

Efficacy of Anesthesia for Cesarean Section in Pregnant Women with Community-Acquired Pneumonia and First-Degree Respiratory Failure

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Abstract This study investigates the optimization of anaesthesia strategies for pregnant women with community-acquired pneumonia (CAP) and first-degree respiratory failure undergoing abdominal delivery. Three subgroups were analyzed based on the anesthetic technique: spinal anaesthesia (SA), epidural anaesthesia (EA), and balanced epidural anaesthesia (BEA), all combined with non-invasive ventilation. The study assessed the efficacy of anaesthesia through clinical signs, hemodynamic, stress indices, and the degree of sensory and motor blockade. Results indicated that SA was associated with a more pronounced decrease in blood pressure and a higher level of segmental blockade, while BEA provided a more stable hemodynamic profile with a pronounced sedative effect. The study also revealed that initial preoperative values of central and peripheral hemodynamic were within the hypokinetic mode of blood circulation. The SA subgroup experienced more pronounced hemodynamic disturbances, especially before skin incision and during the most traumatic stages of the operation. The BEA subgroup showed minimal hemodynamic disturbances and better stability in hemodynamic parameters throughout the operation. The findings underscore the importance of careful selection and monitoring of anaesthesia techniques in this patient population to ensure optimal outcomes.

Keywords Anaesthesia, Caesarean Section, Community-Acquired Pneumonia, Pregnant Women, Respiratory Failure, Spinal Anaesthesia, Epidural Anaesthesia, Balanced Epidural Anaesthesia, Non-Invasive Ventilation

1. Introduction

Pneumonia has been a significant public health concern for over a century, with its incidence and mortality rates showing a marked decrease since the early 20th century due to advances in medical science and public health measures. However, the World Health Organization (WHO) highlights that pneumonia continues to be a pressing issue, particularly among vulnerable populations, including pregnant women [1-4].

Pregnancy is a unique physiological state that increases susceptibility to viral respiratory infections due to alterations in the immune and cardiovascular systems [5-10]. These changes can lead to a higher likelihood of developing severe respiratory viral infections in pregnant women [11,12]. The 2019-2021 pandemic of the novel coronavirus (COVID-19) brought this vulnerability into sharp focus, as the incidence of COVID-19 in pregnant women was higher than that in the general population. Pregnant women infected with SARS-CoV-2, the virus responsible for COVID-19, are at

an increased risk of severe disease progression. Numerous studies have reported adverse pregnancy outcomes in COVID-19 patients, with mortality rates among pregnant women infected with SARS-CoV-2 reported to be as high as 25% [13,12].

The progression of acute respiratory failure (ARF) in pregnant women with community-acquired pneumonia further complicates the clinical picture. ARF is characterized by pronounced functional disorders of the respiratory system and impaired gas exchange, which negatively impact both the respiratory and cardiovascular systems. The primary cause of ARF in pregnant women with community-acquired pneumonia is often related to ventilation-perfusion mismatches, continued blood flow in non-ventilated lung areas due to infiltration, and compression of the diaphragm by the pregnant uterus.

Anesthesiological support for abdominal and vaginal delivery in pregnant women with community-acquired pneumonia presents a significant challenge in modern anesthesiology and obstetrics. This challenge is particularly acute in labouring women with severe forms of community-acquired pneumonia accompanied by respiratory failure. Additionally, complications arising from circulatory failure and severe extragenital

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diseases further complicate the situation. These women require an individualized approach to anaesthesia care, with the primary goal being the safety of delivery and the stability of essential life support systems throughout labor and the immediate postpartum (or postoperative) period. A comprehensive prenatal assessment of the degree of respiratory insufficiency and the severity of community-acquired pneumonia is crucial for the successful management of these cases.

Addressing the complex interplay of factors that contribute to the increased risk of pneumonia in pregnant women requires a multidisciplinary approach. This includes not only advancements in medical treatment and anesthesiological techniques but also a focus on preventive measures, early detection, and tailored management strategies to ensure the health and safety of both the mother and the fetus.

The primary aim of this study is to optimize anesthetic strategies for pregnant women with community-acquired pneumonia (CAP) and first-degree respiratory failure undergoing abdominal delivery. This involves developing an evidence-based approach to anaesthesia that minimizes risks, enhances maternal and fetal outcomes, and ensures the stability of vital functions throughout the perioperative period.

2. Materials and Methods

This prospective study aimed to evaluate the efficacy of different anesthetic techniques in pregnant women with CAP and first-degree respiratory failure undergoing abdominal delivery. The study was conducted from 2018 to 2023 and included 86 pregnant women with a mean age range of 21 to 45 years and a gestational age of 32-41 weeks. All patients were admitted for emergency or planned abdominal delivery, with the timing and method of delivery determined individually based on the clinical condition of the women, gestational age, and fetal condition.

The participants were treated at the obstetric department of the multidisciplinary clinic of Samarkand State Medical University (SamSMU), the regional perinatal center, and the city maternity complex №3 of Samarkand. The choice of anesthetic method during surgical delivery was made with careful consideration of the severity of CAP and the degree of respiratory failure. The patients were divided into three subgroups based on the anesthetic technique used:

First Subgroup (n=34): Women who underwent spinal anaesthesia (SA) and non-invasive ventilation (NIV) with positive end-expiratory pressure (PEEP) and a fractional inspired oxygen (FiO₂) of 60-100%.

Second Subgroup (n=28): Women who underwent epidural anaesthesia (EA) and NIV with positive PEEP and FiO₂ of 60-100%.

Third Subgroup (n=24): Women who underwent balanced epidural anaesthesia (BEA) and NIV with positive PEEP and FiO₂ of 60-100%.

Blood loss during abdominal delivery ranged from approximately 350 mL to 800 mL. The study adhered to the National Clinical Protocol "Management and Delivery of Pregnant Women with Pneumonia" (2021) approved by the Ministry of Health of the Republic of Uzbekistan and intensive care protocols for COVID-19. The anesthetic tactics for pregnant women with increasing signs of respiratory failure were individualized and determined by a consilium of physicians. The choice of combined anaesthesia with NIV and positive PEEP was based on continuous monitoring of maternal SpO₂ ($\geq 94\%$) and fetal condition (cardiotocography) in the absence of contraindications to central neuraxial blockade (CNB).

The efficacy of anesthesia was assessed based on clinical signs, hemodynamics, stress indices, and the degree of sensory and motor blockade. Hemodynamic parameters were studied using echocardiography and monitored with a Scillar monitor. The stress index (SI) was evaluated using mathematical analysis of heart rhythm, total cortisol levels in blood plasma, and the rate of excretion of noradrenaline in urine. The study was conducted in four stages: on the operating table, before the skin incision, during the traumatic stage of the operation, and at the end of the operation.

All numerical values obtained during the study were processed using the method of variation statistics. The statistical analysis was performed using Student's t-test with the assistance of the Microsoft Excel program. The results are presented as the mean (M) \pm standard error (m), where M represents the arithmetic mean and m represents the standard error of the mean.

Differences between groups and within groups at different stages of the study were considered statistically significant at a p-value of less than 0.05 ($P < 0.05$). The statistical analysis aimed to evaluate the differences in hemodynamic parameters, stress indices, and other relevant measures across the different subgroups and at various stages of the study.

3. Results

Clinical Course of Anesthesia

The clinical course of SA with 0.5% hyperbaric bupivacaine solution and NIV in CPAP mode was observed in pregnant women with CAP and first-degree respiratory failure. The classical signs of complete segmental sensory-motor blockade were formed within 8-10 minutes post-administration, with the level of distribution reaching beyond T6-T7 dermatomes to T4-T5. This elevated distribution level was attributed to the increased intra-abdominal pressure from the pregnant uterus, dyspnea, and respiratory insufficiency. An early and pronounced decrease in BP was noted, necessitating vasopressor support in some cases. However, the timely administration of minimal doses of mesaton allowed for rapid stabilization of arterial hypotension.

The clinical course of EA with 0.5% bupivacaine solution was similar in terms of the time required for the development of

complete segmental sensory-motor blockade and its level of distribution. However, the degree of BP decrease at the time of EA surgical stage development was more pronounced, requiring intraoperative vasopressor support in some cases. Despite this, BP remained stable throughout the subsequent stages of surgery, with no further correction needed. Postoperative epidural analgesia provided adequate pain relief, early activation, and rapid recovery of motor function and gastrointestinal tract evacuation.

BEA with 0.375% bupivacaine solution and continuous infusion of propofol or dexmedetomidine resulted in a pronounced sedative effect within 8-10 minutes post-administration. Clinical signs of segmental sensory-motor blockade began to form, reaching their maximum by the 15th minute, with the surgical stage lasting 1.5-2.0 hours. The administration of sedatives induced drowsiness, indifference to surroundings, and good adaptation to NIV. Blood pressure remained stable throughout the operation, with a slight decrease in heart rate observed. No clinical signs of hypoxia or hypercapnia were detected. At the end of the operation, all patients were alert, responsive, and free from pain for 5-6 hours.

In summary, the clinical course of anesthesia in pregnant women with CAP and first-degree respiratory failure varied depending on the type of anesthesia used. SA was associated with a more pronounced decrease in BP and a higher level of segmental blockade, while BEA provided a more stable hemodynamic profile with a pronounced sedative effect.

Hemodynamic and Peripheral Circulation Parameters

The study revealed that the initial preoperative values characterizing central and peripheral hemodynamics in all

three subgroups were within the hypokinetic mode of blood circulation (table 1). This was characterized by moderately pronounced tachycardia, decreased single and minute cardiac output, elevated mean dynamic pressure (MDP) and total peripheral vascular resistance (TPR), and reduced minute diuresis, fitting into the concept of "oliguria."

Before skin incision, at the height of the complete segmental sensorimotor and sympathetic block, there was a significant decrease in MDP and TPR in all subgroups, most pronounced in the SA subgroup. The heart rate (HR) significantly decreased in this stage, with the most pronounced changes observed in the SA subgroup. The cardiac index (CI) did not change significantly in the EA and BEA subgroups relative to the initial preoperative values, while in the SA subgroup, it decreased to 84% of the initial preoperative values. This pronounced decrease in cardiac output, with an unchanged stroke index (SI), could be attributed to a sharp decrease in HR due to a pronounced segmental sympathetic blockade. Correspondingly, minute diuresis decreased sharply in the SA subgroup, indirectly characterizing the aggravation of peripheral blood circulation disturbance.

During the most traumatic stages of the operation, no significant differences in the studied hemodynamic parameters were registered in all three subgroups relative to the previous stage. However, the most significant shifts were observed in the SA subgroup. Minimal hemodynamic disturbances were noted in the BEA subgroup when balanced EA with reduced concentrations of local anesthetics was used. The further decrease in minute diuresis in the SA subgroup at this stage indirectly indicated further deterioration of peripheral blood circulation.

Table 1. Some indicators of hemodynamics and peripheral circulation at the stages of anesthesia and surgery in women with community-acquired pneumonia with first-degree ARF of 1,2,3 subgroups

Stages of the study	Gr	Studied parameters					
		HR, beats/min	MDP, mmHg.	SI, mL/m ²	CI, L/m ² /min	TPR, dyn/sxcm ⁵	Minute diuresis, mL/min
On the operating table	1	87,5±2,3	94,8±1,6	27,9±1,8	2,43±0,06	1642,2±48,1	0,59±0,03
	2	88,8±2,1	93,2±1,4	27,1±1,9	2,4±0,09	1634,6±54,3	0,57±0,02
	3	89,6±1,9	94,5±1,3	26,8±2,1	2,41±0,07	1658,2±50,8	0,54±0,02
Before the skin incision	1	72,2±1,1*Δ	70,4±1,4*Δ●	28,2±1,6	2,04±0,04*●Δ	1452,6±50,3 *	0,36±0,02 *●Δ
	2	80,6±1,3*	80,6±2,1*●□	27,6±1,6	2,29±0,06 ●	1476,3±39,6 *	0,52±0,03 ●
	3	83,2±2,1*	86,6±2,1*□	27,8±1,8	2,38±0,09	1486,2±44,3 *	0,51±0,02
Traumatic stage	1	74,8±1,2*Δ	72,8±2,1*Δ●	26,4±1,1	1,97±0,02*●Δ	1555,1±48,4	0,29±0,02 *□●Δ
	2	83,2±1,4*	78,2±1,8*Δ	26,9±1,4	2,27±0,03 93,3 ●Δ	1459,5±42,3 *	0,49±0,02 *●
	3	84,6±1,2*	90,1±2,2	27,3±1,6	2,36±0,04 97,9	1581,2±44,2	0,47±0,02 *
End of surgery	1	72,4±3,1*Δ	70,6±1,3*Δ	27,4±1,5	1,99±0,03 81,9*●Δ	1493,4±51,6 *	0,34±0,02 *●Δ
	2	80,4±1,8*	76,6±2,2*Δ	27,8±1,6	2,28±0,09 95 ●	1416,7±46,3 *	0,56±0,04 □●
	3	80,9±1,9*	85,7±1,8*	28,8±1,4	2,36±0,08 97,9	1480,7±51,4 *	0,59±0,06 □

Note: * - statistically significant relative (p<0.05) to baseline values; □ - statistically significant (p<0.05) relative to the previous stage of the study; ● - statistically significant differences (p<0.05) between subgroups 1 and 2; Δ - statistically significant differences (p<0.05) compared with subgroup 3.

Table 2. Some indicators of ABB, blood gas composition, and SpO₂ at the stages of anesthesia and surgery in women with community-acquired pneumonia with first-degree ARF in 1,2,3 subgroups

Studied parameters	Gr	Stages of the study			
		On the operating table	Before the skin incision	Traumatic stage	End of surgery
RR, per min	1	24,2±0,6	20,8±0,4 *	21,6±0,3 *	21,4±0,4 *
	2	24,8±0,5	21,6±0,4 *	22,2±0,3 *	21,6±0,3 *
	3	23,9±0,6	21,6±0,3 *	22,8±0,4	21,3±0,3 *
LV, mL/kg	1	4,52±0,21	4,56±0,22	4,42±0,21	5,12±0,24*□
	2	4,38±0,29	4,48±0,26	4,36±0,32	5,16±0,22●*□
	3	4,56±0,29	4,61±0,32	4,51±0,26	5,24±0,23*□
MV, mL/kg min	1	110,2±4,8	96,2±3,6 *	95,2±3,1 *	108,2±3,6 □
	2	109,6±4,2	98,7±3,2 *	96,8±3,3 *	111,8±3,4 □
	3	109,1±3,9	102,4±3,8	101,7±3,2	112,2±3,4 □
pH	1	7,33±0,014	7,32±0,011	7,32±0,012	7,34±0,011
	2	7,34±0,012	7,33±0,09	7,33±0,011	7,34±0,09
	3	7,34±0,013	7,33±0,012	7,33±0,012	7,35±0,011
pCO ₂ , mmHg	1	29,8±0,6	32,3±0,4 *	32,6±0,3 *	32,4±0,3 *
	2	30,4±0,6	32,6±0,6 *	32,4±0,4 *	32,6±0,4 *
	3	30,2±0,5	33,1±0,4 *	32,6±0,3 *	32,2±0,4 *
pO ₂ , mmHg	1	74,6±1,9	74,8±1,6	74,1±1,8	76,4±1,6
	2	74,5±1,6	74,6±1,6	74,9±1,9	75,8±1,6
	3	74,3±2,1	74,8±1,4	75,6±1,6	77,2±1,4
BC, mmol/L	1	-7,2±0,32	-7,8±0,34	-7,9±0,42	-7,4±0,32
	2	-7,6±0,41	-7,8±0,44	-7,6±0,34	-7,2±0,28
	3	-7,4±0,34	-7,6±0,32	-7,6±0,34	-7,2±0,28
SpO ₂ , %	1	92,9±1,3	92,6±1,1	93,2±0,9	93,8±1,2
	2	92,8±1,2	92,4±1,4	93,8±1,1	94,2±1,3
	3	92,6±1,4	92,4±1,2	93,6±0,9	94,6±1,2

Note: * - reliability of differences ($p<0.05$) in comparison with baseline values; □ - reliability of differences ($p<0.05$) in comparison with the previous stage of the study; Δ - reliability of differences in comparison with the 3rd subgroup; ● - reliability of differences ($p<0.05$) between the 1st and 2nd subgroups under study.

The end of the operation in all studied groups was accompanied by a tendency to normalize the studied hemodynamic parameters, although the hypodynamic mode of blood circulation was still preserved. In the EA and BEA subgroups, the hemodynamic parameters studied approached the initial preoperative values, and minute diuresis increased significantly. In the SA subgroup, the parameters were significantly different from those in the BEA subgroup, indicating better hemodynamic stability in the latter.

In summary, the data on the effects of the tested variants of CNB on some hemodynamic and peripheral circulation parameters indicate that the initial preoperative values were within the hypokinetic mode of blood circulation. The SA subgroup experienced more pronounced hemodynamic disturbances, especially before skin incision and during the most traumatic stages of the operation. The BEA subgroup showed minimal hemodynamic disturbances and better stability in hemodynamic parameters throughout the operation.

Respiratory Function and Gas Exchange

The study evaluated the impact of different variants of

CNB on respiratory function and gas exchange in pregnant women with CAP and first-degree respiratory failure. It was found that the tested CNB variants did not have a pronounced depressive effect on external respiration or gas exchange (table 2).

Adequate minute ventilation (MV) was maintained in all three subgroups (spinal anesthesia [SA], epidural anesthesia [EA], and balanced epidural anesthesia [BEA]) due to compensatory tachypnea. The respiratory rate (RR) increased slightly in all subgroups, maintaining oxygenation despite the presence of pneumonia and acute respiratory failure (ARF). This was associated with the increased intra-abdominal pressure caused by the pregnant uterus, leading to a high diaphragm standing and a decrease in the volume of the ventilated part of uninflamed lungs.

Lung volume (LV) did not change significantly before the skin incision in all three subgroups. However, at the end of the operation, there was a significant increase in LV and MV in all subgroups, with a tendency to increase partial pressure of oxygen (pO₂) and oxygen saturation (SpO₂). This improvement in respiratory parameters could be attributed

to the resolution of physiological changes post-delivery, normalization of intra-abdominal pressure, and continuous respiratory support with non-invasive ventilation (NIV) in continuous positive airway pressure (CPAP) mode with positive end-expiratory pressure (PEEP) and oxygen supply.

It should be noted that when using SA, there was a higher and more pronounced segmental-motor block, accompanied by partial blockade of the intercostal nerves (Th12-Th5). However, the use of reduced concentrations of bupivacaine in BEA was not associated with such a pronounced motor blockade, which could be explained by the normalization of external respiration function and gas exchange due to operative delivery and respiratory support with NIV in CPAP mode.

In conclusion, the CNB variants tested did not have a pronounced depressive effect on external respiration or gas exchange. Adequate oxygenation and ventilation were maintained throughout the operation, with an improvement in respiratory parameters observed at the end of the surgery.

Autonomic System Parameters

The study assessed the impact of different variants of CNB on parameters of the autonomic nervous system (ANS) in pregnant women with CAP and first-degree respiratory failure (table 3).

Stress Index (SI)

The initial preoperative values of the SI reflected a pronounced activation of the sympathetic part of the ANS due to acute respiratory failure and hypoxia. Right before the operation, a significant 27% decrease in SI was registered in women in the SA subgroup, indicating a significant decrease in sympathetic influences and the degree of tension of the heart rhythm regulatory systems. In the EA and balanced epidural anesthesia (BEA) subgroups, only a tendency to decrease in SI was observed, amounting to 209.3 ± 16.9 units and 218.4 ± 18.3 units, respectively.

Total Plasma Cortisol (TC)

Total plasma cortisol increased significantly in all

subgroups, reflecting an adequate protective response of the sympathoadrenal system to hemodynamic restructuring and decreased sympathetic influences. The increase was by 52.8% in the SA subgroup, 40.2% in the EA subgroup, and 44.3% in the BEA subgroup.

Noradrenaline (NA) Excretion

The rate of excretion of noradrenaline (NA) in urine increased significantly in all subgroups, indicating activation of the sympathoadrenal system. The values were 118 ± 11 nmol/L in the SA subgroup, 121 ± 13 nmol/L in the EA subgroup, and 124 ± 13 nmol/L in the BEA subgroup.

During the most traumatic stages of the operation, SI significantly increased relative to the initial preoperative values and the previous stage of the study in all subgroups. However, the studied parameters did not exceed the limits of "stress-norm," confirming the adequacy of anesthesia. At the end of the surgery, moderate tension in the cardiac rhythm regulatory system was observed, with SI significantly exceeding preoperative absolute values in all subgroups.

In conclusion, the CNB variants tested in this study influenced certain parameters of the autonomic system, with a significant decrease in SI observed in the SA subgroup and an increase in total plasma cortisol and noradrenaline excretion in all subgroups. These changes reflect the activation of the sympathoadrenal system in response to surgical trauma and hypoxia.

The clinical course of SA and its impact on hemodynamics, respiratory function, and autonomic system parameters in pregnant women with CAP and first-degree respiratory failure, as observed in the provided article, can be compared with data available in the literature [12,14].

The rapid onset of complete segmental sensory-motor blockade within 8-10 minutes and the level of distribution reaching T4-T5 dermatomes in the SA group aligns with the typical characteristics of spinal anesthesia in obstetric patients. This is consistent with the historical progression of spinal anesthesia for labor and delivery, which has evolved significantly since its first description in 1901 [11,4,15].

Table 3. Some indicators of the autonomic system at the stages of anesthesia and surgery in women with community-acquired pneumonia with first-degree ARF of 1,2,3 subgroups

Studied parameters	Group	Studied parameters			
		On the operating table	Before the skin incision	Traumatic stage	End of surgery
SI, con.units	1	$236,4 \pm 20,3$	$174,6 \pm 10,4$ * Δ	$312,8 \pm 16,3$ * $\square\Delta$	$328,4 \pm 19,4$ *
	2	$228,6 \pm 20,8$	$209,3 \pm 16,9$	$341,4 \pm 18,2$ * $\square\Delta$	$336,1 \pm 17,2$ *
	3	$235,9 \pm 23,6$	$218,4 \pm 18,3$	$392,4 \pm 19,6$ * \square	$346,4 \pm 19,8$ *
TC, nmol/L	1	$467,8 \pm 42,3$	$714,8 \pm 38,2$ *	$801,4 \pm 36,4$ *	$788,3 \pm 34,5$ *
	2	$481,4 \pm 38,6$	$675,3 \pm 40,1$ *	$786,9 \pm 39,2$ *	$746,4 \pm 36,2$ *
	3	$489,2 \pm 40,3$	$706,2 \pm 32,4$ *	$816,4 \pm 36,4$ * \square	$768,3 \pm 33,7$ *
NA, nmol/L (urine)	1	$8,2 \pm 1,2$	NA	NA	$11,8 \pm 1,1$ *
	2	$8,7 \pm 0,9$	NA	NA	$12,1 \pm 1,3$ *
	3	$8,3 \pm 0,9$	NA	NA	$12,4 \pm 1,3$ *

Note: * - statistically significant differences ($p < 0.05$) relative to baseline values; \square - statistically significant differences ($p < 0.05$) relative to the previous stage of the study; Δ - statistically significant differences ($p < 0.05$) relative to the 3rd subgroup; \bullet - statistically significant differences ($p < 0.05$) between the 1st and 2nd subgroups.

The significant decrease in MDP and TRP before skin incision, especially pronounced in the SA group, is in line with the known effects of spinal anesthesia on hemodynamics. The study by a randomized clinical trial observed changes in hemodynamics, stress, and inflammatory responses during labor in hypertensive pregnant women undergoing continuous spinal anesthesia (CSA) and continuous EA, which can provide a comparative perspective [4-6].

The maintenance of adequate MV and oxygenation in all subgroups, despite the presence of pneumonia and acute respiratory failure (ARF), is an important finding. The study on the impact of the interval between induction of spinal anesthesia to delivery on umbilical arterial cord pH of neonates delivered by elective cesarean section provides additional insights into the effects of spinal anesthesia on respiratory parameters and neonatal outcomes [13,16,17-25].

The significant decrease in the SI in the SA group and the increase in total plasma cortisol and noradrenaline excretion in all subgroups reflect the activation of the sympathoadrenal system in response to surgical trauma and hypoxia. This is consistent with the understanding of the autonomic system's response to anesthesia and surgical stress [3-4].

The results of the study are consistent with the existing literature on the effects of spinal anesthesia in pregnant women undergoing surgery. The findings contribute to the understanding of the clinical course of anesthesia, hemodynamic changes, respiratory function, and autonomic system parameters in this specific patient population. Further research and comparative studies are needed to validate these results and explore the implications for clinical practice.

4. Conclusions

The study explored the clinical course of SA, EA, and balanced epidural anesthesia (BEA) in pregnant women with CAP and first-degree respiratory failure. The findings reveal that SA was characterized by a rapid onset of complete segmental sensory-motor blockade, extending to higher dermatomes (T4-T5) due to factors such as increased intra-abdominal pressure and respiratory insufficiency. In contrast, EA and BEA exhibited similar onset times but differed in terms of blood pressure reduction and hemodynamic stability, with BEA providing the most stable profile throughout the operation.

Hemodynamic and peripheral circulation parameters indicated a significant decrease in MDP and TRP before skin incision across all subgroups, with the most pronounced changes observed in the SA subgroup. The study further demonstrated that BEA offered the most stable hemodynamic profile throughout the surgical procedure.

Respiratory function and gas exchange were adequately maintained in all subgroups despite the presence of CAP and acute respiratory failure, with an improvement in respiratory parameters noted at the end of the surgery. The study highlighted that different variants of CNB have distinct impacts on hemodynamics, respiratory function, and autonomic

system parameters in this patient population.

The autonomic system parameters showed a significant decrease in the SI in the SA subgroup, indicating a reduction in sympathetic influences. Additionally, an increase in total plasma cortisol and noradrenaline excretion was observed in all subgroups, reflecting the activation of the sympathoadrenal system in response to surgical trauma and hypoxia.

In conclusion, the study underscores the importance of careful selection and monitoring of anesthesia techniques in pregnant women with CAP undergoing surgery to ensure optimal outcomes. The distinct impacts of different CNB variants on hemodynamic stability, respiratory function, and autonomic system responses highlight the need for further research to validate these results and explore their implications for clinical practice.

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