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Influence of Obesity on Surgical Regional Anesthesia in the Ambulatory Setting: An Analysis of 9,038 Blocks

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Background: **Regional anesthesia is increasing in popularity for ambulatory surgical procedures. Concomitantly, the prevalence of obesity in the United States population is increasing. The objective of the present investigation was to assess the impact of body mass index (BMI) on patient outcomes after ambulatory regional anesthesia.**

Methods: **This study was based on prospectively collected data including 9,038 blocks performed on 6,920 patients in a single ambulatory surgery center. Patients were categorized into three groups according to their BMI (<25 kg/m^2, 25–29 kg/m^2, ≥30 kg/m^2). Block efficacy, rate of acute complications, postoperative pain (at rest and with movement), postoperative nausea and vomiting, rate of unscheduled hospital admissions, and overall patient satisfaction were assessed. Linear and logistic multivariable analyses were used to obtain the risk-adjusted effect of BMI on these outcomes.**

Results: **Of all patients 34.8% had a BMI <25 kg/m^2, 34.0% were overweight (BMI 25–29 kg/m^2), and 31.3% were obese (BMI ≥ 30 kg/m^2). Patients with BMI ≥30 kg/m^2 were 1.62 times more likely to have a failed block (P = 0.04). The unadjusted rate of acute complications was higher in obese patients (P = 0.001). However, when compared with patients with a normal BMI, postoperative pain at rest, unanticipated admissions, and overall satisfaction were similar in overweight and obese patients.**

Conclusions: **The present investigation shows that obesity is associated with higher block failure and complication rates in surgical regional anesthesia in the ambulatory setting. Nonetheless, the rate of successful blocks and overall satisfaction remained high in patients with increased BMI. Therefore, overweight and obese patients should not be excluded from regional anesthesia procedures in the ambulatory setting.**

OBESITY continues to dramatically increase in the United States.[1] The extent of obesity is quantified through the body mass index (BMI), which is defined as the relationship between height and weight (weight [kg]/height^2 [m^2]). The BMI is divided in five categories: <25 kg/m^2 = normal, 25–30 kg/m^2 = overweight, >30 kg/m^2 = obesity, >35 kg/m^2 = morbid obesity, >55 kg/m^2 = super morbid obesity.[2] Today 64.5%[1] of the United States population is overweight, and obesity among United States adults has almost doubled during the last decades.[3,4] This epidemic has dramatic implications for anesthesiologists.[3] Obese and morbidly obese patients are at high-risk for difficult airway management, cardiopulmonary dysfunction, acid aspiration, and markedly increased perioperative morbidity and mortality.[3,5] Because of this increased risk, the Royal College of Surgeons considered morbid obesity a contraindication for day-case surgery in the United Kingdom.[6]

Regional anesthesia (RA) offers several advantages when treating obese patients, including minimal airway intervention, less cardiopulmonary depression, improved postoperative analgesia,[7,8] decreased opioid consumption, decreased postoperative nausea and vomiting (PONV),[7–10] and therefore reduced postanesthesia care unit (PACU)[10] and hospital length of stay.[8,9] Moreover, RA has been associated with improved postoperative analgesia,[7,8] particularly when long-acting local anesthetics[11] or continuous peripheral nerve blocks[12] were used. Despite these advantages, RA can be technically challenging in the obese. These challenges are related to difficulties in patient positioning, identifying the usual bony and muscular landmarks, and the depth of needle penetration.[3]

Current data quantifying the effect of increased BMI on patient outcomes after RA are scarce. The objective of the present investigation was to examine the efficacy, complication rate, and potential benefits of RA used for ambulatory surgery in patients with different BMIs. We hypothesized that block failure rate was related to BMI.

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Materials and Methods

Approval to perform the present analysis was obtained from our Institutional Review Board, Duke University Medical Center, Durham, North Carolina. In this study 6,920 patients classified as American Society of Anesthesiologists physical status I–IV, age 13 or older were prospectively enrolled. The age cut-off is based on the standard procedure of our institution to perform RA in pediatric patients aged 13 or older similarly to the adult population. All patients receiving an upper or lower extremity peripheral nerve block (single injection or continuous technique), paravertebral block, central neuraxial block (spinal or epidural), or combined blocks such as lumbar plexus and sciatic nerve blocks between July 1998 and March 2001 at the Duke University Ambulatory Surgery Center were included. Patients were not excluded for any reason.

Regional anesthetic techniques and the need to repeat the block were determined at the discretion of the individual anesthesiologist and performed by attending staff including five attending anesthesiologists, two ambulatory and regional anesthesia fellows, and residents (clinical anesthesia years two and three).

Single injection peripheral nerve blocks were performed using a nerve stimulator and a 20-gauge, 21-gauge, or 22-gauge insulated needle with length of 50, 100, or 150 mm respectively (Stimuplex®, B.Braun, Bethlehem, PA). Continuous peripheral nerve blocks were performed using a nerve stimulator and an 18-gauge insulated Tuohy needle with different lengths including 38.1, 102, and 152 mm (Contiplex®, B. Braun). The nerve stimulator current was less than 0.5 mA for all blocks. Patients were provided sedation with intravenous midazolam and fentanyl. Patients with previous history of PONV received prophylaxis with intravenous ondansetron 4 mg. Blocks were performed in a preoperative holding area using routine monitors and supplemental oxygen.

All patient data were prospectively collected in the Duke University Ambulatory Surgery Center Database. This database is a repository of clinical data, which is part of the standard patient documentation including information on patient demographics, American Society of Anesthesiologists physical status, anesthetic and surgical procedures, complications, and patient satisfaction, among others. Surgical services were subdivided into orthopedics, general surgery, urology, plastics, and gynecology. Twenty-two different RA procedures were included in the present study (table 1).

The primary outcome of the present investigation was block failure. Each block performed was classified as "surgical" or "failed." A block was defined as "surgical" if the first attempt at placing the block resulted in adequate anesthesia for surgery. Needle redirection during block performance was still considered as the first attempt. Block failure was defined as any "nonsurgical block," including the need to repeat the block (at the discretion of the anesthesiologist) or the need for intraoperative local anesthetic infiltration, general anesthesia, or immediate postoperative opioids. If surgical anesthesia was not obtained in patients simultaneously undergoing multiple RA procedures, all blocks were defined as "failed." Another endpoint was acute block complications related to local anesthetic toxicity, including initial signs and symptoms of toxicity (*e.g.*, metallic taste, perioral paresthesia, tinnitus), central nervous system toxicity (*e.g.*, preseizure excitation, seizures), and cardiovascular toxicity (*e.g.*, arrhythmias, cardiac arrest), as well as the occurrence of hematomas, epidural or intrathecal spread, and pneumothorax. Further outcomes, including PACU length of stay (defined as the time between PACU admission and PACU discharge) and patient disposition from the PACU (dichotomized into regular discharge *versus* unplanned admission to the 23-h observation unit or hospital) were also recorded. In addition, specially trained nurses for data collection recorded the following data: patients were asked in the PACU to report their pain at rest and with movement at the surgical site using a verbal analog scale (0 = no pain to 10 = worst imaginable pain). Also, patients requiring opioids (*e.g.*, intravenous morphine, intravenous fentanyl, or oral oxycodone) or treatment for PONV were noted. Finally, postoperative data were collected by telephone call at 24 h after the intervention. Patients were asked to rate their overall satisfaction with the anesthesia experience on a five-point scale (1 = very dissatisfied to 5 = very satisfied). If the patients were unavailable at the first telephone call, a second call was placed 1 day later. Patients unavailable by telephone contact received a written questionnaire by mail.

Table 1. Frequency Distribution of Performed Blocks (n = 9,038)

Nerve Block Category	Block Technique	Frequency (%)
Peripheral nerve blocks	Superficial cervical plexus	0.2%
	Interscalene	12.7%
	Supraclavicular	4.6%
	Infraclavicular	0.1%
	Axillary	5.5%
	Wrist	0.2%
	Lumbar plexus	10.1%
	Femoral nerve	6.1%
	Sciatic nerve	17.1%
	Saphenous nerve	0.9%
	Ankle	2.5%
Central neuraxial blocks	Spinal	9.8%
	Continuous epidural	0.6%
Continuous peripheral nerve blocks	Continuous interscalene	4.4%
	Continuous supraclavicular	0.1%
	Continuous infraclavicular	0.01%
	Continuous axillary	0.2%
	Continuous lumbar plexus	2.5%
	Continuous femoral nerve	0.1%
	Continuous sciatic nerve	3.2%
Paravertebral blocks	Paravertebral	18.4%
	Continuous paravertebral	0.2%

* As a result of rounding, the percentages do not total 100%.

The primary predictor variable was BMI. Patients were divided into three mutually exclusive categories (<25 kg/m^2, 25–29 kg/m^2, ≥30 kg/m^2). The cut-off values for these categories were chosen to obtain similar numbers of patients in each category. We initially attempted to create a fourth category for morbidly obese patients (BMI ≥35 kg/m^2). The number of events in this category was, however, prohibitively small for multivariable analyses.[13] Thus, we combined obese and morbidly obese patients into one group.

Statistical Analysis

Descriptive analyses were performed using means and SD for continuous variables and frequencies and percent-

Table 2. Patient Characteristics (n = 6,920)

	Category	BMI <25	BMI 25–29	BMI ≥30	All Patients	*P* Value*
Age (yr ± SD)	–	45 ± 18	50 ± 17	50 ± 15	48 ± 17	<0.0001
Race	Caucasian	84.7%	80.6%	70.9%	79.0%	<0.0001
	Other	15.3%	19.4%	29.1%	21.0%	<0.0001
Gender	Male	37.7%	56.5%	44.4%	46.2%	<0.0001
	Female	62.3%	43.5%	55.6%	53.8%	<0.0001
ASA Physical Status	I	29.9%	12.6%	7.2%	20.0%	<0.0001
	II	52.8%	57.2%	58.2%	56.0%	<0.0001
	III	15.8%	19.6%	32.7%	22.4%	<0.0001
	IV	1.5%	1.6%	2.0%	1.7%	0.38
Mean BMI	–	22.2	27.3	36.3	28.4	<0.0001
Surgical Service	Orthopedics	61.3%	60.5%	60.6%	60.8%	0.83
	General	29.6%	30.7%	29.6%	30.0%	0.67
	Urology	4.6%	4.0%	5.3%	4.6%	0.09
	Plastics	3.1%	3.3%	3.0%	3.1%	0.77
	Gynecology	1.3%	1.5%	1.5%	1.4%	0.90

As a result of rounding, not all percentages total 100%.

* *P* values are based on unadjusted comparisons among different BMI categories.

ASA = American Society of Anesthesiologists; BMI = body mass index; SD = standard deviation.

ages for categorical variables. Unadjusted comparisons between the outcomes in different BMI categories were performed using two-sample Student *t* tests, chi-square tests, and analysis of variance. The risk-adjusted association between BMI and the outcomes was evaluated using linear and logistic regression models. To eliminate potential confounding, statistical models were adjusted for age, gender, American Society of Anesthesiologists physical status, surgical specialty, and block type. For the latter, we have categorized the RA procedures into four subsets to combine blocks with similar characteristics: 1) central neuraxial blocks (spinal, continuous epidural); 2) peripheral nerve blocks (superficial cervical plexus, interscalene, supraclavicular, infraclavicular, axillary, wrist, lumbar plexus, femoral nerve, sciatic nerve, saphenous nerve, and ankle); 3) continuous peripheral nerve blocks (continuous interscalene, continuous supraclavicular, continuous infraclavicular, continuous axillary, continuous lumbar plexus, continuous femoral nerve, continuous sciatic nerve); and 4) paravertebral blocks (paravertebral, continuous paravertebral).

To assess whether block failure rate was similarly increased in obese patients in the subsets of adults and adolescents, risk-adjusted analyses were performed stratified by age (<20 yr, ≥20 yr). Furthermore, risk-adjusted block failure rates were assessed by block category (central neuraxial blocks, peripheral nerve blocks, continuous peripheral nerve blocks, paravertebral blocks). Finally, risk-adjusted analyses were performed in the subsets of patients receiving one block *versus* those receiving more than one block.

For complication rate and PONV requiring treatment, the number of events (number of patients with complications or PONV requiring therapy) was prohibitively low to perform risk-adjustment.[13,14] It is well known that at least 10 events should be available for each independent variable (covariate) to obtain accurate estimates in multiple logistic regression analyses.[13,14] Thus, for complications and PONV requiring therapy only the results of bivariable analyses are reported. For all other outcomes risk-adjusted multivariable analyses were performed.

Results

The patient population (n = 6,920) included approximately equal percentage of males (46.2%) and females (53.8%), was predominantly Caucasian (79.0%), and had an average age of 48 ± 17 yr. The distribution of American Society of Anesthesiologists physical status was I (20.0%), II (56.0%), III (22.4%), and IV (1.7%). The BMI distribution was 34.8% <25 kg/m^2, 34.0% 25–29 kg/m^2, and 31.3% ≥30 kg/m^2. The mean BMIs were 22.2, 27.3, and 36.3 kg/m^2, for the BMI categories <25, 25–29, and ≥30 kg/m^2, respectively. Patient characteristics by BMI classification are listed in table 2.

There were 9,038 blocks performed on 6,920 patients. Of these 6,920 patients, 4,891 received one block, 1,942 received two blocks, 85 received three blocks, and two received four blocks. The frequencies of performed blocks are displayed in table 1. Of 6,920 patients, 6,165 (89.1%) had a surgical block, 206 (3.0%) had the block repeated, 306 (4.4%) required additional intraoperative local anesthetic infiltration at the surgical site, and 243 (3.5%) underwent general anesthesia. The overall block failure rate was 10.9%. The block failure rate in the different BMI categories was as follows: BMI <25: 9.5%, BMI 25–29: 10.7%, and BMI ≥30: 12.7%. In the subset of patients with BMI ≥35, the block failure rate was 12.9%. Block failure rate was significantly higher in patients receiving more than one block compared with patients

Table 3. Acute Block Complications (n = 22)

Acute Block Complications	Regional Anesthesia Techniques After Which Complications Occurred
Pneumothorax (n = 2)	Paravertebral block
Preseizure excitation (n = 5)	Axillary block
	Paravertebral block
Seizure (n = 2)	Combined lumbar plexus and sciatic nerve blocks
Subdural block (n = 1)	Interscalene block
Epidural spread (n = 12)	Lumbar plexus
	Paravertebral block

receiving only one block (BMI <25: 12.5% *versus* 6.3%, $P < 0.0001$; BMI 25–29: 11.3% *versus* 8.8%, $P = 0.04$; BMI ≥30: 15.7% *versus* 7.7%, $P = 0.002$). Significant differences of failure rates between obese patients and those with normal BMI were found for lumbar plexus block (9.5% *versus* 8.4%, $P = 0.04$) and for continuous interscalene block (15.2% *versus* 9.0%, $P = 0.02$).

Unadjusted Endpoints

In bivariable analyses, greater BMI was associated with increased block failure ($P = 0.002$). Acute block complications occurred in 22 patients (0.3%) (table 3). All complications were managed with conventional measures and none required postponement or cancellation of surgery. The unadjusted complication rate was significantly higher in obese patients ($P = 0.001$). Overweight patients experienced less pain with movement in the PACU ($P = 0.02$). There were no significant differences between the BMI categories for pain requiring opioids in the PACU ($P = 0.21$), pain scores at rest ($P = 0.18$), PONV requiring treatment ($P = 0.28$), length of PACU stay ($P = 0.45$), unanticipated 23-h observation unit and inpatient admissions ($P = 0.99$), and the rate of patients with the greatest level of satisfaction ($P = 0.94$) (table 4).

Risk-adjusted Endpoints

After adjusting for potential confounding variables, the block failure rate was higher for overweight (1.54, 95% CI: 0.99, 2.39, $P = 0.06$) and obese patients (1.62, 95% CI: 1.03, 2.55, $P = 0.04$). Pain with movement was significantly decreased in obese and overweight patients ($P = 0.003$ and 0.05, respectively). No significant differences between other risk-adjusted endpoints between the BMI categories were found (table 5).

Risk-adjusted Stratified Endpoints

In risk-adjusted analyses stratified by age, block failure rates were not significantly higher in overweight (<20 yr: $P = 0.07$, >20 yr: $P = 0.08$) and obese patients (<20 yr: $P = 0.08$, >20 yr: $P = 0.06$). The risk-adjusted block failure rate in peripheral nerve blocks was significantly higher in obese patients ($P = 0.04$) but not in overweight patients ($P = 0.07$). For other block types, the block failure was not significantly increased neither in obese nor overweight patients (paravertebral blocks, overweight: $P = 0.11$, obese: $P = 0.14$; central neuraxial blocks, overweight: $P = 0.14$, obese: $P = 0.09$; continuous peripheral nerve blocks, overweight: $P = 0.10$, obese: $P = 0.08$). Finally, compared with normal BMI patients, the block failure rate remained significantly higher in obese patients receiving more than one block

Table 4. Unadjusted Outcomes

Variable	Category	BMI <25	BMI 25–29	BMI ≥30	All Patients	*P* Value*
Block failure	Yes	9.5%	10.7%	12.7%	10.9%	0.002
	No	90.5%	89.3%	87.3%	89.1%	
Acute block complications	Yes	0.2%	0.1%	0.7%	0.3%	0.001
	No	99.8%	99.9%	99.3%	99.7%	
Pain requiring opioids in PACU	Yes	11.4%	10.2%	11.9%	11.2%	0.21
	No	88.6%	89.8%	88.1%	88.8%	
Pain score at rest on VAS ± SD	–	0.3 ± 1.4	0.3 ± 1.3	0.3 ± 1.4	0.3 ± 1.4	0.18
Pain score with movement on VAS ± SD	–	0.4 ± 1.5	0.3 ± 1.3	0.4 ± 1.5	0.4 ± 1.4	0.02
PONV requiring treatment in PACU	Yes	1.2%	0.7%	1.2%	1.0%	0.28
	No	98.8%	99.3%	98.8%	99.0%	
PACU length of stay ± SD (min)	–	264 ± 211	274 ± 211	268 ± 221	266 ± 215	0.45
Unplanned admission to the 23 h observation unit or hospital	Yes	3.1%	3.2%	3.3%	3.2%	0.99
	No	96.9%	96.8%	96.7%	96.8%	
Complete satisfaction with regional anesthesia procedure 24 h postoperatively	–	96.7%	97.1%	97.1%	97.0%	0.94

* *P* values are based on unadjusted comparisons among different BMI categories.

Complete satisfaction is defined as 5/5 on satisfaction scale.

As a result of rounding, not all percentages total 100%.

BMI = body mass index; PACU = postanesthesia care unit; PONV = postoperative nausea and vomiting; SD = standard deviation; VAS = verbal analog scale.

Table 5. Risk-Adjusted Outcomes in the Entire Patient Sample (n = 6,920)

Variable	Category†	Odds ratio (95% confidence interval)	Beta Coefficient (SE)	*P* Value*
Block failure rate	BMI <25	Referent		
	BMI 25–29	1.54 [0.99–2.39]		0.06
	BMI ≥30	1.62 [1.03–2.55]		0.04
Pain requiring opioids in PACU	BMI <25	Referent		
	BMI 25–29	0.92 [0.74–1.13]		0.41
	BMI ≥30	0.98 [0.79–1.21]		0.85
Unplanned admission to the 23 h observation unit or hospital	BMI <25	Referent		
	BMI 25–29	0.90 [0.61–1.33]		0.61
	BMI ≥30	0.94 [0.63–1.42]		0.77
Complete satisfaction with regional anesthesia 24 h postoperatively	BMI <25	Referent		
	BMI 25–29	1.13 [0.98–1.29]		0.09
	BMI ≥30	1.11 [0.96–1.28]		0.14
PACU length of stay, min	BMI <25		Referent	
	BMI 25–29		−5.5 (8.4)	0.51
	BMI ≥30		−3.6 (8.9)	0.63
Pain at rest in PACU	BMI <25		Referent	
	BMI 25–29		−0.20 (0.14)	0.15
	BMI ≥30		−0.18 (0.14)	0.20
Pain with movement in PACU	BMI <25		Referent	
	BMI 25–29		−0.36 (0.12)	0.003
	BMI ≥30		−0.23 (0.12)	0.05

* *P* values are based on risk-adjusted comparisons among different BMI categories.

BMI <25 serves as reference category; Complete satisfaction is defined as 5/5 on satisfaction scale.

BMI = body mass index; PACU = postanesthesia care unit.

($P = 0.04$). The difference between obese and normal BMI patients was only marginally significant in the subset receiving only one block ($P = 0.05$).

Discussion

The present investigation based on one of the largest published collectives of patients undergoing regional anesthesia clearly reveals that obesity represents a challenge for the anesthesiologist. The block failure and complication rates were significantly higher in the subset of obese patients. Nonetheless, the rate of successful blocks and overall satisfaction remained high in patients with increased BMI. Therefore, overweight and obese patients should not be excluded from RA procedures.

Previous data quantifying the efficacy of different RA procedures performed on normal BMI, overweight, and obese patients are scarce. It seems intuitive that obesity renders the identification of important anatomic landmarks more difficult[3,15] when performing RA, which leads to increased block failure. Although the findings of previous studies[16–18] have been contradictory, some authors reported a positive association between overweight and more frequent block failure in obese patients.[19] Carles *et al.*[16] performed 1,468 brachial plexus blocks at the humeral canal using a nerve stimulator. The authors reported a block failure rate of 4.9%. Unadjusted block failure rate was independent of weight, age, gender, experience of anesthesiologist, and type of surgery. Similarly, Conn *et al.*[17] found no association between interscalene brachial plexus block failure for shoulder surgery and patient weight and height. Conversely, Gatra *et al.*,[19] evaluating the efficacy of supraclavicular brachial plexus block for anesthesia of the upper limb, found block failure to be more common in obese and noncooperative patients. The study, however, had a small sample size, and the authors provided neither a definition of "obesity" nor information about whether the association between obesity and block failure was statistically significant.

In our opinion, the main challenges in performing RA in obese patients are the appropriate landmark identification, the correct patient positioning, and the use of appropriate equipment. It is critically important that the patient positioning is done before administrating sedation, when the patients are still able to appropriately follow the anesthesiologist's instructions. Second, there are some "recipes" that enable the performance of a successful block in obese patients even if important landmarks cannot be identified. For instance, if the femoral artery pulsation cannot be palpated before performing a femoral nerve block, the needle entry site chosen in our group is the midpoint between the anterior superior iliac spine and pubic tubercle at the level of the inguinal crease. Finally, it is cardinal that the needle is long enough. Short needles may lead to block failures despite optimal patient positioning and correct anatomic landmark identification.

Some studies recommend the use of special techniques to facilitate RA in obese patients.[20–22] Pham-Dang *et al.*[21] found a significantly reduced failure rate of continuous axillary brachial plexus block using a new technique in which the approach to the neurovascular sheath was guided under fluoroscopy. Others have suggested the use of ultrasonographic guidance to improve performance of RA procedures in obese patients.[15]

In unadjusted bivariable analysis, obesity was associated with a significantly ($P = 0.001$) higher complication rate. However, the overall occurrence of complications was extremely low (0.3%) in our patient sample regardless of the BMI category and compare favorably with those of previous studies evaluating the efficacy of paravertebral nerve blocks[7,20,23] and brachial plexus blocks,[24] suggesting that RA remains an excellent option even for patients with increased BMI.

In the present investigation, overweight and obese patients experienced significantly reduced pain scores with movement in the PACU. This association was observed as well for pain scores at rest and opioid requirements in the PACU, however, below the level of statistical significance. The rationale for these findings is unclear. Whether these results are related to increased pain tolerance, higher prevalence of diabetic neuropathy, or less extensive surgery in this subset of patients remains unknown. Further investigations are needed to evaluate these findings.

Compared with general anesthesia, RA techniques have shown in some studies to significantly shorten the PACU length of stay,[7,10] total length of hospital stay,[8,9,25] increase overall patient satisfaction,[8,26] and decrease unplanned hospital admission resulting from pain, drowsiness, and vomiting.[10] Although it would seem intuitive that PACU length of stay would be longer and the rate of unscheduled admission to the 23-h observation unit or hospital higher in overweight and obese patients as a result of increased prevalence of associated comorbidities, our findings did not support this assumption. Also, the high rate of complete satisfaction in patients with increased BMI could be a potential reflection of decreased average pain scores in this subset. Surprisingly, the rates of complete satisfaction exceeded 95% of patients in all BMI categories. Similar results were also found in subsets of patients older and younger than 20 yr and for patients undergoing different RA procedures. This high level of overall satisfaction clearly shows that RA techniques are very well accepted among patients with increased BMI and further demonstrates that overweight and obese patients should not be excluded from undergoing regional anesthesia in the ambulatory setting.

We acknowledge certain limitations of the present investigation. First, all blocks were performed at a single academic institution and by a relatively small group of highly trained anesthesiologists. As a result the findings may not be reproducible if these techniques were performed by less experienced anesthesiologists. Another limitation is the potential clustering of events in patients simultaneously undergoing multiple regional anesthesia procedures.

Despite these drawbacks, the present investigation has numerous strengths. First, the sample size is larger than in any previous publications, enabling us to reach conclusions with greater confidence. Second, as opposed to most previous studies, a broad variety of RA techniques were evaluated, which increases the applicability of our findings. Third, our analysis is based on a consecutive patient sample, thus minimizing selection bias, and finally, all data were prospectively collected by trained research personnel.

In summary, the present investigation shows that obesity represents a challenge for the anesthesiologist performing RA, even if highly experienced. Nonetheless, we provide compelling evidence that RA techniques are very well accepted among patients with increased BMI with high success and satisfaction rates. The present study may have important implications on the routine care of overweight and obese patients undergoing ambulatory surgery. Clearly, overweight and obese patients should not be excluded from undergoing regional anesthesia in the ambulatory setting.

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