● Research Article

Acupuncture accelerates recovery after general anesthesia: a prospective randomized controlled trial

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ABSTRACT

BACKGROUND: Acupuncture anesthesia was created in the 1950’s in China and continues to be used today during most major surgeries. It is widely used in China for such complex operations as brain, heart, and abdominal surgery. It is popular in China because it is economical, practical, and beneficial to the patients. With acupuncture anesthesia there is less bleeding during surgery and there is also quicker post-operative recovery.

OBJECTIVE: This randomized prospective study aims at comparing the effect of two acupoints (Yongquan, KI1 and Renzhong, DU26) with sham acupuncture and no acupuncture on the time to recovery of consciousness after general anesthesia by means of the Bispectral Index monitor (BIS).

DESIGN, SETTING, PARTICIPANTS AND INTERVENTIONS: This is a prospective randomized controlled study. We randomly assigned 50 patients to 5 groups during recovery from surgical anesthesia. Four groups had acupuncture on KI1 (group A), DU26 (groups B), both KI1 and DU26 (group C), and sham points (group D), and one had no acupuncture (group E).

MAIN OUTCOME MEASURES: Bispectral Index (BIS), time to spontaneous eye opening, time to tracheal extubation, and time to following commands were measured as the main outcome measures.

RESULTS: Time to spontaneous eye opening differed among groups ($P=0.002$), as well as time to tracheal extubation ($P<0.0001$) and time to following commands ($P=0.0006$). BIS values differed significantly among groups both 5 and 10 min after the end of anesthesia ($P<0.0001$ and $P=0.0004$, respectively). BIS values of groups D and E were lower than those of the other groups and those of group C were higher. The same pattern was observed also 15 and 30 min after the end of anesthesia, although the difference among groups was not significant at these time points ($P=0.164$ and $P=0.104$, respectively).

CONCLUSION: Acupuncture on DU26 and KI1 accelerates recovery of consciousness after general anesthesia. Moreover, a possible synergistic effect of DU26 and KI1 is suggested. This issue may play a role in the optimization of operating room management and raise interest about the usefulness of acupuncture on unconsciousness states of different nature.

Keywords: acupuncture therapy; anesthesia, general; anesthesia recovery period; randomized controlled trial

1 Introduction

Acupuncture in the perioperative period has been extensively studied[1,2]. Postoperative pain control[3], treatment and prophylaxis of postoperative nausea, vomiting[4,5] and ileus[6] and treatment of postextubation laryngospasm[7] are examples of remarkable fields of interest for acupuncture in this setting. Moreover the sedative effect of acupuncture may reduce anxiety in patients undergoing surgery under local anesthesia[8].

Much less is known about acupuncture for recovery of consciousness. Indeed many resuscitation points are traditionally indicated for the symptomatic treatment of loss of consciousness. It has been suggested that acupuncture can accelerate the recovery of brain function in patients with severe brain injury, brain neoplasm and cerebral haemorrhage[9–16]. Correction of hemodynamic instability induced by halothane and morphine has been described in dogs[17] and a reduction of anaesthetics activity has been reported in rabbits[18]; however, to our knowledge, only one study[19] evaluated the potential effect of acupuncture in reducing the time of recovery of consciousness after general anesthesia, a situation in which unconsciousness is pharmacologically maintained.

This prospective randomized study aims at comparing the effects of two acupoints (Yongquan, KI1 and Renzhong, DU26) with sham acupuncture and no acupuncture on the time to recovery of consciousness after general anesthesia by means of the Bispectral Index (BIS) monitor, which is an electroencephalogram (EEG)-derived numeric parameter inversely correlated with the degree of sedation[20].

2 Methods

2.1 Patient enrolment

The study had the approval of the local Ethical Committee and the enrolled patients signed a specific informed consent form.

We prospectively studied 50 consecutive patients from April 2006 to April 2007 who were scheduled to undergo short elective surgery (30 min to 2 h from general anesthesia induction to its reversal) in the San Raffaele Hospital, Italy. Exclusion criteria were: age lower than 18 or greater than 75, pregnancy, previous history of neurological or psychiatric disorder, coagulopathy, diabetes mellitus (type 1 or 2), anatomic abnormalities or local infections precluding acupuncture, refusal to sign the informed consent form, or American Society of Anesthesiology (ASA) score > 2[21]. The ASA score is a system for assessing the fitness of cases before surgery in 5 categories of risk, ASA 1 for healthy patients to ASA 5 for moribund patient who is not expected to survive. ASA 2 patients are patients with a systemic disease that does not interfere with normal life. All the other patients were enrolled in the study.

2.2 Anesthesia protocol

Anesthesia was induced with fentanyl 1 mg/kg, thiopental 5 mg/kg and atracurium 0.5 mg/kg i.v. and maintained with sevoflurane and remifentanil (i.v.) in order to maintain a BIS value < 40. Mechanical ventilation was maintained with a tidal volume of 6–8 mL/kg and a respiratory rate to maintain 30–35 mmHg end tidal carbon dioxide (ETCO2).

Before the end of surgery ketorolac 30 mg (i.v.) (or paracetamol 1 g (i.v.) in patients allergic to nonsteroidal anti-inflammatory drugs), tramadole 100 mg (i.v.), ranitidine 50 mg (i.v.), and metoclopramide 10 mg (i.v.) were administered and residual neuromuscular block was reversed with neostigmine 2 mg (i.v.) and atropine 1 mg (i.v.). Heart rate (HR), pulse-oxymetry (SpO2), non-invasive blood pressure (NIBP) and BIS value were recorded every 2 min throughout surgery.

BIS is a validated system used in anaesthesiology to measure the effects of specific anaesthetic drugs on consciousness and to track changes in the patient’s level of sedation (BIS VIEW™ Aspect Medical System, Inc., Norwood, USA). The BIS device incorporates a dedicated software that integrates the EEG signal by means of a proprietary algorithm and yields a number (the “BIS value”) that ranges from 0 (no electrical brain activity) to 100 (full consciousness). The BIS value decreases linearly with increasing depth of anesthesia.

2.3 Acupuncture protocol

Anesthesia administration was stopped at the end of the surgical suture (T0). At this moment patients were assigned to one of five groups according to a previous randomization list. The randomization list was generated with the Stata software before the beginning of the study.

Group A: acupuncture of bilateral KI1, on the sole of the foot in the depression formed by flexing the foot toward the plants, between the second and third metatarsal bone to about one-third of the distance between the base of the second toe and the heel (perpendicular insertion, 0.5–0.7 cm deep).

Group B: acupuncture of DU26, above the upper lip along the midline at the junction of the upper third with the lower two-third of the depression between the root of the nose and the upper edge of the lip (oblique transverse-up insertion, 0.2–0.5 cm deep).

Group C: acupuncture of bilateral KI1, as in group A, and DU26, as in group B.

Group D: bilateral sham acupuncture: a point located between KI1 and the lateral margin of the foot (perpendicularly, 0.5–0.7 cm deep), and a point at the apex of the chin (oblique transverse-up insertion, 0.2–0.5 cm deep).

Group E: no acupuncture.

Acupuncture sterile disposable needles were used (0.3 mm × 25 mm; Hwato, Suzhou Medical Appliance Factory, China; sterilized with ethylene oxide gas). Acupuncture
was performed by two experienced acupuncturists (LG or EM).

Patients received no sensorial or verbal stimulation except for continuous manual stimulation of the inserted acupuncture needles according to the practice of traditional Chinese medicine (TCM).

2.4 Monitoring

We registered time to spontaneous eye opening, time to tracheal extubation, and time to following commands.

BIS values were recorded 5, 10, 15 and 30 min after T₀ (BIS₅, BIS₁₀, BIS₁₅ and BIS₃₀, respectively).

The needles were removed before patient’s transfer to the recovery room, which took place after the last BIS record, 30 min after T₀.

The decision to extubate the patient was left to the anaesthetist in charge of the patient, who was not involved in the study, not aware of its goal and not acquainted with acupuncture. This decision was founded on the Ramsey Sedation Score[22] according to the standard practice of our hospital.

Data collection was performed by a senior resident in anesthesia, who was also not aware of the study’s goal and not acquainted with acupuncture.

2.5 Statistical analysis

Statistical analysis was performed with Stata 11.1 (Copyright 2009 StataCorp. LP, StataCorp, 4905 Lakeway Drive, College Station, Texas, USA). Continuous data are shown as mean ± standard deviation and were analyzed using analysis of variance (ANOVA) or repeated measure ANOVA as appropriate. Bonferroni correction was applied for multiple comparisons. Categorical data are shown as number (%) and were analyzed using the Chi square or Fisher’s exact test. Results were considered significant if $P<0.05$.

3 Results

3.1 Patients characteristics

Three patients were considered dropout: two out of group A (one withdrew his informed consent and one required immediate reintervention for surgical complications) and one out of group D (she required immediate reintervention for surgical complications).

We studied 47 patients: 8 patients in group A, 10 in group B, 10 in group C, 9 in group D and 10 in group E. Five patients underwent abdominal surgery (laparoscopic cholecystectomy) and 42 had ophthalmic surgery (18 dacryocystorhinostomy, 8 corneal transplant, 4 eye evisceration, 6 orbitotomy and 6 vitrectomy). The flow chart of this trial is shown in Figure 1.

The five groups did not differ in age, gender, ASA status, and length of surgery (Table 1).

HR, SpO₂, NIBP, and BIS values recorded throughout surgery were not different among groups.

3.2 Mean time from the end of anesthesia respectively to eye opening, extubation and following command

Time to spontaneous eye opening differed among groups ($P=0.002$). See Table 2. Post-hoc analysis indicates that there was statistical significance between group D and group B ($P=0.024$) and between group D and group C ($P=0.011$).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Age (mean ± standard deviation, years)</th>
<th>Gender (male/female)</th>
<th>ASA 2 patients (n (%))</th>
<th>Time of surgery (mean ± standard deviation, min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – KI1</td>
<td>8</td>
<td>42.5±15.4</td>
<td>3/5</td>
<td>4 (50.0%)</td>
<td>73.6±17.3</td>
</tr>
<tr>
<td>B – DU26</td>
<td>10</td>
<td>58.0±15.9</td>
<td>4/6</td>
<td>7 (70.0%)</td>
<td>88.1±61.0</td>
</tr>
<tr>
<td>C – KI1 + DU26</td>
<td>10</td>
<td>52.7±18.5</td>
<td>4/6</td>
<td>7 (70.0%)</td>
<td>85.4±29.7</td>
</tr>
<tr>
<td>D – Sham acupuncture</td>
<td>9</td>
<td>52.1±13.8</td>
<td>5/4</td>
<td>6 (66.7%)</td>
<td>74.8±22.4</td>
</tr>
<tr>
<td>E – No acupuncture</td>
<td>10</td>
<td>43.3±17.0</td>
<td>6/4</td>
<td>7 (70.0%)</td>
<td>79.7±19.5</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>50.0±16.7</td>
<td>22/25</td>
<td>31 (66.0%)</td>
<td>80.3±35.5</td>
</tr>
</tbody>
</table>

ASA: American Society of Anesthesiology.
Time to tracheal extubation also differed among groups ($P<0.0001$). Post-hoc analysis indicates that there was statistical significance between group D and group A ($P=0.002$), group D and group B ($P=0.005$) and group D and group C ($P=0.001$). Group E differed from group A ($P=0.045$) and C ($P=0.018$), but not from group B ($P=0.125$).

Time to following commands also differed among groups ($P=0.0006$). Post-hoc analysis indicates that group D differed from group A ($P=0.036$) and group C ($P=0.024$), but not from group B ($P=0.151$).

### 3.3 Bispectral Index values

BIS values (Table 3) differed significantly among groups both 5 and 10 min after the end of anesthesia ($P<0.0001$ and $P=0.0004$, respectively). BIS values of groups D and E were lower than those of the other groups and BIS values of group C were higher. Post-hoc analysis on BIS values 5 min after the end of anesthesia indicates that group D differed from groups A ($P=0.007$), B ($P=0.048$) and C ($P=0.001$). Group E also differed from groups A ($P=0.005$), B ($P=0.039$) and C ($P<0.001$). Post-hoc analysis on BIS values 10 min after the end of anesthesia indicates that group D differed from group C ($P=0.001$). Group E also differed from group C ($P<0.001$).

The same pattern was observed also 15 and 30 min after the end of anesthesia, although the difference among groups was not significant at these time points ($P=0.164$ and $P=0.104$, respectively).

No intra- or post-operative complications occurred in the 47 patients. In particular no complication related to acupuncture ensued.

### 4 Discussion

Perioperative acupuncture has been advocated for sedation, to reduce intraoperative opioid use, to decrease postoperative pain, to reduce nausea and vomiting and to stabilize cardiac function and ameliorate some consequences of anesthesia and surgery. The mechanism of some of these effects has been addressed in several studies.

Nevertheless acupuncture may also induce other changes in the central nervous system that lead to less studied clinical effects. We focused on the possible effect of acupuncture in accelerating recovery of consciousness in unconscious patients.

In patients with brain injury SPECT imaging showed acupuncture-induced cerebral blood flow (CBF) increases; these were correlated with improvements in consciousness.

Electrical stimulation of DU26 has been shown to increase ventilation by increasing both the respiratory frequency and the amplitude of breathing acts. Recovery of consciousness with acupuncture after cardiac arrest and

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Mean time from the end of anesthesia respectively to eye opening, extubation and following command in the five study groups (Mean ± standard deviation, min)</th>
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</thead>
<tbody>
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<td>Group</td>
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<td>9</td>
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<tr>
<td>E – No acupuncture</td>
<td>10</td>
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</table>

$P<0.05$, **$P<0.01$, vs group A; △ $P<0.05$, △△ $P<0.01$, vs group B; ▲ $P<0.05$, ▲▲ $P<0.01$, vs group C.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Bispectral Index values (Mean ± standard deviation)</th>
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</table>

BIS$_5$, BIS$_10$, BIS$_15$ and BIS$_30$ represent BIS values registered at 5, 10, 15 and 30 min after the end of anesthesia respectively. ▾$P<0.01$, vs group A; △ $P<0.05$, △△ $P<0.01$, vs group B; ▲ $P<0.05$, ▲▲ $P<0.01$, vs group C. BIS: Bispectral Index.

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According to TCM, loss of consciousness is due to yin-deficiency or yang-deficiency syndrome or Jue syndrome due to unbalance between qi and blood induced by deficiency of qi and accumulation of phlegm. Consciousness is supported by kidney that resides in the heart. This may be a clue to understand the observed mechanism of action of KI1, which is the jing-well point of the kidney channel. But the loss of consciousness may be also due to an imbalance between yin and yang and this justifies the beneficial effect of DU26, “the core of man”, located near the meeting point of Renmai with Dumai channels, the meridians receiving yang from heaven and yin from earth respectively. In fact DU26 is traditionally indicated as the single most important resuscitation point.

Our data suggest that acupuncture of DU26, KI1 or DU26 and KI1 together accelerates the recovery of consciousness after general anesthesia. Moreover a possible synergistic effect of DU26 and KI1 is suggested by our results.

In order to study recovery time, we recorded three clinical variables (time to eyes opening, extubation and following commands) that reflect the everyday anaesthesiological practice. Given the position of the needles we employed, it was impossible to warrant blindness of the anaesthetist in charge towards randomization. Anyway he was not involved in the study, not aware of its goal and not acquainted with acupuncture. Moreover the study of BIS values confirmed our clinical observations.

Our study was not designed to investigate the mechanism of this effect of acupuncture. Anyway unconsciousness during anesthesia is pharmacologically induced and maintained and acupuncture may enhance the anaesthetic drugs washout by increasing cardiac output, CBF and ventilation.

Painful stimulation does not seem to play a role in the observed shortening of recovery time, since groups do not differ in HR and NIBP. Moreover the sham acupuncture group exhibits the longest recovery time and the lowest postoperative BIS values.

During the study we applied manual stimulation of the needles, according to the simplest technique of toning of TCM. Electrical stimulation or moxibustion over the acupoints may be alternatives.

Optimization of the operating room management plays a major role in modern anesthesia and our data may help improve turnover time by accelerating recovery time. Moreover future studies could address the usefulness of the effect of acupuncture on unconsciousness states of different nature by clarifying the mechanism underlying it.

## 5 Competing interests

The authors declare that they have no competing interests.


