Original Article

Anesthesia and Postoperative Analgesia for Cesarean Section: A Retrospective Observational Study

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Abstract

Objectives: The current state of the art for c-section anesthesia includes the use of regional anesthesia techniques because of their effectiveness, safety, and extended postoperative analgesia. This study aimed to analyze the anesthetic techniques employed for c-section and postoperative analgesic regimens and to identify predictive factors for postoperative pain, postoperative complications, and hospitalization time. **Study Design:** A retrospective, observational study was conducted on pregnant women who underwent c-section between January and December 2021. Demographic data, medical comorbidities, indications for c-section, anesthetic techniques, and postoperative outcomes (pain, complications, and hospitalization time) were registered. Linear and logistic regression were applied for data analysis. **Results:** Data from 925 women who underwent c-sections were analyzed. Combined spinal–epidural anesthesia was the most used technique for elective c-sections (423 out of 430 women), while general anesthesia was commonly used in emergent procedures (29 out of 39 women). Epidural analgesia was the most commonly used technique for postoperative pain management (83%), and pruritus (8.9%) and headaches (4.1%) were the most frequently registered complications. Risk factors for moderate/severe pain included lower body mass index, conversion to general anesthesia, and the use of systemic analgesia. Preeclampsia and intrathecal morphine increased postoperative complications. General anesthesia and some postoperative complications were predictors for longer hospitalization times. **Conclusions:** This study suggests that a multimodal analgesic approach with neuraxial morphine and/or local anesthetics, nonsteroidal anti-inflammatory drugs, and acetaminophen is central to achieve an effective postoperative analgesia after a c-section. However, further studies should investigate the optimal neuraxial analgesic combination to minimize side effects.

Keywords: *Cesarean section, epidural analgesia, obstetric anesthesia, postoperative analgesia*

Introduction

Anesthesia for cesarean section (c-section) and postoperative analgesia are critical aspects of modern obstetric care. The main goals of anesthesia for c-section are to provide pain relief during the surgical procedure while minimizing the risks to both the mother and the baby. Postoperative analgesia aims to control pain after the surgery and improve patient comfort and recovery.[1-4]

The current state of the art for c-section anesthesia includes the use of regional anesthesia techniques, such as epidural anesthesia and spinal anesthesia. These techniques provide excellent pain relief and have a low risk of adverse effects. Local anesthetics, such as lidocaine, bupivacaine, and ropivacaine, are commonly used in epidural anesthesia. Opioids, such as fentanyl and sufentanil, can also be used via epidural, typically in combination with local anesthetics in lower doses to minimize their risks. Numerous studies have consistently demonstrated the efficacy and safety of these techniques, with a low incidence of adverse effects on the mother and the newborn. As a result, regional anesthesia is the gold standard for c-section anesthesia. General anesthesia should only be used if there is any contraindication to the regional anesthetic technique or in emergency situations where rapid delivery is necessary and there is no time to perform a regional technique.[1,2]

Regarding recommendations on postoperative analgesia for c-section, it should ensure the mother's ability to care for her newborn, which mandates intraoperative initiation and postoperative

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continuation of a multimodal analgesia plan. This approach includes several interventions such as paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs), intrathecal morphine or diamorphine, epidural morphine and/or local anesthetics, intravenous dexamethasone, single-injection wound infiltration, continuous wound infiltration, and fascial plane blocks.[3,4]

Notwithstanding the accumulating evidence regarding anesthesia and analgesia for c-section, some topics are still under debate. One of these topics relates to drugs and their doses, specifically those used for epidural top-up during urgent/emergent c-sections in pregnant women who already have an epidural catheter in place for labor analgesia.[5,6] With respect to postoperative analgesia, despite neuraxial morphine being one of the most effective options, in some countries, long-acting neuraxial opioids are still underused because of concerns related with respiratory side effects.[7] General anesthesia for c-section also raises some concerns in this population, and the safest way to perform it remains under discussion in the literature.

The primary aim of this study is to comprehensively examine the anesthetic techniques employed during c-sections and to evaluate the postoperative analgesic regimens used for pain management in women who undergo c-sections. In addition, we aim to identify potential risk factors associated with postoperative pain and complications following cesarean delivery. Furthermore, the study seeks to investigate the duration of hospitalization for these patients and explore factors that may influence the length of their hospital stay. By addressing these aspects, we intend to contribute with valuble insights into the field of obstetrics and enhance the care provided to women undergoing c-sections, ultimately improving their overall surgical experience and postoperative outcomes.

Materials and Methods

This retrospective observational study was conducted at Unidade Local de Saúde de Santo António, Porto, Portugal after obtaining approval from the Quality Management, Risk, Health, and Safety Department and the institution's ethics committee. Data were obtained from the electronic medical records of patients in accordance with national law regulating confidentiality and protection of clinical data.

Selection and description of participants

All pregnant women who underwent cesarean delivery at our hospital between January 2021 and December 2021 were included. Pregnant women who had no clinical information regarding cesarean anesthesia were excluded. Demographic data, including age, weight, and height, as well as medical and obstetric comorbidities were recorded. The indications for the c-section, their classification of urgency (elective/urgent/emergent), and Apgar scores were assessed. Regarding anesthetic practice, the anesthetic technique, the incidence of conversion to general anesthesia, and postoperative analgesia were also recorded.

To evaluate postoperative outcomes, the maximum numeric pain scores in the first 24 h, hospitalization time, and postoperative complications during the length of hospital stay were recorded. Numeric Rating Scale (NRS) pain scores of ≤3 were categorized as mild pain, while scores of ≥4 were categorized as moderate to severe pain.

Statistical analysis

Statistical analysis was performed using International Business Machine Statistical Package for the Social Sciences software version 25. Categorical variables are presented as frequency (percentage), and continuous variables are shown as mean ± standard deviation (SD). Multivariate linear regression and logistic regression models were used to identify postoperative outcomes: *P* values, odds ratio, and respective 95% confidence intervals were obtained. Chi-squared test was used to verify the association between variables. A *P* value <0.05 was considered statistically significant.

Results

A total of 925 pregnant women aged between 16 and 51 years were submitted to c-section during the study period. Most of the c-sections were classified as an urgent (49.3%) or elective (46.5%) procedure, with previous uterine surgery being the most frequent indication for c-section [Table 1]. Endocrine–metabolic disorders (such as obesity, diabetes mellitus, and thyroid disorders), gestational diabetes, and preeclampsia were the most frequent pathologies presented by the pregnant women included in this study.

Regarding the anesthetic techniques, combined spinal-epidural anesthesia and general anesthesia were the most used techniques for elective and emergent c-sections, respectively. In procedures classified as urgent, the most used technique was epidural top-up anesthesia [Table 2].

Of the total number of pregnant women submitted to regional anesthesia (n = 840), 55 women (6.5%) required conversion to general anesthesia [Table 1].

With respect to c-section performed with epidural anesthesia (n = 327), 2% lidocaine was used in 19.6% of cases, 0.75% ropivacaine was used in 12.8% of cases, and a mixture of the two drugs was injected in 32.4% of cases. There were no anesthetic records of epidural drugs used in 35.2% of cases.

Most women were transferred to the obstetrics ward after c-section (99.2%), and the mean hospitalization time after the surgery was 3.47 ± 1.39 days.

Postoperative analgesia was achieved by multiple techniques. In 114 (12.3%) cases, systemic conventional analgesia was solely used, combining several opioid and

nonopioid drugs such as acetaminophen, NSAIDs, and tramadol. Epidural analgesia was selected in 768 (83%) cases and intrathecal morphine (100 μg) was the analgesic option in 4.3% of cases. In three cases, a transversus abdominis plane (TAP) block was performed. Specifically, concerning epidural analgesia, morphine (2–3 mg) was administered in 56.4% of cases, ropivacaine (at concentrations up to 0.2%) was used in 2.3% of cases, and regimens including both types of drugs mentioned were prescribed in 41.3% of cases. When neuraxial analgesia was performed, pain scores, respiratory rate, level of consciousness, blood pressure, motor block, bladder function, and catheter insertion site were monitored in all women. The classification of the maximum level of postoperative pain in the first 24 h based on the prescribed analgesic regimen is presented in Table 3. In general, 86.6% of the puerperal women reported mild postoperative pain, 12.3% reported NRS scores ≥4, and there were no records in 1.1% of cases.

Table 1: Demographic data, anesthetic technique, and postoperative complications

Variables	Data
Age (years)[a]	32.77±5.54
Body mass index[a]	31.23±5.73
Urgency of cesarean section[a]	
Elective	430 (46.5)
Urgency	456 (49.3)
Emergency	39 (4.2)
Anesthetic technique[a]	
General anesthesia	83 (9.0)
Epidural	327 (35.4)
Spinal	85 (9.2)
Combined spinal–epidural	428 (56.2)
No records	2 (0.2)
Regional anesthesia cases converted to general anesthesia[a]	
No	647 (76.8)
Yes	55 (6.5)
No records	140 (16.6)
Postoperative analgesia[a]	
Conventional	114 (12.3)
Epidural	768 (83.0)
Intrathecal morphine	40 (4.3)
TAP block	3 (0.3)
Hospitalization time[b]	3.47±1.39
Postoperative complications[b]	289 (31.2)
Nausea and vomiting	22 (2.4)
Pruritus	82 (8.9)
Headache	38 (4.1)
Urinary retention	12 (1.3)
Hypertension	28 (3.0)
Anemia	37 (4.0)
Uterine atony or postpartum hemorrhage	19 (2.1)
Surgical reintervention	4 (0.4)

Data given as frequency (percentage) or mean±SD. [a]Input variables for regression models. [b]Output variables for regression models. SD=Standard deviation, TAP=Transversus abdominis plane

Complications and/or side effects were registered in 289 women (31.2%), the most frequent being pruritus (8.9%) and headaches (4.1%) [Table 1].

Regarding the association between postoperative analgesia and outcome variables such as postoperative pain and postoperative complications, a tendency toward a lower percentage of moderate/severe pain was observed with epidural analgesia (Chi-square test, $P = 0.136$) [Table 3]. In addition, women who received epidural analgesia had a lower percentage of complications (Chi-square test, $P = 0.015$). The women in whom a TAP block was performed were excluded from this analysis due to the low incidence ($n = 3$).

Logistic regression analysis showed that a lower body mass index (BMI) ($P = 0.027$; odds ratio [OR] 0.953 [95% confidence interval {CI} 0.912–0.995]), conversion to general anesthesia ($P = 0.008$; OR 2.59 [95% CI 1.277–5.246]), and systemic analgesia ($P = 0.031$; OR 3.02 [95% CI 1.105–8.277]) were the risk factors for moderate to severe pain.

In addition, logistic regression analysis also showed that preeclampsia ($P = 0$; OR 2.75 [95% CI 1.605–4.718]) and intrathecal morphine ($P = 0.005$; OR 4.604 [95% CI 1.604–13.214]) were the risk factors for the occurrence of postoperative complications.

General anesthesia and the incidence of postoperative complications, such as hypertension, uterine atony/postpartum hemorrhage, anemia, headaches, and the need for surgical reintervention, were predictors for increasing

Table 2: Anesthetic technique according to the classification of the urgency of the cesarean section

	General anesthesia	Regional anesthesia			No records	Total, *n* (%)
		Epidural	Spinal	CSE		
Elective CS	17	7	33	373	-	430 (46.5)
Urgent CS[a]	37	311	51	55	2	456 (49.3)
Emergency CS[a]	29	9	1	-	-	39 (4.2)
Total *n* (%)	83 (9.0)	327 (35.4)	85 (9.2)	428 (46.3)	2 (0.2)	925 (100)
			840 (90.8)[b]			

[a]Emergency CS: recommended time to skin incision ≤15 min; urgent CS: recommended time to skin incision ≤180 min.[8] [b]Of these, 55 cases were converted to GA. CS=cesarean section, CSE=combined spinal–epidural, GA= General anesthesia

Table 3: Classification of postoperative pain in the first 24 h after cesarean section according to the type of analgesia

Analgesia type	Conventional			Intrathecal morphine		Epidural			TAP block	
Postoperative pain	Mild	Moderate–severe	No records	Mild	Moderate–severe	Mild	Moderate–severe	No records	Mild	Moderate–severe
Total *n* (%)	93 (81.6)	20 (17.5)	1 (0.9)	34 (85.0)	6 (15.0)	673 (87.6)	86 (11.2)	9 (1.2)	1 (33.3)	2 (66.7)
		114 (100)		40 (100)			768 (100)		3 (100)	

Postoperative ENS pain scores ≤3 were classified as "mild pain"; scores≥4 were classified as "moderate–severe pain". TAP=transversus abdominis plane

hospitalization time. Surgical reintervention, hypertension, and atony/postpartum hemorrhage were the postoperative complications that increased the hospitalization time most by 9.73 ($P < 0.001$, 95% CI 8.490–10.978), 1.7 ($P < 0.001$, 95% CI 1.263–2.138) and 1.14 ($P < 0.001$, 95% CI 0.564–1.723) days, respectively.

Discussion

Despite global efforts to reduce the rate of cesarean deliveries, it remains the most common surgical procedure in the USA, and in certain countries, the rate of cesarean deliveries exceeds 40%.[9,10] Although neuraxial anesthesia is preferable to general anesthesia for c-section because it is associated with less maternal and neonatal morbidity and mortality, there are occasions when general anesthesia is indicated.[2]

In this retrospective analysis, there was a notable preference for regional anesthesia techniques, which were used in 90.8% of cases. General anesthesia was primarily employed in urgent or emergency situations. This preference aligns with the guidelines established by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia and the Society for Obstetric Anesthesia and Perinatology.[1]

In elective c-section, the combined spinal–epidural technique was predominantly used (373 out of 430 cases). This technique offers the advantage of providing neuraxial anesthesia through a spinal injection of a potentially low dose of local anesthetic. In addition, an epidural catheter can be placed to supplement anesthesia during the procedure and for postoperative analgesia. The second most commonly used technique for elective c-sections was single-shot spinal anesthesia with the addition of morphine for postoperative analgesia, which was performed in the majority of cases where this technique was used. A recent meta-analysis including 15 trials found no evidence supporting the superiority of either technique in terms of hypotension, maximum sensory level, use of vasopressors, duration of block regression, or occurrence of nausea and vomiting. However, the authors emphasized that it is essential to strike a balance between the risks and benefits of choosing a combined spinal–epidural technique, which may require more time, invasiveness and costs, but offers an alternative for supplementing anesthesia in situations where the blockade height is insufficient.[11]

In urgent c-sections, epidural anesthesia was the most commonly used technique, which is likely related to the utilization of epidural catheters placed in the delivery room for labor pain. The epidural top-ups performed in these circumstances included the use of two local anesthetics either individually or in combination: 2% lidocaine and 0.75% ropivacaine. The available data do not include the time elapsed between the administration of local anesthetic and the beginning of the surgical procedure. A recent meta-analysis examining the use of local anesthetics in epidural anesthesia for c-sections revealed that 2% lidocaine has a faster onset time compared to 0.75% ropivacaine.[12] This finding suggests that ropivacaine 0.75% may be less desirable for emergent c-sections.[12] While it is a commonly practiced technique among anesthesiologists, there is limited literature available on the combination of multiple local anesthetics for epidural anesthesia, specifically in c-sections.[13] Most studies on this topic primarily focus on peripheral nerve blocks instead. Mixing local anesthetics can make the toxicity calculation more complex. Regardless of the choice of drugs for epidural top-up, it should always take into account the local anesthetic and adjuvants previously administered for labor analgesia, the actual urgency of the c-section, the anesthesiologist experience, and the pathology presented by the pregnant woman. Therefore, multidisciplinary discussion with the obstetric team is crucial in this regard.

In our study, general anesthesia was performed mainly in urgent/emergency situations, accounting for 14.9% of cases (as an initial technique in 83 cases and as a rescue technique in 55 cases). There is no consensus on the optimal rate of general anesthesia for c-sections. A previous retrospective study conducted in the last decade has reported that general anesthesia rates for c-sections range from 5% to 15%, which is consistent with the findings of our study.[14] In addition, from the results of our study, general anesthesia appears to be associated with a longer hospital stay. However, it cannot be ruled out that the clinical indication for performing a general anesthesia may have also contributed to the observed increase in the length of hospital stay.

A failed neuraxial anesthesia can be a distressing event for both the mother and the anesthesiologist, potentially leading to decreased maternal satisfaction and exposing the mother and baby to the risks associated with general anesthesia. The conversion rate from regional anesthesia to general anesthesia in our study was 6.5%. This percentage is relatively consistent with the findings of a retrospective

study involving over 19,000 pregnant women, which reported failure rates of 7.1% for epidural anesthesia using labor epidural catheters and 2.7% for spinal anesthesia during cesarean procedures.[15]

With respect to the management of postoperative pain associated with c-section, it differs significantly from other surgeries, as its success or failure can affect the quality of life of two individuals, the mother and the newborn, during one of the most important moments in their lives, thus impacting the satisfaction levels of pregnant women. The postoperative analgesia for the postpartum women in this study primarily consisted of a locoregional technique, with only 12.3% of cases receiving solely systemic multimodal analgesia. Epidural analgesia was the most commonly used technique (83% of cases).

In the vast majority of cases (86.6%), mild pain (NRS $\leq$ 3) was reported in the first 24 postoperative hours, which is an aspect to highlight in the ongoing progress of fast-track recovery programs after c-section. Epidural analgesia and intrathecal morphine were the analgesic regimens that had the lowest percentages of moderate to severe pain (11.3% and 15%, respectively). Furthermore, systemic conventional analgesia was found to be a risk factor for moderate/severe pain in the logistic regression analysis conducted in this study. These results are encouraging for the use of regional anesthesia techniques for c-section that allow for extending their action to postoperative analgesia.

In addition to the risk factors for moderate to severe pain, the finding that lower BMI in pregnant women was considered a risk factor is not in line with the results that were expected. To the authors' knowledge, there are no studies analyzing the impact of BMI on the success of postoperative analgesia in c-sections. One possible explanation is that epidural catheters for labor were placed earlier and tested more extensively in obese pregnant women to avoid the need for general anesthesia and airway intervention if a c-section would be necessary.

Alternatives to neuraxial analgesia, such as bilateral TAP block, have shown some evidence of providing superior pain relief, higher patient satisfaction, and reduced reliance on rescue opioid analgesia when intrathecal morphine is not administered.[16-19] However, due to the limited number of cases in this study (n = 3), the statistical significance of TAP block could not be determined to draw conclusive findings about its effectiveness. In this regard, prospective studies are needed to understand the quality of analgesia with abdominal wall blocks, such as the TAP block.

Many of the complications and side effects documented in this study, including urinary retention, nausea and vomiting, and pruritus, are likely attributable to the use of opioids. In addition, intrathecal morphine was identified as a predictor for the occurrence of postoperative complications in this study. Current guidelines suggest the use of neuraxial morphine whenever it is possible, as the use of postoperative lumbar epidural analgesia with local anesthetics has been associated with impaired mobilization.[4] Our results suggest that it is important to consider the balance between the effectiveness and side effects of neuraxial opioid utilization in comparison to other analgesic drug strategies like epidural local anesthetics. Postoperative complications that were noticed (i.e., nausea and vomiting, urinary retention, and pruritus) may impair early oral intake, resting periods, and postoperative discharge, which are also prerequisites of an optimal postoperative analgesia.[20] Accordingly, prospective studies focusing on different doses and concentrations of local anesthetics and an effective evaluation of lower limb weakness are necessary to further evaluate the risks and benefits of opioids in opposition to the risks and benefits of epidural local anesthetics for postoperative analgesia after a c-section.

There are some limitations associated with our study. First, it is a single-center, retrospective study and, therefore, it is dependent on the accuracy and completeness of the clinical records. In addition, the very low frequency of certain variables, such as the utilization of TAP blocks, does not allow any reliable conclusion regarding the benefits of its use in patients in whom neuraxial analgesia was not performed.

The available data regarding epidural top-up for urgent c-section also does not contribute to a better understanding of the current practice regarding local anesthetic selection in these situations. In both scenarios, future prospective studies are required.

In conclusion, our results suggest that a multimodal analgesic approach with neuraxial morphine and/or local anesthetic, NSAIDs, and acetaminophen is central to achieve an effective postoperative analgesia after a c-section. However, further studies should be conducted to investigate the optimal neuraxial analgesic combination to avoid the side effects associated with neuraxial opioids.

The role of locoregional analgesia in this field was highlighted, emphasizing the need for individualized techniques and a careful selection of drugs, from a risk–benefit perspective. Furthermore, the role of rescue analgesic strategies, such as abdominal wall blocks and local infiltration anesthesia, remains to be further characterized specifically in patients in whom neuraxial analgesia is not an option.

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Conflicts of interest

There are no conflicts of interest.

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