Obesity Surgery (2019) 29:3800–3808
https://doi.org/10.1007/s11695-019-04074-1

ORIGINAL CONTRIBUTIONS

The Effect of Intraoperative Dexmedetomidine Versus Morphine on Postoperative Morphine Requirements After Laparoscopic Bariatric Surgery

Carine Zeeni[1] · Marie T. Aouad[1] · Dayane Daou[2] · Sara Naji[1] · Samar Jabbour-Khoury[1] · Ramzi S. Alami[3] · Bassem Y. Safadi[4] · Sahar M. Siddik-Sayyid[1]

Published online: 8 July 2019

Abstract

Background Dexmedetomidine is an α_2 receptor agonist with sedative and analgesic properties. During bariatric surgery, its use may reduce postoperative opioid requirements, reduce their side effects, and improve quality of recovery.

The aim of this prospective randomized controlled trial was to compare the effect of dexmedetomidine bolus and infusion versus morphine bolus given prior to the end of laparoscopic bariatric surgery.

Methods Sixty morbidly obese patients (BMI > 40 kg m^{-2}) aged 18 to 60 years, undergoing laparoscopic sleeve gastrectomy, received morphine sulfate (bolus 0.08 mg kg^{-1} followed by a saline infusion) (group M, $n = 30$) or dexmedetomidine (loading dose of 1 μg kg^{-1} followed by 0.5 μg kg^{-1} h^{-1}) (group D, $n = 30$) 30 min before the end of surgery.

Data collected included morphine consumption in the post-anesthesia care unit (PACU) (primary outcome) and at 24 h, pain intensity, nausea, heart rate, blood pressure, vomiting, sedation, and quality of recovery.

Results There was no significant difference in morphine consumption in the PACU (group D 12.2 ± 5.44 mg, group M 13.28 ± 6.64 mg, $P = 0.54$) or at 24 h (group D 40.67 ± 24.78 mg, group M 43.28 ± 27.79 mg, $P = 0.75$); when accounting for intraoperative morphine given group M had significantly higher morphine consumption when compared to group D (23.48 ± 6.22 mg vs. 12.22 ± 5.54 mg, respectively, $P < 0.01$). Group D patients had more cardiovascular stability.

Conclusions Dexmedetomidine given prior to end of laparoscopic sleeve gastrectomy provides the same level of postoperative analgesia as morphine with better hemodynamic profile.

Keywords Dexmedetomidine · Morphine · Bariatric surgery · Obesity · Postoperative pain

✉ Sahar M. Siddik-Sayyid
ss01@aub.edu.lb

Carine Zeeni
cz07@aub.edu.lb

Marie T. Aouad
mm01@aub.edu.lb

Dayane Daou
dd21@aub.edu.lb

Sara Naji
sara_bnj@hotmail.com

Samar Jabbour-Khoury
sj00@aub.edu.lb

Ramzi S. Alami
ra204@aub.edu.lb

Bassem Y. Safadi
bassem.safadi@lau.edu.lb

[1] Department of Anesthesiology, American University of Beirut Medical Center, Beirut, Lebanon

[2] Keserwan Medical Center, Keserwan, Jounieh, Lebanon

[3] Department of Surgery, American University of Beirut Medical Center, Beirut, Lebanon

[4] Department of Surgery, Lebanese American University, Beirut, Lebanon

Introduction

Dexmedetomidine (Precedex®, Hospira, IL) is a potent and highly selective α-$_2$ adrenoreceptor agonist with sedative, anxiolytic, sympatholytic, and analgesia-sparing properties [1–5]. Systemic administration of dexmedetomidine has been reported to reduce both the anesthetic and opioid requirements in the perioperative period. In addition, it has minimal effects on ventilation [1, 6, 7] and has been increasingly used as an adjuvant drug during general anesthesia to improve the management of morbidly obese patients [8–10]. It has even been used as a sole substitute for intraoperative opioids in a few reports [11, 12].

Enhanced Recovery after Surgery (ERAS) protocols are suggested as the state of the art approach to the care of the surgical patient. In the most recent ERAS published protocol for bariatric surgery, there was strong evidence and recommendations to reduce the consumption of opioids by using multimodal analgesia [13]. Furthermore, respiratory function is compromised after bariatric surgery because obesity induces severe restrictive syndrome and lying flat can induce atelectasis [13]. Moreover, perioperative opioids promote obstruction of the upper airways which might induce postoperative hypoxemia [14]. Therefore, the ultrashort-acting opioid remifentanil is frequently used during laparoscopic bariatric surgery to replace long-acting opioids intraoperatively. However, morphine supplementation at the end of surgery remains mandatory to avoid hyperalgesia and postoperative pain. Previous studies on bariatric patients used dexmedetomidine as a sole agent throughout the surgery [9, 11] and/or after surgery [8, 11], but none have examined the influence of dexmedetomidine given at the end of laparoscopic sleeve gastrectomy versus morphine for the control of postoperative pain following a remifentanil-based anesthetic.

The purpose of this prospective, randomized, double-blind study was to demonstrate that the analgesic efficacy of dexmedetomidine is equivalent to that of morphine. Both medications, when administered at the end of surgery, should have the same efficacy with regard to opioid requirements and pain scores in the early postoperative period in morbidly obese patients undergoing laparoscopic sleeve gastrectomy. Secondary outcomes included intraoperative and postoperative hemodynamics, sedation scores, nausea and vomiting, pruritus, respiratory complications, and readiness to discharge collected in the post-anesthesia care unit (PACU). Quality of recovery using (QoR-40) scoring system 24 h after surgery was also compared between the two groups, in addition to an overall satisfaction score collected 1 month after surgery.

Materials and Methods

This prospective, randomized, double-blind trial was conducted at the American University of Beirut Medical Center (AUBMC), registered with ClinicalTrials.gov (NCT02213159) on August 8, 2014, and adheres to CONSORT guidelines. This study obtained ethical approval (Institutional review Board, ID: ANES.CZ.02) by the Ethical Committee of the American University of Beirut, Beirut, Lebanon on May 15, 2014. After IRB approval, patients who were scheduled for laparoscopic sleeve gastrectomy were identified and approached by a member of the research team. Subsequently, written informed consent was obtained from American Society of Anesthesiologists (ASA) II patients with morbid obesity aged 18 to 60 years (body mass index (BMI) >40 kg/m or >35 kg/m with comorbid conditions such as hypertension, diabetes, and/or sleep apnea). Patients were excluded if they had allergy to morphine or α-2 adrenergic agonists, weight over 180 kg, history of uncontrolled hypertension, heart block greater than first degree, or other clinically significant morbidities. Also, patients were excluded if they received an opioid analgesic within a 24-h period prior to surgery, had history of alcohol, drug abuse, chronic opioid intake, psychiatric disorder, or were pregnant or breastfeeding.

Patients were randomly assigned using a computer-generated random number table with block randomization (10 blocks, 6 patients each) to one of two treatment groups: group D received dexmedetomidine and group M received morphine. Boluses were filled in identical 20-ml syringes labeled BOLUS and were run at 120 ml/h, and infusions of saline and dexmedetomidine were filled in identical 20-ml syringes labeled INFUSION and run at a rate of 0.05 ml/kg/h. Study medications were prepared by an anesthesia staff member not involved in data collection. Doses were based on the patient's actual body weight. The investigators, anesthesiologists, PACU and ward nurses, as well as the patients were blinded to the randomization schedule.

Patients were premedicated with midazolam 20 μg/kg iv prior to entering the operating room. Standard ASA monitoring devices were used. Induction of anesthesia was achieved using propofol 2 mg/kg, fentanyl 1 μg/kg, and lidocaine 1 mg/kg. Rocuronium 0.6–1.2 mg/kg or succinylcholine 1–2 mg/kg were administered to facilitate tracheal intubation. All patients received dexamethasone 8 mg iv after induction. Maintenance of anesthesia was provided using a mixture of oxygen and air ($FiO_2 = 50\%$) and sevoflurane 2%. A remifentanil infusion (0.1–0.5 μg/kg/min) was started after intubation and stopped at the completion of wound closure. Mean arterial pressure values were maintained within 20% of baseline values by varying the infusion of remifentanil. Thirty minutes prior to the anticipated completion of surgery, patients in group D received dexmedetomidine 1 μg/kg over 10 min followed by 0.5 μg/kg/h until removal of the laparoscope, and

patients in group M received morphine 0.08 mg/kg over 10 min followed by a saline infusion until removal of the laparoscope. Ondansetron 8 mg iv was then given and sevoflurane was turned off. After completion of wound closure, residual neuromuscular block was antagonized with neostigmine 40 μg/kg iv and glycopyrrolate 10 μg/kg iv or sugammadex. The oxygen flow rate was then increased to 8 l/min. Patients were extubated in the operating room and transported to the PACU.

In PACU, a morphine PCA machine (baseline 0, bolus 2 mg, lockout 6 min, 4 h maximum dose 40 mg) was attached to the patient. NRS pain scores were obtained upon arrival and repeated at regular intervals. Postoperative morphine therapy was titrated in both groups by increments of 2 mg if the NRS pain score was > 4. Patients were allowed to self-administer morphine using the PCA when judged capable by the PACU nurse. The primary outcome measure was total morphine consumption in PACU.

Secondary outcome measures were intraoperative hemodynamic values, total morphine consumption at 24 h, NRS pain scores at rest in PACU and at 24 h, time to discharge readiness from PACU, incidence of pruritus, nausea and vomiting, and respiratory complications in PACU, as well as quality of recovery at 24 h through the QoR-40. This questionnaire consists of 40 items related to five domains linked to quality of life with scores ranging from 40 to 200 and has been validated as a reliable tool to assess postoperative quality of recovery [15, 16]. Furthermore, hemodynamic values, NRS pain scores, and modified Observer's Assessment of Alertness/Sedation Scale (OAA/S) scores were recorded at 5-min intervals for the first 15 min after arrival to the PACU, and subsequently at 15-min intervals until transfer to the ward.

The NRS nausea scores and episodes of emesis, as well as the need for rescue antiemetic therapy, were recorded at 30-min intervals until PACU discharge. Patients reporting a NRS nausea score > 3 were given metoclopramide 10 mg iv. Respiratory complications including obstruction requiring chin lift/jaw thrust or nasopharyngeal airway, number of desaturation episodes of ≤ 92% for 10 s despite O_2 supplementation, and need for reintubation were recorded. Patients were contacted by phone 1 month after discharge and asked to rate their overall satisfaction with their surgical experience on an NRS scale.

The sample size was computed after calculating Δ as follows: $\Delta = \mu_0 - \mu_1/\gamma$ (μ_0 = mean dose of morphine in the morphine group, μ_1 = mean dose of morphine in the dexmedetomidine group, and γ = standard deviation). The following values were obtained based on Arain's study [17]: $\mu_0 = 9$, $\mu_1 = 4.5$, $\gamma = 6$. Therefore, with β of 0.2 and α of 0.05 and two-sided test, the calculated number of patients is 28 in each group. The sample size was increased to 30 per group to compensate for potential subject loss during the course of the study. Continuous data (demographics, intraoperative characteristics, morphine consumption, time to first morphine requirement, intraoperative and PACU hemodynamics, vomiting and rescue antiemetics, episodes of desaturation, and chin lift/jaw thrust) were represented as means ± SD and analyzed using Student's *t* test, categorical data (respiratory complications, pruritus) were represented as numbers and percentages and analyzed using χ^2 or Fisher's exact test as appropriate. Scores (NRS pain and nausea scores, OAA/S scores, QoR-40 scores, and NRS satisfaction scores) were represented as medians and interquartile ranges and analyzed using Mann-Whitney *U* test. *P* values < 0.05 were considered significant. We used SPSS version 23 (SPSS Inc., Chicago, IL) for our statistical analysis.

Results

A total of 145 patients were assessed for eligibility between August 2014 and July 2015. Sixty patients were enrolled in the study, one patient was excluded due to morphine allergy, and three patients were excluded due to surgical complications requiring early surgical re-exploration. The final number of patients included was 27 patients for group D and 29 patients for group M (Fig. 1).

Both groups were similar regarding baseline demographics and intraoperative data except for a higher incidence of history of hypertension in group M (Table 1).

There were no significant differences in morphine consumption in the PACU or at 24 h (Fig. 2). Also, NRS pain scores were similar (Table 2). However, when accounting for intraoperative morphine given, group M had significantly more morphine consumption (intraoperative plus PACU morphine) than group D (23.48 ± 6.22 mg vs 12.22 ± 5.54 mg, respectively; $P < 0.01$). Time to first morphine requirement was not significantly different between groups (group D 8.89 ± 10.68 min vs group M 7.62 ± 8.49 min, respectively; $P = 0.74$).

Intraoperatively systolic (SBP) and diastolic blood pressures (DBP) were significantly lower in group D than in group M at different time points after the start of the study drugs and at extubation (Fig. 3a, b). However, severe hypotension (SBP ≤ 90 mmHg) did not occur in either group. Furthermore, heart rate (HR) was significantly lower in group D compared to group M at extubation (Fig. 3c).

In PACU, at most time points, SBP, DBP, and HR were significantly lower in group D compared to group M (Fig. 4a–c).

Although NRS nausea scores (Table 2), episodes of emesis 0 (IQR 0 to 0) for group D vs. 0 (IQR 0 to 1) for group M, and rescue antiemetic use 0 (IQR 0 to 0) for group D vs. 0 (IQR 0 to 1) for group M were higher in group M than in group D, the difference did not reach statistical significance. Only one patient in group M complained of pruritus, none in group D. No

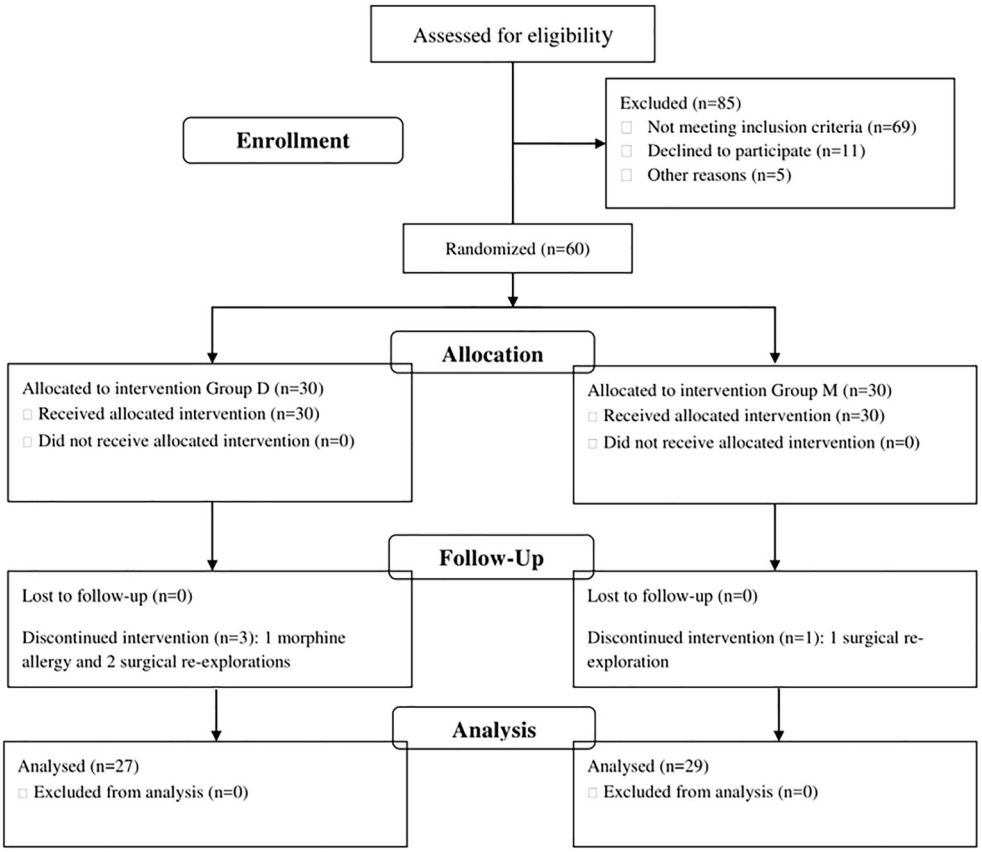

Fig.1 Consort flow diagram

patient required chin lift/jaw thrust maneuvers, nasal airway insertion, or was re-intubated in PACU.

Time to discharge readiness from PACU was not statistically different between the groups 78.37 ± 27.10 min for

Table 1 Demographic characteristics and intraoperative data

Variable		Dexmedetomidine $n = 27$	Morphine $n = 29$	*P*value
Age (years)		38.04 ± 12.43	38.03 ± 10.44	0.89
Height (m)		1.67 ± 0.09	1.70 ± 0.10	0.33
Weight (kg)		117.67 ± 18.75	120.69 ± 21.68	0.64
BMI (kg m^{-2})		42.14 ± 6.53	41.78 ± 5.86	0.86
Baseline SBP (mmHg)		139.48 ± 20.59	138.66 ± 16.91	0.78
Baseline DBP (mmHg)		81.89 ± 14.14	84.34 ± 13.21	0.73
Baseline HR (bpm)		86.22 ± 14.03	83.21 ± 12.41	0.52
Surgical duration (min)		100.15 ± 25.23	103.72 ± 24.36	0.45
Time to extubation (min)		108.52 ± 24.83	110.28 ± 22.66	0.58
Total intraoperative remifentanil (mg)		1.63 ± 0.77	1.92 ± 0.77	0.17
Obstructive sleep apnea	No	17 (63.0)	18 (62.1)	0.94
	Yes	10 (37.0)	11 (37.9)	
Hypertension	No	14 (51.9)	25 (86.2)	0.005
	Yes	13 (48.1)	4 (13.8)	
Diabetes mellitus	No	24 (88.9)	22 (75.9)	0.30
	Yes	3 (11.1)	7 (24.1)	
Reversal agent	Prostigmine	10 (37.0)	12 (41.4)	0.74
	Suggamadex	17 (63.0)	17 (58.6)	

Values are means ± SD and numbers, percentages

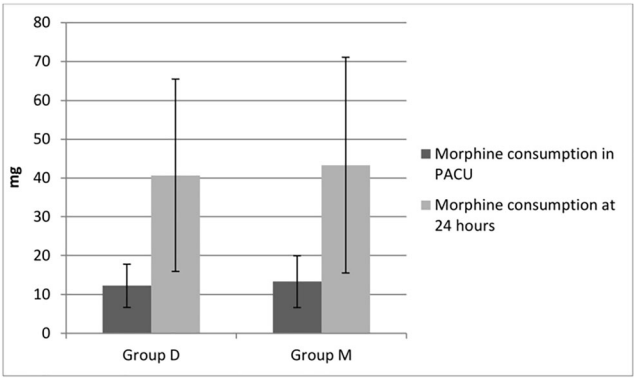

Fig.2 Morphine consumption in post anesthesia care unit and at 24 h

group D vs 76.62 ± 19.92 min for group M, $P = 0.77$. PACU OAA/S sedation scores were not significantly different between groups (Table 2). Quality of recovery scores and NRS scores for satisfaction 1 month post-discharge were comparable between groups (Table 2).

Discussion

Our findings support the administration of dexmedetomidine as an alternative to morphine toward the completion of bariatric surgery following a remifentanil-based anesthetic. This is based on equivalent morphine requirements and pain scores in PACU, with the advantage of more hemodynamic stability during emergence and the early postoperative period in the dexmedetomidine group compared with the morphine group.

Remifentanil infusion is commonly used during bariatric surgery for its rapid onset and short analgesic duration independent of dose and duration. However, considerable evidence suggests that exposure to high-dose remifentanil paradoxically enhances pain sensitivity and increases analgesic requirements [18–20]. Therefore, a longer acting drug such as morphine is given at the end of the procedure. There is recent advocacy for opioid-free anesthetics that may contribute to improved recovery. We have shown that dexmedetomidine administered at the end of the procedure is equivalent to morphine for the control of postoperative pain.

Enhanced tyrosine phosphorylation of the NR2B subunit of the NMDA receptor contributes to nociceptor activity-induced spinal plasticity and the development of central sensitization leading to remifentanil-induced postoperative hyperalgesia [21]. Dexmedetomidine decreases spinal tyrosine phosphorylation of the NR2B subunit, therefore, decreasing remifentanil induced postoperative hyperalgesia. Furthermore, dexmedetomidine may reduce inflammation response [22, 23] and hyperalgesia resulting from it [24, 25]. It also modulates norepinephrine release from the locus ceruleus centrally and stimulates α-2 receptors directly in the spinal cord, inhibiting nociceptive neuron firing [26]. In addition, dexmedetomidine appears to potentiate the analgesic effect

Table 2 NRS pain, nausea, OAA/S, and QoR-40 scores

	Group		
	Dexmedetomidine	Morphine	
Variable	Median (IQR)	Median (IQR)	*P*value
NRS pain at arrival to PACU	6.00 [5.00 to 8.25]	7.00 [3.50 to 9.50]	0.62
NRS pain at 60 min	4.00 [3.00 to 6.00]	5.00 [4.00 to 6.00]	0.24
NRS pain at first morphine requirement	7.00 [5.00 to 8.00]	7.50 [5.25 to 9.00]	0.83
NRS pain at 24 h	4.00 [2.00 to 6.00]	4.00 [2.00 to 4.50]	0.46
NRS nausea at arrival to PACU	2.50 [0.00 to 7.00]	3.00 [0.00 to 7.00]	0.85
NRS nausea at 60 min	2.50 [0.00 to 5.00]	0.50 [0 to 4.75]	0.84
NRS nausea at 24 h	2.00 [0.00 to 6.75]	3.00 [3.00 to 7.00]	0.26
OAA/S at arrival to PACU	4.00 [3.00 to 5.00]	4.00 [4.00 to 5.00]	0.27
OAA/S at 60 min	4.00 [3.00 to 5.00]	4.00 [3.50 to 5.00]	0.34
QoR-40	165.00 [141.00 to 173.00]	169.00 [154.00 to 181.00]	0.14
QoR Comfort	44.00 [39.00 to 50.00]	46.00 [38.00 to 50.50]	0.70
QoR Emotional state	38.00 [31.00 to 43.00]	40.00 [35.00 to 43.00]	0.85
QoR Psychological support	33.00 [29.00 to 35.00]	34.00 [30.00 to 35.00]	0.77
QoR Physical independence	19.00 [13.00 to 23.00]	21.00 [18.00 to 24.00]	0.16
QoR Pain	28.00 [25.00 to 32.00]	28.00 [25.50 to 31.50]	0.99
NRS for satisfaction at 1 month	10.00 [9.00 to 10.00]	9.00 [8.00 to 10.00]	0.29

Values are medians and interquartile ranges

NRS numerical rating scale, *OAA/S* observer's assessment of alertness/sedation scale, *QoR* quality of recovery score, *min* minutes

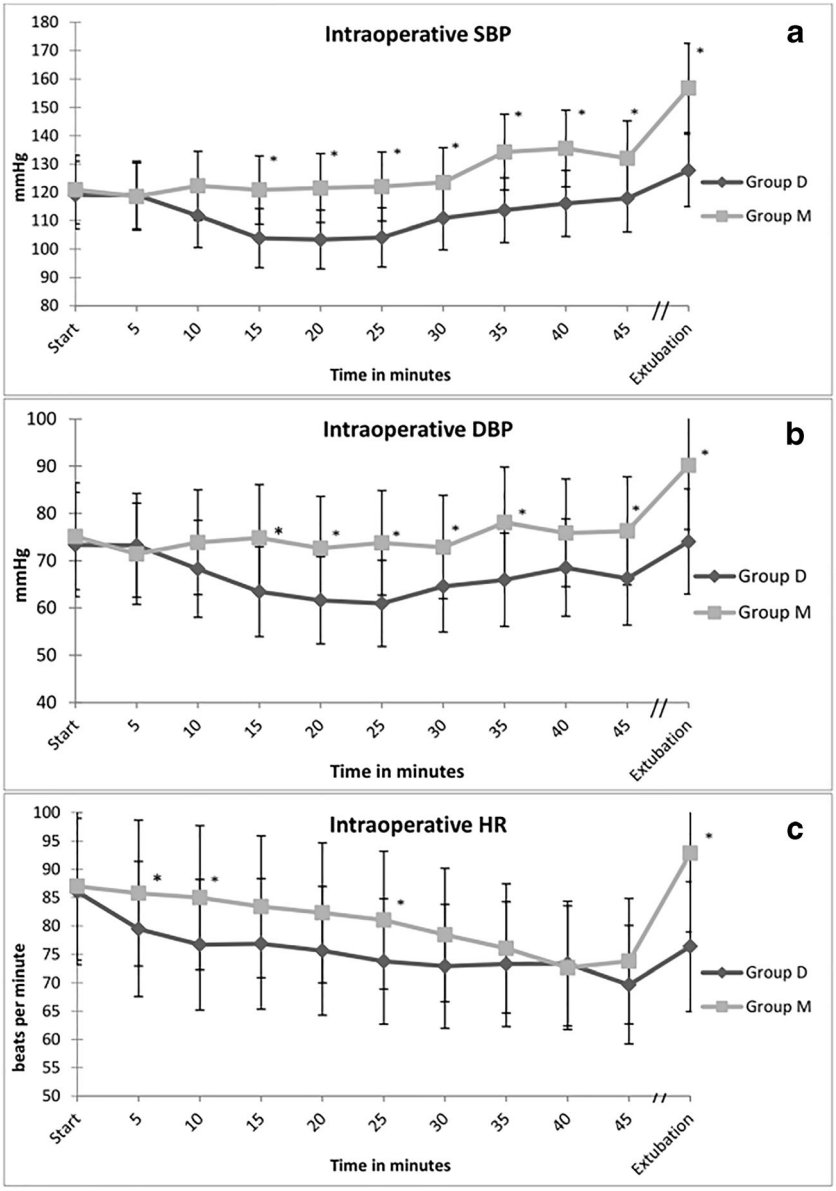

Fig.3 **a** Intraoperative systolic blood pressure from study drug infusion start to extubation. SBP, systolic blood pressure; $^*P < 0.05$. **b** Intraoperative diastolic blood pressure from study drug infusion start to extubation. DBP, diastolic blood pressure; $^*P < 0.05$. **c** Intraoperative heart rate from study drug infusion start to extubation. HR, heart rate; $^*P < 0.05$

of opiates (synergistic action) [27–29]. It may therefore be an effective treatment option for preventing remifentanil-induced hyperalgesia.

Initially, dexmedetomidine acts peripherally on vascular smooth muscle α-2B receptors, resulting in vasoconstriction, transient increases in blood pressure (BP), and reflex decreases in HR mainly seen after rapid administration of large doses. Following this initial peripheral effect, a more gradual central effect results in a decreased sympathetic outflow and circulating catecholamine levels, with an increased vagal activity, causing a decrease in HR and BP [1, 30]. The transient increase in BP was not seen with the bolus dose in our study, probably blunted by the sevoflurane and remifentanil. However, the sympatholytic effects were evident during emergence as the SBP, DBP, and HR were significantly lower in group D vs. group M. These findings concur with those of other studies [31, 32] and confer the advantage of better hemodynamic stability at emergence in a patient population that may have significant cardiac comorbidities.

Following intravenous administration, dexmedetomidine has a rapid distribution phase (6-min distribution half-life) and a terminal half-life of 2 h. In our study, dexmedetomidine was given around 30 min before the end of the surgery in order to achieve a sustained postoperative therapeutic analgesic level. Dexmedetomidine is extremely lipophilic and it is likely that, in the morbidly obese patient, it will be taken up by the fatty tissue thereby prolonging its elimination and providing prolonged postoperative analgesia. The analgesic effect might have lasted as long as the hemodynamic effect; as a matter of fact, in our study, the difference in BP and HR between the

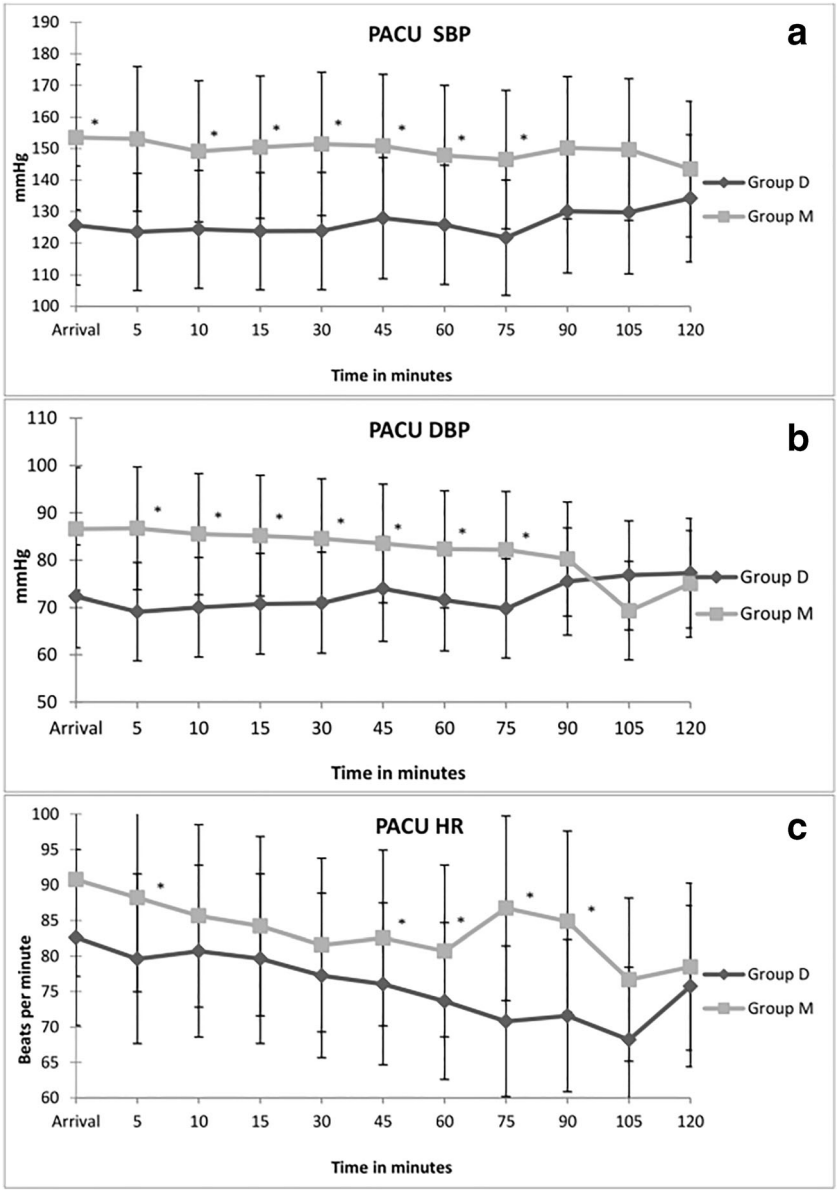

Fig.4 **a** Post anesthesia care systolic blood pressure. PACU, post anesthesia care unit; SBP, systolic blood pressure; *$P < 0.05$. **b** Post anesthesia care unit diastolic blood pressure. PACU, post anesthesia care unit; DBP, diastolic blood pressure; *$P < 0.05$. **c** Post anesthesia care unit heart rate. PACU, post anesthesia care unit; HR, heart rate; *$P < 0.05$

two groups disappeared at 75 min and 90 min, respectively, from PACU admission time.

In their retrospective study, Dholakia et al. [33] demonstrated that a dexmedetomidine infusion can safely be administered perioperatively to morbidly obese patients. Furthermore, they provided data suggesting that a perioperative dexmedetomidine infusion may result in less need for opioids and earlier discharge, particularly after laparoscopic gastric bypass surgery. In a prospective randomized study on the effects of different infusion rates of dexmedetomidine on postoperative variables in laparoscopic bariatric surgery, it was shown that a dexmedetomidine infusion of 0.2–0.8 μg/kg/h of actual body weight produced anesthetic sparing effects and a reduction in the need for opioids and antiemetics. The patients had lower mean arterial pressure values in the early postoperative period [9]. Another study in bariatric patients comparing dexmedetomidine 0.8 μg/kg bolus followed by 0.4 μg/kg/h continuous infusion with placebo showed decreased fentanyl and propofol consumption for maintenance of anesthesia and more stable hemodynamics while postoperative pain and total amount of morphine were decreased [34].

There are limited studies in the literature comparing dexmedetomidine to opioids head to head post bariatric surgery. A previous study compared dexmedetomidine directly to fentanyl as an adjunct to desflurane anesthesia and showed decreased HR, BP, desflurane requirement, postoperative pain level, and morphine use in the PACU [12]. Another study compared intravenous infusion of dexmedetomidine initiated

and continued for 24 h following laparoscopic bariatric surgery with morphine infusion and found no difference in mean rescue morphine and paracetamol requirements. However, the dexmedetomidine group received a significantly lower total amount of morphine over 24 h [8]. We compared dexmedetomidine versus morphine on the characteristics of recovery following a remifentanil-based anesthetic. Likewise, our patients in the morphine group received a larger dose of morphine compared to the dexmedetomidine group when taking into account intraoperative morphine given.

A review of the literature yielded only one prospective study comparing dexmedetomidine to morphine in the early perioperative period in non-bariatric surgery [17]. Similar to our study, patients received either dexmedetomidine or morphine infusion based on their actual body weight 30 min before the anticipated completion of each procedure. These investigators determined that the dexmedetomidine-treated patients required significantly less supplemental morphine to achieve equivalent analgesia and that they had a significantly slower HR in the PACU. Of note, this study was performed on non-obese patients undergoing different types of major intra-abdominal or orthopedic surgeries, which could explain the difference with our results.

A meta-analysis has shown that dexmedetomidine administration significantly decreases postoperative pain and has an opioid sparing effect compared to placebo. Additionally, it seems to reduce opioid-related adverse events, although clear statistical significance was not reached for most variables (PONV, pruritus, and respiratory depression) [35]. Similarly, in our study, NRS nausea scores and rescue antiemetic use did not show a statistically significant difference between groups. The intraoperative use of dexamethasone and ondansetron may have influenced the incidence and severity of PONV; in addition, our study may be underpowered to detect a difference in PONV and other opioid-related side effects.

A recent study evaluating the postoperative effects of a single intraoperative dose of dexmedetomidine (1 mg/kg delivered over 10 min) vs. placebo administered at the time of surgical closure in patients undergoing laparoscopic Roux-en-Y gastric bypass surgery showed no reduction in the immediate PACU usage of opioids but a significant reduction in reported pain scores and a decrease in the number of PCA attempts for opioids made by patients [36].

Unlike other studies where dexmedetomidine was shown to improve quality of recovery scores [37–39], in our patient population, there were no differences between groups regarding QoR-40 at 24 h. This could be explained by the fact that both groups received morphine postoperatively hence dampening the advantages conferred by avoiding opioids intraoperatively. A limitation of our study is that we did not continue the infusion of the study medication in the PACU to achieve a more prolonged opioid-sparing effect. We also did not assess NRS pain scores at cough; our patient population having had laparoscopic surgery could have had significant shoulder pain during cough.

Conclusions

In conclusion, this study showed that dexmedetomidine at the end of surgery is a good alternative to morphine for the control of postoperative pain following a remifentanil-based anesthetic. The hemodynamic stability provided by dexmedetomidine may confer an advantage in the obese population where the incidence of comorbidities is high and has significant impact on the perioperative management. More importantly, in this era of concern over perioperative opioid use, dexmedetomidine should be considered as part of the armamentarium that may facilitate the recovery process of obese patients who are at increased risk of postoperative respiratory complications.

Acknowledgements We would like to thank Mrs. Fadia Shebbo for her assistance with the study.

Financial Support and Sponsorship This work was supported by an intramural medical practice plan grant of the American University of Beirut Medical Center.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Ebert TJ, Hall JE, Barney JA, et al. The effects of increasing plasma concentrations of dexmedetomidine in humans. Anesthesiology. 2000;93(2):382–94.
2. Talke P, Richardson CA, Scheinin M, et al. Postoperative pharmacokinetics and sympatholytic effects of dexmedetomidine. Anesth Analg. 1997;85(5):1136–42.
3. Talke P, Chen R, Thomas B, et al. The hemodynamic and adrenergic effects of perioperative dexmedetomidine infusion after vascular surgery. Anesth Analg. 2000;90(4):834–9.
4. Jaakola ML, Salonen M, Lehtinen R, et al. The analgesic action of dexmedetomidine–a novel alpha 2-adrenoceptor agonist–in healthy volunteers. Pain. 1991;46(3):281–5.
5. Aho MS, Erkola OA, Scheinin H, et al. Effect of intravenously administered dexmedetomidine on pain after laparoscopic tubal ligation. Anesth Analg. 1991;73(2):112–8.

6. Venn RM, Hell J, Grounds RM. Respiratory effects of dexmedetomidine in the surgical patient requiring intensive care. Crit Care. 2000;4(5):302–8.
7. Hsu YW, Cortinez LI, Robertson KM, et al. Dexmedetomidine pharmacodynamics: part I: crossover comparison of the respiratory effects of dexmedetomidine and remifentanil in healthy volunteers. Anesthesiology. 2004;101(5):1066–76.
8. Abu-Halaweh S, Obeidat F, Absalom AR, et al. Dexmedetomidine versus morphine infusion following laparoscopic bariatric surgery: effect on supplemental narcotic requirement during the first 24 h. Surg Endosc. 2016;30(8):3368–74.
9. Tufanogullari B, White PF, Peixoto MP, et al. Dexmedetomidine infusion during laparoscopic bariatric surgery: the effect on recovery outcome variables. Anesth Analg. 2008;106(6):1741–8.
10. Ramsay MA, Saha D, Hebeler RF. Tracheal resection in the morbidly obese patient: the role of dexmedetomidine. J Clin Anesth. 2006;18(6):452–4.
11. Hofer RE, Sprung J, Sarr MG, et al. Anesthesia for a patient with morbid obesity using dexmedetomidine without narcotics. Can J Anaesth. 2005;52(2):176–80.
12. Feld JM, Hoffman WE, Stechert MM, et al. Fentanyl or dexmedetomidine combined with desflurane for bariatric surgery. J Clin Anesth. 2006;18(1):24–8.
13. Thorell A, MacCormick AD, Awad S, et al. Guidelines for perioperative Care in Bariatric Surgery: enhanced recovery after surgery (ERAS) society recommendations. World J Surg. 2016;40(9):2065–83.
14. Siyam MA, Benhamou D. Intubation in morbidly obese patients. Anesth Analg. 2003;96(3):913.
15. Gornall BF, Myles PS, Smith CL, et al. Measurement of quality of recovery using the QoR-40: a quantitative systematic review. Br J Anaesth. 2013;111(2):161–9.
16. Myles PS, Weitkamp B, Jones K, et al. Validity and reliability of a postoperative quality of recovery score: the QoR-40. Br J Anaesth. 2000;84(1):11–5.
17. Arain SR, Ruehlow RM, Uhrich TD, et al. The efficacy of dexmedetomidine versus morphine for postoperative analgesia after major inpatient surgery. Anesth Analg. 2004;98(1):153–8. table of contents
18. Chu LF, Angst MS, Clark D. Opioid-induced hyperalgesia in humans: molecular mechanisms and clinical considerations. Clin J Pain. 2008;24(6):479–96.
19. Singler B, Troster A, Manering N, et al. Modulation of remifentanil-induced postinfusion hyperalgesia by propofol. Anesth Analg. 2007;104(6):1397–403. table of contents
20. Lee C, Song YK, Jeong HM, et al. The effects of magnesium sulfate infiltration on perioperative opioid consumption and opioid-induced hyperalgesia in patients undergoing robot-assisted laparoscopic prostatectomy with remifentanil-based anesthesia. Korean J Anesthesiol. 2011;61(3):244–50.
21. Koppert W, Sittl R, Scheuber K, et al. Differential modulation of remifentanil-induced analgesia and postinfusion hyperalgesia by S-ketamine and clonidine in humans. Anesthesiology. 2003;99(1):152–9.
22. Ueki M, Kawasaki T, Habe K, et al. The effects of dexmedetomidine on inflammatory mediators after cardiopulmonary bypass. Anaesthesia. 2014;69(7):693–700.
23. Xiang H, Hu B, Li Z, et al. Dexmedetomidine controls systemic cytokine levels through the cholinergic anti-inflammatory pathway. Inflammation. 2014;37(5):1763–70.
24. Zheng Y, Cui S, Liu Y, et al. Dexmedetomidine prevents remifentanil-induced postoperative hyperalgesia and decreases spinal tyrosine phosphorylation of N-methyl-d-aspartate receptor 2B subunit. Brain Res Bull. 2012;87(4–5):427–31.
25. Belgrade M, Hall S. Dexmedetomidine infusion for the management of opioid-induced hyperalgesia. Pain Med. 2010;11(12):1819–26.
26. Weerink MAS, Struys M, Hannivoort LN, et al. Clinical pharmacokinetics and pharmacodynamics of Dexmedetomidine. Clin Pharmacokinet. 2017;56(8):893–913.
27. Peng K, Liu HY, Wu SR, et al. Effects of combining Dexmedetomidine and opioids for postoperative intravenous patient-controlled analgesia: asystematic review and meta-analysis. Clin J Pain. 2015;31(12):1097–104.
28. Unlugenc H, Gunduz M, Guler T, et al. The effect of pre-anaesthetic administration of intravenous dexmedetomidine on postoperative pain in patients receiving patient-controlled morphine. Eur J Anaesthesiol. 2005;22(5):386–91.
29. Blaudszun G, Lysakowski C, Elia N, et al. Effect of perioperative systemic alpha2 agonists on postoperative morphine consumption and pain intensity: systematic review and meta-analysis of randomized controlled trials. Anesthesiology. 2012;116(6):1312–22.
30. Dyck JB, Maze M, Haack C, et al. The pharmacokinetics and hemodynamic effects of intravenous and intramuscular dexmedetomidine hydrochloride in adult human volunteers. Anesthesiology. 1993;78(5):813–20.
31. Guler G, Akin A, Tosun Z, et al. Single-dose dexmedetomidine attenuates airway and circulatory reflexes during extubation. Acta Anaesthesiol Scand. 2005;49(8):1088–91.
32. Yun Y, Wang J, Tang RR, et al. Effects of an intraoperative Dexmedetomidine bolus on the postoperative blood pressure and pain subsequent to craniotomy for Supratentorial tumors. J Neurosurg Anesthesiol. 2017;29(3):211–8.
33. Dholakia C, Beverstein G, Garren M, et al. The impact of perioperative dexmedetomidine infusion on postoperative narcotic use and duration of stay after laparoscopic bariatric surgery. J Gastrointest Surg. 2007;11(11):1556–9.
34. Bakhamees HS, El-Halafawy YM, El-Kerdawy HM, et al. Effects of dexmedetomidine in morbidly obese patients undergoing laparoscopic gastric bypass. Middle East J Anaesthesiol. 2007;19(3):537–51.
35. Schnabel A, Meyer-Friessem CH, Reichl SU, et al. Is intraoperative dexmedetomidine a new option for postoperative pain treatment? A meta-analysis of randomized controlled trials. Pain. 2013;154(7):1140–9.
36. Ranganathan P, Ritchie MK, Ellison MB, et al. A randomized control trial using intraoperative dexmedetomidine during roux-en-Y gastric bypass surgery to reduce postoperative pain and narcotic use. Surg Obes Relat Dis. 2019;15(4):588–94.
37. Kim SH, Oh YJ, Park BW, et al. Effects of single-dose dexmedetomidine on the quality of recovery after modified radical mastectomy: a randomised controlled trial. Minerva Anestesiol. 2013;79(11):1248–58.
38. Lee SH, Lee CY, Lee JG, et al. Intraoperative Dexmedetomidine improves the quality of recovery and postoperative pulmonary function in patients undergoing video-assisted Thoracoscopic surgery: a CONSORT-prospective, randomized, controlled trial. Medicine (Baltimore). 2016;95(7):e2854.
39. Ge DJ, Qi B, Tang G, et al. Intraoperative Dexmedetomidine promotes postoperative analgesia and recovery in patients after abdominal colectomy: a CONSORT-prospective, randomized, controlled clinical trial. Medicine (Baltimore). 2015;94(43):e1727.