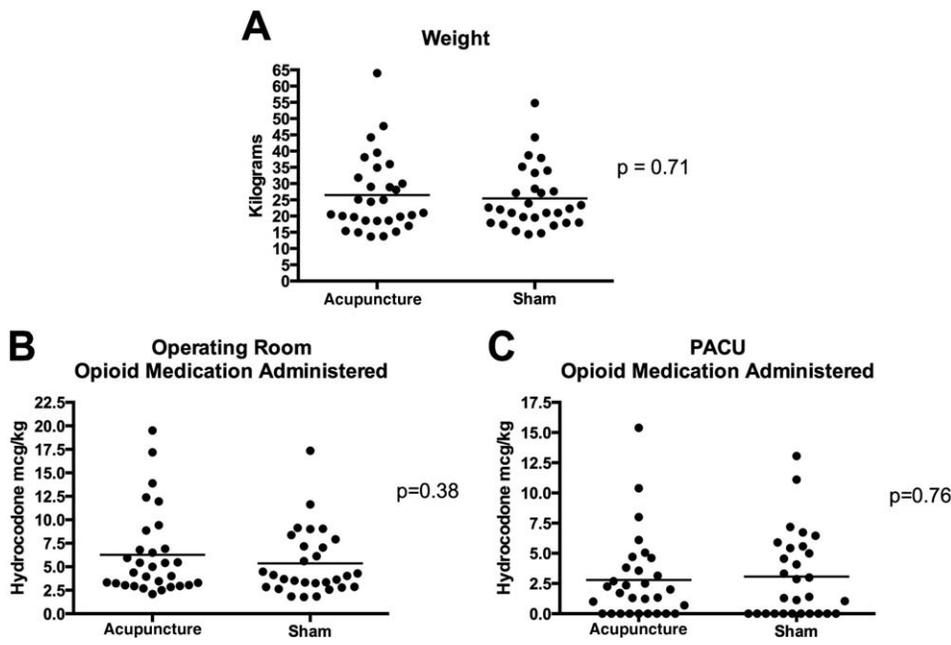


Fig. 4. (A) Weight distribution for both the acupuncture and control groups with each patient represented by a dot. Horizontal lines represent the mean. (B) Standardized hydromorphone mcg/kg units administered for each patient in the operating room. (C) Standardized hydromorphone mcg/kg units administered for each patient in the PACU. PACU = postanesthesia care unit.

experienced significantly less pain at various postoperative time points as compared to the control cohort, and also that the onset of analgesia in the acupuncture cohort began by 36 hours postoperatively, whereas the control group did not reach significant analgesia until 84 hours postoperatively.

Although pain is considered a clinical endpoint in and of itself, we looked at additional clinically relevant measures of oral intake and nausea/vomiting as secondary endpoints of pain control. Oral intake was significantly more improved in the acupuncture group than the control group ($P = 0.01$) (Fig. 7). The effect of time on oral intake was also significant with and without correction for sphericity ($P < 0.0001$ for both, $rANOVA$). When compared to oral intake at the postoperative 12-hour time point, the acupuncture group had significantly increased oral intake starting at 24 hours and lasting through all remaining time points examined, whereas the control group had significantly increased oral intake starting at 72 hours postoperatively. The incidence of nausea and vomiting after leaving the PACU did not significantly differ between the two groups: five patients in the acupuncture group and seven patients in the control group experienced nausea and/or vomiting ($P = 0.12$).

DISCUSSION

The use of acupuncture has increasingly been explored in the perioperative period. There have been several studies examining acupuncture's effect on posttonsillectomy nausea and vomiting.^{8,15-18} Far fewer have assessed the ability of acupuncture to reduce pain in this challenging setting. Although the application of acupuncture analgesia to posttonsillectomy patients was first reported in 1973,¹⁹ only one, which was conducted in an adult patient population, has explored this in a randomized, controlled fashion.⁹ Furthermore, this study

applied acupuncture only postoperatively in conjunction with NSAID administration in an inpatient setting. To our knowledge, there is no prior randomized trial examining the effect of intraoperative acupuncture on posttonsillectomy pain in a pediatric population.

In a randomized controlled trial, Lin et al. examined the effect of intraoperative acupuncture on postoperative pain and emergence agitation in 60 children undergoing myringotomy and tympanostomy tube placement.¹² As in our study, acupuncture was administered immediately after induction of anesthesia. Postoperative pain was assessed by a blinded evaluator using the CHEOPS (Children's Hospital of Eastern Ontario Pain Scale) pain scale. The CHEOPS Pain Scale is a validated pain scale used to evaluate postoperative pain in young children.²⁰ It grades six parameters (cry, facial, verbal, torso, touch, and legs) and applies points ranging from 0 to 3, for a minimum score of 4 and maximum score of 13. Compared to the control group, pain and agitation scores were significantly lower in the acupuncture group upon arrival in the PACU, with those effects continuing beyond 30 minutes.

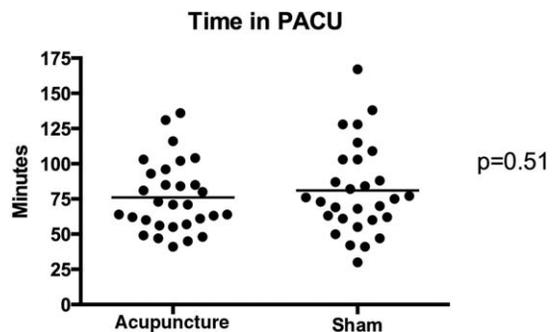


Fig. 5. The total amount of time spent in the PACU. PACU = postanesthesia care unit.

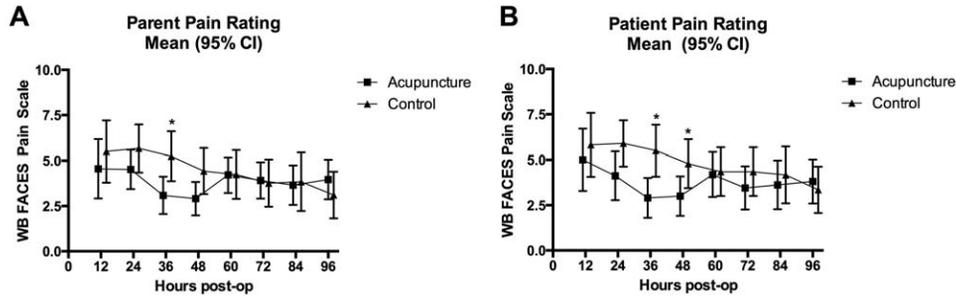


Fig. 6. Home survey-reported pain data (A) Parent rating of pain over time, measured every 12 hours for 96 hours. Wong Baker FACES Pain Scale utilized with higher numbers indicating increased pain. Asterisks are noted over time points when differences between two groups were statistically significant. (B) Patient rating of pain over time.

In our study, there were no differences between the acupuncture and control groups in terms of the amount of administered opioid medications administered intraoperatively or in the PACU, and there was no difference in the amount of time spent in PACU. These findings may be attributed to several factors. First, the degree of pain experienced after tonsillectomy exceeds that from myringotomy and tube placement; therefore, the amount of analgesics needed to control postoperative pain and minimize agitation is expected to be higher. Second, PACU nurses were given the liberty of administering additional doses of opioids on an as-needed basis. The possibility of generous administration may have masked any differences between the two groups. There were no differences noted in nausea/vomiting between the two groups both perioperatively and postoperatively. Our patients had very low rates of nausea/vomiting; therefore, other factors in our regimen (e.g. surgical technique, postprocedure gastric suctioning, propofol administration for intubation and antiemetic administration) may have confounded the results.

We do, however, find the differences between the treatment and control groups in postoperative pain scores to be clinically significant, particularly when treatment resulted in an earlier improvement of oral intake. In the pain management literature, a 2-point reduction on the standard 11-point scale (0–10) is considered a clinically important difference,²¹ and that criteria is met when surveying both the parents and the patients. In our study, we focused primarily on perioperative endpoints such as opioid requirement, time in

PACU, pain scores, and oral intake. Additional study of these endpoints may further characterize the clinical significance of our findings. The effects of intraoperative acupuncture without additional postoperative acupuncture treatment are likely time limited. This probably explains the limited treatment effect up to 48 hours observed in our study.

We did not observe any adverse side effects of acupuncture in this study. Complications related to acupuncture are very rare; however, study participants were still counseled on the risks of capillary bleeding/hematoma, pain, and infection. Worldwide infection rates from acupuncture since the 1970s have been no higher than 0.0031%.²² Our use of sterile disposable needles and alcohol prep to the skin further diminished this risk.

Intraoperative acupuncture is a relatively new area of research. One of the strengths of this study is its rigorous double-blinded randomized design with a sham acupuncture control. Tonsillectomy is a consistent and reproducible procedure, as opposed to studies involving intraoperative acupuncture applied to a variety of different procedures. Weaknesses of this study include a modest lost to follow-up rate of 27% and a small number of patients, limiting the power of our study to detect differences that may be present between the two groups. Further studies involving more extensive acupuncture regimens and a larger patient population would be of interest.

CONCLUSION

This study demonstrates that intraoperative acupuncture is feasible, well tolerated, and results in improved pain and oral intake postoperatively.

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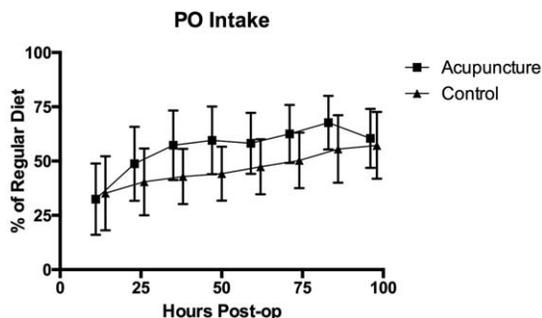


Fig. 7. Home oral intake measured every 12 hours, as a percentage of the child's normal diet.

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