

Blood Pressure and Heart Rate Outcomes during Caesarean Section under Spinal Anaesthesia: A Comparative Analysis

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Abstract

This study aimed to investigate the factors contributing to low blood pressure during caesarean sections and its consequences. Our results show that there were significant differences in blood pressure values before and after spinal anaesthesia, with no statistically significant differences in blood pressure levels. Conversely, we found a statistically significant difference in heart rate before and 5 minutes after spinal anaesthesia. These findings suggest that maintaining adequate blood volume through intravenous fluids and closely monitoring blood pressure throughout the procedure can help prevent low blood pressure during caesarean sections. Additionally, our results highlight the importance of monitoring heart rate changes during spinal anaesthesia to prevent potential complications.

Keywords: blood pressure. Heart rate. spinal anaesthesia. caesarean section.

1. Introduction

Spinal anaesthesia-induced hypotension (SAH) occurs frequently during caesarean section and is primarily caused by sympathetic nerve blockade. SAH has a negative impact on patient wellbeing, and in the awake parturient, it causes nausea, dizziness and vomiting (1). Maternal hypotension can also have adverse effects on the foetus by decreasing utero placental blood flow, negatively affecting Apgar scores as well as causing fatal acidosis and other signs of distress such as tachypnoea. Rapid and precise restoration of blood pressure is therefore essential to prevent negative maternal and neonatal outcomes (1).

2. Methods

2.1 Data collection:

Data were collected by conducting a questionnaire for women who underwent a caesarean section in

the women's department at the Misurata Medical Centre during the period from 20 October to 30 November 2023, and reviewing patient files to find out their medical history.

3. Discussion

3.1 Blood Pressure Differences

The study you described investigated the differences in blood pressure before and after spinal anaesthesia in pregnant women undergoing caesarean section. While the initial descriptive statistics suggested some differences in blood pressure measurements, the statistical tests ultimately revealed no statistically significant differences between the following comparisons:

Blood pressure before spinal and first blood pressure post spinal

Blood pressure before spinal and blood pressure 5 minutes post spinal

Blood pressure before spinal and blood pressure after delivery of the baby

Blood pressure before spinal and blood pressure after 10 minutes

Blood pressure before spinal and blood pressure after finishing the operation

It's important to remember that even though there may be observed differences in the average values, these differences might not be statistically significant. This means that the observed differences could be due to chance alone, rather than a true effect of the spinal anaesthesia.

3.2 Heart Rate Differences :

The scenario for heart rate is different. While there were no significant differences for most comparisons, there was a statistically significant decrease in heart rate 5 minutes after spinal anaesthesia compared to the heart rate before spinal anaesthesia. This finding suggests that spinal anaesthesia might temporarily affect heart rate in pregnant women undergoing caesarean section.

3.3 Overall: The study suggests that spinal anaesthesia does not have a significant impact on blood pressure in healthy pregnant women undergoing caesarean section. However, there might be a temporary decrease in heart rate 5 minutes after the administration of spinal anaesthesia.

4. Conclusion

4.1 The statistical methods used:

- 1- The mean finds out the extent of the high or low responses of the study sample for each Measure.
- 2- Standard Deviation to identify the extent of the deviation of the study sample responses for each degree from its arithmetic mean.
- 3- Paired samples T- Test: This test was used to study the significant differences of two independent samples.

4.1.1 Age:

Table1: distribution of the study sample by Age.

| Item | Frequency | Percent |
|------------------------|-----------|---------|
| Less than 30 years old | 14 | 32.6% |
| From 30 to 40 years | 26 | 60.5% |

| | | |
|---------------------|----|------|
| From 40 to 50 years | 3 | 7% |
| Total | 43 | 100% |

It is clear from Table (1) related to the distribution of the study sample by Age, that the percentage of Less than 30 years old reached (32.6%), which is equal to the percentage of from 30 to 40 years (50.5%). And the percentage of from 40 to 50 years (7%). Figure (1) shows this.

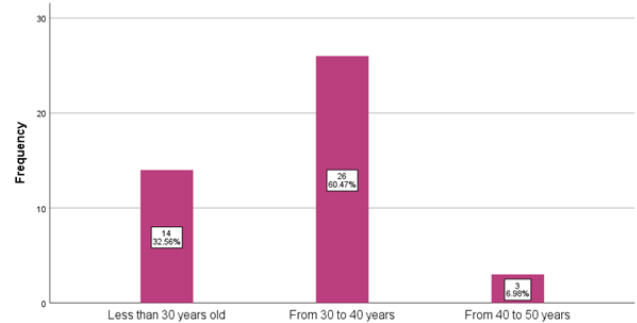


Figure:(1) Distribution of the study sample by Age. ***Intravenous fluid 1500-1000(ml)N/S or R/L.**

Table 2: distribution of the study sample by Intravenous fluid 1500-1000) ml) N/S or R/L.

| Item | Frequency | Percent |
|------|-----------|---------|
| Yes | 43 | 100% |

It is clear from Table (2) related to the distribution of the study sample by Intravenous fluid 1500-1000) ml) N/S or R/L, that the percentage of yes reached (100%). Figure (2) shows this.

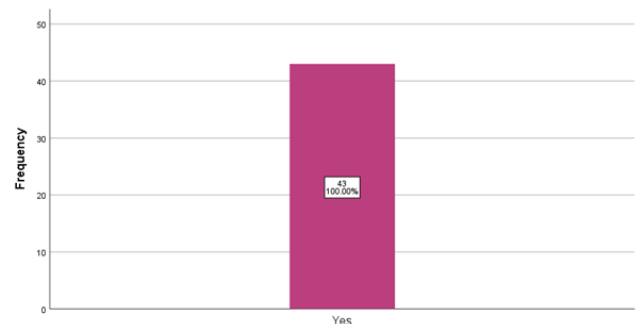


Figure 2: Distribution of the study sample by Intravenous fluid 1500-1000(ml)N/S or R/L. ***Ephedrine I.V (3 -6 mg).**

Table 3: Distribution of the study sample by Ephedrine I.V (3 -6 mg).

| Item | Frequency | Percent |
|------|-----------|---------|
| Yes | 8 | 18.6% |

| | | |
|-------|----|-------|
| No | 35 | 81.4% |
| Total | 43 | 100% |

It is clear from Table (3) related to the distribution of the study sample by Ephedrine I.V (3 -6 mg), that the percentage of yes reached (18.6%), which is equal to the percentage of No (81.4%). Figure (3) shows this.

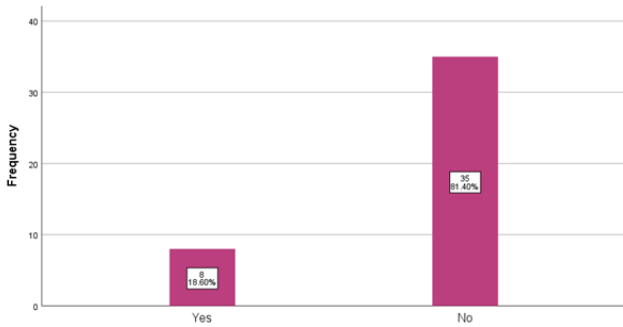


Figure 3: Distribution of the study sample by Ephedrine I.V (3 -6 mg).

***Ephedrine I.V**

Table 4: Distribution of the study sample by Ephedrine I.V

| | | |
|-------|-----------|---------|
| Item | Frequency | Percent |
| Yes | 40 | 93% |
| No | 3 | 7% |
| Total | 43 | 100% |

It is clear from Table (4) related to the distribution of the study sample by Ephedrine I.V, that the percentage of yes reached (93%), which is equal to the percentage of Female (7%). Figure (4) shows this.

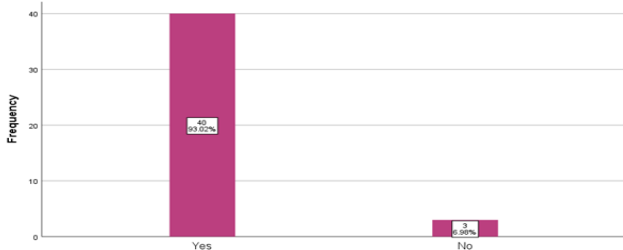


Figure 4: Distribution of the study sample by Ephedrine I.V

***Atropine I.V**

Table 5: Distribution of the study sample by Atropine I.V

| | | |
|-------|-----------|---------|
| Item | Frequency | Percent |
| Yes | 1 | 2.3% |
| No | 42 | 97.67% |
| Total | 43 | 100% |

It is clear from Table (5) related to the distribution of the study sample by Atropine I. V , that the percentage of yes reached (2.3 %), which is equal to the percentage of No (97.67 %). Figure (5) shows this.

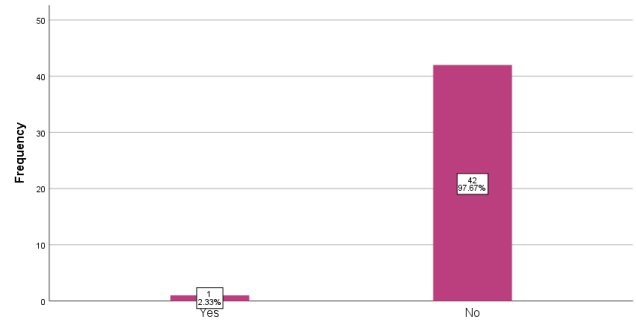


Figure 5; Distribution of the study sample by Atropine I.V

***Intravenous fluid**

Table 6: Distribution of the study sample by Intravenous fluid.

| | | |
|------|-----------|---------|
| Item | Frequency | Percent |
| Yes | 43 | 100% |

It is clear from Table (6) related to the distribution of the study sample by Intravenous fluid, that the percentage of yes reached (100%). Figure (6) shows this.

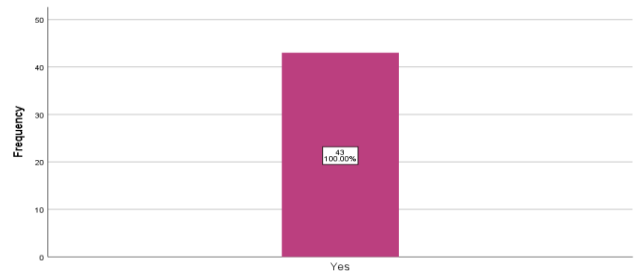


Figure 6: Distribution of the study sample by Intravenous fluid.

4.2 Answering the study questions:

4.2.1 The first question:

-Is There statistically significant differences between the level of Blood pressure before spinal and First blood pressure post spinal?

Table (7) The results between test for the of Blood pressure before spinal and First blood pressure post spinal.

| Blood pressure before spinal | | First blood pressure posts spinal | | The difference between the two means | Correlation | p-value |
|------------------------------|----------------|-----------------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -.95 | 0.363 | 0.017 |
| 82.72 | 15.79 | 81.76 | 20.63 | | | |

The results of table (7) showed that there were differences between the values of the Blood pressure before spinal and First blood pressure post spinal, as the difference between the two averages was (-.95) and the correlation coefficient was (0.363), and the correlation was significant between the Blood pressure before spinal and First blood pressure post spinal, as it reached (p-value = (.017)). It is less than (0.05) between the Blood pressure before spinal and First blood pressure post spinal.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (8).

Table (8) Results of answering the first question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | .299 | .767 |

It is clear from Table (8) that the value of (t = 0.299) and the value of statistical significance (p-value = .3767), which is more than the level of significance (.05), which indicates do not existence of statistically significant differences in the level of the First blood pressure post spinal, and Figure (7) shows the mean of the Blood pressure before spinal and First blood pressure post spinal.

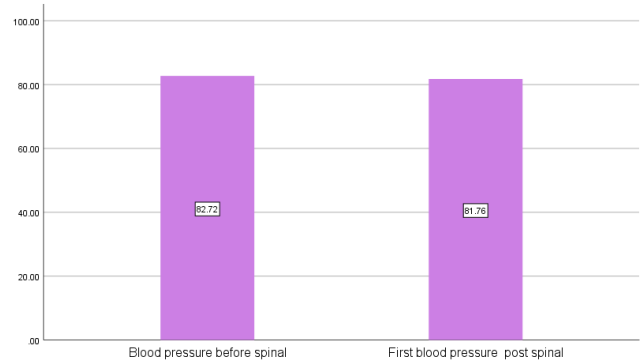


Figure 7: mean of the Blood pressure before spinal and First blood pressure post spinal.

4.2.2 The Second question:

-Is There statistically significant differences between the level of Blood pressure before spinal and Blood pressure 5min post spinal?

Table (9) The results between test for the of Blood pressure before spinal and Blood pressure 5min post spinal.

| Blood pressure before spinal | | Blood pressure 5min post spinal | | The difference between the two means | Correlation | p-value |
|------------------------------|----------------|---------------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -2.209 | 0.233 | 0.132 |
| 82.72 | 15.79 | 80.51 | 24.42 | | | |

The results of table (9) showed that there were differences between the values of the Blood pressure before spinal and Blood pressure 5min post spinal, as the difference between the two averages was (-2.209) and the correlation coefficient was (0.233), and the correlation was significant between the Blood pressure before spinal and Blood pressure 5min post spinal, as it reached (p-value = (.132)). It is less than (0.05) between the Blood pressure before spinal and Blood pressure 5min post spinal.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (10).

Table (10) Results of answering the Second question.

| Df | t-test | p-value |
|----|--------|---------|
|----|--------|---------|

| | | |
|----|------|------|
| 42 | .561 | .577 |
|----|------|------|

It is clear from Table (10) that the value of ($t = 0.561$) and the value of statistical significance ($p\text{-value} = .577$), which is more than the level of significance (.05), which indicates do not existence of statistically significant differences in the level of the Blood pressure 5min post spinal, and Figure (8) shows the mean of the Blood pressure before spinal and Blood pressure 5min post spinal.

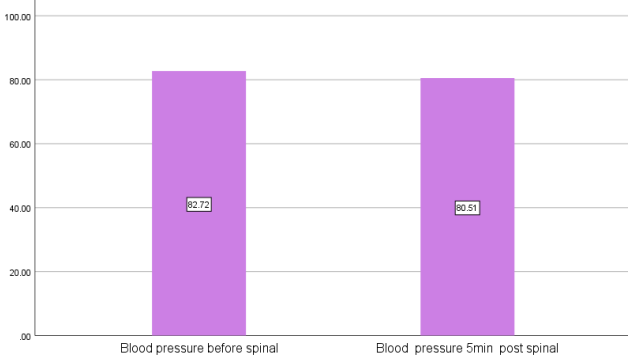


Figure 8: mean of the Blood pressure before spinal and Blood pressure 5min post spinal.

4.2.3 The Third question:

-Is There statistically significant differences between the level of Blood pressure before spinal and Blood pressure after delivery baby?

Table (11) The results between test for the of Blood pressure before spinal and Blood pressure after delivery baby.

| Blood pressure before spinal | | Blood pressure after delivery baby | | The difference between the two means | Correlation | p-value |
|------------------------------|----------------|------------------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -2.465 | 0.157 | 0.314 |
| 82.72 | 15.79 | 80.25 | 22.18 | | | |

The results of table (11) showed that there were differences between the values of the Blood pressure before spinal and Blood pressure after delivery baby, as the difference between the two averages was (-2.465) and the correlation coefficient was (0.157), and the correlation was significant between the Blood pressure before

spinal and Blood pressure after delivery baby, as it reached ($p\text{-value} = (.314)$). It is more than (0.05) between the Blood pressure before spinal and Blood pressure after delivery baby.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (12).

Table (12) Results of answering the Third question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | .643 | .524 |

It is clear from Table (12) that the value of ($t = 0.643$) and the value of statistical significance ($p\text{-value} = .524$), which is more than the level of significance (.05), which indicates do not existence of statistically significant differences in the level of the Blood pressure after delivery baby, and Figure (9) shows the mean of the Blood pressure before spinal and Blood pressure after delivery baby.

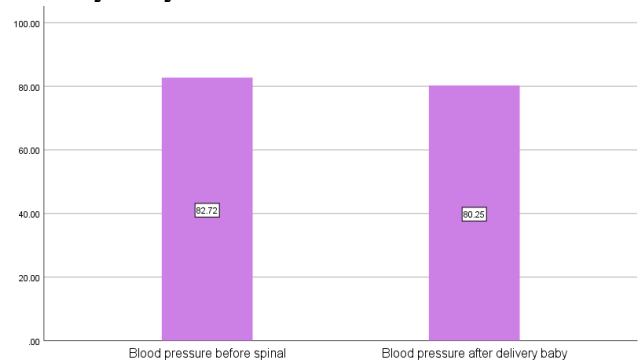


Figure 9: shows the mean of the Blood pressure before spinal and Blood pressure after delivery baby

4.2.4 The Fourth question:

-Is There statistically significant differences between the level of Blood pressure before spinal and Blood pressure after 10min?

Table (13) The results between test for the of Blood pressure before spinal and Blood pressure after 10min.

| Blood pressure before spinal | | Blood pressure after 10min | | The difference between the two means | Correlation | p-value |
|------------------------------|----------------|----------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -0.302 | 0.244 | 0.115 |
| | | | | | | |

| | | | | | | |
|-------|-------|-------|-------|--|--|--|
| 82.72 | 15.79 | 82.41 | 18.92 | | | |
|-------|-------|-------|-------|--|--|--|

The results of table (13) showed that there were differences between the values of the Blood pressure before spinal and Blood pressure after 10min, as the difference between the two averages was (-0.302) and the correlation coefficient was (0.244), and the correlation was significant between the Blood pressure before spinal and Blood pressure after 10min, as it reached (p-value = (.115)). It is more than (0.05) between the Blood pressure before spinal and Blood pressure after 10min.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (14).

Table (14) Results of answering the Fourth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | .092 | .927 |

It is clear from Table (14) that the value of (t = 0.092) and the value of statistical significance (p-value = .927), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Blood pressure after 10min, and Figure (10) shows the mean of the Blood pressure before spinal and Blood pressure after 10min.

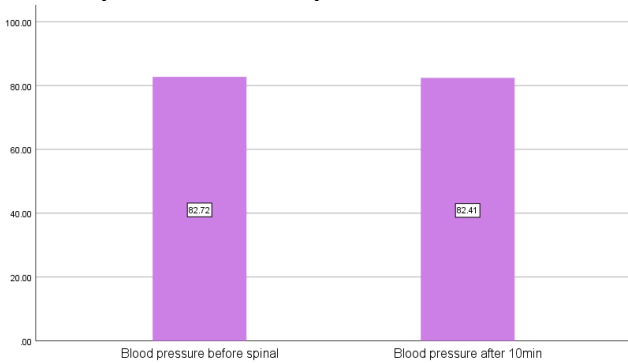


Figure 10: mean of the Blood pressure before spinal and Blood pressure after 10min.

4.2.5 The Fifth question:

-Is There statistically significant differences between the level of Blood pressure before spinal and Blood pressure after finish operation?

Table (15) The results between test for the of Blood pressure before spinal and Blood pressure after finish operation.

| Blood pressure before spinal | | Blood pressure after 10min | | The difference between the two means | Correlation | p-value |
|------------------------------|----------------|----------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -2.340 | 0.088 | 0.579 |
| 82.72 | 15.79 | 80.38 | 18.19 | | | |

The results of table (15) showed that there were differences between the values of the Blood pressure before spinal and Blood pressure after finish operation, as the difference between the two averages was (-2.340) and the correlation coefficient was (0.088), and the correlation was significant between the Blood pressure before spinal and Blood pressure after finish operation, as it reached (p-value = (.579)). It is more than (0.05) between the Blood pressure before spinal and Blood pressure after finish operation.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (16).

Table (16) Results of answering the Fifth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | .595 | .555 |

It is clear from Table (16) that the value of (t = 0.595) and the value of statistical significance (p-value = .555), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Blood pressure after finish operation, and Figure (11) shows the mean of the Blood pressure before spinal and Blood pressure after finish operation.

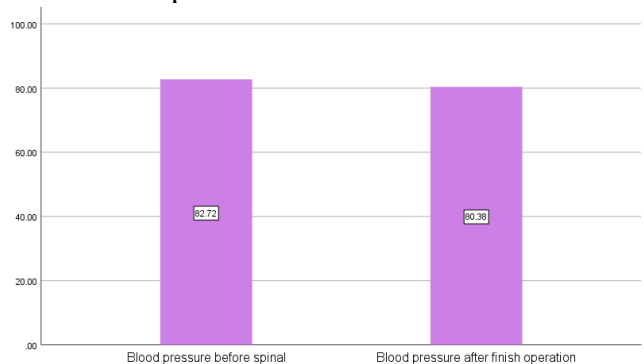


Figure 11: mean of the Blood pressure before spinal and Blood pressure after finish operation.

4.2.6 The Sixth question:

-Is There statistically significant differences between the level of Heart rate before spinal and Heart rate post spinal?

Table (17) The results between test for the of Blood pressure before spinal and Heart rate post spinal.

| Heart rate before spinal | | Heart rate post spinal | | The difference between the two means | Correlation | p-value |
|--------------------------|----------------|------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | 2.16 | 0.679 | 0.000 |
| 95.97 | 14.56 | 98.11 | 22,92 | | | |

The results of table (17) showed that there were differences between the values of the Heart rate before spinal and Heart rate post spinal, as the difference between the two averages was (+2.16) and the correlation coefficient was (0.679), and the correlation was significant between the Heart rate before spinal and Heart rate post spinal, as it reached (p-value = (.000)). It is less than (0.05) between the Heart rate before spinal and Heart rate post spinal.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (18).

Table (18) Results of answering the Sixth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | -0.832 | .410 |

It is clear from Table (18) that the value of (t = -0.832) and the value of statistical significance (p-value = .410), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Heart rate post spinal, and Figure (12) shows the mean of the Heart rate before spinal and Heart rate post spinal.

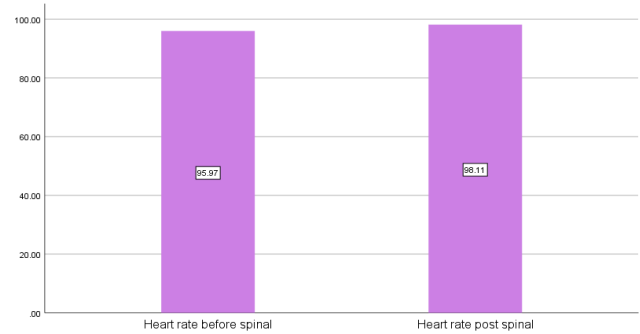


Figure 12: mean of the Heart rate before spinal and Heart rate post spinal.

4.2.7 The Seventh question:

- Are there statistically significant differences between the level of Heart rate before spinal and Heart rate 5min post spinal?

Table (19) The results between test for the of Blood pressure before spinal and Heart rate 5min post spinal.

| Heart rate before spinal | | Heart rate 5min post spinal | | The difference between the two means | Correlation | p-value |
|--------------------------|----------------|-----------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -15.46 | 0.199 | 0.200 |
| 95.97 | 14.56 | 80.51 | 24.42 | | | |

The results of table (19) showed that there were differences between the values of the Heart rate before spinal and Heart rate 5min post spinal, as the difference between the two averages was (-15.46) and the correlation coefficient was (0.199), and the correlation was significant between the Heart rate before spinal and Heart rate 5min post spinal, as it reached (p-value = (.200)). It is more than (0.05) between the Heart rate before spinal and Heart rate 5min post spinal.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (20).

Table (20) Results of answering the Seventh question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | 3.927 | .000 |

It is clear from Table (20) that the value of (t = (3.927) and the value of statistical significance (p-value = .000), which is less than the level of significance (.05)), which indicates existence of statistically significant differences in the level of the Heart rate 5min post spinal, and Figure (13) shows the mean of the Heart rate before spinal and Heart rate 5min post spinal.

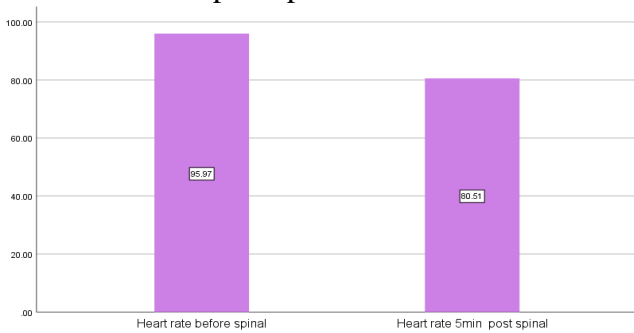


Figure 13: Heart rate before spinal and Heart rate 5min post spinal.

4.2.8 The Eighth question:

-Are there statistically significant differences between the level of Heart rate before spinal and Heart rate after delivery baby?

Table (21) The results between test for the of Blood pressure before spinal and Heart rate after delivery baby.

| Heart rate before spinal | | Heart rate after delivery baby | | The difference between the two means | Correlation | p-value |
|--------------------------|----------------|--------------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | +1.95 | 0.563 | 0.000 |
| 95.97 | 14.56 | 97.92 | 19.50 | | | |

The results of table (21) showed that there were differences between the values of the Heart rate before spinal and Heart rate after delivery baby, as the difference between the two averages was (+1.46) and the correlation coefficient was (0.563), and the correlation was significant between the Heart rate before spinal and Heart rate after delivery baby, as it reached (p-value = (.000)). It is less than (0.05) between the Heart rate before spinal and Heart rate after delivery baby.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (22).

Table (22) Results of answering the Eighth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | -1.125 | .267 |

It is clear from Table (22) that the value of (t = (-1.125) and the value of statistical significance (p-value = (.267), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Heart rate after delivery baby, and Figure (14) shows the mean of the Heart rate before spinal and Heart rate after delivery baby.

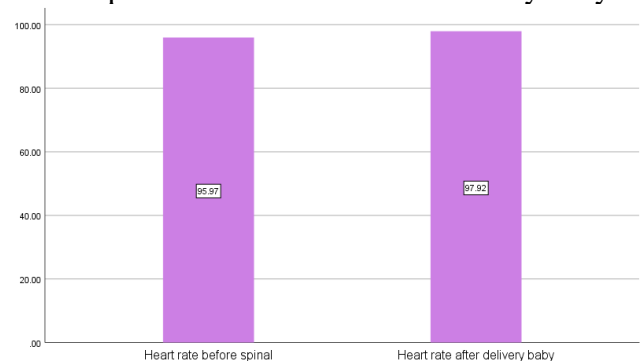


Figure 14: Heart rate before spinal and Heart rate after delivery baby.

4.2.9 The Ninth question:

-Are There statistically significant differences between the level of Heart rate before spinal and Heart rate after 10 min?

Table (23) The results between test for the of Blood pressure before spinal and Heart rate after 10min.

| Heart rate before spinal | | Heart rate after 10min | | The difference between the two means | Correlation | p-value |
|--------------------------|----------------|------------------------|----------------|--------------------------------------|-------------|---------|
| Mean | Std. Deviation | Mean | Std. Deviation | -1.14 | 0.131 | 0.408 |
| 95.97 | 14.56 | 94.83 | 13.46 | | | |

The results of table (23) showed that there were differences between the values of the Heart rate before spinal and Heart rate after 10min, as the

difference between the two averages was (-1.14) and the correlation coefficient was (0.131), and the correlation was significant between the Heart rate before spinal and Heart rate after 10min, as it reached (p-value = (.408)). It is more than (0.05) between the Heart rate before spinal and Heart rate after 10min.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (24).

Table (24) Results of answering the Ninth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | 0.095 | .924 |

It is clear from Table (24) that the value of (t = (0.095) and the value of statistical significance (p-value = (.924), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Heart rate after 10min, and Figure (15) shows the mean of the Heart rate before spinal and Heart rate after 10min.

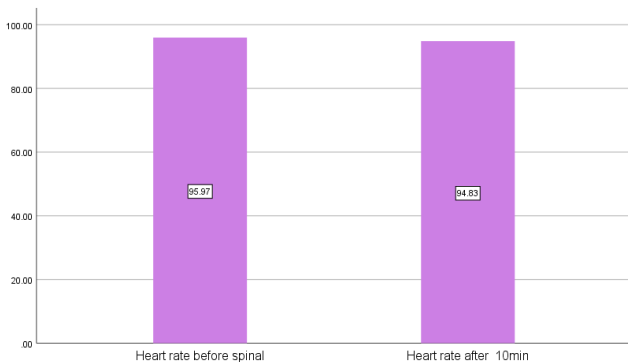


Figure 15: Heart rate before spinal and Heart rate after 10min.

4.2.10The Tenth question:

-Are There statistically significant differences between the level of Heart rate before spinal and Heart rate after finish operation?

Table (25) The results between test for the of Blood pressure before spinal and Heart rate after finish operation.

| Heart rate before spinal | Heart rate after finish operation | The difference between the two means | Correlation | p-value |
|--------------------------|-----------------------------------|--------------------------------------|-------------|---------|
| | | | | |

| Mean | Std. Deviation | Mean | Std. Deviation | -2.02 | 0.138 | 0.385 |
|-------|----------------|-------|----------------|-------|-------|-------|
| 95.97 | 14.56 | 93.95 | 13.46 | | | |

The results of table (25) showed that there were differences between the values of the Heart rate before spinal and Heart rate after finish operation, as the difference between the two averages was (-2.02) and the correlation coefficient was (0.138), and the correlation was significant between the Heart rate before spinal and Heart rate after finish operation, as it reached (p-value = (.385)). It is more than (0.05) between the Heart rate before spinal and Heart rate after finish operation.

To ensure the validity of these differences in terms of their significance, the researchers used the (t) test for two non-independent (linked) samples, as shown in Table (26).

Table (26) Results of answering the Tenth question.

| Df | t-test | p-value |
|----|--------|---------|
| 42 | 0.443 | .660 |

It is clear from Table (26) that the value of (t = (0.443) and the value of statistical significance (p-value = (.660), which is more than the level of significance (.05)), which indicates do not existence of statistically significant differences in the level of the Heart rate after finish operation, and Figure (16) shows the mean of the Heart rate before spinal and Heart rate after finish operation.

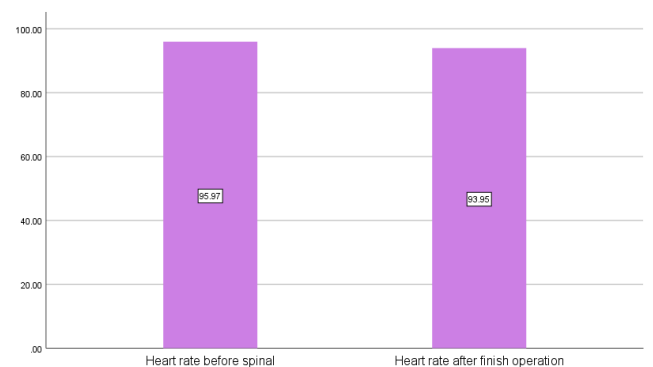


Figure 16: Heart rate before spinal and Heart rate after finish operation.

References

1. The New York School of Regional Anaesthesia (NYSORA) continuing medical education [Internet]. New York. [cited 2019 Feb 24] Spinal anaesthesia; [about 111 KB]. Available from: <https://www.nysora.com/techniques/neuraxial-and-perineuraxial-techniques/spinal-anesthesia/>.
2. Corke BC, Datta S, Ostheimer GW, Weiss JB, Alper MH. Spinal anaesthesia for caesarean section. The influence of hypotension on neonatal outcome. *Anaesthesia*. 1982;37:658–62. 10.1111/j.1365-2044.1982.tb01278.x [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
3. Kennedy RL, Friedman DL, Katcka DM, Selmants S, Smith RN. Hypotension during obstetrical anaesthesia. *Anesthesiology*. 1959;20:153–5. 10.1097/00000542-195903000-00001 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
4. Klöhr S, Roth R, Hofmann T, Rossaint R, Heesen M. Definitions of hypotension after spinal anaesthesia for caesarean section: literature search and application to parturients. *Acta Anaesthesiol Scand*. 2010;54:909–21. 10.1111/j.1399-6576.2010.02239.x [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
5. Burns SM, Cowan CM, Wilkes RG. Prevention and management of hypotension during spinal anaesthesia for elective Caesarean section: a survey of practice. *Anaesthesia*. 2001;56:794–8. 10.1046/j.1365-2044.2001.02058-5.x [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
6. Ngan Kee WD, Khaw KS, Ng FF. Comparison of phenylephrine infusion regimens for maintaining maternal blood pressure during spinal anaesthesia for Caesarean section. *Br J Anaesth*. 2004;92:469–74. 10.1093/bja/ae088 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
7. Kinsella SM, Carvalho B, Dyer RA, Fernando R, McDonnell N, et al. International consensus statement on the management of hypotension with vasopressors during caesarean section under spinal anaesthesia. *Anaesthesia*. 2018;73(1):71–92. 10.1111/anae.14080 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
8. Kestin IG. Spinal anaesthesia in obstetrics. *Br J Anaesth*. 1991;66:596–607. 10.1093/bja/66.5.596 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
9. Salinas FV, Sueda LA, Liu SS. Physiology of spinal anaesthesia and practical suggestions for successful spinal anaesthesia. *Best Pract Res Clin Anaesthesiol*. 2003;17(3):289–303. 10.1016/S1521-6896(02)00114-3 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
10. McClure JH, Brown DT, Wildsmith JA. Effect of injected volume and speed of injection on the spread of spinal anaesthesia with isobaric amethocaine. *Br J Anaesth*. 1982;54:917–20. 10.1093/bja/54.9.917 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
11. Neal JM. Hypotension and bradycardia during spinal anaesthesia: Significance, prevention, and treatment. *Tech Reg Anesth Pain Manage*. 2000;4(4):148–54. 10.1053/trap.2000.20600 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
12. Lewinsky RM, Riskin-Mashiah S. Autonomic imbalance in preeclampsia: evidence for increased sympathetic tone in response to the supine-pressor test. *Obstet Gynecol*. 1998;91:935–9. 10.1097/00006250-199806000-00011 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
13. Kashihara K. Roles of Arterial Baroreceptor Reflex During Bezold-Jarisch Reflex. *Curr Cardiol Rev*. 2009;5(4):263–7. 10.2174/157340309789317805 [\[PMC free article\]](#) [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
14. Borgeat A, Ekatothramis G, Schenker CA. Postoperative nausea and vomiting in regional anaesthesia. *Anesthesiology*. 2003;98:530–47. 10.1097/00000542-200302000-00036 [\[PubMed\]](#) [\[CrossRef\]](#) [\[Google Scholar\]](#)
15. Hirose N, Kondo Y, Maeda T, Suzuki T, Yoshino A. Relationship between regional cerebral blood volume and oxygenation and blood pressure during spinal anaesthesia in women

undergoing cesarean section. *J Anesth.* 2016;30:603–9. 10.1007/s00540-016-2165-6

[PubMed] [CrossRef] [Google Scholar]

16. Ratra CK, Badola RP, Bhargava KP. A study of factors concerned in emesis during spinal anaesthesia. *Br J Anaesth.* 1972;44:1208–11. 10.1093/bja/44.11.1208

[PubMed]

[CrossRef] [Google Scholar]

17. Hirose N, Kondo Y, Maeda T, Suzuki T, Yoshino A, Katayama Y. Oxygen supplementation is effective in attenuating maternal cerebral blood deoxygenation after

spinal anesthesia for cesarean section. *Adv Exp Med Biol.* 2016;876:471–7.