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Description of The Hemodynamic Condition in Patients with Subarachnoid Block

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ABSTRACT
Background: Subarachnoid block (SAB) anesthesia is widely used in surgical procedures and may cause hemodynamic changes that require close monitoring. This study aimed to describe the hemodynamic condition in patients undergoing subarachnoid block anesthesia.
Methods: This study employed a descriptive quantitative design with a cross-sectional observational approach using repeated measurements. A total of 265 respondents were selected using purposive sampling. Data were collected using observation sheets to assess hemodynamic parameters, including systolic and diastolic blood pressure, mean arterial pressure (MAP), heart rate, and oxygen saturation (SpO_2). Measurements were recorded before SAB and at 5, 10, 15, 20, 25, and 30 minutes after anesthesia. Data were analyzed using univariate analysis and presented as frequency distributions.
Result: The results showed that most respondents were male (52.1%), and the most common type of surgery was sectio caesarea (20.4%). The majority of SAB injections were performed at the L3–L4 level (56.2%). Hemodynamic changes were observed, with a decrease in systolic and diastolic blood pressure and MAP at 5–10 minutes after SAB, followed by stabilization within normal ranges at 15–30 minutes. Heart rate remained mostly within normal limits, while oxygen saturation (SpO_2) was stable at 95–100% in all respondents throughout the observation period.
Conclusion: In conclusion, subarachnoid block anesthesia causes transient hemodynamic changes, particularly in the early phase after administration, but these parameters tend to stabilize over time. Continuous monitoring is essential, especially within the first 10 minutes, to prevent potential complications.

Keywords: Subarachnoid Block, Hemodynamic Changes, Blood Pressure, Mean Arterial Pressure, Heart Rate, Oxygen Saturation.

INTRODUCTION

Hemodynamics is a circulation picture that describes the work function of a vital human organ, namely the function of the lungs and heart (Sirait, 2016). Hemodynamic changes can occur in patients undergoing surgery using spinal anesthesia techniques (Sirait & Yuda, 2019). This occurs due to the vasodilation of blood vessels and blocked sympathetic nerves, thereby dominating the performance of the parasympathetic nerves (Kurniadita et al., 2021). The hemodynamic condition greatly influences the oxygen-conducting function in the body and involves heart function (Alivian, 2018). Low hemodynamics can cause hypotension, which results in decreased blood supply to the tissues; oxygen and nutrients are not delivered, and ultimately there can be a decrease in the body's metabolism. On the other hand, if hemodynamics are too high, it will result in high blood pressure (Gustomi & Qomariyah, 2018). This increase or decrease in pressure affects the body's homeostasis. In addition, hypotension in surgical patients with spinal anesthesia results in heavier heart work. If this incident continues, hypoxia can occur so that blood flow to all tissues is reduced (Ansyori & Rihiantoro, 2016)

Hemodynamic instability after spinal anesthesia ranges from around 8 to 33% (Gebrargs et al., 2021). There were differences in hemodynamic status in patients before and during the first 15 minutes of spinal anesthesia (Saputra, 2018). In their research, Terkawi et al., (2015) also stated that one of the side effects that often occurs in spinal anesthesia is hypotension in around 40% of non-obstetric patients and 80% of obstetric patients. Meanwhile, the pulse frequency decreased by around 10% from baseline (Ristiyadi, 2022). The incidence of hypotension in SC patients with spinal anesthesia was seen in research by Tanambel et al., (2017) where as many as 18.18% experienced a decrease in systolic blood pressure (TDS) and 11.11% experienced a decrease in diastolic blood pressure (TDD). Based on research by Rustini et al., (2016), 49% of caesarean section patients with spinal anesthesia experienced hypotension. The picture of unstable vital signs is an indication of increased or decreased tissue perfusion conditions and failure of the heart to contract (Alivian, 2018). This results in an increase in respiratory frequency and a decrease in blood oxygen pressure

The cardiovascular effects due to spinal anesthesia are closely related to the level of sympathetic blockade, which reaches the innervation at thoracic level 1 to lumbar level 2 (T1-L2). Sympathetic blockade due to spinal anesthesia causes dilation of blood vessels, thereby reducing systemic vascular resistance, which will cause hypotension. The higher the spinal blockade, the more the compensatory mechanism due to sympathetic inhibition will be suppressed. Blockade of preganglionic sympathetic nerve fibers causes venous vasodilation, resulting in a shift in blood volume, especially to the splanchnic region and also the lower extremities, thereby reducing blood flow back to the heart (Ma'ruf & Hafiduddin, 2022). Apart from that, lung function is also affected by the administration of spinal anesthesia, namely changes in oxygen saturation after 5 minutes of spinal anesthesia with an average oxygen saturation of 98% (Apriliawati, 2014). Meanwhile, according to research by Indriani et al., (2022), hypotension and bradycardia occurred after 5 minutes of spinal anesthesia with an average systolic blood pressure of 89.28 mmHg, diastolic 59.35 mmHg, and pulse 59.53 times/minute. Based on the description above, hemodynamic changes still occur in patients undergoing surgery under spinal anesthesia and can have a negative impact on the patient's body. Therefore, this study aims to provide a comprehensive description of the hemodynamic condition in patients undergoing subarachnoid block anesthesia.

METHODS

This study employed a descriptive quantitative research design with a cross-sectional observational approach using repeated measurements of hemodynamic parameters over time. The study was conducted in the operating room unit (IBS) of Wangaya Hospital, Denpasar City. The population consisted of all patients who underwent surgery using subarachnoid block (SAB) anesthesia during the study period. The sample size was determined using the Slovin formula with a 5% margin of error, resulting in a total of 265 respondents. A non-probability sampling technique with a purposive sampling method was used to select participants based on predetermined criteria. The inclusion criteria were: (1) patients undergoing surgery with subarachnoid block anesthesia, (2) patients aged ≥18 years, and (3) patients who provided informed consent. The exclusion criteria were: (1) patients with incomplete hemodynamic data, (2) patients with pre-existing severe cardiovascular instability, and (3) patients receiving additional anesthesia techniques that could affect hemodynamic responses

Data were collected using an observation sheet completed directly by the researcher. Hemodynamic parameters observed included systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), heart rate, and oxygen saturation (SpO_2). Measurements were recorded at baseline (before SAB) and at 5, 10, 15, 20, 25, and 30 minutes after the administration of subarachnoid block anesthesia. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Univariate analysis was conducted to describe the distribution of each hemodynamic parameter at each observation time point. The results were presented in the form of frequency distributions and percentages to provide a comprehensive description of hemodynamic changes in patients undergoing subarachnoid block anesthesia. Ethical approval was obtained from the institutional ethics committee, and all respondents provided informed consent prior to participation.

RESULTS

Table 1. Respondent Characteristics

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
17-25	37	14
26-35	61	23
36-45	54	20.4
46-55	62	23.4
56-65	51	19.2
Gender		
Man	138	52.1
Woman	127	47.9
Types of Surgery		
TUR-P	27	10.2
URS	47	17.7
Herniotomy	23	8.7
Hemorrhoidectomy	19	7.2
Appendiktomy	49	18.5
SC	54	20.4
TAH BSO	14	5.3
ORIF	32	12.1
Injection Level		
L2-L3	33	12.5
L3-L4	149	56.2
L4-L5	83	31.3

Based on Table 1, it shows that in terms of age characteristics, the majority of respondents were aged 46–55 years, for a total of 62 people (23.4%). The gender characteristics show that the majority of respondents were men, with a total of 138 people (52.1%). The characteristics of the type of surgery show that SC procedures were performed more frequently among respondents, with a total of 54 people (20.4%). The injection level for subarachnoid block procedures is mostly done at L3–L4.

Table 2. Systolic Blood Pressure in Patients who underwent SAB.

Systolic Blood Pressure	Frequency (n)	Percentage (%)
Before SAB		
100-130 mmHg	114	43
>130 mmHg	151	57
5 minutes after SAB		
<100 mmHg	85	32.1
100-130 mmHg	180	67.9
Minute 10		
<100 mmHg	114	43
100-130 mmHg	151	57
Minute 15		
<100 mmHg	48	18.1
100-130 mmHg	217	81.9
Minute 20		
<100 mmHg	17	6.4
100-130 mmHg	248	93.6
Minute 25		
<100 mmHg	12	4.5
100-130 mmHg	253	95.5
Minute 30		
100-130 mmHg	265	100

Based on Table 2, before the subarachnoid block was performed, the majority of respondents had systolic blood pressure >130 mmHg. Most of them found a decrease in the 5th and 10th minutes. Meanwhile, at 15–30 minutes, the majority of respondents had normal systolic blood pressure (100–130 mmHg). Only a few were found to have a systolic blood pressure <100 mmHg.

Table 3. Diastolic Blood Pressure in Patients who Underwent SAB.

Systolic Blood Pressure	**Frequency (n)**	**Percentage (%)**
Before SAB		
80-90 mmHg	114	43
>90 mmHg	151	57
5 minutes after SAB		
<80 mmHg	85	32.1
80-90 mmHg	180	67.9
Minute 10		
<80 mmHg	114	43
80-90 mmHg	151	57
Minute 15		
<80 mmHg	48	18.1
80-90 mmHg	217	81.9
Minute 20		
<80 mmHg	17	6.4
80-90 mmHg	248	93.6
Minute 25		
<80 mmHg	12	4.5
80-90 mmHg	253	95.5
Minute 30		
80-90 mmHg	265	100

Based on table 3, before subarachnoid block was performed, the majority of respondents had diastolic blood pressure >90 mmHg. Most of them found a decrease in the 5th and 10th minutes. Meanwhile, at 15-30 minutes, the majority of respondents had normal diastolic blood pressure (80-90 mmHg). Only a few were found to have diastolic blood pressure <80 mmHg.

Table 4. MAP in patients undergoing SAB

MAP	**Frequency (n)**	**Percentage (%)**
Before SAB		
70-105 mmHg	114	43
>105 mmHg	151	57
5 minutes after SAB		
<70 mmHg	85	32.1
70-105 mmHg	180	67.9
Minute 10		
<70 mmHg	114	43
70-105 mmHg	151	57
Minute 15		
<70 mmHg	48	18.1
70-105 mmHg	217	81.9

Minute 20		
<70 mmHg	17	6.4
70-105 mmHg	248	93.6
Minute 25		
<70 mmHg	12	4.5
70-105 mmHg	253	95.5
Minute 30		
70-105 mmHg	265	100

Based on Table 4, before the subarachnoid block was performed, the majority of respondents had a MAP >105 mmHg. Most of them found a decrease in the 5th and 10th minutes. Meanwhile, at 15-30 minutes, the majority of respondents had normal MAP (70-105 mmHg). Only a few were found to have MAP <70 mmHg.

Table 5. Pulse in Patients who Underwent SAB.

Pulse	**Frequency (n)**	**Percentage (%)**
Before SAB		
60-100x/menit	181	68.3
>100x/menit	84	31.7
5 minutes after SAB		
<60x/menit	26	9.8
60-100x/menit	239	90.2
Minute 10		
<60x/menit	3	1.1
60-100x/menit	262	98.9
Minute 15		
<60x/menit	5	1.9
60-100x/menit	260	98.1
Minute 20		
60-100x/menit	265	100
Minute 25		
60-100x/menit	265	100
Minute 30		
60-100x/menit	265	100

Based on Table 5, the pulse rate in respondents before the subarachnoid block was carried out until 30 minutes after the subarachnoid block was carried out was mostly in the normal range (60-100x/minute). There were only a few who experienced a decrease in the 5-15th minute with results <60x/minute

Table 6. SpO2 in patients undergoing SAB.

SpO2	**Frequency (n)**	**Percentage (%)**
Before SAB		
95-100%	265	100
5 minutes after SAB		
95-100%	265	100
Minute 10		
95-100%	265	100
Minute 15		
95-100%	265	100
Minute 20		
95-100%	265	100
Minute 25		

95-100%	265	100
Menit 30		
95-100%	265	100

Based on table 6 on SpO2 with a total of 265 respondents before the subarachnoid block was carried out until the 30th minute after the subarachnoid block was carried out, SpO2 was found to be 95-100% for 265 respondents (100%).

DISCUSSION

In terms of characteristics, the majority of respondents are in the early elderly category. Age is one of the factors causing hypotension in patients undergoing subarachnoid block. The older you get, the less energy you produce, so the muscle's ability to contract, including the heart muscle, decreases (Nurbudiman 2020). The gender characteristics show that the majority of respondents are men. In general, an adult man has a stronger mental attitude towards things that threaten him compared to women (Ii &Ops, 2014). Regarding the characteristics of the type of surgery, the majority of respondents were patients who underwent SC procedures. This occurred due to blockage of impulse conduction from the sympathetic nerves, which was characterized by vasodilation and a decrease in heart rate, accompanied by suppression of the inferior vena cava and loss of tone during the caesarean section. Meanwhile, the injection level characteristics show that the majority are carried out at L3–L4. Anesthesia that successfully blocks certain sympathetic nerves causes extensive vasodilation and, of course, hemodynamic changes (Kurniadita et al., 2021)

The research results found that before SAB was carried out, the majority of respondents experienced high blood pressure and MAP. Most of the decrease occurs in the 5th and 10th minutes. Sympathetic blockade due to spinal anesthesia causes blood vessel dilation, thereby reducing systemic vascular resistance, which will cause hypotension. The higher the spinal blockade, the more the compensatory mechanism due to sympathetic inhibition will be suppressed. Blockade of preganglionic sympathetic nerve fibers causes venous vasodilation, resulting in a shift in blood volume, especially to the splanchnic region and also the lower extremities, thereby reducing blood flow back to the heart (Ma'ruf & Hafiduddin, 2022). Hemodynamic changes after subarachnoid block occur in the early minutes because the time required for the anesthetic drug to cause a certain level of nerve blockade is 5–10 minutes. Subarachnoid block triggers a decrease in systemic vascular resistance (SVR) and/or cardiac output, often causing hypotension. At 15–30 minutes, the majority of respondents had normal blood pressure and MAP. Only a few were found to have hypotension. This is due to the administration of drugs to overcome hemodynamic changes. Vasopressors are drugs used to treat spinal anesthesia and hypotension. Currently, ephedrine is the first-line standard for treating hypotension in anesthesia cases because it is safe to use, easy to obtain, and often used by anesthetists. The effect of ephedrine is not only to increase muscle contractility, beats, and cardiac output through β1 receptors, but peripheral vasoconstriction and increased blood pressure also occur through activation of α receptors (Sumardi et al., 2015). There is a similarity in the time of change between changes in systolic and diastolic blood pressure and changes in MAP because of the interrelationship of these two parameters. This is because the calculation of the MAP number comes from the sum of systolic and diastolic blood pressure.

Regarding pulse, the research results found that before the SAB was carried out, the majority of respondents' pulse was in the normal range. In the 5th minute after SAB, several respondents were found to experience bradycardia. The mechanism of blood pressure and pulse in the occurrence of anesthetic effects can be explained when there is a decrease in vascular resistance caused by sympathetic block, which in turn causes vasodilation and ultimately causes a decrease in arterial pressure. During excessive parasympathetic activity, activation of the Bezold-Jarisch reflex (BJR) and increased baroreceptor activity can cause hypotension and bradycardia (Ristiyadi, 2022). Most of the patients who underwent SAB did not experience a decrease in pulse or had a normal pulse at 10–30 minutes. Only a few were found to have bradycardia. This is due to the administration of crystalloid fluid coloading during surgery, which is known to maintain a normal pulse. Crystalloid fluid coloading is given to prevent all complications resulting from the induction of spinal anesthesia, including hypotension, bradycardia, nausea and vomiting, agitation, shivering, pallor, respiratory depression, and decreased consciousness (Atashkhoei et al., 2018).

SpO2 before SAB until 30 minutes after SAB is in the normal range. The frequency of SpO2 in patients undergoing subarachnoid block can vary depending on several factors, namely the patient's previous condition, the dose of anesthetic drug given, oxygen monitoring carried out, and the patient's individual response to the procedure. Continuous SpO2 monitoring is carried out to ensure that patients maintain adequate oxygen saturation levels (Mutukwa & Gonah, 2016). In addition, administering anesthetic drugs into the subarachnoid space can affect the respiratory and circulatory systems, which in turn can affect oxygen saturation. Such as hypotension, which causes the blood supply to the tissues to decrease, then oxygen and nutrients are not delivered, and ultimately there can be a decrease in the body's metabolism.

CONCLUSION

This study concludes that the hemodynamic condition of patients undergoing subarachnoid block (SAB) anesthesia shows dynamic changes, particularly in the early phase after anesthesia administration. A decrease in systolic blood pressure, diastolic blood pressure, and mean arterial pressure (MAP) was observed within the first 5–10 minutes following SAB, indicating an initial hypotensive response. However, these parameters gradually returned to normal ranges between 15 and 30 minutes after anesthesia. Heart rate remained relatively stable, with most patients maintaining values within the normal range throughout the observation period, although a slight decrease was observed in a small proportion of patients during the early minutes. Oxygen saturation (SpO_2) remained stable and within normal limits (95–100%) in all patients from baseline until 30 minutes after SAB. Overall, subarachnoid block anesthesia causes transient hemodynamic changes, particularly a temporary decrease in blood pressure during the early phase, but tends to stabilize over time. These findings highlight the importance of close hemodynamic monitoring, especially within the first 10 minutes after SAB administration, to prevent potential complications.

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