



Acupuncture in management of acute dental pain – A systematic review and meta-analysis[☆]



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ARTICLE INFO

Article history:

Received 11 April 2022

Received in revised form 16 February 2023

Accepted 23 February 2023

Keywords:

Dental treatment

Toothache

Complementary therapies

Analgesia

Anesthesia

Anxiety

ABSTRACT

Acute dental pain is a common issue leading to dental consultation. Besides causal therapy, patients are treated with acupuncture, but efficacy in acute dental pain is still not clarified. We aimed to evaluate results of recent research to estimate the efficacy of acupuncture compared to pain-relieving approaches in treatment of acute dental pain. A systematic review of controlled trials being published between database inception and 2020 were conducted to evaluate the efficacy of acupuncture (alone or as complementary therapy) compared to local anesthesia or conventional analgesic medications in acute dental pain (intraoperatively and postoperatively) and to clarify whether acupuncture reduces the use of postoperative analgesic medications. Of 1672 publications, 23 publications met the inclusion criteria. From these, 11 randomized controlled trials (n = 668) reported on the efficacy of acupuncture on postoperative acute dental pain. Patients, who received acupuncture, showed lower pain scores postoperatively compared to sham acupuncture (Relative Risk −0.77, 95% Confidence interval −1.52 to −0.03). Overall, the results suggest a potential role of acupuncture in improving acute dental pain intraoperatively and postoperatively as well as improving the efficacy of local anesthesia, but the results are limited due to methodological shortcomings emphasizing the necessity for future high-quality research.

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[☆] Scientific field of dental science: acute dental pain, postoperative dental pain, acupuncture

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1. Introduction

Dental pain is a common and global problem, which leads to discomfort, inability to chew or other general symptoms like headaches or earache. Dental pain also impacts sleep, school/work performance and overall productivity and often requires consultation of a dentist [1–3]. The World Dental Federation (FDI - Fédération Dentaire Internationale) defined oral health as “multi-faceted” that “includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex (head, face, and oral cavity)” [4]. In 2003, the World Health Organization (WHO) recommended the reduction of toothache as a priority issue in their Global Oral Health Promotion Agenda for the year 2020 [5]. Furthermore, in the Systematic Analysis for Global Burden of Disease it was found that in 2017 around 2.3 billion people suffer from untreated caries in permanent teeth, which might lead to acute dental pain [6]. Further reasons for acute dental pain are teeth extraction, trauma, infection and also non-odontogenic sources [7]. Commonly, painkillers such as ibuprofen and paracetamol as well as opioid analgesics are routinely prescribed for postoperative pain after treating caries and related problems as inflamed oral tissues [7,8]. These medications, however, may be associated with several side effects such as gastric ulcers, gastrointestinal bleeding, kidney failure and liver damage, especially when overdosed or taken for a longer period of time, and even abuse and addiction in case of opioid analgesics intake [9,10]. A promising approach to treat acute dental pain and to reduce the usage of commonly used painkillers for acute dental pain might be acupuncture as recent research indicates acupuncture is efficacious for relieving acute pain due to various conditions [11,12]. Several studies indicate that an additional acupuncture therapy is able to reduce necessity of analgesic medication in different types of pain [13,14]. Additionally, acupuncture is also reported to reduce anxiety, which is a common issue in patients with dental diseases as many patients fear intraoperative and postoperative pain, especially in relation to tooth removal, or suffer from a general anxiety about dental treatments and the pain that can be experienced [15–19]. Although a systematic review on effectiveness of acupuncture in treating acute dental pain concluded that acupuncture can be effective in relieving dental pain, the authors recommended that the effect of acupuncture needs to be compared to conventional analgesia [20]. Therefore, this systematic review aimed to evaluate results of recent research to estimate the efficacy of acupuncture compared to other pain-relieving approaches in treatment of acute dental pain. To address the aim, the following research questions were defined:

1. Does acupuncture accompanying therapy relieve postoperative dental pain compared to placebo/local anesthetics (LA)/analgesic medications?
2. Does acupuncture improve the intraoperative efficacy of LA, or is it equivalent or even superior to LA?
 - a. Does acupuncture in addition to LA lead to better intraoperative analgesia?
 - b. Does acupuncture in addition to LA lead to a faster elimination of pain?
 - c. Does acupuncture alone result in better or equivalent analgesia compared to placebo/LA/analgesic medications?
3. Does acupuncture reduce postoperative analgesic medications use in dental patients?

2. Materials and methods

The systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses Statement) [21], the PRISMA P ([...]–Protocols) [22] and PRISMA-A ([...]–Acupuncture) [23] Statements as well as the Cochrane Handbook of Systematic Reviews of Interventions [24] and the AMSTAR 2 guidelines for systematic reviews that include randomized or nonrandomized studies of healthcare interventions [25]. The systematic review was registered in PROSPERO (CRD42021213764; date of registration: 05 January 2021) before the onset of the systematic review.

Two reviewers (MM and AKL) screened the titles and abstracts of reports identified by electronic searches in databases (MEDLINE via PubMed, Cochrane Library, Web of Science) from database inception to 31st of December 2020. We obtained full-text copies of all potentially relevant articles, which were independently assessed by two reviewers (MM and AKL). Further information about the search strategy can be found in the Appendix. Evaluation of abstracts and full-text screening was restricted due to language barriers as only research in English, German, French or Spanish were able to be considered.

2.1. Eligibility criteria

Search and eligibility criteria were defined according to the PICO (S) analysis [26]: The population (P) was defined as adult, healthy patients without general illnesses who suffer from acute toothache or need dental treatment. The intervention (I) was any form of acupuncture pre-/intra-/postoperatively as monotherapy or in addition to local anesthetics (LA; prilocaine, articaine, lidocaine) and/or analgesic medications (non-steroidal anti-inflammatory drugs (NSAID), paracetamol or others). The comparison (C) were LA (prilocaine, articaine, lidocaine or others) and/or analgesic medications (NSAIDs, paracetamol or others). The outcome (O) was (i) the postoperative as well as (ii) the intraoperative pain (measured by numeric rating scale (NRS), visual analogue scale (VAS)), (iii) the better analgesia (measured by NRS and VAS) and (iv) the faster onset of LA

after an additional application of acupuncture to LA, and (v) the consumption of analgesic medications.

2.2. Criteria of inclusion and exclusion

We included all adult patients aged 18 and over, men and women, irrespective of previous illnesses and pre-treatments. Furthermore, our intervention was any form of acupuncture treatment (needle acupuncture, electro acupuncture) that relates to the above-mentioned question, standardized measurement of pain sensation (e.g. via NRS, VAS, questionnaire). Trials reporting pain sensations only assessed subjectively by physicians/dental clinicians/ dental specialists without using a standardized measurement scale were not considered. Acupuncture could be used as monotherapy or in combination with local anesthesia or conventional painkillers. Acupressure was not considered. Eligible studies had to have compared acupuncture (as defined before) with local anesthetics (prilocaine, articaïne, lidocaine or other) and / or analgesic medications (NSAIDs, paracetamol or others). We considered any controlled clinical trials (randomized and not randomized controlled studies). In-vitro studies, animal studies, case series, single case reports and conference reports were not eligible for inclusion.

2.3. Extracted items

Author; Country; Time point of the study; Duration of the study; Information on the patient pool (number, age, sex, diagnosis, inclusion and exclusion criteria, number of randomized, analyzed, excluded patients); Description of acupuncture; Pain and anesthesia treatment; Description of user, type, frequency, time of application; Protocol deviations; Description of the measurement method; Duration of the survey; Results concerning the outcome parameters; Risk of bias assessment.

2.4. Synthesis of results

The results were presented in tabular form. As far as possible, the results were summarized in categories (qualitatively) for a better comparability. A narrative summary was created for studies that could not be statistically presented or shown in graphs. Meta-Analyses were performed with RevMan [27]. Calculations were based on a random-effects model. For binary outcomes, relative risks (RR) and 95% confidence intervals (95% CI) were calculated. For continuous outcomes, we calculated mean differences and their 95% CI. Due to a moderate to high risk of bias of included randomized controlled trials, a subgroup analysis was performed including only trials with the lowest risk of bias (at least four positive ratings in low risk of bias).

2.5. Risk of bias assessment

The risk-of-bias analysis for randomized controlled trials was carried out according to the methodology of the Cochrane Collaboration (Risk of Bias Tool) [24] or for non-randomized controlled trials using the ROBINS-I tool [28]. Assessed characteristics for randomized controlled trials: bias arising from the randomization process (random sequence generation and allocation concealment); bias due to blinding processes; bias due to deviations from intended interventions; bias due to missing outcome data; bias in measurement of the outcome; bias in selection of the reported result. Assessed characteristics for non-randomized controlled trials: bias due to confounding; bias in selection of participants into the study; bias in classification of interventions; bias due to deviations from intended interventions; bias due to missing data; bias in measurement of the outcome; bias in selection of the reported result. Non-reporting of information regarding the assessed

characteristic was rated as “unclear”. The assessment was carried out by two independent reviewers (MM and AKL). In case of conflicting decisions, a common consensus was reached.

3. Results

In total, 1673 records (Medline via PubMed 311; Web of Science (WoS)-all databases 731; Cochrane library 630) were obtained. After removal of duplicates, 1052 studies were screened by title and abstract leading to an exclusion of 1007 records. The remaining 45 studies underwent detailed full-text evaluation. Twenty-two studies were excluded due to the wrong intervention ($n = 10$), wrong patient population ($n = 5$), wrong outcomes ($n = 3$) or language barriers ($n = 2$) and one study each was excluded due to type of publication (conference paper) ($n = 1$) and another previously not detected duplicate ($n = 1$).

In the end, the results of 23 studies (21 randomized controlled trials and 2 non-controlled trials) were further evaluated (Fig. 1).

3.1. Does acupuncture accompanying therapy improve postoperative dental pain compared to placebo/local anesthesia (LA)/ analgesic medications?

The entire characteristics of the included randomized controlled trials addressing the first research question are presented in Table 1. Eleven randomized controlled trials investigated postoperative pain with a total number of 693 participants. Two trials of Lao et al. [29,30] as well as one trial by Arslan et al. [31] compared acupuncture with placebo acupuncture. Murugesan et al. [32] compared acupuncture + placebo to placebo acupuncture + placebo and to placebo acupuncture + ibuprofen. Tavares et al., Kitade et al. and Coe et al. [33–35] compared acupuncture with usually applied anesthetics. Vase et al. [36] compared acupuncture, placebo acupuncture and usually applied anesthetics. Sampaio-Filho et al. [37] compared a low-level-laser acupuncture to a kind of placebo acupuncture (device was switched off). Sung et al. [38] compared acupuncture, acupuncture plus codeine, codeine alone and placebo. Ekblom et al. [39] compared pain before and after acupuncture with no treatment. The most frequently performed operation was the removal of tooth, mostly third molar; only two trials by Arslan et al. and Murugesan et al. [31,32] dealt with pain treatment during an endodontic treatment. The main scale to assess pain was the visual analogue scale (VAS) – seven studies applied VAS [31,33–37,39], one used a verbal rating scale [38], two measured the time till moderate pain was reached [29,30], and one used a modified VAS, called the Heft-Parker VAS (HP-VAS) [32,40]. Eight trials (both trials of Lao et al., Arslan et al., Murugesan et al., Tavares et al., Coe et al., Vase et al. and Sung et al. [29–34,36,38]) reported a positive effect of acupuncture compared to other groups. Two trials did not reveal significant differences between acupuncture groups and control groups (Kitade et al. and Sampaio-Filho et al. [35,37]). Further one trial by Ekblom et al. [39] found a significant increase of postoperative pain after a pre-treatment acupuncture compared to no treatment.

3.2. Does acupuncture improve the intraoperative efficacy of LA, or is it equivalent or even superior to LA/analgesic medications?

The entire characteristics of the included randomized controlled trials addressing the second research question and its sub-questions are presented in Table 2.

3.2.1. Does acupuncture in addition to LA lead to better intraoperative analgesia?

Three randomized controlled trials investigated intraoperative analgesia with a total number of 337 participants (Table 2a). Two studies by Brandwein et al. [41,42] compared sole acupuncture,

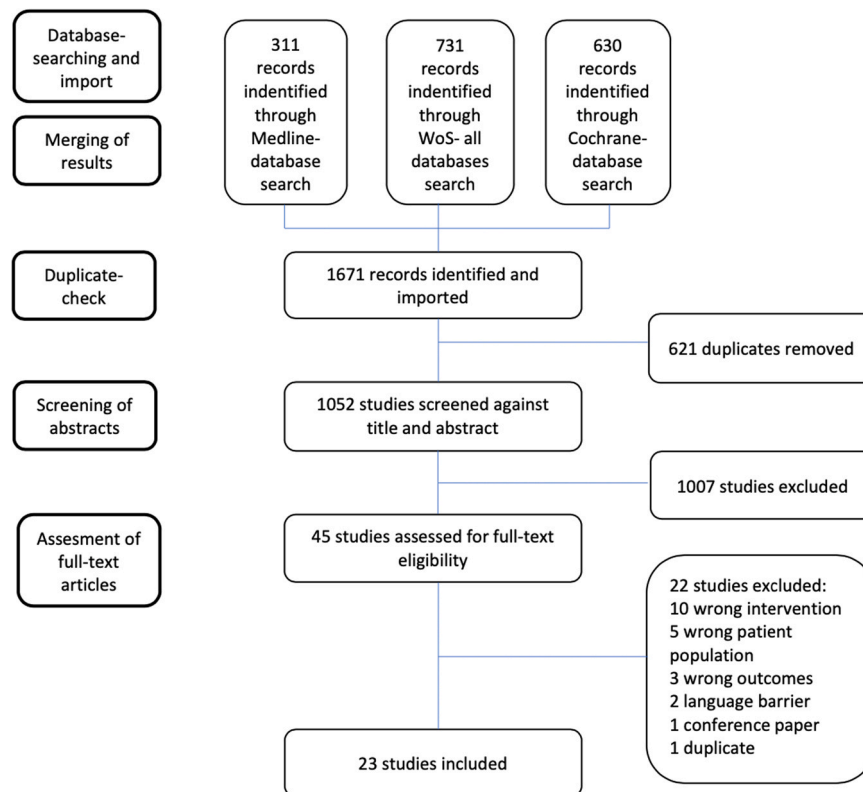


Fig. 1. Study selection process.

acupuncture + lidocaine and sole lidocaine treatment, whereas another study by Jalali et al. [43] compared acupuncture + lidocaine with placebo acupuncture + lidocaine. In the first study of Brandwein et al. [41], the authors reported the number of “complete” anesthetics (“absence of all painful sensations throughout the procedure”) and the percentage of no, mild or severe pain during dental drilling. In a second publication by Brandwein et al. [42] the percentage of no, mild or severe pain during excavation and pulp exposure was described. Jalali et al. [43] evaluated the pain (measured by VAS) and the number of successful anesthetics (once an additional anesthetic was necessary, the primary anesthetic approach was described as “unsuccessful”) during endodontic treatment. In both trials of Brandwein et al. [41,42], lidocaine was found to be superior to acupuncture. In the second trial of Brandwein et al. [41] acupuncture was able to improve intraoperative analgesia. Jalali et al. [43] reported a significantly better rate of complete anesthesia in the acupuncture group compared to the placebo acupuncture group.

3.2.2. Does acupuncture in addition to LA lead to a faster elimination of pain?

Only one trial by Rosted et al. [44] investigated in a three armed randomized controlled trial (regional block anesthesia plus segmental acupuncture, regional block anesthesia plus heterosegmental superficial acupuncture and regional block anesthesia only) the time until sufficient anesthesia in 30 participants. The authors found that anesthesia was reached more rapidly with anesthesia plus segmental acupuncture than with heterosegmental or block anesthesia only (Table 2b).

3.2.3. Does acupuncture alone result in better or equivalent analgesia compared to placebo/LA/analgesic medications?

Seven randomized controlled trials investigated acupuncture as a sole anesthetic with a total number of 474 participants (Table 2c). Four trials by Chapman et al., De Matos et al., Almeida et al. and Taub et al. [45–48] compared acupuncture with placebo acupuncture; Chapman et al. [45] as well as Almeida et al. [47] added two additional groups for comparison (Chapman et al.: one with transcutaneous electrical stimulation, one without treatment; Almeida et al.: one with dipyrone and one with placebo dipyrone); De Matos et al. added an additional group without treatment. As previously mentioned, two studies by Brandwein et al. [41,42] compared sole acupuncture, acupuncture + lidocaine and sole lidocaine treatment. In a trial by Sharma et al. [49], acupuncture was compared to a subperiosteal infiltration. All of the trials evaluated the anesthetic effect of acupuncture during painful stimulation of a tooth (Chapman et al. and De Matos et al. [45,46] by painful electrical tooth stimulation, Brandwein et al., Taub et al. and Sharma et al. [41,48,49] by dental drilling and the second trial by Brandwein et al. and Almeida et al. [42,47] by a root canal treatment). Pain was rated subjectively in three studies (both trials by Brandwein et al. and Taub et al. [41,42,48]. Chapman et al. [45] used a verbal rating scale. Almeida et al. and Sharma et al. [47,49] applied VAS and HP-VAS, respectively. De Matos et al. [46] used Borg’s perceived exertion and pain scale (BORG CR10). Chapman et al., Almeida et al. and De Matos et al. [45–47] reported superiority of acupuncture compared to no treatment. In the trial by Almeida et al. [47], acupuncture achieved the similar pain relief than dipyrone. The trial by Sharma et al. [49] revealed similar results in the acupuncture group compared to the group with subperiosteal infiltration of local anesthetics.

Table 1
Comparison of randomized controlled addressing (1) "Does acupuncture accompanying therapy improve postoperative dental pain compared to placebo/local anesthetics/analgesic medications?".

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention- n	Outcome
Randomized controlled trials										
Lao et al.[29]	1999	time to reach moderate pain and to medication request, consumption of analgesic medications	extraction of mandibular third molar	post	(1) acupuncture (2) placebo acupuncture	39 (19/20)	time (min)	post (7 days)	LI 4, ST6, ST7, SJ17	Mean pain-free time was significantly longer in group 1 than in group 2 (172.9 vs. 93.8 min, $p = 0.01$). Mean time before pain medication request was significantly longer in group 1 than in group 2 (242.1 vs. 166.2 min, $p = 0.01$). (see also Table 3)
Lao et al.[30]	1995	relief of postoperative pain, consumption of analgesic medications	extraction of mandibular third molar	post	(1) acupuncture (2) placebo acupuncture (2)	22 * (11/8)	time (min) to reach moderate pain	post (every 15 min until moderate pain level)	LI4, ST6, ST7, SJ17	Group 1 had a significantly longer time for reaching moderate pain than group 2 (181 vs. 71 min, $p = 0.046$). All patients in group 2 experienced no pain relief and received a rescue pain medication. (see also Table 3)
Arslian et al.[31]	2019	relief of postoperative pain	endodontic treatment	pre & intra	(1) acupuncture (2) placebo acupuncture	30 (15/15)	VAS (0–100)	pre post (1/3/5/7 days)	LI4	Significantly lower pain levels in group 1 compared to group 2 at all points of measurement ($p < 0.05$). (see also Table 3)
Murugesan et al.[32]	2017	relief of postoperative pain	endodontic treatment	pre	(1) acupuncture with placebo (2) placebo acupuncture with placebo (3) placebo acupuncture with ibuprofen	157(53/52/52)	HP-VAS (0–170)	pre post (15/30/45/60 min; 12/24/48 h)	LI 4, St 6, St 7, SJ 17	Significantly lower levels after 15, 30, 45 and 60 min for group 1 compared to other groups ($p < 0.05$). Significantly lower levels after 12, 24 and 48 h for group 1 compared with groups 2 and 3 ($p < 0.05$), no significant difference between groups 2 and 3.
Tavares et al.[33]	2007	relief of postoperative pain, consumption of analgesic medications	extraction of mandibular third molar	pre & post	(1) acupuncture (2) no treatment (control)	48(24/24)	VAS (0–100)	post (2/4/6 h)	LI4, F3, E44, VB39, TA21, B60, HT7, "Ponto Total" + electric stimulation	Significantly lower pain level in group 1 to all times ($p < 0.05$). (see also Table 3)
Coe et al.[34]	1999	relief of postoperative pain, consumption of analgesic medications	extraction of at least both mandibular third molars	pre & intra	(1) acupuncture (2) no treatment (control)	40 (20/20)	VAS (0–10)	post (0/2/18/ 72 h)	LI4, ST6 + electric stimulation	Significantly lower pain levels in group 1 compared to group 2 after 18 h ($p < 0.05$). (see also Table 3)
Kitade et al.[35]	2002	relief of postoperative pain	extraction of mandibular third molar (grad A easy, grad B complicated)	pre & post	(1) grade A with acupuncture (2) grade A control (3) grade B with acupuncture	54 (10/12/12/20)	VAS (0–10)	post	LI4, ST7, ST6 + low frequency electrical acupuncture (3 Hz)	Similar pain levels in group 1 compared to group 2 (53.1 ± 23.2 vs. 39.5 ± 29.7 , $p > 0.05$). Similar pain levels in group 3 compared to group 4 (55.5 ± 36.2 vs. 58.6 ± 29.7 , $p > 0.05$). (continued on next page)

Table 1 (continued)

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention	Outcome
Vase et al.[36]	2013	relief of postoperative pain	extraction of mandibular third molar	post	(4) grade B control (1) acupuncture (2) placebo (3) no treatment (control)	111(n. d.)	VAS (0–10)	pre post (13/28 min)	T44, LI4, ST7, ST6, TE17 + affirmation of acupuncture effectiveness	Significant interaction between pain and treatment groups at all times ($p < 0.001$). Significant lower pain level in group 1 compared to group 3 ($p < 0.001$), but not of group 1 compared to group 2. No difference in pain levels before and after treatment. (see also Table 3)
Sampaio-Filho et al.[37]	2018	relief of postoperative pain, consumption of analgesic medications	extraction of third molar	post	(1) low-level-laser auricular acupuncture points (2) low-level-laser turned off at auricular acupuncture points (control)	44 tooth in patients*(38/38)	VAS (0–100)	post (24/48 h)	LI4 + manual stimulation	More pain relief in group 1 compared to group 4 after 30/60/90 min ($p < 0.01$). More pain relief in group 1 compared to group 2 after 30 min ($p < 0.01$). More pain relief of group 2 compared to other groups after 120/150/180 min
Sung et al.[38]	1977	relief of postoperative pain	tooth extractions, mainly third molar	post	(1) acupuncture (2) acupuncture + codeine (3) codeine (4) placebo (control)	40(n. d.)	verbal rating scale (0–3)	post (30/60/90/120/150/180 min)	LI4 + manual stimulation	Group 1 experienced significantly more pain than group 2 and group 3 direct after operation as well as after 12 h. Total pain score (sum of all measurements) was significantly lower in group 1 compared to group 3 ($p < 0.01$) and in group 2 compared to group 3 ($p < 0.05$). (see also Table 3)
Ekblom et al.[39]	1991	relief of postoperative pain, consumption of analgesic medications	extraction of one impacted mandibular third molar	pre & post	(1) pre-acupuncture (2) post-acupuncture (3) no acupuncture (control)	10(25/25/60)	VAS (0–10)	intra post (hourly measured, summed up for each 12 h until 72 h)	ST6, ST7, SI9, LI4, SJ5 + manual stimulation	More pain relief in group 1 compared to group 4 after 30/60/90 min ($p < 0.01$). More pain relief in group 1 compared to group 2 after 30 min ($p < 0.01$). More pain relief of group 2 compared to other groups after 120/150/180 min

Sorted by number of reference. Time of acupuncture and time of rating before (pre), during (intra) and after (post) the operation. n. d.: not differentiated, NRS: numeric rating scale, VAS: visual analogue scale, HP-VAS: Heft-Parker VAS
 *loss of 3 patients during the trial due to no pain experience +loss of 3 patients in each group due to infection, loss to follow-up and systemic problems

Table 2

Comparison of randomized controlled addressing (2) "Does acupuncture improve the intraoperative efficacy of local anesthetics (LA), or is it equivalent or even superior to LA?" a. Does acupuncture in addition to LA lead to better intraoperative analgesia? b. Does acupuncture in addition to LA lead to a faster elimination of pain? c. Does acupuncture alone result in better or equivalent analgesia compared to placebo/LA/analgesic medications?

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention	Outcome
a - Randomized controlled trials										
Brandwein et al.[41]	1976	anesthetic effect of acupuncture, experience of pain during acupuncture	dental drilling	pre & intra	(1) acupuncture anesthesia (2) acupuncture + lidocaine anesthesia (3) lidocaine anesthesia (control)	113 (same cohort during (1), (2) and (3))	n. a.	intra	LI4, ST36, ST44, K7, ST6, ST5, GV26, ST7, ST18, SI18, LI20, LI19 + electrical stimulation	Higher rate of complete anesthesia in group 3 compared to group 1 (no p-value calculated). No difference between group 3 and 1 in the "incomplete" or occasional pain group. (See also Table 2c)
Brandwein et al.[42]	1976	anesthetic effect of acupuncture, experience of pain during acupuncture	excavation & pulp exposure	pre & intra	(1) acupuncture anesthesia (2) acupuncture + lidocaine (3) lidocaine anesthesia (control)	184 (70/41/73)	n. a.	intra	LI4, ST36, ST44, K7, ST6, ST5, GV26, ST7, ST18, SI18, LI20, LI19 + Manual Stimulation + Electric stimulation C31	Difference between groups 3 & 2 in favor of 2 was found. (See also Table 2c)
Jalali et al.[43]	2015	anesthetic effect of acupuncture, experience of pain during acupuncture	endodontic treatment (pulpotomy)	pre & intra	(1) acupuncture + lidocaine (2) placebo acupuncture + lidocaine (control)	40 (20/20)	VAS (0–100)	intra	LI4	The success rate (complete anesthesia) of inferior alveolar nerve block was significantly higher in group 1 compared to group 2 (p < 0.05).
b - Randomized controlled trials										
Rosted et al. [44]	2004	time after injection to sufficient anesthesia during acupuncture	dental drilling	intra	(1) regional block anesthesia with segmental acupuncture (2) regional block anesthesia with heterosegmental superficial acupuncture (3) regional block anesthesia only (control)	30 (10/10/10)	time (s)	intra	SI19, ST5 and ST6 within the innervation of the 3rd branch of the trigeminal nerve, LI4, TE3 bilaterally + manual stimulation	Significantly faster sufficient anesthesia in group 1 compared to group 2 (62 vs. 115 s, p < 0.015). Significantly faster sufficient anesthesia in group 1 compared to group 3 (62 vs. 119 s, p < 0.032).
c - Randomized controlled trials										
Brandwein et al.[41]	1976	anesthetic effect of acupuncture, experience of pain during acupuncture	dental drilling	pre & intra	(1) acupuncture anesthesia (2) acupuncture + lidocaine anesthesia (3) lidocaine anesthesia (control)	113 (same cohort during (1), (2) and (3))	n. a.	intra	LI4, ST36, ST44, K7, ST6, ST5, GV26, ST7, ST18, SI18, LI20, LI19 + electrical stimulation	Higher rate of complete anesthesia in group 3 compared to group 1 (no p-value calculated). No significant difference between groups 2 and 3. (See also Table 2a)
Brandwein et al.[42]	1976	anesthetic effect of acupuncture, experience of pain during acupuncture	excavation & pulp exposure	pre & intra	(1) acupuncture anesthesia (2) acupuncture + lidocaine (3) lidocaine anesthesia (control)	184 (70/41/73)	n. a.	intra	LI4, ST36, ST44, K7, ST6, ST5, GV26, ST7, ST18, SI18, LI20, LI19 + manual Stimulation + electric stimulation C31	Group 3 experienced a quicker and better anesthesia than group 1 (no p-value calculated). (See also Table 2a)

(continued on next page)

Table 2 (continued)

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention	Outcome
Chapman et al. ^[45]	1976	anesthetic effect of acupuncture, experience of pain during acupuncture	painful stimulus of a tooth	intra	(1) acupuncture (2) placebo acupuncture (3) transcutaneous electrical stimulation-TES (4) no treatment (control)	60 (15/15/ 15/15)	verbal rating scale (1–7)	intra	LI4 + electric stimulation	Group 1 and 3 showed a small sensory analgesic response to treatment, significant reduction in perceiving strongest stimulus as painful compared to controls. Group 1, 2 and 3 showed a significant reduction in magnitude of stimulus ratings after treatment. The effects in group 1 were most pronounced at the lowest level of stimulation, while in group 2 TES affected the perception of all levels of dental stimuli.
De Matos et al. ^[46]	2020	anesthetic effect of acupuncture, experience of pain during acupuncture	painful stimulus of a tooth	pre & intra	(1) acupuncture (2) placebo acupuncture (3) no treatment (control)	35 (same cohort during (1), (2) and (3))	BORG CR10 (0–12)	pre post (15/30 min)	LI 4, ST 6, ST 7 + Manual manipulation (rotation of the needle)	Significantly lower pain ratings over all post-treatment time points for group 1 compared to group 3 ($p < 0.001$). Significantly greater decrease of pain in group 1 compared to group 2 ($p < 0.01$). Similar decrease of pain in group 1 compared to groups 3 and 4.
Almeida et al. ^[47]	2019	relief of acute pain	treatment of pulpitis	pre & intra	(1) acupuncture (2) placebo acupuncture (3) dipyrone (4) placebo dipyrone	56 (14/14/ 14/14)	VAS (1–10)	intra	LI4, ST44, CV23, EX-HN3	No differences between the groups.
Taub et al. ^[48]	1979	anesthetic effect of acupuncture	dental drilling	pre & intra	(1) acupuncture (2) placebo acupuncture (control)	51 (26/25)	n. a.*	post	LI4	No statistical significant difference between group 1 and group 2 (3.3 ± 4.16 vs. 2.7 ± 4.65 , $p = 0.670$).
Sharma et al. ^[49]	2018	experience of pain during acupuncture	tooth preparation	pre & intra	(1) acupuncture (2) subperiosteal infiltration (control)	40 teeth in 15 patients (20/20)	HP-VAS (0–170)	intra	SI 18, ST 2, ST 3, GV 26, CV 23, LI 4, ST 44	No statistical significant difference between group 1 and group 2 (3.3 ± 4.16 vs. 2.7 ± 4.65 , $p = 0.670$).

Sorted by reference number. Time of acupuncture and time of rating before (pre), during (intra) and after (post) the operation/treatment. n. a.: not applicable. VAS: visual analogue scale, HP-VAS: Heft-Parker VAS, s: seconds, BORG CR 10: Borg's perceived exertion and pain scales *subjectively reported pain ("would choose experimental condition again"/equal or less pain than local anesthesia/pain reduction (excellent/good)/no pain)

3.3. Does acupuncture reduce postoperative analgesic medications use in dental patients?

The entire characteristics of included randomized controlled trials addressing the third research question are presented in Table 3. Seven randomized controlled trials investigated the consumption of analgesic medications after dental interventions with a total amount of 425 participants. Ekblom et al. [39] used three groups for comparison (acupuncture preoperatively, acupuncture postoperatively and no acupuncture). Two trials of Lao et al. and one trial of Michalek-Sauberer et al. [29,30,50] compared acupuncture and placebo acupuncture, whereas Coe et al. and Tavares et al. [33,34] compared acupuncture with a group without treatment. Sampaio-Filho et al. [37] compared a low-level-laser acupuncture to a kind of placebo acupuncture (device was switched off). All studies except of Arslan et al. [31], who performed endodontic treatment, included patients with a tooth extraction. The outcome was the number of pills consumed with different comparisons.

Lao et al., Arslan et al. and Tavares et al. [29,31,33] found a significantly lower consumption of analgesic medications in the acupuncture groups. Ekblom et al. [39] reported an increased intake of analgesic medications in patients, who received preoperative acupuncture. All other trials found a tendency indicating a lower intake of analgesic medications in acupuncture groups, but the results did not reach the level of statistical significance.

3.4. Results of non-randomized controlled trials

Characteristics of the evaluated non-randomized controlled trials are presented in Table 4.

Lux et al. [51] compared acupuncture with local anesthesia. Scarsella et al. [52] compared pain before acupuncture (i.e. baseline), after bilateral acupuncture at a single pain-relieving point, and after acupuncture at 2–3 additional tooth-specific points on the affected side. Lux et al. [51] investigated postoperative pain of 200 participants by NRS. Scarsella et al. [52] measured pain of 100 participants by VAS. In both studies, pain intensity differed significantly between the groups. Lux et al. [51] found a significant lower pain rating in the acupuncture group, fewer patients in the acupuncture group needed analgesic medications and the total intake of analgesic medication was significantly lower in the acupuncture group. Scarsella et al. [52] found a significant lower VAS in both groups after acupuncture treatment compared to the group before acupuncture. The pain of the group, who received acupuncture of specific tooth-related acupuncture points, were significantly lower compared to the group with acupuncture of a sole pain-relieving point.

3.5. Risk of bias within the studies

Twenty-one of the included studies were classified as randomized controlled trials. The assessment of bias is summarized graphically in Fig. 2. None of the included studies had a publicly available study protocol. To clarify methodological ambiguities, all corresponding authors of included studies were contacted by e-mail for further information, but no author responded, which is why several ambiguities are shown in Fig. 2. None of the included trials met the criteria to be rated with an overall rating of low risk of bias according to the Cochrane Risk of Bias Tool (RoB 2). All studies showed an unclear risk of bias for at least two or more categories. In three randomized controlled trials [30,46,49] a high risk of bias for at least one category was detected. Of 21 included trials all stated that they randomly assigned patients, but 12 did not mention how the allocation sequence was created and who was responsible for creation as well as how the assignment was performed. Additionally, most of the trials did not report about blinding of participants, study staff and statisticians.

3.6. Results of meta-analyses

Meta-Analyses were performed for 471 patients being separated in three subgroups for a better comparability. Group 1 included trials comparing acupuncture and placebo acupuncture ($n = 202$). Due to great heterogeneity of included studies ($I^2 = 83\%$) a random effects model with 95% confidence interval (CI) was chosen. The total random effects showed -0.77 in favor of acupuncture (95% CI -1.52 to -0.03), so a statistical significance was given. Calculated values are graphically presented in Fig. 3A.

Group 2 included trials comparing acupuncture and local anesthesia ($n = 269$) for relieving intraoperative pain. Due to great heterogeneity of included studies ($I^2 = 86\%$) a random effects model with 95% CI was chosen. The total random effects showed no significance (-4.14 , 95% CI -15.39 to 7.11). Calculated values are graphically presented in Fig. 3B.

Group 3 included trials comparing the consumption of analgesic medications with and without acupuncture ($n = 247$). Due to great heterogeneity of included studies ($I^2 = 70\%$) a random effects model with 95% CI was chosen. The consumption of analgesic medications with a mean difference calculated with random effects of -0.32 (95% CI from -2.09 to 1.45) favoring acupuncture did not reach the level of statistical significance. Calculated values are graphically presented in Fig. 3C.

Due to partly high differences in risk of bias-analyses, we performed subgroup analyses including only studies with lower risk of bias (at least four positive ratings in low risk of bias): The results of group 1 did not change. For group 2, no analysis was conducted as after strict assessment of risk of bias only one study was left. Two studies of group 3 were eligible for subgroup analysis resulting in a mean difference of -0.31 (95% CI from -2.06 to 1.43). All results of group 3 are shown in Fig. 3D, but calculation was only performed for two studies with the lowest risk of bias.

4. Discussion

Pain management in dentistry is of high relevance, but efficacy of acupuncture in treating acute dental pain is still not clarified. The results of our systematic review emphasize a potential role of acupuncture in acute dental pain management, but are limited due to methodological flaws as most of the studies missed to report about recommended methodological requirements such as randomization and blinding in detail. Randomization and blinding are the basis for inference in clinical trials eliminating selection bias, ensuring similarity of groups and maximizing validity [53,54]. Overall, the results of our systematic review are not generalizable for all dental pain patients as we focused on acute dental pain and did not distinguish different forms of acute dental pain. Furthermore, the results are not able to provide information about the usage of acupuncture in treatment of chronic dental pain.

The systematic review did not report about differences between different forms of acupuncture or other comparative treatments such as analgesic medications and local anesthetics in detail as well as about sex differences in acute dental pain management. The type of intervention used in the control group is always a critical point in acupuncture trials. Typical approaches for control groups are placebo acupuncture, sham acupuncture as well as no treatment, also seen in the included trials in our systematic review, but the validity is limited as patients and investigators are often able to recognize the control approach [55]. The most common approach for controlling acupuncture trials is sham acupuncture. In sham acupuncture, the insertion of the needle is not localized to points of the Chinese meridian system [56]. Other control methods, such as the device of Takakura and Yajima, use non-penetrating needles and a needle barrel, which is applied with pressure and without skin piercing [57]. The device of Takakura and Yajima includes a soft

Table 3
Comparison of randomized controlled addressing (3) "Does acupuncture reduce postoperative analgesic medications use in dental patients?"

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention	Outcome
Randomized controlled trials										
Lao et al.[29]	1999	time to reach moderate pain and relief of request, consumption of analgesic medications	extraction of mandibular third molar	post	(1) acupuncture (2) placebo acupuncture	39 (19/20)	n. a.	post (7 days)	LI 4, ST6, ST 7, SJ17	Average pain medication consumption was significantly less in group 1 than in group 2 (1.1 vs. 1.65 tablets, $p = 0.05$). (see also Table 1)
Lao et al.[30]	1995	relief of postoperative pain, consumption of analgesic medications	extraction of mandibular third molar	post	(1) acupuncture (2) placebo acupuncture (2)	22 * (11/8)	n. a.	post (every 15 min until moderate pain level)	LI4, ST6, ST7, SJ17	Lower consumption of analgesic medication in group 1 compared to group 2 after 24 h (2.4 vs. 1.5 tablets, no p -value) and after 7 days (17.6 tablets vs. 21.4 tablets, no p -value). (see also Table 1)
Arsilan et al.[31]	2019	relief of postoperative pain	endodontic treatment	pre & intra	(1) acupuncture (2) placebo acupuncture	30 (15/15)	n. a.	pre post (1/3/5/7 days)	LI4	Need of analgesic medications higher in group 2 compared to group 1 ($p < 0.05$). (see also Table 1)
Tavares et al.[33]	2007	relief of postoperative pain, consumption of analgesic medications	extraction of mandibular third molar	pre & post	(1) acupuncture (2) no treatment (control)	48(24/24)	n. a.	post (2/4/6 h)	LI4, F3, E44, VB39, TA21, B60, HT7, "Ponto Total" + electric stimulation	Subjects in group 1 and group 2 had a mean intake of 1.92 \pm 2.04 tablets and 4.58 \pm 3.87 tablets ($p < 0.05$), respectively. (see also Table 1)
Coe et al.[34]	1999	relief of postoperative pain, consumption of analgesic medications	extraction of at least both mandibular third molars	pre & intra	(1) acupuncture (2) no treatment (control)	40 (20/20)	n. a.	post (0/2/18/72 h)	LI4, ST6 + electric stimulation	No difference in consumption of analgesic medications between the groups (12.75 \pm 6.65 tablets in group 1 vs. 14.95 \pm 8.85 tablets in group 2, $p > 0.05$). (see also Table 1)
Sampaio-Filho et al.[37]	2018	relief of postoperative pain, consumption of analgesic medications	extraction of third molar	post	(1) low-level-laser at auricular acupuncture points (2) low-level-laser turned off at auricular acupuncture points (control)	84 tooth in 42 patients*(38/38)	n. a.	post (24/48 h)	auricular: 55, 51, 87, 3, 6, 13	Similar consumption of analgesic medication in both groups (1.47 \pm 2.50 tablets in group 1 vs. 1.57 \pm 3.12 tablets in group 2, $p > 0.05$). (see also Table 1)
Eklblom et al.[39]	1991	relief of postoperative pain, consumption of analgesic medications	extraction of one impacted mandibular third molar	pre & post	(1) pre-acupuncture (2) post-acupuncture (3) no acupuncture (control)	110 (25/25/60)	n. a.	intra post (hourly measured, summed up for each 12 h until 72 h) post (48 h)	ST6, ST7, SI19, LI4, SJ5 + manual stimulation	Total sum of analgesic medications was significantly higher in group 1 compared to group 3 ($p < 0.03$). (see also Table 1)
Michalek-Sauberer et al.[50]	2007	consumption of analgesic medications	extraction of mandibular third molar	pre, intra & post	(1) auricular acupuncture (2) auricular electro acupuncture (3) placebo acupuncture	149(37/76/36)	n. a.	post (48 h)	auricular: 1, 55, 84 + electrical stimulation	No difference of consumption of analgesic medications between groups (group 1: 4.6 (range 0–11) tablets vs. group 2: 5.2 (range 0–12) tablets vs. group 3: 5.4 (range 0–10) tablets.

Sorted by number of reference. Time of acupuncture and time of rating before (pre), during (intra) and after (post) the operation. n. a.: not applicable, VAS: visual analogue scale
 *loss of 3 patients during the trial due to no pain experience *loss of 3 patients in each group due to infection, loss to follow-up and systemic problems

Table 4
Comparison of non-randomized controlled addressing relief of intra- and postoperative pain in dental patients.

Study	Year	Aim	Operation	Time of acupuncture	Compares	n (size of subgroups)	Scale (range)	Time of rating	Intervention	Outcome
Non-randomized controlled trials										
Lux et al.[51]	2014	relief of postoperative pain, consumption of analgesic medications	extraction of third molar	pre, intra & post	(1) acupuncture (2) local anesthesia (control)	100 (50/50)	NRS (0–10)	Post (0.4,8,12 h; 1 day, 7–10 days)	auricular: 28, 1, “anxiety”	At the various measurement intervals, pain intensity while resting ($p = 0.004$) or chewing ($p = 0.007$) was significantly lower in group 1 compared to group 2. The number of analgesic medications ($p = 0.017$) and the total postoperative consumption of analgesic medications ($p < 0.0001$) was significantly lower in group 1 compared to group 2.
Scarsella et al.[52]	1994	relief of postoperative pain	all kind of oral surgery	post	(1) after acupuncture (single I14) (2) after acupuncture (I14 + tooth spec. points) (3) before acupuncture (control)	200 (100/100; group 3 entire cohort)	VAS (0–10)	post	I14, CV26, LI20, CV24, ST6, SI18, ST5, ST7, SI18 + electro acupuncture	Group 3 had a significantly higher pain level compared to groups 1 and 3 ($p < 0.01$). Group 2 had a significantly lower pain level compared to group 1 ($p < 0.05$).

Sorted by number of reference. Time of acupuncture and time of rating before (pre), during (intra) and after (post) the operation. NRS: numeric rating scale, VAS: visual analogue scale

material to generate the feeling of real needling for the investigator to ensure also investigator blinding. Another included trial in our systematic review by Jalali et al. [43] used absorbent cotton and tape to avoid knowing whether the needle is penetrating or not, but there is no scientific evidence for this kind of blinding. In a systematic review and meta-analysis by Zhang et al., who included 36 studies, a comparison of different approaches such as the previous mentioned device of Takakura and Yajima for controlling in acupuncture trials was made [58]. Further devices, which were evaluated, were the device of Streitberger and Kleinhenz [59], which is almost identical to the device of Takakura and Yajima, but without a blinding of the investigator, and the device of Park et al. [60], which is similar to the device of Streitberger and Kleinhenz, but with the addition of a flange in order to maintain hygienic capability. The authors concluded that even though all studies with the device of Takakura and Yajima were not included in meta-analysis it seems to be the only device which could be used for double blinding. Nevertheless, the authors pointed out the need to investigate other devices and to perform more rigorous studies to evaluate the appropriateness of the blinding procedure. However, the validity of the device of Takakura and Yajima was doubted by other researchers [55].

Most of the included studies in our systematic review used visual analogue scale (VAS) scores for evaluation of pain. The usage of a VAS score is a standardized technique to evaluate a subject's pain [61]. Some of the included trials used non-standardized techniques such as “time to reach moderate pain” [29,30] or “time to first dose” [34] to evaluate postoperative pain, which is affected by an individual's perception of moderate pain. Furthermore, the comparison with local anesthesia bears a risk of bias as onset of local anesthesia, especially block anesthesia, depends on technique [62]. For an optimal efficacy, the anesthetic solution should be applied as close as possible to the mandibular foramen [63,64], but anatomical variations might decrease efficacy [63,65]. In addition, the duration of the effect depends on the concentration, the (amount of) enzymes involved in the degradation and the vasoconstrictor used [66]. A further issue limiting comparability of included studies, was the usage of dental drilling to induce pain. In the included studies, dental drilling was not standardized so the depth of drilling remains unclear. The number of innervated dentinal tubules is highest close to the pulp, which implies a higher perception of pain the deeper you drill into the tooth [67]. Furthermore, it is likely, that the pain provoked by electric stimuli applied to a tooth, an approach used in studies in our systematic review, is a different type of pain than that provoked by drilling or inflammation [68]. Root canal treatment may also be perceived differently depending on the type of pulpitis [69]: Does the tooth still respond to external stimuli and does nociception still function appropriately or is the pulp already necrotic and the periapical osteolytic bone is the site of the pain? These questions have not been examined in detail, but an impact on pain perception caused by a pulpitis is likely, since root canal treatment of a necrotically affected tooth can be performed with almost absence of pain, whereas still residual vital pulp can be associated with very severe pain during instrumentation [70].

Although more than 20 years have passed since the previous systematic review by Ernst et al. [20], which served as a template for our review, acupuncture research still faces the issue of designing high-quality research. It seems alarming that little has changed in the last 25 years and that we still have to criticize the poor methodology and the non-transparency of various bias assessment criteria after our recent systematic review. Even though we found a significant effect of acupuncture on the postoperative pain levels, which was our first research question, the results have to be interpreted with care as only three studies [31,32,36] were able to be evaluated by meta-analysis due to the above mentioned methodological flaws. The results of the systematic review are also not able to clearly clarify the second research question, focusing on the

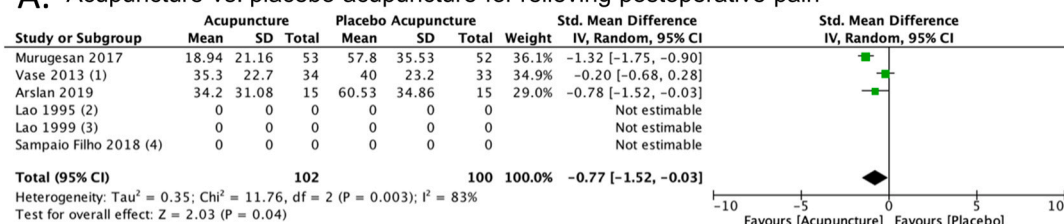
	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
de Almeida et al. [47]	?	?	?	?	?	?	?
Arslan et al. [31]	+	+	+	?	?	?	?
Brandwein et al. [41]	?	?	?	?	?	?	?
Brandwein et al. [42]	?	?	?	?	?	?	?
Chapman et al. [45]	?	?	?	?	?	?	?
Coe et al. [34]	?	?	?	?	?	?	?
de Matos et al. [46]	+	+	?	?	?	-	?
Eklblom et al. [39]	?	?	?	+	+	?	?
Jalali et al. [43]	+	+	?	+	?	?	?
Lao et al. [29]	?	?	?	?	-	-	?
Lao et al. [30]	+	+	+	?	+	?	?
Michalek-S. et al. [50]	+	?	+	?	+	?	?
Murugesan et al. [32]	+	+	+	+	?	?	?
Rosted et al. [44]	+	+	+	+	?	?	?
Sampaio-F. et al. [37]	+	+	+	?	+	+	?
Sharma et al. [49]	+	+	?	?	?	?	-
Sung et al. [38]	?	?	?	?	?	?	?
Taub et al. [48]	?	?	+	?	?	?	?
Tavares et al. [33]	?	?	?	?	+	?	?
Vase et al. [55]	+	+	+	?	?	?	?

Fig. 2. Assessment of bias, The risk-of-bias was assessed according to the recommendation of the Cochrane Collaboration (Risk of Bias Tool); non-reporting of a potential bias risk was rated as “unclear”, selective reporting and reporting of incomplete data was found in two studies implying a high bias risk. (green circle = low risk of bias, yellow circle = unclear risk of bias, red circle = high risk of bias).

comparison of acupuncture and local anesthesia (LA). Three studies [41–43] evaluated the quality of acupuncture anesthesia, but all three revealed different results. Brandwein et al. found [41] that LA alone was superior to acupuncture anesthesia in the number of “complete anesthetics”, but when they investigated “no, mild or severe pain” in combination during dental drilling, acupuncture anesthesia showed a similar effect as local anesthesia. In the second publication by Brandwein et al. [42], a superiority of acupuncture combined with LA in comparison with LA alone was found. However, both trials by Brandwein et al. [41,42] have to be seen with caution, as lack of blinding is a potential risk of bias. The third trial by Jalali et al. [43] presented a “triple-blind” study with the comparison of acupuncture + LA and placebo acupuncture + LA. The authors stated a significantly higher success rate of the inferior alveolar nerve block with real acupuncture, but the sample size was very small again limiting the validity of results. Although there were several

interesting tendencies in the evaluated studies supporting the view that acupuncture could have a similar efficacy to that of LA or could be able to improve LA efficacy, these results should also be evaluated with caution due to the before mentioned numerous methodological flaws. Interestingly, meta-analysis did not reach the level of a significance regarding the consumption of analgesic medications (third research question), emphasizing that application of acupuncture seems to be not able to reduce postoperative usage of analgesic medications. Six out of seven included trials showed a positive effect of acupuncture, but only three of the studies [29,30,33] produced statistically significant findings. In contrast, Eklblom et al. [39] reported a significant higher intake of analgesic medications post-operatively and a higher level of pain after acupuncture. The authors suggested that mental relaxation (a reduced state of anxiety) after acupuncture and a concomitant reduction in the “natural activation” of the body’s pain-inhibiting systems may explain the results.

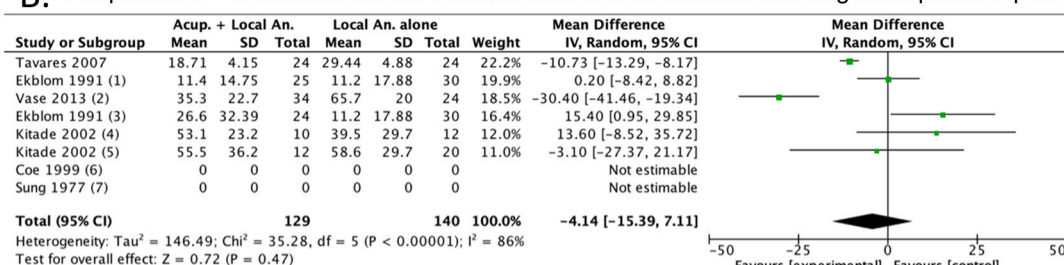
A. Acupuncture vs. placebo acupuncture for relieving postoperative pain



Footnotes

- (1) The author's answer to how many participants were in each group is still pending, 34 control patients is written, estimated Acup. is 34, Placebo Acup. 33
- (2) Data can neither be calculated nor digitised from a graphical representation
- (3) Data can neither be calculated nor digitised from a graphical representation
- (4) Data can neither be calculated nor digitised from a graphical representation

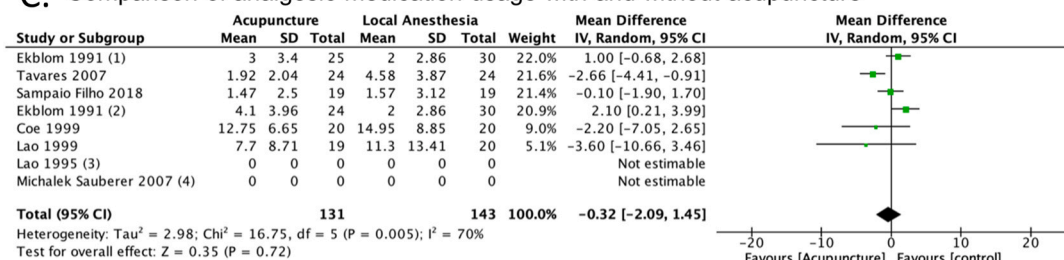
B. Acupuncture + local anaesthesia vs. local anaesthesia alone in relieving intraoperative pain



Footnotes

- (1) with POSToperative Acupuncture, control total/2 to have two groups to compare
- (2) The author's answer to how many participants were in each group is still pending, 34 control patients is written
- (3) with PREoperative Acupuncture, control total/2 to have two groups to compare
- (4) Third Molar Extraction- Easy to extract
- (5) Third Molar Extraction- Difficult (bone cutting etc.) to extract
- (6) Data can neither be calculated nor digitised from a graphical representation
- (7) Data can neither be calculated nor digitised from a graphical representation

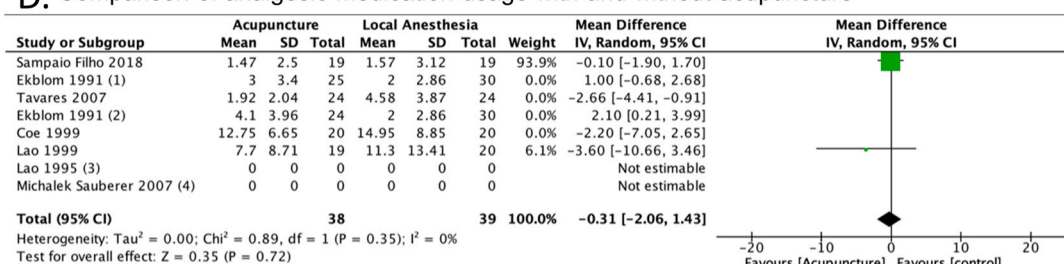
C. Comparison of analgesic medication usage with and without acupuncture



Footnotes

- (1) with POSToperative Acupuncture, control total/2 to have two groups to compare
- (2) with PREoperative Acupuncture, control total/2 to have two groups to compare
- (3) Data can neither be calculated nor digitised from a graphical representation
- (4) Data can neither be calculated nor digitised from a graphical representation

D. Comparison of analgesic medication usage with and without acupuncture*



Footnotes

- (1) with POSToperative Acupuncture, control total/2 to have two groups to compare
- (2) with PREoperative Acupuncture, control total/2 to have two groups to compare
- (3) Data can neither be calculated nor digitised from a graphical representation
- (4) Data can neither be calculated nor digitised from a graphical representation

Fig. 3. Meta-analyses comparing (A) acupuncture vs. placebo acupuncture for relieving postoperative pain, (B) acupuncture + local anaesthesia vs. local anaesthesia alone in relieving intraoperative pain, (C) acupuncture vs. local anaesthesia regarding postoperative consumption of analgesics and (D) subgroup meta-analysis comparing acupuncture vs. local anaesthesia (*calculation was just performed for the two randomized controlled trials with the lowest risk of bias).

5. Conclusion

Despite preceding scientific advances and the definition of recommendations to ensure high-quality clinical research, there are still methodological flaws in acupuncture research limiting the evaluation of the studies in this systematic review. However, the results suggest a potential role of acupuncture in treatment of acute dental pain intraoperatively and postoperatively as well as improving the efficacy of local anesthesia. The promising effects of acupuncture in treatment of acute dental pain, which were seen in this systematic review, should be validated by future high-quality research.

Funding

None.

Conflict of interest

None.

Acknowledgement

Thank you to Dr. Gunver S. Kienle, Institute for Applied Epistemology and Medical Methodology, University of Witten/Herdecke, Freiburg, Germany for supervision and critical revision.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.jdsr.2023.02.005](https://doi.org/10.1016/j.jdsr.2023.02.005).

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