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Intraoperative Administration of Intravenous Acetaminophen at Induction or End of Surgery and its Relationship with Opioid Consumption and Pain Scores

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TITLE PAGE

INTRAOPERATIVE ADMINISTRATION OF INTRAVENOUS ACETAMINOPHEN AT INDUCTION OR END OF SURGERY AND ITS RELATIONSHIP WITH OPIOID CONSUMPTION AND PAIN SCORES

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ABSTRACT

Obesity has become increasingly prevalent in the United States. Bariatric surgeries have increased as the prevalence of obesity has risen, providing an effective alternative to weight loss. Intravenous acetaminophen (IVA) is a safe and effective non-opioid medication that can be given without the risk of respiratory or cardiac complications. Research has shown that the use of IVA during surgery can improve postoperative pain scores, reduce opioid requirements, and improve patient satisfaction.

A retrospective cohort study of 200 patients (100 per group) undergoing laparoscopic bariatric surgery (LBS) was performed. Statistical analysis was used to determine the relationship between those who received IVA near anesthesia induction or near end of surgery and intraoperative/postoperative opioid consumption and pain scores. Other study variables included: age, gender, American Society of Anesthesiologists (ASA) classification, Body Mass Index (BMI), and length of anesthesia (LOA).

The results of the study determined there was no significant relationship between the administration time of IVA and intraoperative/postoperative opioid consumption or pain scores. There were significant relationships found between IVA administration time and BMI, age, and LOA.

While no significant relationships were found related to the administration timing of IVA and opioid consumption and pain scores, many studies have found efficacy in the use of IVA in reducing opioid consumption and pain scores in a variety or procedures and populations. Although this study did not provide results influencing the administration timing of IVA, it is recommended that other studies follow a similar study design in further investigation into the use of IVA to enhance anesthesia care and improve patient safety.

OBJECTIVES

The primary objective of this study was to determine whether intravenous acetaminophen (IVA) should be given near anesthesia induction or near the end of surgery to optimize postoperative pain scores and minimize opioid consumption in patients undergoing laparoscopic bariatric surgery (LBS). The hypotheses for this study are:

1. Patients who underwent LBS and received IVA within 30 minutes of anesthesia induction will have lower intraoperative opioid consumption compared to patients who received IVA within 30 minutes of end of surgery.
2. Patients who underwent LBS and received IVA within 30 minutes of anesthesia induction will have lower postoperative opioid consumption compared to patients who received IVA within 30 minutes of end of surgery.
3. Patients who underwent LBS and received IVA within 30 minutes of anesthesia induction will have lower postoperative pain scores compared to patients who received IVA within 30 minutes of end of surgery.

BACKGROUND

The Center for Disease Control (CDC) defines obesity as a body mass index (BMI) of greater than 30 in adults (CDC, 2016). Obesity is a growing concern for healthcare providers all over the world. One study reported that the prevalence of obesity in the United States was approximately 35% among men and women (Flegal, K. M., Carroll, M. D., Kit, B. K., & Ogden, C. L., 2012). Obesity brings with it many comorbidities and risk factors for acute and chronic illness that can complicate the patient's response to anesthesia.

Among the comorbidities seen in obese patients, physiologic changes of the neck and airway pose an increased threat to the safety of the patient during anesthesia care. Increased

adipose tissue, particularly around the neck and oropharynx, can result in airway changes that limit the patient's ability to breathe and limit the anesthesia provider's access to the airway. Frequency of asthma and obstructive sleep apnea (OSA) in the obese patient are of serious concern due to the difficulty in manual and/or mechanical ventilation when the patient is lying flat and/or anesthetized (Thompson et al., 2011).

The prevalence of OSA in the obese population has been shown to be directly related to BMI. A study of 290 patients preparing for weight loss surgery revealed that more than 70% of patients with a BMI from 31-94 had OSA (Lopez, P. P., M.D., Stefan, B., M.S., Schulman, C. I., M.D., & Byers, P. M., M.D., 2008). A meta-analysis studying the postoperative outcomes of patients with OSA showed that patients were more likely to experience oxygen desaturation, respiratory failure, and require intensive care during the postoperative recovery period (Kaw, R. et al., 2012). Due to the overwhelming difficulty of managing obesity as an illness many patients have found successful treatment with weight loss surgery/LBS. The American Society for Metabolic and LBS (ASMBS) reported that from the years 2011-2015 nearly 900,000 bariatric procedures were performed in the United States (ASMBS, 2016). A meta-analysis performed by Ribaric, G., Buchwald, J., & McGlennon, T. reported that LBS proved to be more effective than other weight loss strategies (Ribaric, G. et al., 2013).

In order to provide optimal patient outcome for those undergoing LBS adequate anesthesia depth and pain management are essential. Anesthetic gases, opioids, and other adjunctive medications allow the anesthesia provider the greatest ability to maintain patient safety. However, due to the common side effects of these medications, patients remain at risk for adverse effects. Opioids commonly result in a depressed respiratory drive and decreased mental alertness. A 2008 study showed that patients taking opioids were 67% more likely to

experience OSA (Farney, R. J., Walker, J. M., Boyle, K. M., Cloward, T. V., & Shilling, K. C., 2008). During anesthesia induction, these complications can be managed effectively by performing laryngoscopy and tracheal intubation followed by mechanical ventilation. The anesthesia provider can maintain airway protection during the intraoperative period in the same manner and manage pain by administering opioids and other analgesics.

Airway protection has become the greatest concern for the care of obese patients during the emergence of anesthesia (Greenwood, 2017). As patients emerge from anesthesia they become aware of their surgical pain and pain management becomes of particular concern. Pain management in the immediate postoperative period requires a balance of the patient's alertness and ability to breath spontaneously to maintain adequate ventilation. An imbalance of the patient's respiratory ability and analgesic administration in these crucial minutes after surgery can result in respiratory distress/failure, cardiac depression, and even death. These serious adverse effects can be due to an over-sedation effect (respiratory failure/cardiac depression) that result in airway obstruction or a hyper-stimulatory effect that comes as a result of inadequate pain control. A systematic review of more than 8,000 patients revealed that, in all included studies, opioid administration resulted in an increase incidence of upper airway obstruction. This review further showed that in many cases opioid administration correlated with decreased respiratory compliance and airway reflexes (Ehsan, Z., Mahmoud, M., Shott, S. R., Amin, R. S., & Ishman, S. L., 2016).

Obese patients commonly suffer from OSA and are difficult to maintain pain control. A study presented by the Journal of the American Society of Anesthesiologists reported that patients with OSA experienced increased pain as compared to patients without OSA (Doufas, A. G., Tian, L., Davies, M. F., & Warby, S. C., 2013). As obese patients have a significantly higher

prevalence of OSA we can conclude that obese patients will likely experience increased pain after surgery resulting in higher analgesic requirements. The administration of opioids during the immediate postoperative period is of concern because it is the time when patients are the most vulnerable to respiratory depression. An effective opioid dose to treat pain may correspondingly be the dose that causes a depressed respiratory drive or decreased mental awareness leading to inadequate ventilation and hypoxemia.

The increased risk that comes from opioid administration in the immediate postoperative period leads the anesthesia provider to rely on multimodal therapies that enhance pain control and limit dangerous adverse effects. IVA is a non-opioid analgesic that can be used to enhance pain management in the surgical patient. While the exact mechanism of action of IVA is unknown numerous studies have shown the efficacy of this medication as an analgesic. Singla et al., showed that IVA had a significantly shorter time to maximum concentration compared to oral or rectal acetaminophen resulting in a faster onset (Singla, NK., et al, 2012). The rapid onset of IVA is due to its 100% bioavailability. The onset of action of IVA is approximately 15 minutes after the start of infusion at a dose of 15mg/kg with a maximum single dose of 1 gram (age 13 years and greater) (Cadence Pharmaceuticals, a Mallinckrodt company, 2013). While IVA is contraindicated in patients with a hypersensitivity to acetaminophen and those with severe liver impairment, there are no reported adverse effects related to respiratory or cardiac systems. IVA, used in multimodal therapy, has the ability to effectively enhance pain control without increasing the risk of respiratory or cardiac depression. Unlike oral or rectal acetaminophen, IVA does not undergo a first-pass hepatic effect which provides an increased bioavailability leading to more effective pain control (Cadence Pharmaceuticals, a Mallinckrodt company, 2013).

The administration of IVA has been shown in numerous studies to be effective in improving postoperative pain scores. A study by Atashkhoyi, S., Rasouli, S., Fardiazar, Z., Ghojazadeh, M., & Hatami, M. P. (2014), showed that 100 patients undergoing cesarean section who received IVA 20 minutes before the end of surgery had significantly lower pain scores in the post anesthesia care unit (PACU) (Atashhoyi et al., 2014). A study of 60 patients showed significantly lower pain scores in cesarean section patients who received IVA 20 minutes preoperatively (Ayatollahi, V., Faghihi, S., Behdad, S., Heiranizadeh, N., & Baghianimoghadam, B, 2014). Another study found that in pediatric patients undergoing inguinal hernia repair likewise showed significantly less pain scores in those who received IVA compared to the placebo group (Kahlili et al., 2016). A 2014 study of patient satisfaction after surgery showed that those receiving IVA reported a score of "excellent" (Apfel, C. C., Souza, K., Portillo, J., Dalal, P., & Bergese, S. D., 2014).

In addition to improved pain scores and patient satisfaction, IVA has been shown to decrease opioid consumption in the intraoperative and postoperative periods. A retrospective study by Song, K., Melroy, M. J., & Whipple, O. C. (2014), showed that 104 patients undergoing LBS who received IVA intraoperatively required less morphine equivalents than the control group who received opioid therapy only. This is one of the limited studies of IVA given to patients undergoing LBS, and while it provides insight into the control of opioids related to this patient population it did not find a significant reduction in pain scores in this population (Song et al., 2014). This evidence supports the proposed study in that administration of IVA near induction or EOS may be a factor in lowering pain scores in the postoperative period. A 2009 study of 90 women undergoing abdominal hysterectomy showed that those who got IVA 30 minutes before induction had lower postoperative pain scores and lower opioid requirements

than those who received IVA 30 minutes before EOS (Arici, S., Gurbet, A., Türker, G., Yavaşcaoğlu, B., & Sahin, S., 2009). This is one of the limited studies providing information related to the difference in administration of IVA near induction or EOS. The study by Arici, et al. in contrast to the study by Song, et al. supports the need for further investigation into the use of IVA in patients undergoing LBS as it relates to administration timing. Jelacic et al. (2016), showed that patients who underwent cardiac surgery used significantly less opioids compared to the placebo group in the first 24 hours postoperatively after receiving IVA intraoperatively but did not show a significant difference in pain scores between the two groups. (Jelacic et al., 2016). A 2015 study of 92 patients who underwent LBS showed a nearly 40% decreased in opioid requirements after having received IVA intraoperatively (Gonzalez, A. M., Romero, R. J., Ojeda-Vaz, M. M., & Rabaza, J. R., 2015).

These studies provide a good foundation of efficacy for the use of IVA in surgical patients. However, the limited information related to the use of IVA in reducing opioid consumption and pain scores in patients undergoing LBS supports the need for further investigation into this important patient population.

METHODOLGY

Design

The design for this study is a cross-sectional cohort. The cross-sectional study design allows for the easy retrieval of patient data and case characteristics that were used to study the relationships related to the use of IVA in patients undergoing laparoscopic bariatric procedures.

Sample

CAMC is a tertiary referral center located in Charleston, West Virginia. There are three main hospitals in the Charleston area: General, Memorial, and Women and Children's Hospitals.

The CAMC health system performs more than 45,000 operating room procedures each year. The CAMC General Hospital performs bariatric surgical procedures, has a dedicated bariatric unit, and an associated Weight Loss Center (CAMC, 2017) (CAMCa, 2017) (CAMCb, 2017).

A chart review was performed on patients who underwent laparoscopic bariatric surgical procedures at the General Hospital between January 1, 2007 and April 1, 2017. Two study groups were compared as they relate to total intraoperative opioid consumption, total opioid consumption during the first two hours of anesthesia recovery, pain scores recorded within 5 minutes of arrival in the post anesthesia care unit (PACU), and pain scores recorded at 1 hour after arrival in the PACU.

The International Classification of Diseases, 9th and 10th revisions, Clinical Modification ICD-9-CM and [ICD-10-CM] codes 44.38 [0D16479, 0D1647A, 0D164J9, 0D164JA, 0D164K9, 0D164KA, 0D164Z9, 0D164ZA] (Roux-en-Y gastric bypass, proximal/distal), 43.89 [ODB63ZZ], (unlisted laparoscopy, stomach), 44.95 [0DV64CZ] (Implantation of adjustable gastric band) 44.82 [0DB64Z3] (Laparoscopy, sleeve gastrectomy) 44.96 [0DW64CZ] (Replacement and revision of gastric band and port) were used for identification of patient records that were included in the study.

- Inclusion criteria consisted of patient's age 18-65 years, American Society of Anesthesiologists (ASA) classification of II-III, who underwent LBS lasting between 60 and 180 minutes, and received IVA within 30 minutes of induction or within 30 minutes of EOS.
- Exclusion criteria consisted of patients outside ages 18-65; outside ASA classification II-III; allergy to acetaminophen; history of: liver disease, opioid

abuse, chronic pain, current use of opioids for acute/chronic pain; patients who underwent open LBS; patients who underwent LBS and did not receive IVA or did not receive IVA within 30 minutes of induction or end of surgery (EOS).

Procedures/Protocol

A retrospective study was performed using patient information gathered from the CAMC EMR system for patients who underwent LBS. A sample of 200 patients who underwent laparoscopic bariatric surgical procedures and received IVA were selected for this study and assigned to one of two groups for comparison. The first group included 100 patients who underwent LBS and received IVA within 30 minutes of anesthesia induction. The second group included 100 patients who underwent LBS and received IVA within 30 minutes of EOS.

Age was assessed based on years of life upon hospital admission on the day surgery. Gender was based on the gender recorded and/or reported by patient as indicated on the patient record. ASA classification was assigned based on the pre-anesthesia assessment performed by an anesthesiologist. BMI was calculated based on patient height and weight as recorded in the pre-anesthesia assessment and was used to assess for obesity. Length of anesthesia (LOA) is defined as the time between anesthesia start time and anesthesia end time. Pain scores were based on the assessment of PACU nurses and total postoperative opioid consumption will be based on the total opioids given in the first 90 minutes in the PACU. Opioid consumption refers to the total opioid amount measured in milligrams (mg) or micrograms (mcg) administered to the patient and will include any opioids given during the preoperative, intraoperative, or postoperative periods. All opioids were converted to morphine equivalents for calculation and comparison between groups.

Data Analysis

Data collected from the CAMC EMR system was analyzed as it relates to the primary objective of the research study. The dependent variables include: total opioid consumption during the intraoperative, total opioid consumption during the postoperative period, and pain scores within 5 minutes of admission to PACU and at 1 hour after arrival in the PACU. The primary independent variable was whether IVA was administered within 30 minutes of anesthesia induction or 30 minutes of EOS. Secondary independent variables include: age, gender, ASA classification, BMI, and LOA.

An independent t-test was used to compare the two groups based on age, BMI, and LOA. A chi-square test was used to compare the two groups based on gender and ASA classification. A step-wise regression statistical analysis was used to determine the relationship between IVA administered within 30 minutes of anesthesia induction, IVA administered within 30 minutes of EOS, age, gender, BMI, ASA classification and LOA; and the total intraoperative opioid consumption, total postoperative opioid consumption, and pain scores on arrival in PACU and at 1 hour after arrival into PACU. A p-value of $<.05$ will determine statistical significance. The data was analyzed using statistic analyzing software (SPSS).

RESULTS

During January 2007 and April 2017, a group of 200 patients that met inclusion criteria were assigned to one of two groups based on the administration time of IVA in the intraoperative period. Group 1 consisted of 100 patients who received IVA within 30 minutes of anesthesia induction. Group 2 consisted of 100 patients who received IVA within 30 minutes of EOS. Statistical analysis was performed to compare these two groups based on age, BMI, LOA, gender, and ASA classification. An independent t-test was performed to compare the study

groups based on age, BMI and LOS, and were found to have no significant differences. The two groups were similar related to age, BMI, and LOA with values of 0.499, 0.692, and 0.266, respectively ($p>0.05$) See Table 1. A chi-square test was used to compare the two groups based on gender and ASA classification and was found to have no significant differences. The two groups were similar related gender and ASA classification with values of 0.849 and 0.617, respectively ($p>0.5$) [See Tables 2-3].

Table 1

	IVGroup	N	Mean	Std. Deviation	Std. Error Mean
Age (years)	Induction	100	42.610	10.2414	1.0241
	End	100	43.640	11.2443	1.1244
LOA (min)	Induction	100	107.220	16.6027	1.6603
	End	100	104.510	17.7118	1.7712
BMI	Induction	100	47.2365	8.12251	.81225
	End	100	46.7628	8.74444	.87444

Table 2

			Gender (M/F)		
			F	M	Total
IVGroup	End	Count	84	16	100
		Expected Count	83.5	16.5	100.0
		Std. Residual	.1	-.1	
	Induction	Count	83	17	100
		Expected Count	83.5	16.5	100.0
		Std. Residual	-.1	.1	
Total		Count	167	33	200
		Expected Count	167.0	33.0	200.0

Table 3

			ASA2		
			0	1	Total
IVGroup	End	Count	75	25	100
		Expected Count	76.5	23.5	100.0
		Std. Residual	-.2	.3	
	Induction	Count	78	22	100
		Expected Count	76.5	23.5	100.0
		Std. Residual	.2	-.3	
Total		Count	153	47	200
		Expected Count	153.0	47.0	200.0

Several step-wise regressions were performed to compare the two groups related to intraoperative/postoperative opioid consumption, and pain scores measured at within five minutes of arrival to PACU and after 1 hour of admission to PACU. This statistical analysis found no significant differences between the two groups as they relate to these variables. This analysis did however find some significant relationships among other values.

The first step-wise regression was to show the relationship between when the IVA was administered and the intraoperative opioid consumption. The other independent variables, age, BMI, LOA, ASA classification, and gender, were also included. The results of this analysis are given in Table 4. There was no relationship between when the IVA was given and the amount of intraoperative opioid consumption. This analysis did however reveal that patients with increased age received significantly less intraoperative opioids compared to others in the group with a value of -0.389 ($p<0.5$). Furthermore, patients with an increased LOA received significantly higher intraoperative opioids with a value of 0.127 ($p<0.5$) [See Table 4].

Table 4

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	47.300	3.173		14.909	.000
	Age (years)	-.378	.071	-.352	-5.300	.000
2	(Constant)	34.307	5.461		6.282	.000
	Age (years)	-.389	.070	-.363	-5.544	.000
	LOA (min)	.127	.044	.189	2.897	.004

a. Dependent Variable: Opioid Total (intraop)

The second step-wise regression was to show the relationship between when the IVA was administered and the postoperative opioid consumption with other independent variables including: age, BMI, LOA, ASA classification, and gender. The results of this analysis are given in Table 5. There was no relationship between when the IVA was given and the total postoperative opioid consumption. This analysis did reveal that patients with an increased age had significantly less opioid consumption compared to others in the group with a value of -0.121 ($p<0.5$) [See Table 5].

Table 5

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	14.330	2.495		5.744	.000
	Age (years)	-.121	.056	-.151	-2.150	.033

a. Dependent Variable: Opioid Total (postop)

The third step-wise regression was to show the relationship between the IVA administration time and the pain score upon admission to PACU. Other independent variables included age, BMI, LOA, ASA classification, and gender. There was no relationship found

between when the IVA was administered and the pain scores upon admission to PACU or any of the independent variables.

The fourth, and last, step-wise regression performed was to show the relationship between when the IVA was given and the pain scores recorded 1 hour after admission to PACU. Other independent variables included age, BMI, LOA, ASA classification, and gender. The results of this analysis are given in Table 6. No relationship was found between when the IVA was given and the pain scores 1 hour after admission to PACU. There were however some significant relationships related to BMI and LOA. As BMI increased, the pain score recorded 1 hour after admission to PACU was significantly decreased with a value of -0.180 ($p<0.5$). In contrast, as LOA increased, the pain scores 1 hour after admission to PACU were also increased with a value of 0.067 ($p<0.5$) [See Table 6].

Table 6

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.805	2.885		4.092	.000
	BMI	-.156	.060	-.180	-2.574	.011
2	(Constant)	5.828	3.888		1.499	.135
	BMI	-.180	.061	-.209	-2.967	.003
	LOA (min)	.067	.030	.159	2.264	.025

a. Dependent Variable: Pain Score (1hr)

DISCUSSION

The purpose of this research study was to determine if administration timing of IVA in patients undergoing LBS had a significant relationship to the reduction of postoperative pain scores or a decrease in total opioid consumption. The hypotheses of the study projected a significant decrease in both pain scores and intraoperative/postoperative opioid consumption.

The results of this study did not support any of the hypotheses as given. They did however, shed light on some important correlations as related to patient demographics and procedure characteristics such as age, BMI, and LOA. While anesthesia providers may have no control over these variables the information gathered in this study can assist providers with more efficient knowledge and an improved practice plan as it relates to this important patient population.

The literature available related to the direct question of IVA administration timing is limited. In direct comparison, our study and the study performed by Arici et al. did not have correlating results. Arici et al. showed that patients who received IVA within 30 minutes of induction of anesthesia had significantly less postoperative pain and used significantly less opioids. These results did correlate with the hypothesis of this study. However, the comparative was limited to patients undergoing abdominal hysterectomy and naturally one that is gender specific. While our study gathered data on weight loss surgery, in general, there are multiple variations of these types of procedures that were included in the data collection. This could be one of the reasons the two studies did not have had correlating results. Where the comparative only included females in their study, this study similarly, studied mostly females (167 compared to 33 males). Overall, while our study compared to the study by Arici, et al. were constructed similarly the two studies differed mainly in the type of procedures performed (Arici et al., 2009).

While this study collected patient data based on a variety of LBS procedures it is expected that the variety of procedures did not have a significant impact on the results of the study. Song, et al., reported that in a study comprised of over 100 patients undergoing various bariatric procedures the IVA groups had no significant difference in pain scores compared with the non-IVA groups included in the study (Song et al., 2014).

This study found that the most significant characteristics related to postoperative pain and opioid consumption in patients undergoing LBS was age, BMI, and LOA. These results are consistent with common practice methods related to opioid dosing and administration. As opioid dosing is generally weight based in kilograms and administration is related to timing it is expected that patients with an increased BMI will have an increased opioid requirement compared to those with a lower BMI. Similarly, since opioids are metabolized at a specific rate, dependent on the medication and the individual, it is expected that as the LOA is increased the total opioid consumption will also increase. This is based on the assumption that the provider desires to maintain the same amount of pain control during the entire procedure.

There are some increased risks to patient safety related to these results. As discussed, the incidence of OSA in patients undergoing LBS is approximately 70% (Lopez, P. P., M.D., Stefan, B., M.S., Schulman, C. I., M.D., & Byers, P. M., M.D., 2008). There are important risks associated with OSA that impact patient safety when opioids are administered. Kaw et al., 2012 revealed obese patients with OSA are more likely to require intensive care due to postoperative complications (Kaw, R. et al., 2012). In conjunction with an increased BMI, this patient population can expect a variable LOA which may increase these risks due to the increased opioid requirements as shown in this study. With an understanding that this high-risk patient population is shown to have increased opioid requirements; anesthesia providers should remain vigilant in recognizing patterns and taking precautions/preparations particularly during emergence and the postoperative period.

Due to the nature of this retrospective design a variety of limitations may have had an impact on the results of the study. The practice of the anesthesia provider may be the factor with the largest impact. While all of the data collected consisted of patients who had procedures at

the CAMC General Hospital, there are a variety of anesthesia providers involved in the care of these patients. In addition to an inconsistent anesthetic plan due to a variety of providers, a generalized anesthetic plan related to the procedure and not the patient may have impacted the results of the study.

Other limitations as related to the patient population may have had an impact on the study results. The primary variable influencing this study was the presence of pain. This variable influenced all analgesics (opioid and non-opioid) administered intraoperatively and postoperatively. In the same regard, the only analgesics included in the study were opioid based analgesics and therefore may have impacted each of the primary results when the patient received a non-opioid analgesic either intraoperative or postoperatively.

While comprehensive inclusion/exclusion criteria were used to select optimal groups for this study design, it is possible that the histories as reported by the patient or collected by the provider were inconsistent or incomplete. Furthermore, relating to the assessment of pain scores, each provider may have inconsistent assessment methods compared to another provider. In the same manner, each patient may interpret their pain differently than another patient in the same situation. Each of these factors may have influenced both the pain scores and total opioid consumption in the postoperative periods.

While some limitations exist, there are some important factors that strengthen this study as a whole. The study design was appropriate for the purpose of the objectives. Furthermore, this study design is applicable to any institution that provides similar services and can therefore apply the information as appropriate. Each patient in either group met comprehensive inclusion/exclusion criteria. These aspects yielded two study groups that were not significantly different. The data collected was from procedures performed at the same facility and while there

are many procedures performed here each year, the surgeons operating in this facility is limited. The majority of the data collected of the 200 patient records had only two surgeons who performed the operation. These factors provide consistency in the procedures performed and limits the variability that could influence the study results.

RECOMMENDATIONS

This study was designed to contribute to the current literature by providing additional insight as to the administration time of IVA in patients undergoing LBS. The results of this study showed that there was no significant relationship between the two groups as they relate to intraoperative/postoperative opioid consumption and postoperative pain scores. While no significant relationship was found in this study, other studies conducted in a similar fashion involving the use of IVA may yield additional information. It is recommended that the application of this study design, particularly related to the administration timing of IVA, be used in a variety of patient populations and a variety of procedures to further understand the use of IVA and its ability as a non-opioid analgesic. Additionally, any study involving patients with an increased BMI and the use of IVA may yield constructive information to assist in maintaining patient safety in this high-risk population.

CONCLUSION

The primary objective of this study was to determine the relationship of the administration timing of IVA and intraoperative/postoperative opioid consumption and postoperative pain scores. It was hypothesized that the early administration of IVA would result in an overall decrease in both opioid consumption and pain scores. However, the results of this study showed that there was no significant relationship between these factors. While patients with an increased BMI undergoing LBS are at an increased risk for complications, the

administration timing of IVA may not have a direct impact on reducing these risks. Other studies have shown efficacy in using IVA to reduce pain scores and opioid consumption. Therefore, IVA should be regularly considered as an effective adjunct to opioid analgesia when creating an anesthetic plan. The application of these principles will assist the anesthesia provider in providing optimal care for each patient and increase overall patient safety.

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