IMPACT OF MATERNAL LATERAL TILT ON CARDIAC OUTPUT DURING CAESAREAN SECTION UNDER SPINAL ANAESTHESIA: A PROSPECTIVE OBSERVATIONAL STUDY

Vijaya Ananth¹, Philitsen², Rajinish Singh³

¹Assistant Professor, of Anaesthesiology, Kanyakumari Government Medical College, Asaripallam, Tamilnadu, India.
²Assistant Professor, Department of Anaesthesiology, Kanyakumari Government Medical College, Asaripallam, Tamilnadu, India.
³Assistant Professor, of Anaesthesiology, Kanyakumari Government Medical College, Asaripallam, Tamilnadu, India.

Abstract

Background: Left uterine displacement (LUD) has been questioned as an effective strategy to prevent aortocaval compression after spinal anaesthesia (SA) for cesarean delivery (CD). We tested if LUD has a significant impact on cardiac output (CO) in patients undergoing cesarean delivery under SA during continuous non-invasive hemodynamic monitoring with OSYPKA MEDICAL Electrical cardiometry. Materials and Methods: Forty patients were included in the final analysis. We considered 2 time points of 5 min each: T3=after SA with LUD; T4=after SA without LUD. LUD was then repositioned for CD. The primary outcome was to evaluate the Impact of maternal lateral tilt on cardiac output during caesarean section under spinal anaesthesia. Other Parameters monitored are Heart Rate, Stroke volume, Stroke volume index, Cardiac index, Systemic Vascular Resistance, Systemic Vascular Resistance Index, Mean arterial Pressure, Systolic Blood Pressure and Diastolic Blood Pressure. Data analyzed from 40 patients were presented as mean, standard deviation, frequency and percentage. Continual variables were compared using paired sample t test. Significance was defined by P value less than 0.05 using two tailed test. Data analysis was performed using IBM-SPSS version 21.0(IBM-SPSS Science Inc., Chicago, IL). Result: In this prospective observational study, continuous hemodynamic monitoring, Cardiac Output did not show any significant variation after LUD removal under SA for cesarean delivery. Cardiac Output, Heart Rate, Stroke volume, Stroke volume index, Cardiac Index, Systemic Vascular Resistance, Systemic Vascular Resistance Index, Mean Arterial Pressure, Systolic Blood Pressure and Diastolic Blood Pressure did not vary significantly with and without LUD after SA. Conclusion: Cardiac Output did not decrease significantly after LUD removal in patients under SA for Cesarean delivery during continuous hemodynamic monitoring. Optimization of fluid and vasopressor therapy may be sufficient to prevent aorto-caval compression by the gravid uterus and the consequent reduction of venous return after SA for Cesarean delivery. LUD did not show a significant impact on Cardiac output during continuous hemodynamic monitoring after SA for cesarean delivery.

INTRODUCTION

Since 1953, the gravid uterus in pregnancies at term has been recognized as a cause of aortic and caval compression in the supine position.¹ ² Later, experiments with venograms provided a visual evidence of the impaired venous return suggesting the adoption of the left uterine tilt in clinical practice.³ ¹ In most patients, venoconstriction of the lower limbs allows complete compensation,⁴ but sympathetic blockade following spinal anaesthesia (SA) for cesarean delivery (CD) blunts the cardiovascular compensatory mechanisms, exacerbating maternal hypotension and neonatal depression.⁵ ⁶ The introduction of a 15° left uterine displacement (LUD) was proposed for the first time by Crawford and colleagues in 1972, as a result of their experiments on 150 women undergoing CD under general anaesthesia.⁷ However, there is no consensus on whether tilting the table improves...
maternal or neonatal outcome. In fact, not only LUD is rarely effectively achieved in every day practice,[7,8] making its efficacy in preventing aortocaval compression unreliable, but it may make the operation more difficult for the surgeon. The introduction of an optimized vasopressor and fluid therapy posed questions on its effective utility.[9–11] A Cochrane review found no differences in hypotensive events between supine and LUD patients.[12] Lee and colleagues measured CO, stroke volume (SV) and systemic vascular resistances by suprasternal Doppler ultrasound in not anesthetized parturients with four levels of left lateral tilt (0°, 7.5°, 15° and 90°),[13] showing that aortocaval compression can be effectively minimized by the use of a left lateral tilt of 15° or greater. On the other hand, Tsai and colleagues showed that NICOM hemodynamic monitoring could not detect any difference in cardiac index between patients with LUD and supine patients,[14] while Chungsamarnyart showed only modest hemodynamic advantages (higher CO, less hypotension, higher dP / dT) with pre-delivery LUD.[15]

**Aim of the Study**
The aim of this prospective observational study was to evaluate the Impact of maternal lateral tilt on cardiac output during caesarean section under spinal anaesthesia.

**MATERIALS AND METHODS**

**Statistical Analysis**
Data analyzed from 40 patients were presented as mean, standard deviation, frequency and percentage. Continual variables were compared using paired sample t test. Significance was defined by P value less than 0.05 using two tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM - SPSS Science Inc., Chicago, IL).

This is an observational study conducted in a Tertiary care Government Hospital during March 2021 – July 2022 in 40 patients undergoing caesarean section under special anaesthesia. Sample size calculation: A sample size of 40 is required to study the impact of maternal lateral tilt on cardiac output during caesarean section under special anaesthesia.

Formula:

\[ \sigma^2 = \frac{n \cdot \epsilon^2 + \sigma^2}{\epsilon^2 + \sigma^2} \]

Calculation:
- \( \sigma = 0.8 \), \( \epsilon = 4\% \), \( \mu = 6.1 \)
- \( n = \frac{3.84^*0.64}{0.06} \) / 0.06
- \( n = 40 \)

**Inclusion Criteria**
1. Written informed consent.
2. Age: 18–35 years pregnant patients at term
3. Elective Cesarean
4. ASA I/II

**Exclusion Criteria**
1. Refusal to participate
2. ASA > 3
3. Cardiac arrhythmias or aortic regurgitation
4. Pregnancy-induced hypertension
5. Preeclampsia
6. BMI > 35 kg/m2
7. Fetal complications
8. Coagulation disorders or contraindication to neuraxial block
9. Emergency surgery
10. Conversion to General Anaesthesia

**Methodology**
After getting the informed consent. OSYPKA MEDICAL. Electrical cardiometry used for the analysis. Anaesthesia was delivered in right lateral position using a 25-G Quinckes spinal needle at the L3-4 vertebral interspace, with hyperbaric 0.5% bupivacaine 2cc. Once the anaesthetic procedure was completed, all patients received a rapid crystalloid co-load of 7 ml/kg over 10 min. During surgery and after delivery, fluid management was left to the attending anaesthesiologist. We considered 2 time points. T3 = after SA with LUD, T4 = after SA without LUD. LUD was accomplished by positioning a wooden wedge and wrapped with cotton, to make it comfortable, and medical sheets with a measured angle of 15° under the right flank of the laying down patient. Hypotension is defined as an absolute value of MAP decreasing 20% from the baseline of 60. After delivery, Oxytocin 10 IU IM was administered

**RESULTS**
Data analyzed from 40 patients were presented as mean, standard deviation, frequency and percentage. Continual variables were compared using paired sample t test. Significance was defined by P value less than 0.05 using two tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM-SPSS Science Inc, Chicago, IL).

| Table 1: Comparison of Hemodynamics between T3 and T4 |
|------------------------------------------------------|
| **Descriptive Statistics**                           | **T3**         | **Mean** | **Std. Deviation** | **T4**         | **Mean** | **Std. Deviation** | **P Value** |
| Cardiac Output                                      | 6.45          | 1.02     |                  | 6.59          | 1.20     |                  | 0.468       |
| Heart Rate                                          | 85.70         | 13.89    |                  | 82.80         | 6.43     |                  | 0.246       |
| Stroke Volume                                       | 77.20         | 11.85    |                  | 78.50         | 12.68    |                  | 0.54        |
| Svi                                                  | 46.10         | 7.49     |                  | 47.60         | 4.03     |                  | 0.151       |
| Ci                                                   | 3.82          | 0.49     |                  | 3.96          | 0.59     |                  | 0.137       |
| Svr                                                  | 1041.40       | 273.13   |                  | 1093.10       | 206.61   |                  | 0.218       |
| Svr Index                                            | 1738.40       | 373.96   |                  | 1698.22       | 305.09   |                  | 0.498       |
| MAP                                                  | 84.50         | 6.01     |                  | 84.10         | 9.23     |                  | 0.591       |
| SBP                                                  | 111.60        | 5.13     |                  | 112.10        | 5.81     |                  | 0.53        |
| DBP                                                  | 71.00         | 8.14     |                  | 69.60         | 12.13    |                  | 0.137       |
There were no statistically significant difference among two groups including cardiac output and other hemodynamic parameters.

Figure 1: Comparison of Cardiac Output between T3 and T4

There were no statistically significant difference among two groups.

Figure 2: Comparison of Heart Rate between T3 and T4

There were no statistically significant difference among two groups.

Figure 3: Comparison of Stroke Volume between T3 and T4

There were no statistically significant difference among two groups.

Figure 4: Comparison of Stroke Volume Index between T3 and T4

There were no statistically significant difference among two groups.

Figure 5: Comparison of Cardiac Index between T3 and T4

There were no statistically significant difference among two groups.

Figure 6: There were no statistically significant difference among two groups

There were no statistically significant difference among two groups.

Figure 7: Comparison of Systemic Vascular Resistance Index between T3 and T4

There were no statistically significant difference among two groups.
There were no statistically significant difference among two groups.

There were no statistically significant difference among two groups.

There were no statistically significant difference among two groups.

DISCUSSION

In this prospective observational study, continuous hemodynamic monitoring, CO did not show any significant variation after LUD removal under SA for CD. Cardiac Output, Heart Rate, Stroke Volume, Stroke Volume Index, Cardiac Index, Systemic Vascular Resistance, Systemic Vascular Resistance Index, Mean Arterial Pressure, Systolic Blood Pressure and Diastolic Blood Pressure did not vary significantly with and without LUD either at baseline or after SA. International recommendations suggest non-invasive blood pressure measurements every minute and prophylactic vasopressor infusion. Optimal fluid and vasopressor therapy controlled the component of hypotension due to the aortocaval compression by the gravid uterus without consequences for the fetus. Cardiac Output is a better indicator of fetal perfusion than blood pressure, due to the changes in peripheral resistances that occur in pregnancy which do not necessarily reflect fetal perfusion. Optimized fluid management and vasopressor therapy may allow an optimal uterine perfusion independently from aortocaval compression. The continuous hemodynamic monitoring allowed to better evaluate the impact of LUD on CO with standard anaesthetic management, correcting for inter-individual variables. Lee and colleagues measured Cardiac Output, stroke volume (SV) and systemic vascular resistances by suprasternal Doppler ultrasound in non-anesthetized parturients with four levels of left lateral tilt (0°, 7.5°, 15° and 90°).\[13\] showing that aortocaval compression can be effectively minimized by the use of a left lateral tilt of 15° or greater. On the other hand, Tsai and colleagues showed that NICOM hemodynamic monitoring could not detect any difference in cardiac index between patients with LUD and supine patients.\[14\] while Chungsamarnyart showed only modest hemodynamic advantages (higher CO, less hypotension, higher dP/dT) with pre-delivery LUD.\[15\] Sonnino et al.\[16\] considered 4 timepoints of 5 min each: T1=baseline with LUD; T2=baseline without LUD; T3=after SA with LUD; T4=after SA without LUD. In that study, comparison of Cardiac Output between T1 and T2, T3 and T4 , and other hemodynamic variables: mean, systolic and diastolic blood pressure (respectively MAP, SAP and DAP), heart rate (HR), stroke volume (SV), stroke volume variation (SVV), pulse pressure variation (PPV), contractility (dP/dt), dynamic arterial elastance (Eadyn) at the different time points was done. They found that there is no significant variation was registered for any variable at any time point. In our study we evaluate the Impact of maternal lateral tilt on cardiac output during caesarean section under spinal anaesthesia. Other Parameters monitored are Heart Rate, Stroke volume, Stroke volume index, Cardiac index, Systemic Vascular Resistance, Systemic Vascular Resistance Index, Mean arterial Pressure, Systolic Blood Pressure and Diastolic Blood Pressure. We found that Cardiac Output did not decrease significantly after LUD removal in patients under SA for Cesarean delivery during continuous hemodynamic monitoring. Optimization of fluid and vasopressor therapy may be sufficient to prevent aorto-caval compression by the gravid uterus and the consequent reduction of venous return after SA for Cesarean delivery. LUD did not show a significant impact on Cardiac Output during...
continuous hemodynamic monitoring after SA for Cesarean delivery.

**Limitation**

Firstly, its design does not include a control group but patients act as their own control after LUD removal before and after SA. On the other hand, the continuous hemodynamic monitoring allowed to better evaluate the impact of LUD on Cardiac Output with standard anesthetic management, correcting for inter-individual variables.

**CONCLUSION**

Cardiac Output did not decrease significantly after LUD removal in patients under SA for Cesarean delivery during continuous hemodynamic monitoring. Optimization of fluid and vasopressor therapy may be sufficient to prevent aorto-caval compression by the gravid uterus and the consequent reduction of venous return after SA for Cesarean delivery.

**REFERENCES**

1. Howard BK, Goodson JH, Mengert WF. Supine hypotensive syndrome in late pregnancy. Obstet Gynecol. 1953;1:371–7.
2. Asmussen E, Christensen EH, Neilsen M. Regulation of circulation in different postures. Surgery. 1940;8:604–7.
3. Scott DB. Inferior vena caval occlusion in late pregnancy and its importance in anaesthesia. Br J Anaesth. 1968;40:120–8.
4. Kinsella SM, Lohmann G. Supine hypotensive syndrome. Obstet Gynecol. 1994;83:774–88.
5. Lee AJ, Landau R. Aortocaval Compression Syndrome: Time to Revisit Certain Dogmas. Anesth Analg. 2017;125(6):1975–85.
6. Holmes F. The supine hypotensive syndrome: 1960. Anaesthesia. 1995;50:972–7.
7. Goodlin RC. Aortocaval compression during cesarean section: A cause of newborn depression. Obstet Gynecol. 1971;37:702–5.
8. Crawford JS, Burton M, Davies P. Time and lateral tilt at Cesarean section. Br J Anaesth. 1972;44:477–84.
9. Jones SJ, Kinsella SM, Donald FA. Comparison of measured and estimated angles of table tilt at Cesarean section. Br J Anaesth. 2003;90:86–7.
10. Aust H, Koehler S, Kuehnert M, Wiesmann T. Guideline-recommended 15° left lateral table tilt during cesarean section in regional anesthesiapractical aspects: An observational study. J Clin Anesth. 2016;32:47–53.
11. Lee AJ, Landau R, Mattingly JL, Meenan MM, Corradini B, Wang S, Goodman SR, Smiley R. Left Lateral Table Tilt for Elective Cesarean Delivery under Spinal Anesthesia Has No Effect on Neonatal Acid-Base Status. Anesthesiology. 2017;12:241–9.
12. Cluver C, Novikova N, Hofmeyr GJ, Hall DR. Maternal position during caesarean section for preventing maternal and neonatal complications. Cochrane Database Syst Rev. 2013;3:CD007623.
13. Lee SW, Khaw KS, Ngan Kee WD, Leung TY. Critchley LA. Haemodynamic effects from aortocaval compression at different angles of lateral tilt in non-labouring term pregnant women. Br J Anaesth. 2012;109:950–6.
14. Tsai S-E, Yeh PH, Hsu PK, et al. Continuous haemodynamic effects of left tilting and supine positions during Caesarean section under spinal anaesthesia with a noninvasive cardiac output monitor system. Eur J Anaesthesiol. 2019;36:72–4.
15. Chungsamarnyart Y, Wacharasint P, Carvalho B. Hemodynamic profiles with and without left uterine displacement: A T randomized study in term pregnancies receiving subarachnoid blockade for cesarean delivery.J Clin Anesth. 2020;64:109796.
16. Chiara Sonnino* , Luciano Frassanito, Alessandra Pierantoni, Pietro Paolo Giuri, Bruno Antonio Zanfini, Stefano Catarci and Gaetano Draisci I. Impact of maternal lateral tilt on cardiac output during caesarean section under spinal anaesthesia BMC Anesthesiology (2022) 22:103 https://doi.org/10.1186/s12871-022-01640-6.