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Acupuncture and related techniques for postoperative pain: a systematic review of randomized controlled trials

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Postoperative pain management remains a significant challenge for all healthcare providers. The objective of this systematic review was to quantitatively evaluate the efficacy of acupuncture and related techniques as adjunct analgesics for acute postoperative pain management. We searched the databases of Medline (1966–2007), CINAHL, The Cochrane Central Register of Controlled Trials (2006), and Scopus for randomized controlled trials (RCTs) using acupuncture for postoperative pain management. We extracted data about postoperative opioid consumption, postoperative pain intensity, and opioid-related side-effects. Combined data were analysed using a random effects model. Fifteen RCTs comparing acupuncture with sham control in the management of acute postoperative pain were included. Weighted mean difference for cumulative opioid analgesic consumption was −3.14 mg (95% confidence interval, CI: −5.15, −1.14), −8.33 mg (95% CI: −11.06, −5.61), and −9.14 mg (95% CI: −16.07, −2.22) at 8, 24, and 72 h, respectively. Postoperative pain intensity (visual analogue scale, 0–100 mm) was also significantly decreased in the acupuncture group at 8 and 72 h compared with the control group. The acupuncture treatment group was associated with a lower incidence of opioid-related side-effects such as nausea (relative risk, RR: 0.67; 95% CI: 0.53, 0.86), dizziness (RR: 0.65; 95% CI: 0.52, 0.81), sedation (RR: 0.78; 95% CI: 0.61, 0.99), pruritus (RR: 0.75; 95% CI: 0.59, 0.96), and urinary retention (RR: 0.29; 95% CI: 0.12, 0.74). Perioperative acupuncture may be a useful adjunct for acute postoperative pain management.

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Postoperative pain management remains a significant challenge for healthcare providers. Many patients experience pain after surgery, with about 86% reporting moderate, severe, or extreme pain.[2 21] Opioids remain the mainstay for postoperative pain control. However, opioid analgesics are associated with undesirable side-effects, including nausea, vomiting, pruritus, sedation, dizziness, and decreased gut motility which can lead to delayed postoperative recovery.[13] The use of adjunct analgesics that provide opioid-sparing effects and decrease the incidence of opioid-related side-effects is therefore useful.

Acupuncture, a component of traditional Chinese medicine, is a well-known and widely used treatment for pain and other conditions that has been employed in China for more than 3000 yr. There have been increasing numbers of clinical trials evaluating the efficacy of acupuncture and related techniques as an adjuvant method for postoperative analgesia. Therefore, we performed this systematic review to quantitatively evaluate the available evidence for the efficacy of acupuncture and related techniques in postoperative pain management.

Methods

We followed the QUORUM guidelines in reporting this meta-analysis.[24] Published reports of clinical trials evaluating acupuncture in the management of acute postoperative pain were sought. Medline (1966–2007), CINAHL, The Cochrane Central Register of Controlled Trials (2006), and Scopus were searched without language restriction. Free text and MeSH terms 'acupuncture', 'acupressure', 'acupoint', 'electro-acupuncture', 'moxibustion', 'pain', 'analgesia', 'analgesic', 'opioid', 'narcotic', 'operation', 'surgical', 'surgery', and 'postoperative' were used for searching. The last electronic search was in October 2007. Abstracts of matching studies were screened by two independent reviewers (J.W.D. and Y.S.). Relevant articles were

obtained in full text for further review. The bibliographies of these articles were also screened for additional studies. We excluded data from letters, abstracts, case reports, experimental studies, or review articles.

Selection criteria

Randomized controlled trials (RCTs) of perioperative acupuncture for treatment of postoperative pain in adults (age >18) were included. The types of acupoint stimulation included were: acupuncture, acupressure, moxibustion, and transcutaneous electrical stimulation at acupoints.[5] Only those studies that reported on relevant postoperative pain outcomes such as postoperative pain scores and analgesic consumption were included. Trials were included if sham or placebo acupuncture was used as control intervention. Trials where the control group did not receive sham or placebo acupuncture were not considered for this review due to lack of blinding in these studies.

Validity assessment

All included reports were assessed by two independent reviewers (J.W.D. and Y.S.) using the modified Oxford Scale.[25] Discrepancies in scores were resolved by discussion with a third reviewer (A.S.H.). The minimum score of an included trial was 1, and the maximum score was 7.

Data abstraction

The following data points were independently extracted by two reviewers (J.W.D. and Y.S.): (i) type of acupuncture, (ii) type of surgery, (iii) type of anaesthesia, (iv) groups studied and number of patients, (v) pain scores at 8, 24, and 72 h after operation, (vi) total opioid analgesic consumption at 8, 24, and 72 h after operation, (vii) opioid-related side-effects, and (viii) duration of recovery room stay. Visual analogue pain scores (VAS, 0–100 mm, 0=no pain, 100=worst pain), as a pain outcome measure, was quantitatively analysed. Verbal rating pain scores (VRS, 0–10) or VAS (0–10) were converted to 0–100 mm VAS pain scores for analysis. Opioid analgesics were converted to morphine equivalents (mg).[20] Data reported in milligram per kilogram were converted to total milligram by multiplying the dose reported by the mean weight of the group. Side-effects noted for analysis included nausea, vomiting, pruritus, urinary retention, dizziness, and sedation. Data on combined nausea/vomiting were grouped under nausea. Side-effects listed as somnolence or drowsiness were grouped under the category of sedation. Itching was grouped under pruritus. We contacted the authors using various means if the manuscript did not report the appropriate data. The data were not considered if the authors failed to respond after numerous attempts. When a trial tested two frequencies for acupoint stimulation, and there was no graphical evidence of significant differences, we combined the data. When the studies did not report data exactly at the time points studied, data collected closest to those times were used for the analysis.

Meta-analysis

For continuous data, weighted mean differences (WMD) with 95% confidence interval (CI) were calculated. If the 95% CI included 0, we assumed that the difference between acupuncture and control was not statistically significant. Dichotomous data were analysed using relative risk (RR) with 95% CI. If the 95% CI around the RR did not include 1.0, we assumed that the difference between the acupuncture and the control groups was statistically significant. For combined data, a random effects model was used by default. Analyses were performed using ReviewManager software (version 4.2, Cochrane collaboration). Data were graphically plotted using forest plots to evaluate treatment effects. Number-needed-to-treat (NNT) was calculated for statistically significant reductions in opioid-related side-effects.

Subgroup analysis was conducted based on whether acupuncture was applied before or after operation. We also performed sensitivity analyses by restricting the analysis to high-quality RCTs as defined as those trials with validity score of 5 or greater and to RCTs in which both patients and assessor blinding was described and the method of blinding deemed adequate. We also conducted two additional sensitivity analyses by restricting the analysis to trials in patients undergoing abdominal surgery, and to trials in which acupuncture was achieved by needling of meridian points, since some believe that acupuncture must involve needle insertion.[3]

Results

We screened 126 potentially relevant papers, of which 111 were excluded for various reasons (Fig. 1). A total of 15 studies met the inclusion criteria (Table 1). All of these articles were in English and used standardized anaesthetic and postoperative analgesia regimens. Four authors were contacted for additional data; one responded.[6] A total of 1166 patients were studied, of whom 668 received acupuncture.

Surgical procedures and acupuncture interventions

The included studies encompassed a wide range of acupuncture interventions and types of surgery (Table 1). The majority of surgery was abdominal (six studies). The remaining studies included maxillo-facial surgery (two), knee surgery (two), haemorrhoidectomy (one), back surgery (one), thoracotomy (one), hip arthroplasty (one), and molar tooth extraction (one). General anaesthesia was used in 10 studies,[4 10 15 16 19 29 32 33 36 42] local anaesthesia in four,[6 17 18 23] and the type of anaesthesia was not specified in one study.[39] Of the 15 studies, six[4 6 9 29 36 42]

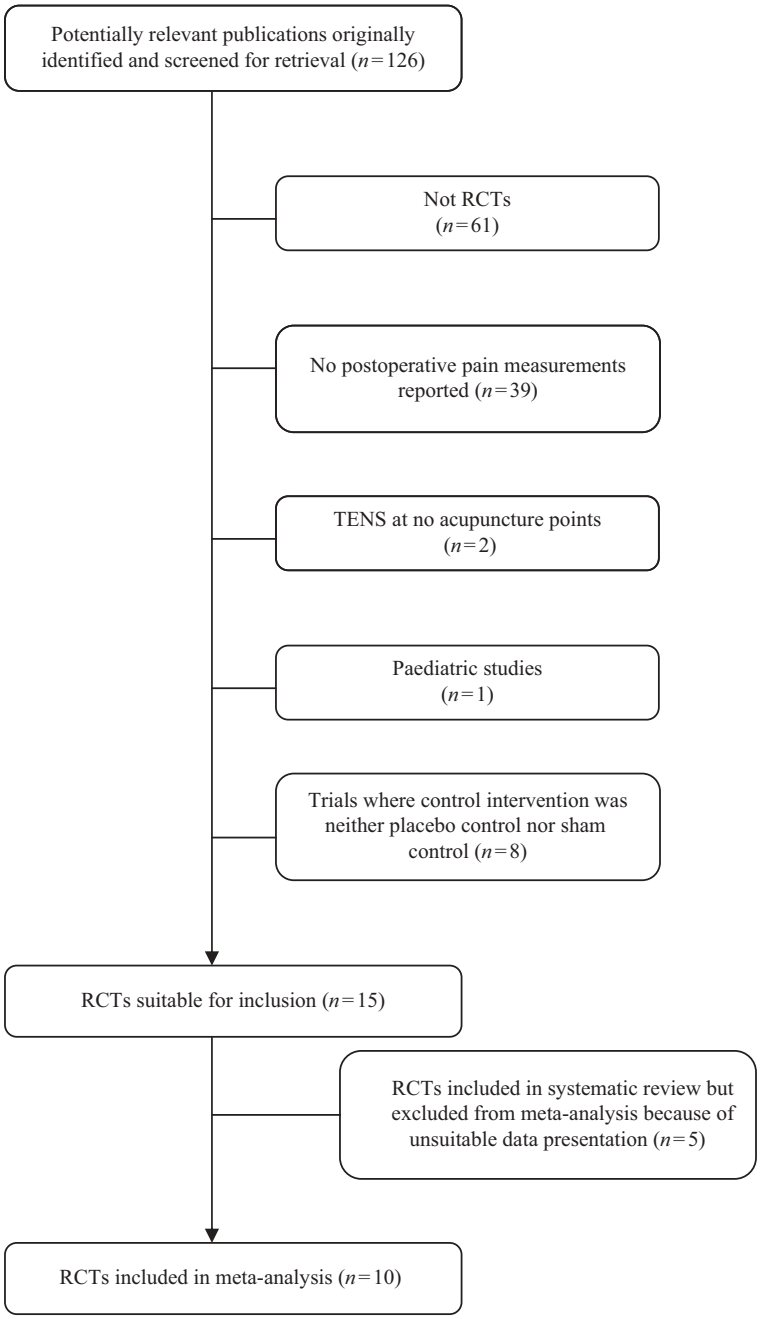

Fig 1 Flow chart of screened, excluded, and analysed studies. RCTs, randomized controlled trials; TENS, transcutaneous electrical nerve stimulation.

employed electro-acupuncture (EA) with two studies testing two frequencies of EA.[19 36] Of the others, there were four manual acupuncture,[16–18 39] one acupressure,[10] one capsicum plaster,[15] and three auricular acupuncture studies.[23 32 33] Acupoints were varied among those studies according to the surgical site and type of acupuncture (Table 1). Among these acupoints, ST36 and LI4 were used in four studies[4 15 19 29] and five studies,[6 17 18 36 42] respectively.

Acupuncture was initiated before surgery in six studies[4 16 19 23 32 33] and after surgery in seven studies.[4 6 10 17 18 36 42] One study tested both preoperative and postoperative acupuncture treatment.[29] The postoperative acupuncture group in this particular study, however, was not included in this review due to lack of blinding. Another study performed acupuncture before surgery and continued treatment for 3–6 days after surgery.[39]

Outcomes

Pain intensity

Nine studies reported VAS pain scores at rest as mean with standard deviation (Fig. 2).[6 15 19 29 32 33 36 39 42] One trial averaged pain scores over the course of the study and

Table 1 Randomized, double-blinded, placebo-controlled trials included in the analysis. A, real acupuncture; C, control; EA, electroacupuncture; AE, auricular electroacupuncture; AA, auricular acupuncture; LI, large intestine meridian; LU, lung meridian; ST, stomach meridian; BL, bladder meridian; GB, gallbladder meridian; LR, liver meridian; KI, kidney meridian; PC, pericardium meridian; TE, triple energiser meridian; Abd, abdominal; Pre-op, preoperative; Post-op, postoperative. Validity score: R, randomization; C, concealment of allocation; DB, double-blinding; F, flow of patients. Type of anaesthesia: G, general anaesthesia, E, epidural; L, local anaesthesia; NR, not reported

Clinical trial	Validity score (R/C/DB/F)	Sham control	Acupoints	Types of surgery (anaesthesia)	Number of patients (A/C)	Types of acupuncture	Administration	Duration
Lin and colleagues[19]	3 (2/0/0/1)	Mock EA with needle insertion	ST36	Abd. hysterectomy (G)	50 (2 A arms)/25	EA	Pre-op	20 min
Usichenko and colleagues[33]	7 (2/1/2/2)	Invasive needle at non-acupoints	Ear acupoints: shenmen, lung, knee joint	Ambulatory knee surgery (G)	61/59	AA	Pre-op	1 day
Usichenko and colleagues[32]	7 (2/1/2/2)	Invasive needle at non-acupoints	Ear acupoints: shenmen lung, thalamus, and hip point	Hip arthroplasty (G)	29/25	AA	Pre-op	3 days
Kim and Nam[15]	5 (2/1/1/1)	Stimulation at non-acupoints	ST36	Abd. hysterectomy (G)	30/30	Capsicum plaster	Pre-op	8 h/day for 3 days post-op
Kotani and colleagues[16]	6 (2/1/2/1)	Needle touched without penetration at acupoints	BL18–BL24 (upper abdominal) BL20–BL26 (lower abdominal)	Abdominal surgery (G+E)	50/48 (upper abd); 39/38 (lower abd)	Manual acupuncture	Pre-op	4 days
Sim and colleagues[29]	5 (2/0/2/1)	Needle touched without penetration at non-acupoints	ST36, PC 6	Abd. hysterectomy (G)	60 (2 A arms)/30	EA	Pre- and post-op	45 min
Wang and colleagues[36]	2 (1/0/0/1)	Mock TENS	LI 4	Lower abdominal surgery (G)	50 (2 A arms)/25	EA	Post-op	30 min every 2 h post-op
Chiu and colleagues[6]	4 (2/0/1/1)	Electro stimulation at non-acupoints	LI 4, LU 7	Haemorrhoidectomy (L)	30/30	EA	Post-op	30 min
Chen and colleagues[4]	1 (1/0/0/0)	Mock TENS	ST 36	Abd. hysterectomy (G)	25/25	EA	Post-op	30 min every 2–3 h post-op
Wong and colleagues[42]	7 (2/1/2/2)	Blunt-tip needle attached at acupoints with Mock EA	LI 4,GB 34, TE 8,GB 36	Thoracotomy (G)	13/12	EA	Post-op	2–30 min sessions for 7 days
Michalek-Sauberer and colleagues[23]	7 (2/1/2/2)	Mock TENS	Ear acupoints: shenmen, tooth, mouth	Molar tooth extraction (L)	76 (AE)/37 (AA)/36	AA	Pre-op	3 h every 6 h for 48 h
Wang and Tronnier[39]	2 (1/0/0/1)	Superficially needling away from acupoints	BL25, GB 31, BL26, GB 30, BL62, BL23, BL36, BL 40, GB 34	Lumbar disc surgery (NR)	66/66	Manual acupuncture	Pre- and post-op	Two to three 15 min treatment for 3–6 days
Lao and colleagues[17]	6 (2/1/2/1)	Plastic tubes taped at non-acupoints	LI 4, ST6, ST7, TE 17	Oral/maxillofacial surgery (L)	21/21	Manual acupuncture	Post-op	20 min
Lao and colleagues[18]	5 (2/0/2/1)	Plastic tubes taped at non-acupoints	LI 4, ST6, ST7, TE 17	Oral/maxillofacial surgery (L)	11/8	Manual acupuncture	Post-op	20 min
Felhendler and colleagues[10]	5 (2/1/1/1)	Light stimulation at non-acupoints	ST 1, ST 45, SP1, SP21, SP4, BL1, BL 67, KI 1, KI 27, KI 4, GB 1, GB 44, LR1, LR14, LR5	Knee arthroscopy (G)	20/20	Acupressure	Post-op	Not reported

was excluded from this analysis.[39] Only one study presented pain intensity on coughing, and meta-analysis was therefore not possible.[15] Three studies did report pain scores but not as mean and standard deviation, and the investigators did not provide the relevant data.[10 16 18] Three studies did not report data on pain scores.[4 17 23]

Three studies reported early (8 h) pain scores which when combined indicated significantly lower scores in the acupuncture group *vs* sham control (WMD: −14.57 mm; 95% CI: −23.02, −6.13).[6 15 19] Combined data from eight studies showed decreased pain scores at 24 h after operation in the acupuncture group compared with the control

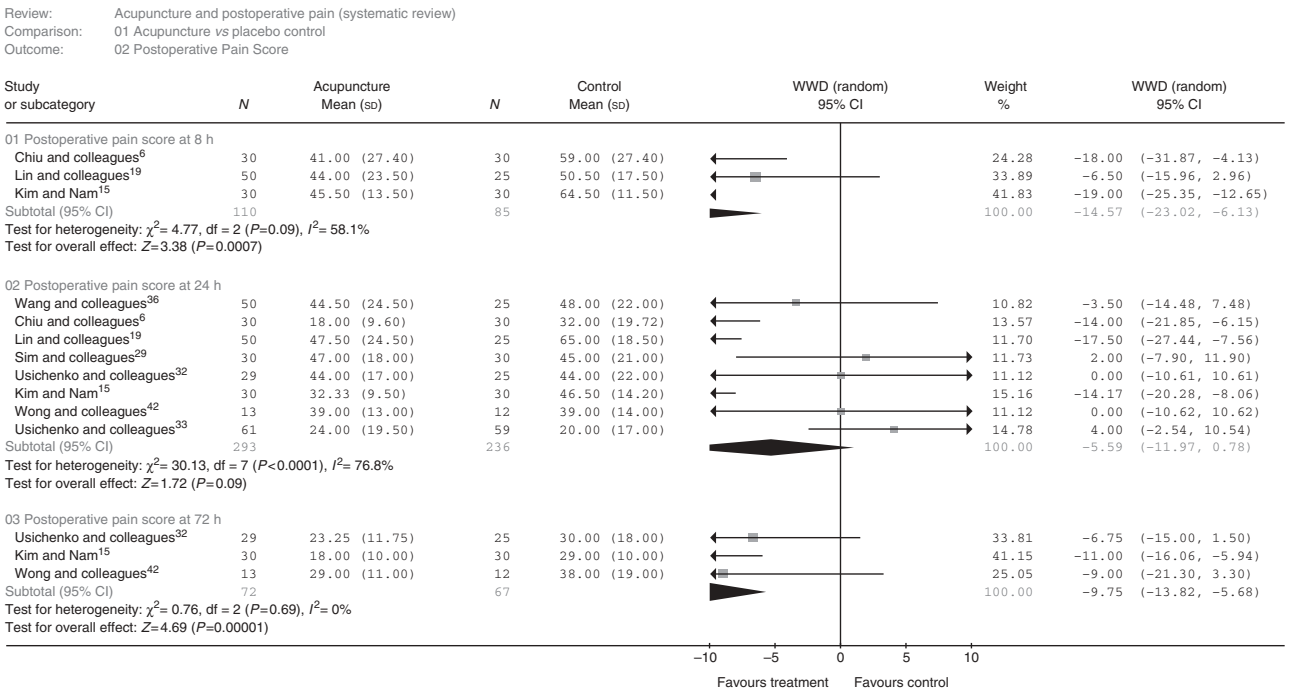

Fig 2 VAS for postoperative pain intensity at 8, 24, and 72 h (0–100 mm). A WMD <0 indicates less pain with acupuncture compared with control. When the 95% CI does not include zero, the difference is considered statistically significant.

group, but the difference was not statistically significant (WMD: −5.59 mm, 95% CI: −11.97, 0.78).[6 15 19 29 32 33 36 42] Three studies reported suitable data for analysis at 72 h after operation.[15 32 42] Combined results from these three studies showed significantly lower pain intensity with acupuncture compared with control at 72 h (WMD: −9.75 mm, 95% CI: −13.82, −5.68).

Cumulative postoperative opioid consumption

Three studies reported early (8 h) postoperative opioid consumption (Fig. 3).[15 19 29] Analgesic consumption was significantly lower in the acupuncture group compared with the sham placebo group (WMD: −3.14 mg; 95% CI: −5.15, −1.14). The morphine-sparing effect was 21%.

Eight studies reported opioid consumption at 24 h.[4 15 16 19 29 32 36 42] The mean difference at this time was −8.33 mg in favour of acupuncture (95% CI: −11.06, −5.61) with a morphine sparing effect of 23%.

Three studies had data suitable for analysis of cumulative 72 h postoperative opioid consumption.[6 32 42] The combined data also favoured acupuncture (WMD of −9.14 mg; 95% CI: −16.07, −2.22) with a 29% morphine sparing effect.

Opioid-related side-effects

Eight studies reported the incidence of nausea,[4 15 16 19 29 32 33 36] and six studies reported vomiting (Fig. 4).[4 15 19 32 33 36] One study reported nausea and vomiting collectively as a single side-effect and these data were grouped as nausea for the analysis.[29] Nausea occurred in 31% of patients in the acupuncture group and 44% of patients in the control group (RR: 0.67; 95% CI: 0.53, 0.86). The NNT was 6. Vomiting occurred in 11% of patients in the acupuncture group, and 15% of patients in the control group. This difference did not reach statistical significance (RR: 0.70; 95% CI: 0.42, 1.15).

Pooled data from seven studies[4 15 16 19 29 32 36] showed that pruritus occurred significantly less in the acupuncture group (23%) compared with the control group (34%) (RR: 0.75; 95% CI: 0.59, 0.96), with an NNT of 13.

Four studies reported on the occurrence of dizziness.[4 19 33 36] Thirty-two per cent of patients in acupuncture group experienced dizziness compared with 43% in the control group (RR: 0.65; 95% CI: 0.52, 0.81), with an NNT of 6. Sedation was reported in four studies.[16 29 32 33] The incidence of sedation was 32% in the acupuncture group and 41% in the control group (RR: 0.78; 95% CI: 0.61, 0.99), with NNT of 11. Only two studies reported urinary retention as an opioid-related side-effect.[6 15] The acupuncture group was associated with a lower incidence of urinary retention (8%) compared with the control group (28%) (RR: 0.29; 95% CI: 0.12, 0.74), with an NNT of 5.

Duration of recovery room stay

Four studies reported the duration of recovery room stay.[4 29 33 36] Combined data showed no significant difference between the acupuncture and the control groups (WMD: −2.30 min; 95% CI: −9.09, 4.50).

Acupuncture-related side-effects

Side-effects related to acupuncture were reported in five studies.[10 15 18 32 33] Since the reported outcomes were

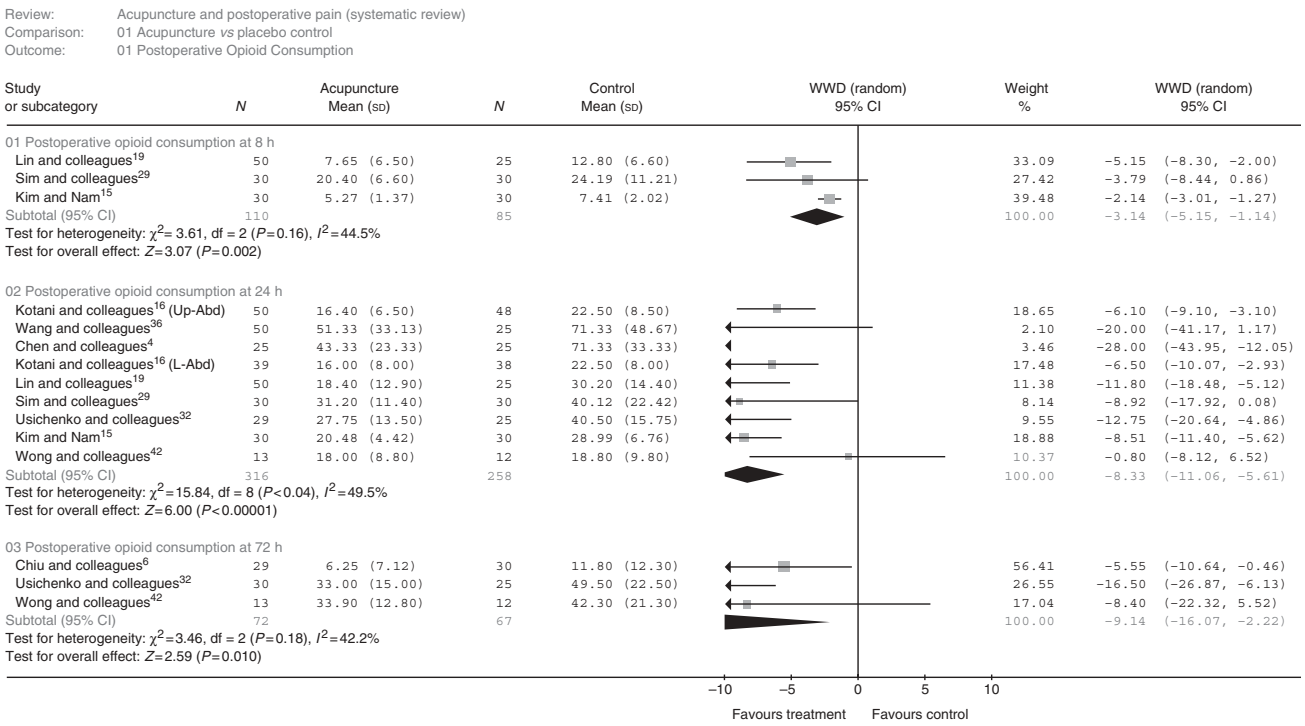

Fig 3 Cumulative postoperative opioid consumption at 8, 24, and 72 h (in mg morphine equivalents). A WMD <0 indicates less morphine consumption with acupuncture compared with control. When the 95% CI does not include zero, the difference is considered statistically significant.

different among the different studies; meta-analysis was not possible. Side-effects included minor bleeding at the acupuncture site and headache,[32] local pain and dizziness,[33] erythema due to Capsicum plaster,[15] and a little discomfort due to De Qi sensation.[18] Instantaneous bradycardia was reported in one trial.[10] None of these side-effects was significantly different compared with the control group, and all were reported to resolve spontaneously.

Subgroup analysis

We performed a subgroup analysis based on whether acupuncture was initiated before or after operation. Ten studies had suitable data for this. Acupuncture was started before operation in six studies[15 16 19 29 32 33] and after operation in four.[4 6 36 42] Only data at 24 h were suitable for subgroup analysis. The reduction in pain scores at 24 h was not statistically significant compared with placebo, whether acupuncture was applied before or after operation. Cumulative opioid consumption was lower in the acupuncture group compared with placebo in the two subgroups; however, the difference was only statistically significant when acupuncture was administered before operation (WMD −7.74 mg, 95% CI: −9.41, −6.07).

Sensitivity analysis

The overall results with regards to postoperative pain score and opioid consumption in the sensitivity analyses, including only studies with high validity scores, those with adequate double blinding, and those using needle acupuncture, were unchanged from the results including all the studies (Table 2).

The positive results for postoperative pain scores and opioid consumption were also unaffected by restricting analysis to studies involving abdominal surgery. Moreover, the pooled data showed significantly lower pain scores in the acupuncture group compared with the sham control at 24 h after operation (WMD −8.71 mm, 95% CI: −17.33, −0.08).

Discussion

In this meta-analysis, we found that acupuncture and related techniques are effective adjuncts for postoperative pain management as demonstrated by a significant reduction of postoperative pain scores and opioid consumption. The opioid-sparing effect was most marked at 72 h after operation where a 29% reduction of morphine consumption was demonstrated. The opioid-sparing effect at 8 and 24 h was 21% and 23%, respectively. It has been suggested that anaesthesia may inhibit the effects of acupuncture and that the analgesic effect of acupuncture is progressively more evident in the postoperative period.[19]

While the reduction in pain scores achieved with acupuncture was statistically significant at 8 and 72 h, the reduction in pain intensity was moderate and it could be argued that it may not be clinically relevant. The same applies to the small absolute reductions in opioid consumption. However, the relative reduction in opioid

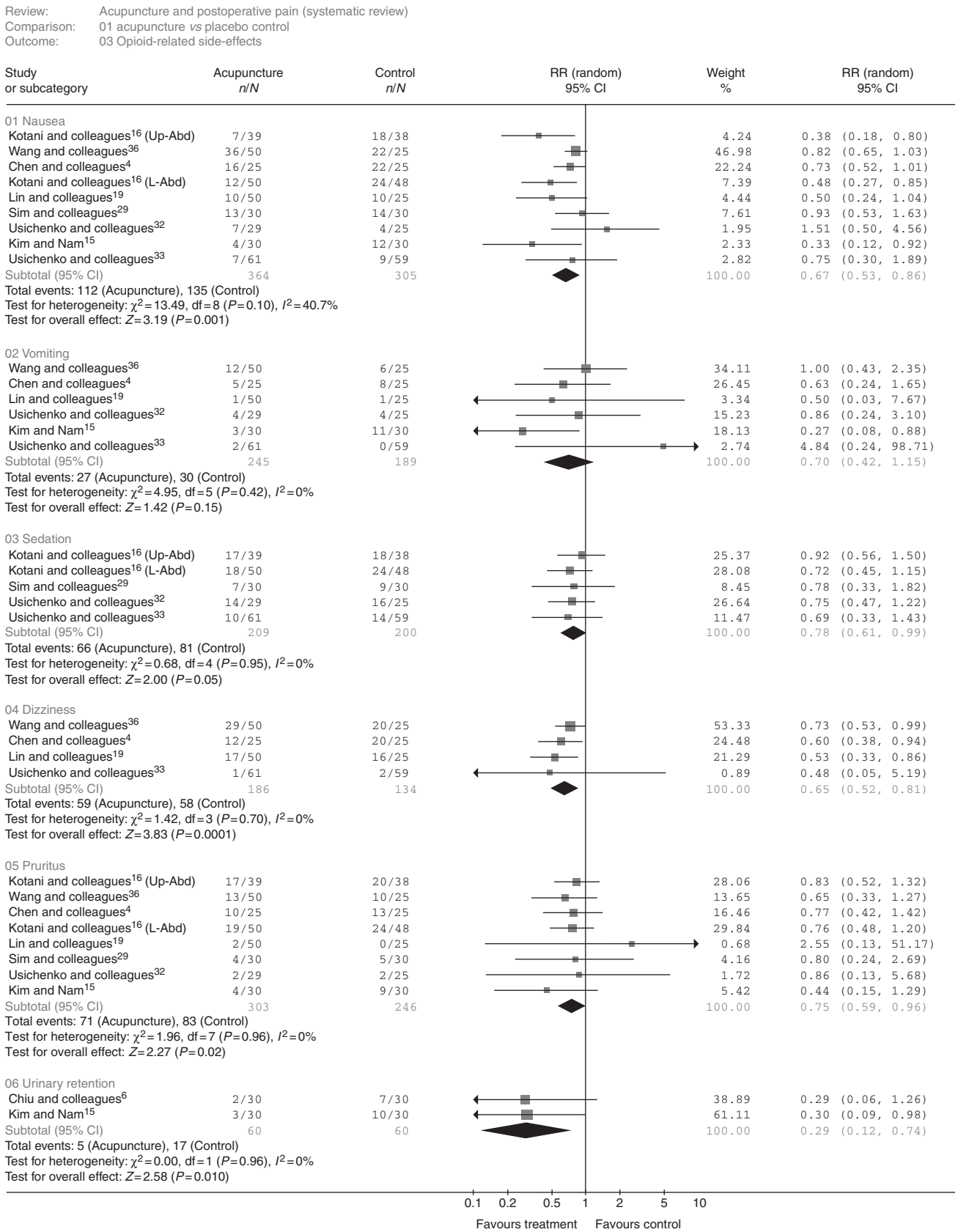

Fig 4 Opioid-related side-effects. A RR <0 indicates less opioid-related adverse effects with acupuncture compared with control. When the 95% CI does not include 1, the difference is considered statistically significant. Up-Abd, upper abdominal surgery; L-Abd, lower abdominal surgery.

Table 2 Results from the sensitivity analyses on the effects of acupuncture compared with the sham control. Sensitivity analyses were not performed at the following times: 8 h when only studies with adequate blinding were included since only one study reported data at that time, at 72 h when only trials involving abdominal surgery were included since no data were available at that time, and at 8 h (for pain scores) when studies with a validity score >4 or those involving needle acupuncture were included since only one study reported data at that time

Sensitivity analysis (number of studies)	Time point	WMD in postoperative pain score (95% CI) (number of studies)	WMD in postoperative opioid consumption (95% CI) (number of studies)
Higher validity (validity score >4)	8 h		−2.20 (−3.05, −1.34) (2)
	24 h	−1.95 (−10.07, 6.16) (5)	−7.09 (−9.13, −5.05) (5)
	72 h	−9.75 (−13.82, −5.68) (3)	−13.61 (−21.92, −5.29) (2)
Adequate blinding	24 h	−2.22 (−2.19, 6.63) (4)	−6.49 (−9.03,−3.96) (4)
	72 h	−7.45 (−14.30, −0.60) (2)	−13.61 (−21.92, −5.29) (2)
Abdominal surgery	8 h	−13.26 (−25.47, −1.05) (2)	−3.14 (−5.15, −1.14) (3)
	24 h	−8.71 (−17.33, −0.08) (4)	−8.53 (−11.25, −5.81) (5)
Needle acupuncture	8 h		−4.38 (−6.97, −1.80) (2)
	24 h	−2.80 (−10.07, 4.48) (5)	−7.11 (−9.74, −4.49) (6)
	72 h	−7.45 (−14.30, −0.60) (2)	−13.61 (−21.92, −5.29) (2)

consumption ranged from 21% to 29%, which is generally considered as being clinically significant. Furthermore, this meta-analysis showed a significant reduction in the incidence of opioid-related adverse effects, including nausea, pruritus, dizziness, sedation, and urinary retention in the acupuncture treatment group. This suggests that the opioid-sparing effects are clinically meaningful. A previous study suggested that patients place almost equal importance in analgesic efficacy and the type and severity of the side-effects when determining the desirability of the outcome of acute pain management.[11] The reduction in nausea, however, could also be attributed to the acupuncture itself with stimulation of some acupoints having anti-emetic effects. It is of note that the studies included in this review did not report specifically on the patients' underlying risk factors for postoperative nausea and vomiting (PONV) such as a history of PONV, history of motion sickness, or smoking status. Opioids are, however, one of the major risk factors for PONV. It is hoped that randomization would balance these other risk factors between the treatment groups, but in the absence of reporting of such risk factors, this is not guaranteed.

The side-effects attributable to acupuncture were minimal and resolved spontaneously. This is an important consideration, since the use of some adjunct analgesics might be limited by the concern for adverse effects such as bleeding and renal dysfunction with the use of non-steroidal anti-inflammatory drugs.[22 43]

Other studies have supported the effectiveness of acupuncture for other types of pain such as chronic knee pain.[40] However, the mechanism of acupuncture analgesia remains unclear. Some proposed mechanisms include activation of the endogenous pain inhibitory system,[1] release of endogenous opioids including β-endorphins, enkephalins, and dynorphins,[12 27 37 38] and non-opioid substances such as serotonin, norepinephrine, and GABA.[26 28]

There are several limitations to this review, and therefore the results should be interpreted with caution. First, there was wide variability in the acupuncture regimens, types of surgery, time of application, and duration of stimulation. However, the analysis including only abdominal surgery, the most common type of surgery in the included studies, suggested that the results were similar in this sensitivity analysis compared with the overall analysis when all types of surgery were included. It is also not known whether some types of acupuncture or patterns of stimulation may be more efficacious for acute postoperative analgesia. Restricting the analysis to studies involving only needle acupuncture did not change the overall results.

Another important limitation was the inconsistent reporting of outcome measures in the included studies. There was a large variation in outcome measures, and those outcomes that might be regarded as clinically significant (e.g. duration of recovery room stay and opioid-related adverse events) were inconsistently reported. For instance, only four of the included studies reported data on the duration of recovery room stay. Furthermore, data reporting was often unsatisfactory; multiple studies presented data as figures only, and attempts in contacting the authors were not always successful. Therefore, we were unable to include such data in the analysis. This review did not include data on the efficacy of acupuncture in reducing the development of chronic pain since only one of the included studies evaluated this outcome.[42] Furthermore, all included studies have a relatively small group size ranging from 8 to 76. It was suggested that inclusion of acupuncture studies with small sample size was a factor that might cause overestimation of the effectiveness of the intervention in systematic reviews.[7] However, others question the inclusion of only large studies in systematic reviews for pain and highlight the value of smaller, well-controlled clinical studies with high internal validity.[41] The possibility of publication bias cannot be excluded. However, methods to detect this bias are unreliable and therefore were not performed.[30] The problem of finding a credible placebo or sham intervention and of blinding in acupuncture studies has been previously highlighted.[8 35] To minimize this problem, we decided to include only studies where the control group received a placebo or sham intervention. Furthermore, our results were not affected by restricting the analysis to studies with adequate double blinding. Finally, we restricted this analysis to

studies in adults. Studies investigating these techniques in children are lacking. However, this is the first meta-analysis on acupuncture and related techniques for postoperative pain management.

This systematic review has identified some areas where future research on the perioperative use of acupuncture is warranted. It remains unclear whether there is a difference in efficacy between preoperative and postoperative acupuncture. Although subgroup analysis indicated that only preoperative acupuncture had a statistically significant opioid-sparing effect, this result should be interpreted with caution since only three studies were included in the postoperative group. More well-designed studies are needed to establish the optimal timing of administration of acupuncture and the ideal duration of stimulation. Studies should also include longer follow-up periods to evaluate the efficacy of acupuncture on preventing the development of chronic pain.

Plasma concentration of adrenal hormones (dopamine, norepinephrine, epinephrine, cortisol, etc.) was considered by several authors to be an excellent objective measure of postoperative pain.[31 34] One study in this review, and one excluded paper, investigated the effects of acupuncture on plasma concentration of adrenal hormones.[14 16] More well-designed studies are needed to further our understanding of the mechanism of pain relief through acupuncture. Furthermore, a comparison of the potential analgesic effect of different acupuncture points and different techniques of stimulating acupoints is needed. Future studies should also be of adequate sample size and report on clinically relevant endpoints of both analgesic efficacy (pain intensity and opioid consumption) and evidence of reduction of opioid-related adverse effects and duration of recovery room stay. Finally, studies incorporating acupuncture techniques as part of multimodal analgesia regimens are needed.

Conclusion

This systematic review suggests that the perioperative administration of acupuncture may be a useful adjunct for postoperative analgesia. Further large, well-designed studies are required to confirm those findings and to answer questions regarding the most efficacious type of acupuncture and optimal timing of administration.

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