Intraoperative infusion of lidocaine reduces postoperative fentanyl requirements in patients undergoing laparoscopic cholecystectomy

[Une perfusion peropératoire de lidocaïne réduit les besoins postopératoires en fentanyl chez les patients subissant une cholécystectomie par laparoscopie]

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Background: Lidocaine has been shown to inhibit neural conduction and to have anti-inflammatory properties. The purpose of this study was to determine whether intraoperative lidocaine infusion reduces opioid consumption in the postanesthesia care unit (PACU).

Methods: Fifty patients were enrolled in this prospective, randomized and observer-blinded study. At induction of anesthesia the control group ($n = 25$) received fentanyl 3 $\mu g \cdot kg^{-1}$ while the lidocaine group received fentanyl 1.5 $\mu g \cdot kg^{-1}$ and a bolus of lidocaine 1.5 $mg \cdot kg^{-1}$ followed by a continuous infusion of lidocaine 2 $mg \cdot kg^{-1} \cdot hr^{-1}$. General anesthesia included propofol, rocuronium, and desflurane titrated to maintain blood pressure and heart rate within set parameters, and the bispectral index between 35 and 50. No supplemental opioids were given during surgery. All patients received acetaminophen, ketorolac, dexamethasone, droperidol and local anesthetics in the skin incision. Patients received fentanyl and ondansetron in the PACU. The primary outcome variable was the amount of fentanyl required in the PACU to establish and to maintain visual analogue scale pain scores < 3.

Results: Most patients received fentanyl for pain relief in the PACU, but the cumulative mean dose was lower in the lidocaine group compared to the control group (98 ± 54 μg, *vs* 154 ± 99 μg, respectively, $P = 0.018$). Lidocaine infusion reduced by 10% the amount of desflurane required ($P = 0.012$). White-Song scores > 12 were attained by all patients in both groups within 30 min of their arrival in the PACU. Median time from arrival to the PACU to discharge home was similar in both groups, 167.5 min in the control group *vs* 180 min in the lidocaine group ($P = 0.649$).

Conclusion: Intraoperative lidocaine infusion reduces opioid consumption in the PACU and intraoperative requirements of desflurane.

CAN J ANESTH 2008 / 55: 11 / pp 754–760

Contexte *: Il a été démontré que la lidocaïne inhibe la conduction nerveuse et possède des propriétés anti-inflammatoires. L'objectif de cette étude était de déterminer si une perfusion peropératoire de lidocaïne réduisait la consommation d'opioïdes dans la salle de réveil.*

Méthode *: Cinquante patients ont été recrutés dans le cadre de cette étude prospective, randomisée et à double insu. Lors de l'induction de l'anesthésie, le groupe témoin ($n = 25$) a reçu 3 $\mu g \cdot kg^{-1}$ de fentanyl, et le groupe lidocaïne a reçu 1,5 $\mu g \cdot kg^{-1}$ de fentanyl ainsi qu'un bolus de 1,5 $mg \cdot kg^{-1}$ de lidocaïne suivi d'une perfusion continue de 2 $mg \cdot kg^{-1} \cdot hr^{-1}$ de lidocaïne. L'anesthésie générale était composée de propofol, de rocuronium et de desflurane titré afin de maintenir la pression artérielle et la fréquence cardiaque dans la limite de paramètres préétablis, et l'index bispectral entre 35 et 50. Aucun opioïde supplémentaire n'a été administré pendant la chirur-*

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Dr S. Lauwick was awarded a clinical fellowship from the Steinberg-Bernstein Centre for Minimally Invasive Surgery and the Montreal General Hospital Foundation, and a clinical research grant from the CHU of LIEGE, Belgium. Dr. G. Michelagnoli received a research fellowship from the Department of Anesthesia, University of Florence, Italy. Dr. G. Mistraletti was supported by the Istituto di Anestesiologia e Rianimazione, University of Milan, San Paolo Hospital, Milan, Italy.

This work was supported by internal funds, Department of Anesthesia, McGill University Health Centre.

None of the authors has any conflict of interest related to this study.

Accepted for publication July 21, 2008.

Revision accepted August 28, 2008.

gie. Tous les patients ont reçu de l'acétaminophène, du kétorolac, de la dexaméthasone, du dropéridol et des agents anesthésiques locaux au niveau de l'incision cutanée. Les patients ont reçu du fentanyl et de l'ondansétron en salle de réveil. Le critère d'efficacité principal était la quantité de fentanyl nécessaire en salle de réveil pour établir et maintenir des scores de douleur < 3 sur une échelle visuelle analogique.

***Résultats** : La plupart des patients ont reçu du fentanyl en salle de réveil pour soulager la douleur, mais la dose moyenne cumulative était plus basse dans le groupe lidocaïne que dans le groupe témoin (98 ± 54 µg, vs 154 ± 99 µg, respectivement, P = 0,018). La perfusion de lidocaïne a réduit la quantité de desflurane requise de 10 % (P = 0.012). Des scores de White-Song > 12 ont été obtenus chez tous les patients dans les deux groupes au cours des 30 premières minutes après leur transfer t à la salle de réveil. Le temps médian entre l'arrivée en salle de réveil et le congé de l'hôpital était semblable dans les deux groupes, soit 167,5 min dans le groupe témoin vs 180 min dans le groupe lidocaïne (P = 0,649).*

***Conclusion** : Une perfusion peropératoire de lidocaïne réduit la consommation d'opiacés en salle de réveil et les besoins peropératoires de desflurane.*

INTRAOPERATIVE analgesia is traditionally provided by opioid analgesics. However, the use of opioids during ambulatory surgery can be associated with an increased incidence of postoperative complications, such as respiratory depression, sedation, postoperative nausea and vomiting (PONV), ileus, and urinary retention.[1] Some of these side effects can delay recovery and discharge from the day-surgery unit, and can cause unanticipated hospital admission.[2] It is therefore appropriate to minimize these side effects by using either multimodal analgesic techniques or adjuvant therapies to reduce the doses of opioids.

The fact that pain after laparoscopic cholecystectomy is complex in nature, and has unique elements compared to other laparoscopic procedures, suggests that effective analgesic treatment must be multimodal in nature.[3] Bisgaards *et al.*[4] suggested a prophylactic multimodal analgesia regimen to reduce postoperative pain, consisting of intraoperative short-acting opioids, injection of local anesthetics into the surgical wound, nonsteroidal anti-inflammatory drugs and dexamethasone. In spite of this multipharmacological intervention, postoperative analgesia has not been consistently satisfactory.[2]

Intravenous lidocaine has been shown to provide good pain relief in patients who underwent retropubic prostatectomy[5] and laparoscopic colon resection.[6] This effect appears to be due to a reduction of neural responses to pain by inhibiting nerve conduction.[7] In addition, lidocaine has significant anti-inflammatory properties.[8] Wu *et al.*[9] administered a lidocaine infusion in patients undergoing laparoscopic cholecystectomy and reported a meperidine-sparing effect during the postoperative period, however the intervention did not include multimodal analgesia. In addition, the study did not report on side effects in the postanesthesia care unit (PACU), and hospital discharge readiness times.

The present prospective, randomized controlled trial was designed to analyze the effect of intraoperative infusion of lidocaine, on postoperative opioid requirements, and the incidence of side effects and readiness for hospital discharge**.** We hypothesized that patients receiving lidocaine infusion would require less fentanyl in the PACU to achieve equivalent analgesic efficacy.

Methods

Patients

The study was approved by the McGill University Health Centre Ethics Board and was conducted between May 2007 and February 2008. Exclusion criteria were: age < 18 yr or > 85 yr, ASA physical status III and greater, history of hepatic, renal or cardiac failure, organ transplant, diabetes, morbid obesity (body mass index > 40 $kg \cdot m^{-2}$), chronic use of opioids, allergy to local anesthetics, or inability to comprehend pain assessment. Patients were instructed before surgery in the use of the verbal rating scale (VRS) to assess pain and fatigue. They were also informed that they would receive a telephone call 24 hr after the surgery, and would be asked to state their VRS at that time, as well as the amount of pain medication used. Before induction of anesthesia, the patients were randomly assigned, using a computer-generated randomization schedule, into two groups of 25 patients each: the control group received fentanyl 3 $\mu g \cdot kg^{-1}$ *iv* at induction as the only intraoperative opioid, while the lidocaine group received fentanyl 1.5 $\mu g \cdot kg^{-1}$ *iv* at induction and continuous intravenous infusion of lidocaine. Allocation concealment was achieved by placing the randomization sequence for each subject in sequentially numbered sealed brown envelopes.

Anesthesia, analgesia and surgical care

Upon arrival in the operating theatre, baseline values of heart rate, blood pressure, oxygen saturation and bispectral index (BIS) were recorded. The anesthetic technique was standardized, and the anesthesiologists (S.L. and F.C.) who executed the study protocol, were not involved in either the preoperative or the postoperative data collection. Patients were

premedicated with midazolan 0.03 mg·kg^{-1} *iv*. Before induction of anesthesia, patients in the control group received fentanyl 3.0 μg·kg^{-1} *iv*, while patients in the lidocaine group received fentanyl 1.5 μg·kg^{-1} *iv* and a bolus injection of lidocaine 1.5 mg·kg^{-1}, followed by a continuous infusion of lidocaine 2 mg·kg^{-1}·hr^{-1} until the end of surgery as previously reported.[10] General anesthesia was induced with propofol 2.5 mg·kg^{-1} *iv* and endotracheal intubation was facilitated with rocuronium 0.8 mg·kg^{-1} *iv*. Anesthesia was maintained with desflurane at an end-tidal concentration adjusted to maintain BIS values between 35 and 50, and the heart rate and systolic blood pressure within ± 20% of respective baseline values. No supplemental fentanyl was given to patients in either group during maintenance of anesthesia. The patients' lungs were mechanically ventilated with a mixture of air in oxygen (F_IO_2 40%), with minute ventilation adjusted to maintain normocarbia (CO_2 between 36 and 44 mmHg). Supplemental neuromuscular blockade was achieved with rocuronium 0.1 mg·kg^{-1} *iv* following assessment of neuromuscular function with train-of-four monitoring. Intravenous normal saline (0.9% NaCl) was administered during surgery at a rate of 6 mL·kg^{-1}·hr^{-1}, and intraoperative normothermia was maintained with forced air warming blankets positioned over exposed parts of the body. Nasopharyngeal temperature was monitored throughout surgery. Soon after induction of anesthesia, acetaminophen 1.3 g *pr* was administered, and dexamethasone 8 mg was given intravenously. Episodes of intraoperative hypotension (mean arterial blood pressure < 60 mmHg), and bradycardia (heart rate < 40 beats·min^{-1}) were recorded, and treated with intravenous boluses of neosynephrine 40 μg or atropine, 0.4 mg respectively. Desflurane was discontinued after the last skin suture, and lidocaine infusion was also stopped at completion of surgery. Residual neuromuscular block was antagonized with neostigmine 0.05 mg·kg^{-1} and glycopyrrolate 0.01 mg·kg^{-1} *iv*. Ketorolac 15 mg and droperidol 0.625 mg were also given intravenously. Patients were then transferred to the PACU.

All operations were performed by two surgeons who were highly experienced in laparoscopic cholecystectomy (L.F. and G.F.). After infiltration of 3 mL of 2% lidocaine in the infraumbilical region, open insertion of a blunt-tipped 12 mm trocar was used to access the peritoneal cavity. Pneumoperitoneum was achieved with carbon dioxide, and intra-abdominal pressure was maintained below 12 mmHg throughout surgery. Three additional 5-mm ports were introduced after infiltration of 2% lidocaine. All patients received a single dose of 5000 U of heparin *sc* and wore antiembolic stockings. Patients were positioned in a 30° anti-Trendelenburg position, and were rotated towards the left side to facilitate exposure of the gall bladder. At the end of surgery, patients were returned to a supine position, and residual carbon dioxide in the peritoneal cavity was expelled by abdominal compression. Ten millilitres of bupivacaine 0.25% with epinephrine was injected into the surgical incisions.

Postoperative care and evaluations

Patients were transferred to the PACU where the blood pressure, pulse, respiration and temperature were monitored and recorded by nurses who were blinded to the randomization sequence. According to study protocol, the PACU nursing staff administered fentanyl 25 μg *iv* boluses for postoperative pain relief, to be administered every five minutes up to a maximum of 200 μg·hr^{-1} only if the VRS score for pain (0–10 scale, where 0 = no pain, and 10 = excruciating pain) was > 3, at rest. Ondansetron 2 mg *iv* was prescribed for persistent nausea (lasting > five minutes) or vomiting, and it could be repeated up to four times over a three-hour period if necessary. The anesthesia record was not made available to the recovery room nurse, to avoid bias. The nurses evaluated patients every five minutes or at the patient's request. Recovery status was evaluated on arrival in the recovery room, and every 30 min for the first two hours by two individuals (D.J.K. and G.M.) who were unaware of the randomization sequence, and having no interaction with either the nurses or the anesthesiologists.

The White-Song scoring system, previously validated for bypassing the PACU and transfer of patients directly from the operating room to the step-down unit, includes the following variables: level of consciousness, physical activity, hemodynamic stability, respiratory stability, oxygen saturation status, postoperative pain assessment and postoperative emetic symptoms.[11] A minimal score of 12 of 14 points would be required for an outpatient to be fast-tracked after general anesthesia. In our institution, no step-down unit is available, and patients are discharged home directly from PACU. The time to achieve a White-Song score, of 12 of 14 points, was used as a tool to assess the speed of recovery.

Patients were discharged home by the nursing staff, according to the following institutionally-standardized criteria used for all outpatient surgeries: patient awake and oriented, stable hemodynamics, stable oxygen saturation > 95% on room air, minimal pain (VRS < 4 on ambulation), absence of nausea and vomiting, with an ability to tolerate oral fluids and to void, and to walk unaccompanied. Standardized rescue oral analgesics

(acetaminophen 650 mg every four hours, naproxen 500 mg every 12 hr, and, if pain persisted, oxycodone 5 mg every four hours, to be taken at home, were prescribed by the surgical team at discharge.

The following data were collected: demographic characteristics, duration of surgery and anesthesia, average end-tidal concentration of desflurane and BIS during surgery (15, 30, 45 and 60 min after induction of anesthesia); cumulative fentanyl dose and ondansetron administered in the PACU, time in the PACU until time discharged home, VRS, incidence of PONV, pruritus, urinary retention, and White-Song score. All patients were contacted by phone 24 hr after discharge from hospital, to assess pain intensity (VRS) and presence of PONV at that time, and the amount of analgesics consumed in the first postoperative 24 hr.

Statistical analysis

The primary outcome of interest, the amount of fentanyl administered for postoperative pain relief to maintain visual analogue scale < 3 in the PACU, was compared by Student's *t* test**.** Secondary outcomes, including the incidence of persistent nausea and the use of ondansetron in the PACU, the White-Song score, and the time spent in the PACU before being discharged home were compared by Wilcoxon rank-sum test. The latter were also applied to VRS scores, and for not normally distributed variables, while the Pearson χ^2 test was used for categorical variables. Data are presented as mean ± standard deviation (median) if normally distributed, and as median [interquartile range] if not, or absolute values (percentage). The level of significance was set at $P < 0.05$ for all analyses. Statistical analysis was performed with the Intercooled Stata 9.2 statistical package (Stata Corporation, College Station, TX, USA).

Determination of sample size requirement was based on mean value of 168 μg ± standard deviation 95 μg from a previous study[12] from this institution on patients undergoing similar surgery. Twenty-five subjects in each group were required to detect a minimum of a 50% reduction in fentanyl requirement in the PACU, with a type-1 error of 0.05 and a power of 95%.

Results

Sixty-three consecutive patients, scheduled for elective outpatient laparoscopic cholecystectomy, were invited to participate in this prospective, randomized study. Of the 63 patients who were screened, nine patients did not meet the criteria, while four patients refused participation. Fifty eligible patients were to be enrolled in this investigation. One patient in the control group was excluded from the analysis because his surgery was converted from laparoscopy to laparotomy. He received epidural analgesia with bupivacaine and fentanyl for 48 hr for postoperative analgesia and he was subsequently admitted to the surgical ward for three days.

TABLE I Demographic characteristics and perioperative data

	Control *n = 25*	*Lidocaine* *n = 25*	*P*
Male / female	12 / 13	5 / 20	
Age (yr)	53.8 ± 16.4 (54)	50.2 ± 15.5 (51)	
Weight (kg)	75.0 ± 14.8 (72)	66.9 ± 13.8 (68)	
Body mass index ($kg \cdot m^{-2}$)	25 [22.7–29.4]	23.7 [21.3–27.7]	
ASA I/II	11 / 14	17 / 8	
History of previous PONV: y/n	1 / 24	0 / 25	
Amount of intraoperative fentanyl (μg)	207.9 ± 44.0 (200)	102.8 ± 26.9 (100)	< 0.0001
End-tidal desflurane (%)	5.8 ± 0.4 (5.8)	5.4 ± 0.5 (5.4)	0.012
Bispectral index	39.5 ± 4.2 (39.5)	39.4 ± 4.4 (39.0)	0.935
Duration of surgery (min)	70 [57.5 – 80]	60 [50 – 65]	0.0158
Converted to open: y/n	1 / 24	0 / 25	0.312

Values are presented as absolute numbers, mean ± standard deviation (median), or median [interquartile range]. *P* values are calculated with Pearson χ^2 test for categorical variables, Student's *t* test for normally distributed variables and Wilcoxon rank-sum test for not-normally distributed variables. ASA = American Society of Anesthesiologists; PONV = postoperative nausea and vomiting.

Patient characteristics and intraoperative clinical data

The study groups were similar with the exception of a greater proportion of males in the control group. The preoperative history of PONV, ASA status and intraoperative BIS scores were similar in the two groups. There was a reduction in the requirement of desflurane in the lidocaine group [Et desflurane 5.42%, confidence interval (CI) 5.21–5.64% in the lidocaine group *vs* 5.77%, CI 5.60–5.94% in the control group, $P = 0.0123$]. The duration of surgery was longer in the control group by an average of ten minutes (68.83 min, CI 60.54–77.13 in the control group *vs* 55.64 min CI 50.43–60.85 min in the lidocaine group) (Table I). The mean dose of rocuronium (73 ± 17 mg) was similar in the two groups. Intraoperative complications (bronchospasm, bleeding) occurred in nine patients, with similar overall event frequencies in the two groups. During surgery, blood pressure and heart rate values were maintained within ± 2 0% of respective baseline values without requirement for either neosynephrine or atropine. Intraoperative body

TABLE II Postoperative clinical data

	Control *n = 24*	*Lidocaine* *n = 25*	*P*
VRS 1 min	4 (2 – 5)	5 (3 – 6)	0.436
VRS 30 min	4 (2 – 5.5)	4 (3 – 5)	0.723
VRS 60 min	3 (2 – 4)	3 (2 – 4)	0.534
VRS 90 min	3 (1 – 3)	3 (2 – 4)	0.488
White-Song score 1 min	11 (10 – 12)	11 (10 – 12)	0.563
White-Song score 30 min	13 (11 – 14)	13 (12 – 14)	0.624
White-Song score 60 min	14 (13 – 14)	14 (13 – 14)	0.488
White-Song score 90 min	14 (13 – 14)	14 (13 – 14)	0.341

Values are presented as median (interquartile range). *P* values are calculated with Wilcoxon rank-sum test. VRS = verbal rating scale for pain.

TABLE III Treatment in the PACU and assessment of recovery

	Control *n = 24*	*Lidocaine* *n = 25*	*P*
Amount of fentanyl used (μg)	153.5 ± 99.5 (162.5)	98.0 ± 54.4 (100)	0.018
Persistent nausea in recovery room: *n* (%)	8 (33)	4 (16)	0.087
Use of ondansetron: *n* (%)	8 (33)	4 (16)	0.087
No. of patients requiring ondansetron (0 / 2 / 4 / 8 mg)	16 / 0 / 6 / 2	21 / 2 / 1 / 1	0.158
No. of patients with White-Song score > 12 at 1st / 30th / 60th min or more	10 / 6 / 8	11 / 11 / 3	0.152
Time from arrival to PACU to discharge home (min)	167.5 [132–225]	180 [155–220]	0.649

Values are presented as median (interquartile range), absolute number, or mean ± standard deviation (median). *P* values are calculated with Student's *t* test for the parametric normally distributed variables, Pearson χ^2 test for categorical variables, Wilcoxon rank-sum test for the parametric not-normally distributed variables. PACU = postanesthesia care unit.

temperatures were maintained between 35.7 and 37.3°C, with no difference between groups.

Postoperative clinical data

Three patients (two in the control group, and one patient in the lidocaine group) were admitted by the surgical team for overnight observation: one patient for bleeding, another for persistent hypertension, and a third for rapid atrial fibrillation. All three patients were discharged the following day. Verbal rating scale scores for pain at rest, and the White-Song scores at admission to PACU and every 30 min for the first 90 min were similar in the two groups (Table II). Most patients received fentanyl for pain relief in the PACU, but the cumulative amount was lower in the lidocaine group (153.54 μg, CI 111.53–195.55 μg) compared to the control group (98.00 μg, CI 75.52–120.48 μg) (Table III). The overall frequency of persistent nausea requiring ondansetron in the control group was similar to that of the lidocaine group. One patient in the control group experienced urinary retention. Patients in both groups reached the White-Song score above 12 by 30 min from the time they were admitted to the PACU, and there was no difference in the time interval between arrival to the PACU and discharge home.

The VRS scores for pain and fatigue and the incidence of PONV in the first 24 postoperative hours were similar in the two groups (Table IV). The average amount of acetaminophen, naproxen and oxycodone consumed in the first 24 postoperative hours was similar in both groups.

Discussion

The results of this study indicate that, in presence of low dose intraoperative opioid, an intravenous infusion of lidocaine impacts on postoperative analgesia by decreasing the postoperative requirements of fentanyl.

Intravenous lidocaine has been shown to be analgesic, anti-hyperalgesic and anti-inflammatory. Animal experiments and clinical studies have revealed the antinociceptive effects of intravenous sodium channel blockers. The effect is thought to reflect the inhibition of primary evoked polysynaptic reflexes in the spinal dorsal horn mediated by a variety of mechanisms including sodium channel blockade.[13] In addition, lidocaine has been shown to have anti-inflammatory properties with modulation of excessive inflammatory response.[14] Perioperative intravenous lidocaine decreases postoperative pain and morphine consumption following prostatic surgery[5] and colon resection.[10] Pain scores improve more during activity than at rest in patients enrolled in an acute rehabilitation program.[10] In addition, restoration of gut motility is facilitated and length of hospital stay is shortened.[15] A possible anti-inflammatory mechanism for accelerating bowel function has been proposed, and more specifically lidocaine seems to target different steps within the inflammatory cascade, the increase in complement and pro-inflammatory cytokines.[14,15] The latter have been shown to be responsible for maintaining postoperative ileus and intestinal permeability disorders.[15] Postoperative pain after laparoscopic cholecystectomy

TABLE IV Clinical assessment and medications used during the first postoperative 24 hr

	Control *n = 24*	*Lidocaine* *n = 25*	*P*
VRS pain at rest	2 (1 – 3)	1.5 (0 – 2)	0.149
VRS pain on coughing	4 (2 – 5)	2.5 (2 – 4)	0.223
VRS pain on walking	2 (1 – 3)	2 (1 – 3)	0.943
VRS shoulder pain	0 (0 – 2)	0 (0 – 1)	0.445
VRS fatigue	3 (2 – 5)	3 (2 – 4)	0.389
PONV y/n	4 / 18	2 / 20	0.380
Acetaminophen (mg)	1614 ± 1252 (1400)	1393 ± 1404 (1000)	0.585
Naproxen (mg)	682 ± 547 (1000)	704 ± 454 (1000)	0.882
Oxycodone (mg)	7.7 ± 11.0 (5)	9.1 ± 8.1 (10)	0.642

Values are presented as median (interquartile range), or absolute numbers. *P* values are calculated with Pearson χ^2 test for categorical variables, and Wilcoxon rank-sum test for parametric not-normally distributed variables. VRS = verbal rating scale for pain; PONV = postoperative nausea and vomiting.

include not only incisional pain, but also visceral pain arising from damage to internal organs.[3] While pain was reported as the dominant complaint and the primary reason for postoperative admission after laparoscopic cholecystectomy,[4] the implementation of multimodal analgesia during the last decade has made this operation an ambulatory procedure in the majority of patients.

There has been some interest in providing guidelines with regards to the surgical and anesthetic management of laparoscopic cholecystectomy following the realization that patients' outcomes can still be significantly improved.[16] This requires a revision of the role of the perioperative care team from providing not only adequate analgesia, but to rearranging the overall perioperative care. A step-up approach has been recommended on the basis of procedure-specific evidence, from data related to other procedures and from meta-analyses.[17] This includes several modalities aimed at minimizing the metabolic stress, enhancing the anti-inflammatory response and maximizing perioperative analgesia. In the present study, the recommendations proposed by the Procedure Specific Postoperative Pain Management (PROSPECT) group were followed, with specific attention to: maintaining normothermia, minimizing tissue damage by using small trocars, preventing PONV, administering adequate fluid intake, and insufflating the peritoneum with low-pressure CO_2. In addition, multimodal analgesic interventions such as local anesthetics infiltration in the surgical incision, short-acting opioids and adequate doses of anti-inflammatory agents and acetaminophen were provided.[17] Within the context of an integrated approach, attempts have been recently made to introduce adjuvants with the intention to facilitate early recovery[18] and to decrease the side effects related to opioids.[1] Esmolol, an ultra-short-acting cardioselective β1- adrenergic receptor antagonist has been infused during laparoscopic cholecystectomy by this group as an alternative to the intraoperative use of fentanyl.[12] It was found to provide a significant postoperative opioid-sparing effect with less PONV and faster hospital discharge. In the present study, the average amount of postoperative fentanyl administered in the lidocaine group was similar to that reported in the esmolol study, indicating that a similar opioid-sparing effect can be achieved with a simple and inexpensive drug such as lidocaine. However, the improved analgesia was not sufficient to attenuate the incidence of persistent nausea in the PACU and to facilitate hospital discharge. One possible explanation is that the study was not powered to detect statistical differences in this secondary outcome. Secondly, the intraoperative dose of fentanyl in the lidocaine group,(half of that administered to the control group), might have been sufficient to have induced persistent nausea, triggering the use of ondansetron, thus delaying the time for home discharge. Whether lidocaine infusion in the absence of intraoperative opioids would spare the amount of postoperative fentanyl required, and further decrease the incidence of persistent nausea, warrants evaluation in future studies examining the predictive risk of PONV.

All investigations conducted with lidocaine infusions, to date, included concurrent intraoperative opioid administration, although in the present study the dose of fentanyl was deliberately reduced by half to test for intraoperative opioid sparing. In addition to opioid sparing during surgery, with lidocaine infusion, there was a 10% reduction in the amount of desflurane required to maintain hemodynamic stability and BIS during surgery. This observation is in agreement with other studies[10,12,19,20] which report a reduction in the concentration of inhalational agents with concurrent infusion of lidocaine.

No differences in self-reported pain scores and PONV were observed between the two groups 24 hr after surgery, as has been shown in a previous laparoscopic cholecystectomy study.[9] In addition, these same authors could not demonstrate any effect of lidocaine on restoration of bowel function. This observation might have been due to the short period of lidocaine infusion necessary to attenuate the inflammatory response, by promoting leukocyte inhibition

and subsequent activation of an inhibitory adrenergic pathyway.[14] In fact, when lidocaine infusion was continued for 24 hr in the postoperative period, the duration of ileus after colon resection was shortened with better postoperative analgesia.[10] Recently, intravenous lidocaine was used for total hip arthroplasty, and no impact on postoperative analgesia was reported.[21] This finding lends further support to the predominant role of lidocaine in the treatment of visceral pain.

In conclusion, intraoperative lidocaine infusion, in combination with low intraoperative doses of short-acting opioids reduces the consumption of fentanyl in the PACU, and the intraoperative desflurane requirements. There is a need to address, in future investigations, whether or not lidocaine impacts on postoperative nausea and vomiting.

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