Postoperative pain and respiratory function in patients treated with electroacupuncture following coronary surgery

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ABSTRACT

الأهداف: تقييم الوظائف التنفسية ونقاط الألم لدى المرضى الخاضعين لعملية تركيب مجازة في الشريان التاجي خلال فترة الأيام السبعة الأولى.

الطريقة: أجريت الدراسة على شريحة مقطعية خلال الفترة ما بين أبريل 2008م إلى أبريل 2009م بكلية الطب – جامعة فيرات –قسم جراحة القلب والجهاز الوعائي –مدينة إلازينق –تركيا. تم تقسيم عدد 30 مريض والذين أجريت لهم عملية (MS) تركيب مجازة للشريان التاجي إلى مجموعة (الوخز الإبري) التي أجري لها الوخز الإبري الكهربائي والتسكين والى المجموعة (التحكم) التي أجريت لها وخز إبري والتسكين فقط. في كل مجموعة تم تسجيل حدة الألم والتسكين الذي تم تلقيه والوظائف التنفسية والمضاعفات الرئوية. تم إعطاء المرضى عقار بيثادين وميتاميزول الصوديوم.

النتائج: من العدد الإجمالي 30 شخص كان هنالك 15 مجموعة التحكم و 15 المجموعة التي أجري لها الوخز الإبري. لم يكن هنالك فروق إحصائية ملحوظة بين المجموعتين من ناحية العمر ونوع الجنس. تمت ملاحظة النقاط البصرية والفروق الإحصائية الملحوظة في عقار الأشخاص الذين تلقوا عقار ميثازول وعقار بيثيدين و في اليوم الثالث والخامس والسادس والسابع بين المجموعتين. وتمت ملاحظة المضاعفات بعد العملية الجراحية (انخماص الرئة) لدى مريضين (13.3%) لدى المرضى، و مريض واحد (6.6%) في كل مجموعة. عقب العملية الجراحية كانت نقاط قيمة قوة حجم الانتهاء وقوة السعة الحياتية أعلى منها قبل العملية الجراحية في المجموعة التي تلقت الوخز الإبري فقط.

خاتمة: كانت قيم الوخز الإبري الكهربائي أعلى فعالية من المعالجات في مجموعة التحكم في انخفاض الألم وتحديد الأدوية المتناولة خلال الأيام السبعة الأولى بعد العملية الجراحية MS.

Objectives: To evaluate respiratory function and pain score in patients undergoing coronary bypass procedures during the first 7 postoperative days.

Methods: The study was carried out as a case-control study between April 2008 and April 2009 in the Department of Cardiovascular Surgery, Firat University Faculty of Medicine, Elazig, Turkey. Thirty patients, who had undergone a median sternotomy (MS) for coronary artery bypass graft, were randomized to either the electroacupuncture and pharmacologic analgesia (acupuncture) group, or the pharmacologic analgesia alone (control) group. In each group, severity of pain, analgesic intake, respiratory function, and pulmonary complications were recorded. Pethidine hydrochloride and metamizole sodium were administered.

Results: Of the 30 subjects, 15 were in the control group and 15 in the acupuncture group. There were no statistically significant differences between the 2 groups in terms of age and gender. Statistically significant differences in metamizole, pethidine, days 3, 5, 6, and 7 visual analogue scale scores were observed between the acupuncture and control groups. Postoperative complications (atelectasia) were observed in 2 (13.3%) patients, one (6.6%) in each group. The postoperative forced expiratory volume in one second /forced vital capacity value was higher than the preoperative value in the acupuncture group.

Conclusions: Electroacupuncture was more effective than control treatments in decreasing pain and limiting opioid and non-opioid medication intake during the first 7 postoperative days following MS.

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Median sternotomy (MS) patients have evidently poorer pulmonary function in the postoperative period than other surgical patients. The pathophysiology of MS patients reflects the effects of general anesthesia, surgical injury, median sternotomy, and cardiopulmonary bypass (CPB) to produce hypoxia, atelectasis, pleural effusion, and dysfunction of the diaphragm.[1] As internal mammary artery (IMA) grafts are employed in coronary artery bypass grafting, impairment of pulmonary function is more proclaimed.[2,3] Patients should remain calm and relaxed following MS. They should be able to breathe easily to prevent atelectasis, and get out of bed early. However, this does not occur in patients with pain.[4] Pain due to MS is usually greater in the first 2 days, and is traditionally alleviated with parenteral opioid-based analgesics.[5] Non-steroid anti-inflammatory agents (NSAIDS) or other types of analgesics usually fail to show significant benefit over opioids in cardiac surgical patients. However, despite their well-known major side effects, opioid analgesics are applied to cardiac surgical patients who should be discharged from the intensive care unit (ICU) on a fast track protocol.[5,6] The well-known side effects of opioids, including respiratory depression, nausea, vomiting, decreased gastro-intestinal (GI) motility or even ileus and urinary retention can prolong the length of stay in the cardiac surgical ICU.[7,8] Acupuncture can alternatively be used in providing analgesia with fewer side effects.[9] This study was designed to evaluate respiratory function and pain score in patients undergoing coronary bypass procedures during the first 7 postoperative days.

Methods. Thirty patients that underwent MS for coronary artery bypass graft (CABG) surgery were included in this case-control study between April 2008 and April 2009 at the Department of Cardiovascular Surgery, Firat University Faculty of Medicine, Elazig, Turkey. Study approval was received from the Firat University Faculty of Medicine Ethics Committee, and all patients gave informed consent. Patients excluded from the study were those scheduled to undergo partial sternotomy or posterolateral or anterolateral thoracotomy. or heart valve operation or heart valve operation together with coronary bypass operation, extrapleural pneumonectomy, or esophagectomy. Patients who had received acupuncture within the previous 6 weeks, or who had heart valve dysfunction (a contraindication to the use of intradermal acupuncture needles) were excluded. Patients with a coagulopathy precluding insertion of an epidural catheter were also ineligible. All patients underwent opening of the left pleural cavity during internal mammary artery harvesting. Patients were randomized based on 'Tables of Random Numbers' to either the electroacupuncture and pharmacologic analgesia (acupuncture) group, or the pharmacologic analgesia alone (control) group to relieve postoperative pain during the first 7 postoperative days. Electroacupuncture (ES-160, Ito Co. Ltd., Tokyo, Japan) unit was used. The electroacupuncture unit provided an alternating current (60 Hz and 20 minutes). Stainless steel acupuncture needles (0.25 mm diameter) were inserted at points: large intestine 4 meridian (Li4), large intestine 11 meridian (Li11), stomach 36 meridian (St36), pericardium 6 meridian (Pc6), and liver 3 meridian (Liv3). The electroacupuncture group adjusted the stimulus intensity until a strong but comfortable tingling sensation was felt. Approximately 2 hours after extubation, electrical stimulation was instituted for 20 minutes in patients who had no analgesics. After a 24-hour rest interval, electroacupuncture was again performed daily during the first 7 postoperative days by the same acupuncture specialist. Patients could request further analgesia (pethidine hydrochloride [HCL] 0.2 mg/kg intravenously [IV] and metamizole sodium, 1 g IV) if necessary during the first 7 postoperative days.[10] Pethidine HCL was given to patients whose pain could not be regulated with metamizole sodium.[11] Pain was assessed approximately one hour after extubation by means of a visual analogue scale (VAS) from 0 (no pain) to 100 (unbearable pain) before treatment (VAS0). Subsequent evaluations, on post-operative days 0, 1, 2, 3, 4, 5, 6, and 7 evaluated pain at rest.[9] A chest roentgenogram was carried out one day before the operation, and on the first and fifth days postoperatively for screening pleural effusion and atelectasis. The same consultant radiologist assessed the results of the roentgenograms. We evaluated patients in terms of respiratory function on the seventh postoperative day, at which time, the notable effects of CPB should have subsided. The lung function indicators of forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and FEV1/FVC were evaluated at the bedside on the day before the operation and repeated on the postoperative seventh day by the same respiratory physiotherapist, using a spirometer (Ultima Medical Graphics, St. Paul, MN, USA). For each patient, intensity of pain, analgesic intake, pulse/min, tension arterial (TA), body temperature, and pulmonary complications were recorded during the first 7 postoperative days. Patients who had heart valve dysfunction and renal failure were excluded. The patients were operated on by the same surgeon to ensure similar surgical technique and perioperative care.[9]

Statistical analysis. The summary statistics are presented as the mean together with standard deviation. The assumption of normality distribution was confirmed by the Shapiro-Wilk test. The data were analyzed with Student's t test, Mann Whitney U test, and Chi-square

Table 1 - Demographic data and variables of acupuncture and control groups.

Variable	Control (n=15)	Acupuncture (n=15)	*P*-value
Age (years)*	51.5±8.50	52.3±8.10	NS
Gender (F/M) (n)	6/9	5/10	NS
Pulse/minute*	88.75±10.10	86.50±11.30	NS
Systolic TA (mm Hg)*	121.15±13.35	115.70±14.20	NS
Diastolic TA (mm Hg)*	65.49±11.45	64.10±8.60	NS
Systemic diseases			NS
Diabetes mellitus, n (%)	2 (13.3%)	2 (13.3%)	
Hypertension, n (%)	2 (13.3%)	2 (13.3%)	
Extubation time (hours)*	8.1±2.2	8.2 ±3.1	NS
Detubation time (hours)*	23.1±2.5	21.9±9.8	NS
Complications, n (%)	1 (6.6%)	1 (6.6%)	NS
Metamizole (g)*	2.0±0.73	0.53±0.51	0.0001
Pethidine (mg)*	223.33±132.10	76.67±84.23	0.002
Preoperative-FEV1*	88.47±20.33†	86.87±11.03**	NS
Preoperative-FVC*	75.20±18.86‡	84.47±14.04††	NS
Preoperative-FEV1/FVC*	86.80±9.37§	81.07±2.01	NS
Postoperative-FEV1*	50.00±20.39	51.67±17.17	NS
Postoperative-FVC*	52.73±23.87	52.60±26.91	NS
Postoperative-FEV1/FVC*	79.53±8.68	83.27±11.64	NS
*VAS**			
Day 0	67.00±8.41	69.33±2.58	NS
Day 1	52.33±15.22	50.33±7.19	NS
Day 2	39.67±13.43	33.33±7.72	NS
Day 3	33.33±14.96	21.67±5.56	0.01
Day 4	26.67±13.45	18.33±5.56	NS
Day 5	26.67±17.59	11.00±3.87	0.01
Day 6	26.00±17.65	10.67±4.17	0.006
Day 7	23.33±20.59	9.33±1.76	0.01

NS - not significant, *mean±standard deviation, †preoperative FEV1 versus postoperative FEV1, ‡preoperative FVC versus postoperative FVC, §preoperative FEV1/FVC versus postoperative FEV1/FVC, **preoperative FEV1 versus postoperative FEV1, ††preoperative FVC versus postoperative FVC, VAS - visual analogue score, FEV1 - forced expiratory volume in one second, FVC - forced vital capacity, TA - tension arterial

test using the Statistical Package for the Social Sciences software (Windows version 15.0, SPSS Inc, Chicago, IL). Two-sided *p*-values of less than 0.05 were regarded as statistically significant.

Results. The demographic data and variables of the acupuncture and control groups are depicted in **Table 1**. Of the 30 subjects, 15 were in the control group and 15 in the acupuncture group. There were no statistically significant differences between the 2 groups in terms of age and gender. Statistically significant differences in metamizole, pethidine, days 3, 5, 6, and 7 for VAS were observed between the acupuncture and control groups (**Table 1**). The control group's preoperative FEV1, FVC, and FEV1/FVC values were significantly higher than the postoperative values, and the acupuncture group's preoperative FEV1 and FVC values were significantly higher than the postoperative values. The acupuncture group's postoperative FEV1/FVC value was non-significantly higher than the preoperative FEV1/FVC value. There was a decrease in the average VAS pain scores from postoperative day 0 to day 7 in both groups (**Table 1**). The mean metamizole sodium doses were significantly higher in the control group than in the acupuncture group (p=0.0001), and the mean pethidine HCL doses were also significantly higher in the control group than in the acupuncture group (p=0.002).

Discussion. In cardiac surgery, most operations are performed through MS. The most important points in postoperative management of such cardiac patients is early extubation from mechanical ventilation in the ICU, and thereafter from the hospital. Unfortunately, there have been no advances in the methods of improving the control of pain, which naturally has significant physiologic benefits after MS such as paucity of atelectasis and infections. Mortality and morbidity after major operations are partly related to the pathophysiologic response to the major injury sustained by the surgical incision, and pain related postoperative complications.[10] Many studies and the broad clinical experience of cardiovascular surgeons revealed that respiratory problems are one of the major factors affecting morbidity and mortality rates after CABG. Prolonged anesthesia and CPB duration, poor preoperative pulmonary function, and poorly executed surgical techniques are the most widely known reasons for respiratory complications after CABG. In a previous study[1] there was evidence that impairment of pulmonary function is more pronounced when the left IMA is used compared with saphenous graft in CABG patients.[1]

Pain in the cardiac ICU is still treated with opioid analgesics. These agents are usually sufficient enough to relieve patients from postoperative pain and dismobility. However, opioids do have well-known adverse effects.[10] Opioids can cause respiratory depression or even apnea, both of which lead to delays in weaning from the ventilator. They can lead to nausea and vomiting and to subsequent aspiration chemical pneumonia. Moreover, ileus or constipation can prolong the ICU stay of the patient. Jaundice is another serious side effect, caused by biliary spasm. Finally, opioids can cause ureteral or cystic spasm and lead to urinary retention. These adverse effects of opioid use mostly affect the immediate postoperative course of the surgical patient.[10] Another alternative is nonsteroidal anti-inflammatory drugs (NSAIDs), but these do not provide an analgesic effect comparable to opioids.[11] A 60% reduction of morphine requirements was achieved with NSAIDs, however,

gastric mucosal ulceration and platelet dysfunction are found in their side effects.[11] Epidural analgesia has been successfully used for MS pain. However, hypotension and motor neuron blockade are known side effects, and the treatment necessitates multiple injections.[12] In addition, since these patients are heparinized, the risk of bleeding and hematoma during epidural anesthesia is increased.

Acupuncture is a complementary treatment for pain with few to no side effects, and data from recent studies suggest that it can relieve both acute and chronic pain.[9,13] Acupuncture is effective in relieving pain following abdominal surgery.[14] In one study,[14] 185 patients for surgery were randomized to apply true or placebo acupuncture. Pain control was superior in the acupuncture group; the percentage of patients with moderate or severe pain at rest on the day immediately following surgery was 72% in the control group, but only 47% in those receiving true acupuncture. In another study,[15] the damage caused by ischemia/reperfusion was decreased by acupuncture therapy in rats.[15]

A postoperative complication (atelectasia) was observed in 2 (13.3%) patients in the current study, one (6.6%) in each group. We found that electroacupuncture was more effective than control treatments in decreasing pain and limiting opioid and non-opioid medications intake during the 7-day postoperative period following MS. We did not encounter adverse effects in the application of acupuncture.

In conclusion, despite the limitation of small sample size, and the reluctance to the methods of the patients, our results indicate that electroacupuncture provided significant pain relief in patients who underwent MS, and decreased opioid and non-opioid analgesic intake. It is plausible to surmise that electroacupuncture could be a viable alternative to pharmacologic analgesics for the treatment of MS patients, and acupuncture intervention can be effectively applied to patients after coronary surgery. In future studies, acupuncture may contribute to postoperative pain management in a randomized trial with larger samples

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