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Antiarrhythmic and analgesic efficacy of stellate ganglion block in laparoscopic cholecystectomy

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ABSTRACT

Background: To explore the effect of right stellate ganglion block (RSGB) during laparoscopic cholecystectomy (LC) for control of intraoperative arrhythmia during CO_2 pneumoperitoneum and postoperative pain relief

Methods: Forty patients undergoing LC in our hospital were selected as the subjects and were randomly divided into group S (20 cases) and group C (20 cases), all patients received RSGB, 10 mL of lidocaine 2% under ultrasound guidance to compare the incidence of arrhythmia (1ry outcome), changes of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MBP) in different time points and postoperative visual analogue scale (VAS) was reported in the 1st, 6th, and 12th hours, respectively, with time to first analgesia request.

Results: Intraoperative arrhythmias was significantly lower in group S rather than group C ($P = 0.037$); postoperative pain profile revealed that there was a significant difference between the 2 groups presented as longer duration for first time to request analgesia ($P = 0.015$) and lower VAS scores specially at the 1st and 6th postoperative hours in group S compared to group C ($P < 0.001$ and 0.004); changes in heart rate and blood pressure, there was a significant difference between the 2 groups in values of both parameters 5 minutes following CO_2 insufflation, group S showed significantly lower HR, SBP, and MBP at this time point than group C.

Conclusion: Patients received RSGB before laparoscopic cholecystectomy can experience lower incidence of arrhythmia, better intraoperative hemodynamics, and effective pain control postoperatively.

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1. Introduction

Laparoscopic surgery has been strongly established to replace open surgery, owning to small surgical incisions, better pain profile, lower incidence of postoperative complications such as bleeding and infection as long as with less financial burden due to long hospital stay in open surgery. Hence, this technique is being increasingly used for surgical removal of diseased gallbladder together with wide use in other general surgery operations [1,2].

Several gases have been used in order to establish pneumoperitoneum, i.e., the insufflation of inert gas within the abdominal cavity to facilitate laparoscopic visualization and manipulation, but CO_2 was proven to be the most suitable being noninflammable, easily passes across membranes and effectively removed during respiration. However, CO_2 pneumoperitoneum is believed to cause stress response including activation of sympathetic nervous system by increasing secretion of adrenaline and norepinephrine from adrenal medulla and so increasing heart rate, blood pressure, and, to a much extent, the incidence of arrhythmia [3,4].

Stellate ganglion is a union of fibers of lower cervical and upper thoracic sympathetic ganglia. Stellate ganglion block (SGB) has been traditionally used to control sympathetic mediated pain in head, neck, upper limbs, complex regional pain syndromes, phantom limb pain, and postherpetic neuralgia. Recently, it's being studied for control of post-traumatic stress disorder, intractable angina and arrhythmias. The mechanism includes both central and peripheral nervous systems, centrally by affecting the autonomic nervous system regulated by the hypothalamus which is also responsible for neuroendocrinal responses, and peripherally by blocking pre and postganglionic sympathetic nerve fibers of the stellate ganglion [5,6].

Therefore, we have focused on the effects of right stellate ganglion block (RSGB) on the incidence of

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arrhythmia (as a primary outcome), heart rate and blood pressure during CO_2 pneumoperitoneum and the subsequent pain relief after end of laparoscopic cholecystectomy (as secondary outcomes).

2. Patients and Methods

This is a randomized clinical trial was carried out in the Assiut University Hospital, Faculty of Medicine, Assiut University, Egypt. Ethical approval for this study was provided by the local medical ethics Committee (IRB17101436); it was prospectively registered in the clinical trials (identifier: NCT04837495) and strictly adhered to the amendments of Helsinki Declaration. Consent was obtained from each participant.

Inclusion criteria included patients of 18–60 years old with ASA I-II status; they were prepared for laparoscopic cholecystectomy. Exclusion criteria included patients with bleeding tendency, coagulopathy, chronic renal impairment, thyroid gland dysfunction, central nervous systems diseases, autonomic neuropathy, cardiopulmonary comorbidities, allergy to local anesthetic which will be used or block, history of long-term oral tranquilizers use, or patient's refusal.

Forty adult participants were randomly (through web-based randomizer) allocated into one of two groups with 1:1 ratio defined as group (S); each patient received 10 ml lidocaine 2% under sonographic guidance block of right stellate ganglion (RSGB) and group (C) was the control group.

Data collection physician was kept blind to grouping process. Preoperatively, all participants were clinically evaluated and trained to report their pain level through the 0–10 points visual analogue scale (VAS).

3. Anesthesia technique

Fasting for at least eight hours before the surgery was ensured before transfer to the theater. As soon as the patient reached, he/she was intravenously infused and heart rate (HR), blood pressure (BP) and pulse oximetry (SpO2) routine monitoring were placed.

The group (S) patients received right SGB immediately before induction of anesthesia, under the guidance of ultrasound using a (10–12 MHz) linear probe. Each participant was placed in the supine position and was asked to turn head towards the left side. Following aseptic preparation of the area of skin, the thyroid gland and midline structures of the tracheal rings were visualized and by scanning laterally to the right side at the level of the cricoid cartilage, the carotid artery and deep to it, the horizontal transverse process of C6 were viewed. The longus coli muscle was apparently identified and reinforced by Doppler imaging to guarantee absence of aberrant vessels along the pathway of needle insertion. Skin was anesthetized with lidocaine 2% and a 22-G regional anesthesia needle was advanced by lateral approach deep to the carotid artery towards the longus colli muscle using in-plane imaging. Resistance loss was felt as the needle penetrated prevertebral fascia which is superficial to longus colli. After careful aspiration, 10 ml of lidocaine 2% was injected resulting in expansion of fascia enclosing the longus colli. The SGB success was confirmed by ipsilateral ptosis, miosis, and facial flushing (Figure 1).

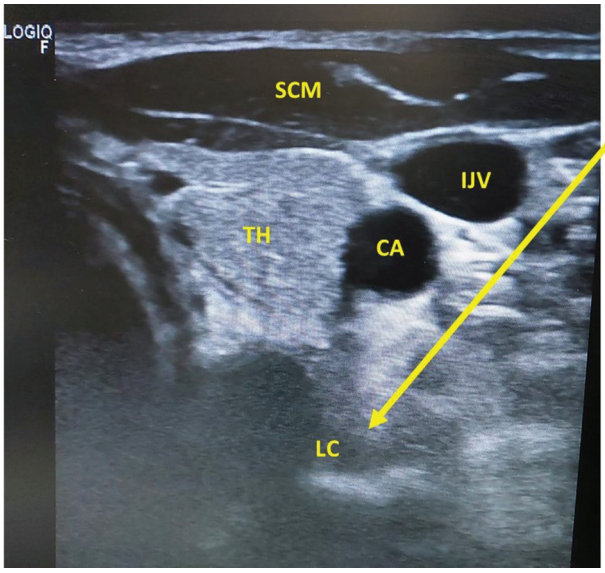

Figure 1. Ultrasonographic guided right stellate ganglion block. Caption :. SCM: sternocleidomastoid muscle; TH: thyroid; CA: carotid artery; IJV: internal jugular vein; LC: longus colli; The yellow arrow represents the direction and depth of the needle.

Following that, routine anesthesia was given to both groups using 2 mg/kg propofol, 2 mcg/kg fentanyl, and 0.5 mg/kg atracurium. After intubation, the patient was mechanically ventilated with a tidal volume of 8 ml/kg and peak airway pressure not to exceed 30 cm H2O, and mandatory rate 12–14/min with end-tidal carbon dioxide tension 35–40 mm Hg. Anesthesia was maintained by 1.5% MAC isoflurane in air oxygen ratio of 1:1 and 0.1 mg/kg atracurium for muscle relaxation. The peritoneal cavity was insufflated with CO_2 (rate of 4–6 liter/min and a pressure of 10–13 mm Hg). The pneumoperitoneum was provided by a constant gas flow of 200–400 ml/min and CO_2 pressure wasn't allowed to exceed 15 mm Hg.

4. Data collection

Patients' demographic and baseline characteristics included age, sex, weight, and height. Intraoperatively, the incidence of arrhythmia and its type and time of onset following CO_2 insufflation were recorded. Changes of blood pressure (systolic SBP, Diastolic DBP, and mean MBP) and heart rate (HR) were documented immediately before anesthesia (baseline value), 5 min, 30 min after the intraperitoneal pressure had reached 11–13 mmHg and immediately

after CO_2 desufflation (end value). In the post anesthesia care unit, the VAS was reported in the 1st, 6th, and 12th hours respectively. Time to first analgesia request was also being included upon which 4 mg nalbuphine was given.

Adverse events such as hypotension, bradycardia, hypertension, tachycardia, or arrhythmia were treated and recorded. Any respiratory complications related to CO_2 insufflation were recorded and treated.

Postoperative analgesia was attained by intravenous ketorolac tromethamine 30 mg (maximally every 6 hours).

5. Statistical analysis

Forty patients were included in this study, and the number is based upon previous study [6] which included 40 adult patients underwent offpump coronary artery bypass grafting and the authors equally and randomly allocated the patients into either SGB group or control group. Analysis of results was done via IBM, SPSS, Version 22. Kolmogorov-Smirnov tested the results as regard normality. Arrhythmia incidence was expressed as number and percentage with Fisher's exact test was utilized for detection of significance. Chi square test was used to assess to categorical data. The Independent sample T-test was utilized for comparison between groups regarding continuous parametric data; whereas Mann-Whitney test for non-parametric data. The significance was considered when p-value <0.0.5.

6. Results

Forty participants were included and completed the study as shown in the CONSORT flow chart (Figure 2); demographic data and operation time of them are shown in Table 1 with no significant difference.

Regarding the incidence of intraoperative arrhythmias (the 1ry outcome), group S showed significantly lower incidence than group C with p-value of 0.037 (Table 2). Evaluation of postoperative pain profile

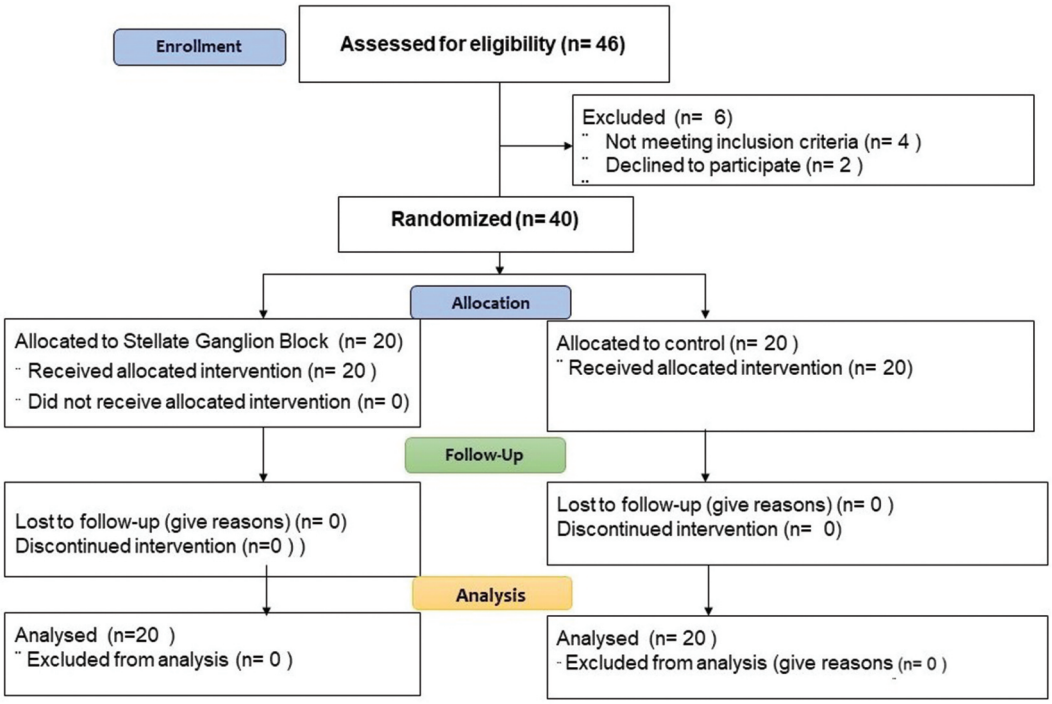

Figure 2. CONSORT flow chart of the participants.

Table 1. Demographic and perioperative data.

Variables	Group S n = 20	Group C n = 20	p-value
Gender (male/female)	1/19	5/15	0.076
Age (years)	38.8 ± 11	35 ± 13	0.33
Weight (kg)	75.053 ± 10.4	79.550 ± 16.8	0.32
Height (cm)	161.73 ± 6.2	164.95 ± 9	0.27
BMI	28.64 ± 3.299	29.11 ± 4.64	0.71
Operative duration (minutes)	44.73 ± 18.29	48 ± 16.49	0.56

Group S received SGB, Group C control.
Data are presented as ratio or mean ± standard deviation.
$p < 0.05$ is considered statistically significant.

Table 2. Incidence of intraoperative arrhythmia.

Types and timing of arrhythmias	Group S n = 20	Group C n = 20	p-value
Bradycardia	1 (5%) During insufflation	2 (10%) During insufflation	0.037*
Tachycardia	-	1 (5%) 5 minutes after insufflation	
SVT	-	1 (5%) 7 minutes after insufflation	
Multiple PVCs	-	1 (5%) 8 minutes after insufflation	

(SVT) supraventricular tachycardia, (PVCs) premature ventricular contractions.
Group S stellate ganglion block group, Group C control group.
Data are presented as number (%).
* $p < 0.05$ is considered statistically significant.

Table 3. Postoperative pain profile.

Variables	Group S n = 20	Group C n = 20	p-value
Time to 1st analgesia request (hours)	5.7 ± 1.6	1.62 ± 0.36	0.015*
VAS at 1st hour postoperative	4.85 ± 0.26 5(1.8)	6.75 ± 0.25 7(1.8)	<0.001*
VAS at 6th hour postoperative	2.15 ± 0.18 2(0)	3 ± 0.23 3(2)	0.004*
VAS at 12th hour postoperative	1 ± 0.05 1(0)	1.15 ± 0.08 1(0)	0.59

VAS is visual analogue scale used for pain control evaluation.
Group S stellate ganglion block group, Group C control group.
Data are presented as mean ± standard error or median (interquartile range).
* $p < 0.05$ is considered statistically significant.

revealed a significant difference between groups presented as longer duration for first time to request analgesia and lower VAS scores specially during the first 6 hours in group S compared to group C with *p*-values of < 0.001 and 0.004 in consequence (Table 3).

As far as to other intraoperative hemodynamics including changes in heart rate and blood pressure, a significant difference was noticed between the two groups in values of both parameters 5 minutes following CO_2 insufflation, group S showed significantly lower HR, SBP, and MBP at this time point than group C with *p*-values of 0.02, 0.02, and 0.02 in consequence (Table 4).

7. Discussion

The current study investigated the effects of RSGB regarding its antiarrhythmic effect during CO_2 pneumoperitoneum in patients undergoing laparoscopic cholecystectomy. We also studied intra operative hemodynamics and post-operative pain control. Our study demonstrated that RSGB decreases the incidence of arrhythmia during CO_2 insufflation, less stress response regarding heart rate and blood pressure intraoperatively and better pain profile during the following 12 hours.

Table 4. Hemodynamics changes during intraoperative period.

Hemodynamics Variables	Group S n = 20	Group C n = 20	p-value
Immediately before anesthesia			
• HR	80.7 ± 12.9	83.6 ± 14.9	0.72
• SBP	130.7 ± 18.6	126.45 ± 15.4	0.64
• DBP	75.89 ± 9.8	73.8 ± 9.7	0.64
• MBP	97.78 ± 12.8	94.35 ± 10.9	0.51
5 minutes following CO_2 insufflation			
• HR	77.4 ± 14.4	85.2 ± 20.37	0.02*
• SBP	119.78 ± 20.5	133.95 ± 20	0.02*
• DBP	71.2 ± 14.2	80.6 ± 13.6	0.06
• MBP	89.78 ± 16	100.9 ± 14.6	0.02*
30 minutes following CO_2 insufflation		83.3 ± 13.47	0.62
• HR	80.8 ± 12.4		
• SBP	124.84 ± 17	126.3 ± 13	0.47
• DBP	74.05 ± 11.8	71.8 ± 11.6	0.78
• MBP	94.78 ± 12.5	93.05 ± 11.5	0.93
Immediately after desufflation			
• HR	82 ± 17.8	85.7 ± 15.5	0.66
• SBP	128.5 ± 16	123 ± 15.6	0.34
• DBP	73.84 ± 10	69.350 ± 9.7	0.31
• MBP	95.78 ± 12.7	89.45 ± 11.86	0.20

HR, Heart Rate, SBP, Systolic Blood Pressure, DBP, Diastolic Blood Pressure, MBP, Mean Blood Pressure.Group S stellate ganglion block group, Group C control groupData are presented as mean ± standard deviation.
* $p < 0.05$ is considered statistically significant.

In accordance with this study, regarding the incidence of arrhythmia, Ouyang et al. [7] found in their study in patients undergoing lung lobectomy that preoperative RSGB can effectively reduce the incidence of arrhythmias; incidence of atrial fibrillation was lower in the block group (3%) than the control group (10%, $p = 0.045$); other atrial arrhythmias incidence was 20% in block group in comparison to control group 38% ($p = 0.005$); and ventricular arrhythmia incidence was 28% in comparison to 39% in control group ($p = 0.09$).

In two similar studies, left SGB had decreased incidence of arrhythmias during cardiac surgeries as that [6,8]. Connors et al. found that the incidence postoperative atrial fibrillation incidence was decreased to 18.2% when compared to the other common incidence which was 27%. Abd Allah et al. study demonstrated that the intraoperative arrhythmias incidence was higher in the control group presented in the form of bradyarrhythmia, supraventricular tachycardia, atrial fibrillation, ventricular tachycardia, and ventricular fibrillation in comparison to the block group where atrial fibrillation occurred only in four patients with the p-value of 0.007.

In the current study, we have found that RSGB has an impact on hemodynamics in the form of lower HR, SBP, and MBP 5 minutes following CO_2 insufflation, W. Chen et al. found similar results in their study on partial hepatectomy [9]. Chen YQ et al. found that MBP and HR were significantly lower at different time points up to completion of surgery in RSGB group, this difference may be due to the use of remifentanil for anesthesia maintenance in their study which is thought to produce lower hemodynamics regarding HR and BP than standard anesthesia [10]. In another study focused upon the effects of SGB on hemodynamic response during induction of anesthesia and endotracheal intubation, Chen YQ et al. found that SGB effectively attenuates stress reflexes during induction of anesthesia in elderly patients [11].

In contrast to our study, Rahimzadeh et al. [12] found in their study insignificant hemodynamic changes when used SGB on patients underwent laparoscopic gynecological during intraoperative and postoperative procedures. The difference may be attributed to the use of different time points for hemodynamics evaluation which were related to intubation, positioning and not only to CO_2 insufflation.

As far as to pain profile postoperatively, our study demonstrated that RSGB in laparoscopic cholecystectomy has longer duration regarding time to first analgesia request and lower VAS scores specially during the early 6 hours postoperatively. Z. Wang et al. [13] found the same results and concluded that performing SGB using lidocaine 0.5% during laparoscopic cholecystectomy can achieve the desired analgesic effect, also the two aforementioned studies; Rahimzadeh et al. [12] and W. Chen et al. [9] found similar results with CO_2 pneumoperitoneum in different surgeries.

This study acknowledges some limitations, first, laboratory investigations were not performed such as epinephrine, norepinephrine and cortisol blood samples at different time points. Second, we have not investigated the efficacy of the block on arrhythmia and hemodynamics in postoperative period. Furthermore, not all anesthesia-undesirable effects (e.g., respiratory depression, postoperative nausea and vomiting, and ileus) were monitored and analyzed. Finally, small sample size and being conducted in single center.

8. Conclusion

Patients received RSGB before laparoscopic cholecystectomy can experience lower incidence of arrhythmia, better intraoperative hemodynamics, and effective pain control postoperatively.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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