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Overview of hemodynamic status in patients under spinal anesthesia

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ABSTRACT

The purpose of this study was to evaluate the hemodynamic picture of patients receiving spinal anesthesia at RSUD Dr. Soedirman Kebumen, focusing on changes in blood pressure, pulse, and oxygen saturation before and after anesthetic injection. This study used quantitative method with descriptive design and cross-sectional approach. The results showed that before injection, 81.0% of patients had normal blood pressure, but after injection, there was an increase in hypotension cases to 17.0% at the 5th minute. By the 20th minute, 93.2% of patients had normal blood pressure again. For pulse, 10.9% of patients had tachycardia before injection, which increased to 6.8% at the 20th minute after injection. Oxygen saturation remained stable, with 100% of patients achieving normal saturation at the 5th and 20th minutes. The conclusion of this study shows that spinal anesthesia can cause significant hemodynamic changes, especially a decrease in blood pressure and an increase in tachycardia frequency, although oxygen saturation remained stable.

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1. Introduction

Spinal anesthesia or spinal anesthesia is an anesthetic technique that is widely used in SC (Sactio Caesarea) with the aim of relieving pain consciously by using local anesthetics injected directly into the cerebrospinal fluid (CSF) with injection locations at L2-L3, L3-L4 to L4-L5 (Taufik et al., 2022). Spinal anesthesia can provide patient satisfaction in terms of technique, faster recovery period, minimal side effects, little impact on the respiratory system, patients can eat immediately after surgery and can provide good muscle relaxation in lower abdominal and external surgery (Budiana & Burhan, 2024).

Spinal anesthesia can affect hemodynamics because it can cause a decrease in blood pressure, so monitoring is necessary (Pontoh et al., 2024). Anesthesia procedures are not differentiated based on the size of the surgery, but the selection of the type of surgery in complex and comprehensive patients, considering that all types of anesthesia have risk factors for complications that can endanger the patient's life (Budiana & Burhan, 2024).

Complications of spinal anesthesia are divided into 2 namely major complications and minor complications, major complications include allergy to local anesthetics, transient neurological syndrome, nerve damage, subarachnoid hemorrhage, infection, total spinal anesthesia, respiratory failure, caudal equina syndrome and other neurological dysfunction. Mild complications include hypotension, postoperative nausea and vomiting (PONV), post-puncture headache, hearing loss, anxiety, tremor, back pain and urinary retention (Hayati et al., 2015).

According to the World Health Organization (WHO) in 2013 in Weiser et al. (2016), The number of patients undergoing surgery is increasing every year. During 2011 there were 140 million patients in all hospitals in the world, then in 2012 there was an increase to 148 million patients. In Indonesia in 2012 there were 1.2 million surgical cases. In connection with surgery, it is necessary to monitor the patient's hemodynamics in advance to ensure patient safety (Sormin et al., 2022).

Hemodynamic monitoring can be a way to evaluate the condition of the heart by observing the blood vessels. It is often associated with circulation in the vascular system with the heart as the organ capable of pumping blood throughout the body (Nuraeni et al., 2022). Hemodynamics is a state of working capacity such as the work of the heart and lungs. Hemodynamic disorders can cause complications, including migraines, nausea and vomiting, blurred vision, dizziness, faster heartbeat, and epilepsy (Nurlinawati et al., 2019).

Hemodynamics can be measured non-invasively and invasively, but invasive measurements are avoided as much as possible to minimize patient risk. Hemodynamic measurements can be made by assessing the hemodynamic profile by measuring blood pressure, heart rate, and mean atrial pressure (MAP) (Fauzia et al., 2023). Hemodynamics are generally measured using a blood pressure meter using a mercury monometer, a stethoscope is used to listen to pulse sounds and left-right lung sounds, and hear the rhythm of the heartbeat, temperature serves to measure body temperature, an oximeter is used to monitor the pulse rate and SpO2 (Sirait, 2020).

The results of the researcher's pre-survey on November 27, 2023 at RSUD Dr. Soedirman Kebumen obtained data on spinal anesthesia patients from the last 3 months from July to September as many as 400 patients and based on the results of interviews with Agus Suryono as an anesthesiologist, it was found that spinal anesthesia patients who experienced hemodynamic changes after injecting spinal anesthesia were more than 60% such as hypotension and bradycardia.

Based on the description above, the researcher is interested in conducting research on the hemodynamic picture of patients with spinal anesthesia in the work area of Dr. Soedirman Kebumen Regional General Hospital.

2. Methods

This study uses a quantitative method with a descriptive design and a cross-sectional approach. This approach examines independent and dependent variables at one time through direct observation. The study aimed to evaluate changes in patient hemodynamic data before and after spinal anesthesia injection at RSUD Dr. Soedirman Kebumen. The research was conducted in three stages: preparation, implementation, and report preparation. Preparation began with the submission of the title, preparation of the proposal, until the proposal examination. The research implementation stage lasted from October 2023 to August 2024, and the report preparation will be completed in July 2024.

The population of this study consisted of all patients who received spinal anesthesia at RSUD Dr. Soedirman Kebumen in the last three months, totaling 697 patients, with an average of 232 patients per month. The study sample was taken using purposive sampling method and calculated using the Slovin formula, resulting in a sample of 147 patients. The inclusion criteria applied were patients who received spinal anesthesia. The study variables included the patient's hemodynamic description, which was measured through an instrument in the form of an observation sheet that recorded the patient's general characteristics and hemodynamic data, such as blood pressure, pulse, and oxygen saturation.

The data collected consisted of primary and secondary data. Primary data was taken directly from patient observation, while secondary data was obtained from sources such as medical records and related literature. The data collection procedure involved direct observation of the patient's hemodynamic status at the 5th, 10th, 15th, and 20th minutes after anesthetic injection. After data collection, data were processed and analyzed using the univariate analysis method to assess the frequency distribution of the variables studied. Research ethics followed the principles of health research ethics, including beneficence, justice, respect for human dignity, informed consent, anonymity, and confidentiality. Prior to the study, patients were given informed consent and explained their rights as respondents, and were guaranteed confidentiality of personal data and research results.

3. Results and Discussion

Data collection for this study was carried out from July 25 to August 18, 2024, The population size in this study was 147 respondents. From this research the following results were obtained:

3.1 Research Results

Table 1.
Frequency distribution of hemodynamics

Hemodynamics	Before (n=147)(%)	Minute 5 (n=147)(%)	Minute 10 (n=147)(%)	Minute 15 (n=147) (%)	Minute 20 (n=147)(%)
Blood pressure					
Hypertension	28 (19.0)	15 (10.2)	8 (5.4)	13 (8.8)	9 (6.1)
Normal	119 (81.0)	107 (72.8)	98 (66.7)	122 (83.0)	137 (93.2)
Hypotension	0 (0.00)	25 (17.0)	41 (27.9)	12 (8.2)	1 (0.7)
Pulse					
Tachycardia	16 (10.9)	12 (8.2)	5 (3.4)	5 (3.4)	10 (6.8)
Normal	129 (87.8)	134 (91.2)	138 (93.9)	139 (94.6)	134 (91.2)
Bradycardia	2 (1.4)	1 (0.7)	4 (2.7)	3 (2.0)	3 (2.0)
Saturation					
Normal	146 (99.3)	147 (100.0)	145 (98.6)	147 (100.0)	147 (100.0)
Hypoxia	1 (0.7)	0 (0.00)	2 (1.4)	0 (0.00)	0 (0.00)

Table 1 shows the changes in blood pressure, pulse, and oxygen saturation before and after spinal injection. Before injection, there were 28 patients (19.0%) with hypertension, 119 patients (81.0%) with normal blood pressure, and none with hypotension. At the 5th minute, hypertensive patients decreased to 15 patients (10.2%), hypotensive patients increased to 25 patients (17.0%), and at the 20th minute, normal blood pressure increased to 137 patients (93.2%), while only 1 patient (0.7%) was hypotensive. In terms of pulse, before injection, 16 patients (10.9%) had tachycardia and 2 patients (1.4%) had bradycardia. At the 20th minute, patients with normal pulse slightly decreased to 134 patients (91.2%), while tachycardia patients increased to 10 patients (6.8%). Oxygen saturation showed better stability, with 146 patients (99.3%) having normal saturation before injection and all patients achieving normal saturation at the 5th minute and 20th minute.

Table 2.
Average Value

Hemodynamics	Mean	Min	Max	Standard Deviation
Blood Pressure				
Before Injection	1.8095	1.00	2.00	0.39402
After Injection Minute5	2.0680	1.00	3.00	0.51895
After Injection10th Minute	2.2245	1.00	3.00	0.53374
After Injection Minute15	1.9932	1.00	3.00	0.41375
After Injection Minute20	1.9456	1.00	3.00	0.25595
Pulse				
Before Injection	1.9252	1.00	3.00	0.28880
After Injection Minute5	1.9932	1.00	3.00	0.24819
After Injection Minute10	1.9864	1.00	3.00	0.23368
After Injection Minute15	1.9524	1.00	3.00	0.29455

Hemodynamics	Mean	Min	Max	Standard Deviation
Oxygen Saturation				
Before Injection	1.0068	1.00	2.00	0.08248
After Injection Minute5	1.0000	1.00	1.00	0.00000
After Injection Minute10	1.0136	1.00	2.00	0.11624
After Injection Minute15	1.0000	1.00	1.00	0.00000
After Injection Minute20	1.0000	1.00	1.00	0.00000

Table 2 shows the data Before injection, blood pressure was measured in 147 subjects with the results showing a minimum value of 1.00, a maximum value of 2.00, an average of 1.8095, and a standard deviation of 0.39402. At the 5th minute after injection, blood pressure measurements showed an increase with a minimum value of 1.00, maximum value of 3.00, mean of 2.0680, and standard deviation of 0.51895. At the 10th minute after injection, the mean blood pressure increased further to 2.2245 with a standard deviation of 0.53374. At the 15th minute after injection, the mean blood pressure decreased slightly to 1.9932 with a standard deviation of 0.41375. At the 20th minute after injection, the mean blood pressure reached 1.9456 with a standard deviation of 0.25595.

Table 2 shows the Pulse data Before injection, pulse was measured in 147 subjects with the results showing a minimum value of 1.00, a maximum value of 3.00, a mean of 1.9252, and a standard deviation of 0.28880. At the 5th minute after injection, the mean pulse slightly increased to 1.9932 with a standard deviation of 0.24819. At the 10th minute after injection, the mean pulse remained almost the same at 1.9864 with a standard deviation of 0.23368. At the 15th minute after injection, the mean pulse decreased slightly to 1.9524 with a standard deviation of 0.29455.Table 4.2 also shows the Oxygen Saturation data before injection, oxygen saturation was measured on 147 subjects with the results showing a minimum value of 1.00, a maximum value of 2.00, a mean of 1.0068, and a standard deviation of 0.08248. At the 5th minute after injection, oxygen saturation showed consistency with minimum and maximum values of 1.00, mean 1.0000, and standard deviation 0.00000. At the 10th minute after injection, oxygen saturation increased slightly with a minimum value of 1.00, a maximum value of 2.00, a mean of 1.0136, and a standard deviation of 0.11624. At the 15th and 20th minutes after injection, oxygen saturation remained constant with a minimum and maximum value of 1.00, a mean of 1.0000, and a standard deviation of 0.00000.

3.2 Discussion

a. Hemodynamic Frequency Distribution

In this study, it was found that before spinal anesthesia injection, a small proportion of patients (19.0%) were hypertensive with the highest blood pressure of 178/102. However, after spinal anesthesia, there was a gradual decrease in the number of hypertensive patients, with the most drastic decrease at 10 minutes (5.4%) with the lowest blood pressure of 86/64. This decrease can be interpreted as the effect of spinal anesthesia, which generally causes a decrease in sympathetic tone, especially in blood vessels, thus lowering blood pressure. However, at 15 minutes, there was an increase in the number of hypertensive patients to 8.8% with the highest blood pressure of 181/104, which may be due to the body's compensation mechanism or clinical interventions such as the administration of vasopressors. At the 20th minute, the number of patients with hypertension decreased again to 6.1%. No patients were hypotensive before spinal anesthesia. However, there was a significant increase in the number of patients with hypotension after anesthesia, especially at the 10th minute, where 27.9% of patients were hypotensive with the lowest blood pressure of 86/64. This is a common effect of spinal anesthesia due to sympathetic nerve blockade resulting in vasodilatation and a decrease in blood pressure. Thereafter, by the 15th and 20th minutes, the number of patients with hypotension was significantly reduced, suggesting a compensatory mechanism or effective therapeutic intervention. Most patients (81.0%) had normal blood pressure before spinal, but had a decrease in the early minutes after anesthesia. This may reflect that although most patients were in the normal category, the effects of anesthesia caused a temporary shift in their blood pressure status. By the 15th and 20th minutes, the number of patients with normal blood pressure increased again, indicating recovery from the initial effects of anesthesia.

Hemodynamic changes after spinal anesthesia occur in the early minutes because the time it takes for anesthetic drugs to cause nerve blockade with a certain level is 5-10 minutes. Spinal anesthesia triggers a decrease in systemic vascular resistance (SVR) and or cardiac output, often leading to hypotension (Hofhuizen et al., 2019). This is in line with research conducted by Azizah et al. (2016) who found that the average blood pressure after spinal anesthesia in the administration of crystalloid and colloidal fluids decreased in the early minutes, namely the first 5 minutes. The same thing was also found by Sumardi et al. (2015) who found that the incidence of hypotension as a result of the administration of spinal anesthesia occurred at the time of the third minute with a decrease of 20% of the initial blood pressure. This decrease in blood pressure must be anticipated by anesthesiologists, including anesthesiologist. Supported by research conducted by Nurjanah et al. (2023) entitled "Hemodynamic Overview of Sectio Caesarea Patients With Spinal Anesthesia at Rsi Banjarnegara" which shows that there are changes in the patient's hemodynamic state since the first 5 minutes after spinal anesthesia injection. Especially the 10th minute after spinal injection.

This study shows that there are other factors that can affect the occurrence of hypotension during spinal anesthesia, in accordance with the following statement Winarno & Sutiyono (2009) that spinal anesthesia techniques are influenced by various factors so that research results may vary. Tanambel et al. (2017) concluded that blood pressure remains within normal limits after spinal anesthesia in sectio caesarea patients. Rustini et al. (2016) also found that the incidence of hypotension in sectio caesarea patients with spinal anesthesia reached 49%, which was influenced by the administration of preloding fluid before anesthesia. Eka Yuni Astuti (2021) confirmed that fluid preloading reduces the risk of hypotension by 20%. Hypotension that occurs during spinal anesthesia is caused by sympathetic blockade resulting in vasodilation, decreased blood volume, and cardiac output, which results in a decrease in blood pressure (Rehatta et al., 2019). In addition, Widiyono et al. (2020) also mentioned that the reduction in blood pressure is affected by the patient's age. Liguori (2004) explained that the incidence of hypotension in spinal anesthesia reaches 8-33% due to sympathetic blockade. This complication can reduce blood flow and cause hypoxia if left untreated. Preventive measures include the administration of crystalloid fluids and vaso precursors such as ephedrine (Sukmaningtyas et al., n.d.).

Before spinal anesthesia, 10.9% of patients had tachycardia, which decreased after anesthesia, but slightly increased again by the 20th minute, presumably as a compensatory response to hypotension. Most patients maintained a normal pulse throughout the observation, although bradycardia remained minimal (Price & Wilson, 2006). Research Saputra & Tahir (2018) found that spinal anesthesia at T4 can cause a decrease in pulse frequency and blood pressure due to sympathetic block. Oxygen saturation remained stable in most patients, although there were slight cases of hypoxia at the 10th minute, which recovered at the 15th and 20th minutes, suggesting that spinal anesthesia had no significant impact on the oxygenation status of patients (Monim).

b. Average Value

Blood pressure was measured in 147 subjects before spinal anesthesia injection with the results of a minimum value of 1.00, a maximum value of 2.00, a mean of 1.8095, and a standard deviation of 0.39402. These values indicate that most patients had blood pressure in the normal to slightly elevated range before administration of spinal anesthesia. At the 5th minute after injection, blood pressure measurements showed an increase with a minimum value of 1.00, a maximum value of 3.00, a mean of 2.0680, and a standard deviation of 0.51895. This increase may be due to the body's initial reaction to the anesthetic injection, which may cause blood pressure fluctuations in response to the decrease in systemic vascular resistance induced by spinal anesthesia. At the 10th minute after injection, the mean blood pressure increased further to 2.2245 with a standard deviation of 0.53374. This indicated a further decrease in vascular resistance and redistribution of blood flow due to sympathetic blockade induced by spinal anesthesia. At the 15th minute after injection, the mean blood pressure decreased slightly to 1.9932 with a standard deviation of 0.41375. This decrease indicates that the body is beginning to adapt to the effects of anesthesia, and some compensatory mechanisms may begin to work to stabilize blood pressure. At the 20th minute after injection, the mean blood pressure reached 1.9456 with a standard deviation of 0.25595. This stability indicates that although there were initial fluctuations, the patient's blood pressure gradually returned to a more stable state over time.

The pulse before injection in 147 subjects showed a minimum value of 1.00, a maximum value of 3.00, a mean of 1.9252, and a standard deviation of 0.28880. These values indicate that most patients had a pulse within the normal range before spinal anesthesia injection. At the 5th minute after injection, the mean pulse increased slightly to 1.9932 with a standard deviation of 0.24819. This increase may be the initial response of the cardiovascular system to the spinal anesthetic injection, which may cause an increase in pulse rate to compensate for the decrease in systemic vascular resistance. At the 10th minute after injection, the mean pulse remained almost the same at 1.9864 with a standard deviation of 0.23368. This stability indicates that after the initial response, the cardiovascular system begins to adjust to the new conditions induced by spinal anesthesia. At the 15th minute after injection, the mean pulse slightly decreased to 1.9524 with a standard deviation of 0.29455. This decrease could be due to further adaptation of the body to the effects of anesthesia, where sympathetic activity is reduced and the pulse rate decreases to achieve homeostasis.

Oxygen saturation before injection in 147 subjects showed a minimum value of 1.00, a maximum value of 2.00, a mean of 1.0068, and a standard deviation of 0.08248. These values indicate that most patients had oxygen saturation within the normal range before administration of spinal anesthesia. At the 5th minute after injection, oxygen saturation showed consistency with minimum and maximum values of 1.00, mean 1.0000, and standard deviation 0.00000. This consistency indicates that spinal anesthesia has no direct impact on the patient's oxygen saturation immediately after injection. At 10 minutes after injection, oxygen saturation increased slightly with a minimum value of 1.00, a maximum value of 2.00, a mean of 1.0136, and a standard deviation of 0.11624. This small increase indicates a slight individual variation in response to anesthesia, but in general, oxygen saturation remained within the normal range. At the 15th and 20th minutes after injection, oxygen saturation remained constant with a minimum and maximum value of 1.00, a mean of 1.0000, and a standard deviation of 0.00000. This stability indicates that the patient continued to maintain good oxygen saturation throughout the observation period, indicating that spinal anesthesia did not interfere with the patient's respiratory function.

4. Conclusion

Based on the results of research at the Central Surgical Installation of RSUD Dr. Soedirman Kebumen, it was concluded that before spinal anesthesia, most patients had normal blood pressure, with a few having hypertension. After 5 minutes post-anesthesia, most patients still showed normal blood pressure, although there was an increase in hypotension cases. At 10 minutes, patients with hypotension increased, but other parameters such as pulse, oxygen saturation, and body temperature remained stable. By the 15th minute, most patients had normal blood pressure again, while by the 20th minute, most patients showed good hemodynamic stability. The mean blood pressure of the patients changed after injection, with an increase at the 5th and 10th minutes, followed by a decrease at the 15th and 20th minutes. However, oxygen saturation remained stable throughout. This study provides suggestions for hospitals to improve the quality of spinal anesthesia services, including better hemodynamic monitoring. Universities are expected to update the curriculum on spinal anesthesia, while further research is recommended to explore additional factors that may influence hypotension. This study is also useful for the community as a source of information regarding spinal anesthesia procedures.

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