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Research Paper

Hemodynamic Differences in Patients Undergoing Cesarean Section with ERACS and Non-ERACS Methods Using Spinal Anesthesia at Siti Hawa Mother and Child Hospital Padang

Nabilah Aisyah Aldhiah[1], Hudila Rifa Karmia[2], Roslaili Rasyid[3], Rini Rustini[4], Selfi Renita Rusjdi[5]

[1]Department of Medicine, Faculty of Medicine, Universitas Andalas, Padang, Indonesia
[2]Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Andalas, Padang, Indonesia
[3]Department of Microbiology, Faculty of Medicine, Universitas Andalas, Padang, Indonesia
[4]Department of Anesthesiology, Faculty of Medicine, Universitas Andalas, Padang, Indonesia
[5]Department of Parasitology, Faculty of Medicine, Universitas Andalas, Padang, Indonesia

Corresponding Author: Nabilah Aisyah Aldhiah

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ABSTRACT

Cesarean section is a surgical procedure to terminate pregnancy through an abdominal incision, which often causes hemodynamic changes, such as hypotension and increased heart rate due to spinal anesthesia. The Enhanced Recovery After Cesarean Section (ERACS) protocol was developed to reduce these complications through a perioperative care approach, including better pain control, early mobilization, and fluid management compared to non ERACS methods. This study aims to analyze the differences in hemodynamic parameters between ERACS and non ERACS methods in cesarean section patients with spinal anesthesia at Siti Hawa Mother and Child Hospital Padang.
This is an observational analytic study using a cross-sectional approach. The sample consisted of 72 cesarean section patients, with 36 samples for each group. Data collection was conducted prospectively from September to November 2024. The instrument used was primary data obtained through observation and recording of hemodynamic parameters on the patient's vital sign monitor.
The results of this study showed significant differences in the average systolic pressure, diastolic pressure, and mean arterial pressure between the preoperative and intraoperative stages at 5, 10, and 15 minutes after sub arachnoid block (SAB) in both ERACS and non ERACS methods (p-value > 0.05). Meanwhile, heart rate showed a significant difference only at 15 minutes intraoperatively after spinal anesthesia (p-value < 0.05). The conclusion is that there is a difference in hemodynamics in patients undergoing cesarean section, with the ERACS method showing better hemodynamic stability compared to the non-ERACS method.

Keywords: cesarean section, ERACS, non ERACS, hemodynamics, spinal anesthesia

INTRODUCTION

Cesarean section is a surgical procedure used to deliver the fetus and terminate the pregnancy through an incision in the abdomen.[1] This procedure is often preferred by pregnant women over vaginal delivery, as vaginal birth is frequently considered difficult and risky.[2] However, patients who undergo cesarean section often experience various discomforts, one of which is pain originating from the abdominal incision.[3] If pain evaluation is performed and followed by effective pain management, it can significantly increase maternal comfort. Additionally, this approach can accelerate early mobilization, enabling faster recovery and reducing the length of hospital stay.[4] Therefore, it is not surprising that interest in improved perioperative care for cesarean section patients continues to rise. Specifically, enhanced recovery care is an effective way to improve clinical benefits and have a positive impact on the healthcare system due to cesarean section, resulting in earlier rehabilitation and patient discharge.[5]

The Enhanced Recovery After Cesarean Section (ERACS) protocol initially focuses on improving pain control, reducing nausea and vomiting, and promoting early post-operative ambulation to shorten hospital stay. The ERACS method was first developed to address issues across three stages: preoperative, intraoperative, and postoperative. In the preoperative period, this method aims to reduce perioperative pathophysiological responses and decrease morbidity. The intraoperative phase seeks to reduce surgical stress, prevent intraoperative hypothermia, and avoid unnecessary blood use. Postoperative goals include pain management, preventing nausea or vomiting, and early feeding to avoid ileus.[6]

Pregnancy can cause increased blood pressure, blood volume, peripheral vascular pressure, and pressure on the right side of the heart. Therefore, cesarean section procedures must be carried out carefully, considering the significant physiological changes in the cardiovascular system during pregnancy.[7] Spinal anesthesia administration in cesarean section patients can affect hemodynamics, leading to decreased systolic and diastolic pressures, mean arterial pressure, and an increased heart rate.[8] Systolic blood pressure, diastolic blood pressure, and mean arterial pressure are key parameters for assessing organ perfusion status and cardiovascular stability. The heart rate reflects the body's compensatory response to changes in blood pressure, such as an increase due to hypotension or a decrease due to bradycardia. These four parameters cover the main indicators needed to assess hemodynamic changes during spinal anesthesia and can be measured with standard monitoring equipment available in the operating room without the need for more complex devices.[9] Hemodynamic monitoring plays a crucial role in patient care, as hemodynamic conditions can change rapidly.[10]

The vasodilation effect on blood vessels caused by spinal anesthesia can lead to hemodynamic instability.[11] This is associated with the sympathetic blockade impact, which can result in a blood pressure drop of up to 10%.[12] The reduction in peripheral arterial tone due to spinal anesthesia, combined with aortic-caval compression by the enlarged uterus, worsens obstetric hypotension caused by spinal anesthesia in patients.[13]

The ERACS method is designed to improve care compared to the non-ERACS method, leading to significant differences between the two. Compared to non-ERACS, ERACS features a shorter fasting period aimed at maintaining patient fitness from preparation to completion of surgery, reduced analgesia doses to speed up patient recovery, and facilitates early mobilization with minimal pain.[14]

Furthermore, one of the perioperative management components of the ERACS protocol includes a fluid management strategy as an integral part, aiming to reduce the risk of hemodynamic instability that may arise during or after spinal anesthesia.[15] The combination of prophylactic phenylephrine infusion and crystalloids has shown a significant reduction in hypotension incidents compared to maintenance fluid use. Understanding these hemodynamic dynamics is crucial for planning and executing spinal anesthesia procedures. Proper monitoring and understanding of hemodynamics in ERACS patients allow for quick responses to changes, optimizing patient recovery, and preventing unwanted complications.[14,15]

In Indonesia, the ERACS method is being implemented as an approach in cesarean section care, demonstrating several advantages compared to the non-ERACS method. The ERACS protocol for cesarean section is still relatively new and has not been widely adopted in various hospitals, so there is a lack of data on its usage. Siti Hawa Mother and Child Hospital Padang is one of the hospitals in Padang City that has applied the ERACS technique for cesarean section deliveries, starting in 2022. Siti Hawa Mother and Child Hospital is a Type C specialty hospital with an appropriate bed occupancy ratio, allowing for a sufficient sample size to represent the population.[16]

Given the rising number of cesarean section deliveries and the increasing popularity of the ERACS method, as well as the lack of research on hemodynamic differences between these two methods, the researcher is interested in examining and analyzing in more detail the potential hemodynamic differences between these two patient groups. Therefore, this study is titled Hemodynamic Differences in Patients Undergoing Cesarean Section with ERACS and Non-ERACS Methods Using Spinal Anesthesia at Siti Hawa Mother and Child Hospital Padang, with the aim of providing deeper insights into the benefits and impacts of applying the ERACS method in cesarean section procedures.

MATERIALS & METHODS

This research is an analytical observational study with a cross-sectional design. The research was conducted at Siti Hawa Mother and Child Hospital in Padang from September 2024 to November 2024. Data were collected through observation and recording of hemodynamic parameters on the patient's vital signs monitor into the observation sheet. The inclusion criteria for this study were patients undergoing cesarean section procedures with the ERACS method using spinal anesthesia and patients undergoing cesarean section with the non-ERACS method using spinal anesthesia. The exclusion criteria included patients with uncontrolled preeclampsia, gestational diabetes with complications, uncorrected heart disease, uterine rupture, patients with severe bleeding, and patients with very preterm gestational age.

STATISTICAL ANALYSIS

The data that has been collected and then analyzed with univariate analysis to see the frequency distribution, followed by bivariate analysis to determine the relationship between the independent and dependent variables using dependent t-tests and independent t-tests.

RESULT

This research involved 72 samples that met the eligibility criteria. A total of 36 subjects were from the ERACS group and 36 subjects were from the non-ERACS group. Below is the table of research subject characteristics.

Table 1. Characteristics of ERACS Method Caesarean Section Patients

Characteristics	Frequency (n)	Percentage (%)
Age		
<20	2	5,6
20-35	31	86,1
>35	3	8,3
BMI		
18,5-22,9	2	5,6
23-24,9	1	2,8
25-29,9	19	52,8
≥30	14	38,9

Based on **Table 1**, the majority of patients were aged between 20-35 years, with a total of 31 individuals (86.1%). Based on Body Mass Index (BMI), the majority of patients fell within the range of 25-29.9, with a total of 19 individuals (52.8%). This indicates that most respondents were classified as having grade 1 obesity.

Table 2. Characteristics of Non-ERACS Method Caesarean Section Patients

Characteristics	Frequency (n)	Percentage (%)
Age		
<20	0	0
20-35	23	63,9
>35	13	36,1
BMI		
18,5-22,9	0	0
23-24,9	1	2,8
25-29,9	15	41,7
≥30	20	55,6

In **Table 2,** the majority of patients were aged between 20-35 years, with a total of 23 individuals (63.9%). There were no patients in the <20 years age range. Based on Body Mass Index (BMI), the majority of patients fell within the ≥30 range, with a total of 20 individuals (55.6%). There were no patients with a BMI of 18.5-22.9 (normal category). It can be concluded that most respondents were classified as having grade 2 obesity.

Table 3. Differences in Preoperative Hemodynamics in Patients with ERACS and Non-ERACS Caesarean Section Methods

Parameter	ERACS method (n = 36)	Non ERACS method (n = 36)	p-value
	Mean ± SD / Median	Mean ± SD / Median	
SBP (mmHg)	120,42 ± 13,20	125,81 ± 13,61	0,093
DBP (mmHg)	78,00	80,00	0,130
MAP (mmHg)	83,64 ± 15,21	88,31 ± 12,19	0,155
Pulse (x/minute)	87,28 ± 10,39	90,94 ± 11,58	0,162

In **Table 3,** diastolic blood pressure in the non-ERACS method was not normally distributed. Therefore, the data is presented in the form of a median. For consistency, diastolic blood pressure data in the ERACS method is also presented as a median, and comparisons were made using the Mann-Whitney test. Table 3 shows that there is no significant difference in the preoperative hemodynamics of cesarean section patients between the ERACS and non-ERACS methods, as the p-value >0.05. Thus, both methods are suitable for comparison.

Table 4. Differences in Intraoperative Hemodynamics at 5 Minutes, 10 Minutes and 15 Minutes Sub Arachnoid Block

Parameter	ERACS method (n = 36)	Non ERACS method (n = 36)	p-value	Mean Difference / Median Difference
	Mean ± SD/ Median	Mean ± SD / Median		
5 Minutes SAB				
SBP (mmHg)	103,94 ± 13,59	108,64 ± 11,93	0,124	-4,694
DBP (mmHg)	57,50 ± 15,64	67,81 ± 11,5	0,002	-10,306
MAP (mmHg)	71,97 ± 14,64	75,19 ± 11,78	0,307	-3,222
Pulse (x/minute)	84,83 ± 15,64	90,22 ± 11,80	0,103	-5,389
10 Minutes SAB				
SBP (mmHg)	105,44 ± 9,01	106,56 ± 10,62	0,634	-1,111
DBP (mmHg)	55,06 ± 11,25	65,17 ± 13,29	0,001	-10,111
MAP (mmHg)	69,50	70,00	0,302	-0,5

Pulse (x/minute)	84,61 ± 14,29	86,00 ± 14,7	0,686	-1,389
15 Minutes SAB				
SBP (mmHg)	111,78 ± 8,26	112,56 ± 13,26	0,766	-0,778
DBP (mmHg)	63,08 ± 10,46	70,56 ± 11,94	0,006	-7,472
MAP (mmHg)	76,11 ± 9,37	79,50 ± 10,83	0,160	-3,389
Pulse (x/minute)	83,06 ± 11,94	85,06 ± 10,81	0,459	-2,000

In **Table 4**, it is known that there is no significant difference in mean systolic blood pressure, mean arterial pressure, and pulse rate between ERACS and non-ERACS method sectio caesarea patients at 5, 10, and 15 minutes after SAB because the p value >0.05. In terms of mean diastolic blood pressure, there was a significant difference between the two groups at all times (5, 10, and 15 minutes after SAB).

Table 5. Differences in Preoperative and Intraoperative Hemodynamics at 5 minutes SAB in Sectio Caesarea Patients

Parameter	ERACS method (n = 36)			Non ERACS method (n = 36)		
	Mean ± SD / Median		p-value	Mean ± SD / Median		p-value
	Pre	5 minutes SAB		Pre	5 minutes SAB	
SBP (mmHg)	120,42	103,94	0,001	125,81	108,64	0,001
DBP (mmHg)	75,56	57,50	0,001	80,00	68,00	0,001
MAP (mmHg)	83,64	71,97	0,001	88,31	75,52	0,001
Pulse (x/minute)	87,28	84,83	0,390	90,94	90,22	0,656

In **Table 5,** it was found that the average systolic blood pressure, diastolic blood pressure, and mean arterial pressure at the preoperative to intraoperative 5-minute SAB stage with the ERACS and non-ERACS methods had a significant difference because the p value was <0.05. While the pulse rate did not have a significant difference, both with the ERACS and non-ERACS methods at the preoperative to intraoperative 5-minute SAB stage.

Table 6. Differences in Preoperative and Intraoperative Hemodynamics at 10 minutes SAB in Sectio Caesarea Patients

Parameter	ERACS method (n = 36)			Non ERACS method (n = 36)		
	Mean ± SD / Median		p-value	Mean ± SD / Median		p-value
	Pre	10 minutes SAB		Pre	10 minutes SAB	
SBP (mmHg)	120,42	105,44	0,001	125,81	106,56	0,001
DBP (mmHg)	75,56	55,06	0,001	80,00	63,50	0,001
MAP (mmHg)	83,64	70,36	0,001	91,50	70,00	0,001
Pulse (x/minute)	87,28	84,61	0,282	90,94	86,00	0,066

In **Table 6,** it was found that the mean systolic blood pressure, diastolic blood pressure, and mean arterial pressure at the preoperative to intraoperative stage of 10-minute SAB with ERACS and non-ERACS methods had a significant difference because the p value was <0.05. Meanwhile, the pulse rate did not have a significant difference, both with the ERACS and non-ERACS methods at the preoperative to intraoperative 10-minute SAB stage.

Table 7. Differences in Preoperative and Intraoperative Hemodynamics at 15 minutes SAB in Sectio Caesarea Patients

Parameter	ERACS method (n = 36)			Non ERACS method (n = 36)		
	***Mean* ± SD**		**p-value**	***Mean* ± SD**		**p-value**
	Pre	**15 minutes SAB**		**Pre**	**15 minutes SAB**	
SBP (mmHg)	120,42	111,78	0,001	125,81	112,56	0,001
DBP (mmHg)	75,56	63,08	0,001	80,00	70,00	0,001
MAP (mmHg)	83,64	76,11	0,012	88,31	79,50	0,001
Pulse (x/menit)	87,28	83,06	0,068	90,94	85,06	0,010

In **Table 7,** it was found that the mean systolic blood pressure, diastolic blood pressure, and mean arterial pressure at the preoperative to intraoperative stage of 15 minutes SAB with ERACS and non-ERACS methods had significant differences because the p value was <0.05. The pulse rate in the non-ERACS method also has a significant difference. While the pulse rate in the ERACS method did not have a significant difference (p>0.05).

DISCUSSION

The patient characteristics based on age in table 1 and table 2 show that most of the patients' ages are in the range of 20-35 years with 31 and 23 people respectively. This age range includes the age category of safe pregnant women, who generally have a lower risk of pregnancy and childbirth. Age 35 years and above has a higher risk of complications during pregnancy and also childbirth including sectio caesarea. Older age also shows a higher risk of hemodynamic changes during the administration of spinal anesthesia, namely the risk of lower blood pressure compared to younger age. This may be due to the decreased vascular autonomic tone that occurs after sympathetic blockade in older individuals. In addition, cardiac output tends to decrease with age which exacerbates the risk of hypotension.[17] A study conducted by Chumpatong et al. (2006) at Siriraj Hospital regarding hypotensive complications due to spinal anesthesia in sectio caesarea patients showed that age was not an independent factor that contributed significantly to the incidence of hypotension.[18]

The characteristics of ERACS method sectio caesarea patients based on BMI in table 1 show that most patients are in the category of obesity level 1. As for the characteristics of BMI of non-ERACS sectio caesarea patients in table 2, it shows that most patients are in the category of obesity level 2. This shows that the majority of sectio caesarea patients are in the obesity category according to the Asia Pacific BMI classification. Research conducted by Puspitasari et al. (2023) at Emanuel Banjarnegara Hospital, showed that BMI with the obese category, namely ≥30 kg/m^2, was at greater risk of hypotension during the administration of spinal anesthesia.[19] This is because in obese individuals, there is an increase in fat tissue which can cause compression of large blood vessels such as the inferior vena cava. This compression can inhibit the return blood flow to the heart, which in turn reduces stroke volume and cardiac output. Spinal anesthesia causes dilatation of blood vessels, which reduces venous return, thus worsening the hypotensive condition.[12]

Based on the results of the study shown in Table 3, the p value >0.05 was obtained in the comparison of each variable. These results indicate that there is no significant difference in the mean systolic blood pressure, diastolic blood pressure, mean arterial pressure, and preoperative pulse rate in ERACS and non-ERACS method cesarean section patients. This occurred because all patients were still in the early stages and there was no influence from anesthetic and analgesic drugs. Based on the results of the analysis, there was homogeneity between the two groups, so the risk of confounding variables affecting the results of the study could be minimized. Therefore, both groups are considered to have the same opportunity to respond to the treatment or variable under study, so the comparison is fair. This is in line with research conducted by Shafiyatu (2023) at Prof. Dr. Margono Soekarjo Banyumas Hospital. The study compared preoperative hemodynamics in the ERACS and non-ERACS method groups which did not find significant differences between the two, so that the two groups were feasible to compare.[20]

All patients in this research had American Society of Anesthesiologists (ASA) classification of 2, which is a patient with mild systemic disease, but without functional limitation. In obstetric cases, ASA 2 includes normal uncomplicated pregnancy, but with some mild risk factors such as mild anemia, mild obesity, or gestational hypertension without target organs being affected.[21] A study by Katori et al. (2023) in Japan showed that the risk of developing hypotension increases with high ASA classification, as patients with high ASA categories tend to have serious medical conditions, such as heart failure, unstable ischemic heart disease, and others. These conditions cause preoperative hemodynamic reserve to worsen, especially in CITO patients, where preoperative evaluation and treatment may be inadequate.[22]

During the intraoperative period, both groups of patients were injected with spinal anesthesia. After induction of spinal anesthesia, there are several complications that can occur, so monitoring the patient's vital signs is very important. This includes measuring the level of anesthesia, which should stabilize within 10 to 15 minutes after the injection.[23] Hemodynamic changes due to spinal anesthesia are related to the sympathetic block effect which can result in blood pressure decreasing by up to 10%. The recumbent position during labor also causes the uterus to compress the abdominal aorta and inferior vena cava, reducing cardiac output and aggravating the patient's condition.[24]

Analysis of differences in intraoperative hemodynamics of ERACS and non-ERACS method sectio caesarea patients in Table 4 was performed using independent t test. However, there were data with abnormal distribution, namely in the MAP parameter at the 10th minute after SAB, so it was analyzed using the Mann Whitney test. The results of the analysis can be concluded that there is no significant difference between ERACS and non-ERACS method sectio caesarea patients. While significant differences exist in the diastolic blood pressure of ERACS and non-ERACS method sectio caesarea patients.

This is in line with research by Ebrie et al. (2022) at Mahatma Ghandi Memorial Hospital comparing bupivacaine 10 mg and bupivacaine 7.5 mg with or without adjuvant fentanyl, showing that there was no significant difference in systolic blood pressure between the two groups.[25] This is different from a study conducted by Shafiyatu (2023) at Prof. Dr. Margono Soekarjo Banyumas Hospital. The study showed there were differences in intraoperative hemodynamics in systolic blood pressure, diastolic blood pressure and mean arterial pressure of ERACS and non-ERACS method sectio caesarea patients. However, the intraoperative pulse rate parameters had similar results where there was no significant difference between the two groups. The study was slightly different in that intraoperative hemodynamic parameters were not measured every 5 minutes and the data used came from medical record data.[20]

The absence of differences in the intraoperative stage could be due to differences in inclusion criteria because in this study, there were elective cesarean section and CITO patients in both ERACS and non-ERACS methods who had different preoperative fluid volumes. So for elective cesarean section, patients have more limited fluid reserves because they have fasted for 6-8 hours. The difference in fluid volume can affect intraoperative hemodynamics and potentially cause variability in the results obtained. This is supported by research conducted by Lova et al. (2024) at RSI Banjarnegara. The study explained that there was a relationship between the length of fasting and the incidence of hypotension. The longer a person fasts, the possibility of hypotension increases due to the reduced volume of body fluids during fasting.[26]

Other causes can also be due to the use of the same vasopressor dose between the ERACS and non-ERACS methods. It is known that the use of vasopressors used at Siti Hawa Padang Hospital is ephedrine with a dose of 2 cc in both ERACS and non-ERACS methods. Vasopressor is a type of drug used to increase blood pressure that is too low (hypotension) which can be life-threatening. Hypotension can trigger intraoperative nausea and vomiting (IONV) in the mother and reduce uteroplacental blood flow, thus disrupting fetal oxygenation.[14,27]

At this intraoperative stage, significant differences between the two groups were only found in diastolic blood pressure parameters ($p < 0.05$). This may be due to diastolic blood pressure reflecting peripheral vascular resistance.[28] When affected by spinal anesthesia, sympathetic blockade occurs especially in the sympathetic plexus that regulates peripheral vascular resistance. This decrease in vascular resistance has more impact on diastolic blood pressure because diastolic reflects blood pressure when the heart is in a state of relaxation, which depends more on vascular tone compared to systolic blood pressure.[29] In the ERACS method, the protocol tends to involve more optimal preoperative strategies, such as controlled intravenous fluid hydration and better use of vasopressor agents to maintain vascular tone. These strategies help to reduce the effects of diastolic hypotension more sharply than in non-ERACS. Effective fluid management and vasopressors can help maintain a more stable diastolic blood pressure post spinal anesthesia.[14]

Based on the results, it shows that there is no significant difference in intraoperative and postoperative pulse rates in the group of patients with ERACS and non-ERACS methods. This is reinforced by the results of a study by Ebrie et al. (2022) at Mahatma Ghandi Memorial Hospital comparing bupivacaine 10 mg and bupivacaine 7.5 mg with or without adjuvant fentanyl, showing that there was no significant difference in pulse rate.[25] Although spinal anesthesia lowers overall blood pressure, heart rate tends to remain stable due to the balance between vasodilatory effects and cardiovascular compensatory mechanisms.[30]

Based on the analysis results in table 5, table 6, and table 7, there were significant differences in mean systolic, diastolic, and mean arterial pressure between the preoperative and intraoperative stages, both at the 5th, 10th, and 15th minutes after SAB, with both ERACS and non-ERACS methods. In contrast, pulse rate showed no significant difference at the intraoperative stage until the 10th minute of SAB for both methods. However, at the 15th intraoperative minute after SAB, a significant difference in pulse rate was found. This is in line with previous research by Rekayanti (2018) at Makassar City Hospital which showed significant changes in blood pressure, but no significant changes in pulse rate in the preoperative and intraoperative states of sectio caesarea.[31]

Table 5 shows that at 5 minutes after SAB, there was a significant decrease in systolic, diastolic, and mean arterial pressure from before SAB in both groups. This occurred due to venous and arterial dilation due to spinal blockade. This blockade affects sympathetic nerves from T5 to L1 segments that innervate arterial and venous smooth muscles, thereby triggering vasodilation. Venous vasodilation causes blood to pool in the splenic area and lower extremities, which reduces venous return to the heart. Meanwhile, arterial vasodilation reduces systemic vascular resistance. Nonetheless, this effect is partially offset by compensation in the form of vasoconstriction in areas of the body not affected by the blockade. This combination of mechanisms contributes to a reduction in cardiac output, stroke volume, arterial pressure, and systemic peripheral resistance.[32] ERACS methods that have preoperative optimization protocols, such as adequate fluid hydration and analgesia control, allow for a more manageable drop in blood pressure compared to non-ERACS. A study conducted by Meng et al. (2021) in

China, which showed that good preoperative preparation reduces the risk of a drastic drop in blood pressure during SAB.[5] The pulse rate showed no significant change in both methods, indicating good cardiovascular control during the first 5 minutes post SAB.

Table 6 shows that at 10 minutes of SAB, the same results were obtained, namely significant changes in systolic blood pressure, diastolic blood pressure, and mean arterial pressure compared to preoperative blood pressure ($p<0.05$). This illustrates the progressive phase of the vasodilating effect of spinal anesthesia that continues to take place in patients undergoing sectio caesarea. In this phase, patients have also been given vasopressor drugs to prevent further decrease in blood pressure, as a preventive measure against more severe hypotension. It can be seen from the data, that the decrease in systolic blood pressure, mean arterial pressure, and pulse rate in non-ERACS is more significant than ERACS. While diastolic blood pressure decreased more significantly in the ERACS method.[33] A decrease in peak hemodynamics was recorded at 10 minutes SAB in both groups. This is in line with research by Pontoh et al. (2023) at RSUD Dr. Soedirman Kebumen, that the incidence of hypotension after spinal anesthesia was recorded at the 10th minute as much as 80.4%.[34] This is due to the redistribution of blood volume to the capacitance vein.

Table 7 shows that at 15 minutes SAB, there was still the effect of spinal anesthesia because there were significant changes in systolic blood pressure, diastolic blood pressure, and mean arterial pressure in ERACS and non-ERACS patients. Although the administration of vasopressants such as ephedrine affects the increase in blood pressure in the following minutes, this shows that the sympathetic block effect is still dominant. Ephedrine, which is widely used in caesarean section patients, is a sympathomimetic drug with direct action on alpha and beta agonist receptors, as well as indirect effects through the release of norepinephrine from presynaptic nerves. Blood circulation to the uterus is more influenced by beta agonist activity than alpha agonists, so ephedrine has minimal impact on uterine blood flow. However, ephedrine is effective in restoring blood pressure in patients who experience hypotension during caesarean section procedures.[17,32]

The results at 15 minutes SAB also found an increase in systolic and diastolic blood pressure compared to the 10th minute. However, this increase was not statistically significant, because the difference in blood pressure that occurred was relatively small. This finding is in line with previous research by Ahmad (2014), which reported a significant decrease in blood pressure in the 5th minute after spinal anesthesia, followed by a gradual increase in the 10th minute until the procedure was completed.[35]

In this research, it was found that there was a difference in hemodynamic decline in the ERACS and non-ERACS methods, where the average hemodynamic decline in the non-ERACS method was greater than in ERACS. Although both methods experienced a decrease in blood pressure and mean arterial pressure, the ERACS method was able to manage the decline in a more controlled and more stable manner. This may be related to the ERACS protocol such as adequate fluid hydration and the use of lower anesthetic doses. The anesthetic drugs used in the patients in this study were bupivacaine, morphine, and sedacum. Patients with non-ERACS method caesarean section used a higher dose of bupivacaine. While in patients with ERACS method caesarean section, low doses of bupivacaine were given plus adjuvant ketorolac suppositories. Analgesics can affect the level of spinal blockade. The use of local anesthetics in lower doses does not block sympathetic nerve fibers in the upper area, thus preventing hypotension. In addition, low doses reduce the risk of toxic effects on the body's systems due to local anesthetics.[36]

The results of a research by Zulkifli (2020) at DR. Wahidin Sudirohusodo General Hospital Makassar, showed a significant difference in the onset and duration of motor block between groups of patients receiving low doses of bupivacaine compared to conventional doses. In patients with conventional doses, the duration of sensory and motor block was longer than low doses. The duration of action of bupivacaine is influenced by the dose given, where higher doses result in longer block durations. This is due to increased binding of bupivacaine to plasma proteins at higher doses, so that the anesthetic effect lasts longer.[37] High doses of bupivacaine can cause significant increases in vasodilation and blood pressure fluctuations, which are at risk of triggering quite severe hypotension. This occurs because the effect of the drug inhibits blood vessel tone and reduces blood flow back to the heart, which in turn drastically lowers blood pressure.

CONCLUSION

There were no significant differences in systolic blood pressure, mean arterial pressure, and intraoperative pulse rate at 5, 10, and 15 minutes after SAB between ERACS and non-ERACS caesarean section patients, but there were significant differences in diastolic blood pressure at the same time between the two groups.

There were significant differences in mean systolic, diastolic, and mean arterial pressure between the preoperative and intraoperative stages at 5, 10, and 15 minutes after SAB for both ERACS and non-ERACS methods, while pulse rate only showed significant differences at 15 minutes intraoperatively after SAB.

There were differences in hemodynamics of caesarean section patients where the ERACS method showed better hemodynamic stability than non-ERACS, with a more controlled decrease in blood pressure and MAP.

Declaration by Authors

Ethical Approval: This study has received approval from the Ethics Commission of the Faculty of Medicine, Andalas University, with the ethical approval letter number: 358/UN.16.2/KEP-FK/2024.

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