Protocol title: Comparison of Arm and Ankle Blood Pressure during Cesarean Delivery: A Blood Pressure Cuffs Pilot Study

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Comparison of Arm and Ankle Blood Pressure during Cesarean Delivery: A Blood Pressure Cuffs Pilot Study

BACKGROUND AND SIGNIFICANCE

A literature search found the incidence of hypotension after subarachnoid block (SAB) varied between 7.4% and 74.1%,[1] while another recent publication discovered the incidence of hypotension to be 5.4%.[2] There is a large variation of definitions used for intraoperative hypertension (IOH) in anesthesia literature. The relationship between these definitions and the incidence of IOH is depicted in Figure 1.[3]

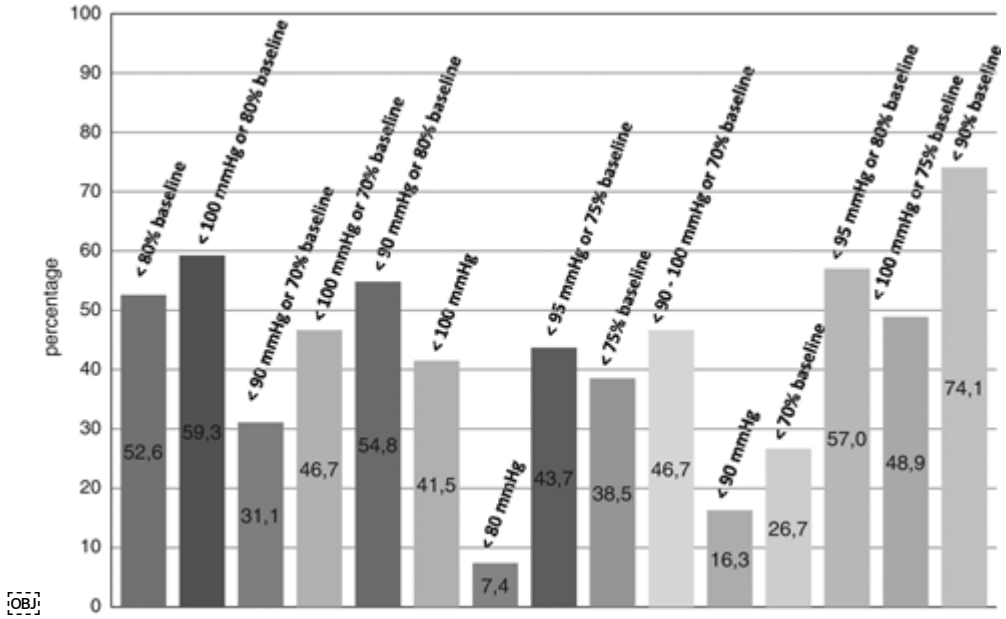

Figure 1. Incidences of hypotension after SAB and the definitions of hypotension

In the last three decades, numerous interventions have been studied and implemented into our daily practice, such as pre-loading versus co-loading, phenylephrine versus ephedrine, and phenylephrine infusion versus intermittent boluses. In addition, the effectiveness of left uterine displacement (LUD) to improve blood flow and pressure remains unclear. Also, there are issues to be addressed on this regard, including:

1. Poor placental perfusion from inadequate LUD due to the potential impact of supine hypotensive syndrome (SHS) secondary to aortocaval compression especially after SAB;
2. Shivering during cesarean delivery (CD) resulting in inaccurate BP measurements, the incidence of shivering during CD is reported to be 21.9%.[4] It is unclear the impact of shivering during CD on blood pressure (BP) measurements;
3. Patient discomfort during BP measurements, calf > arm > ankle.[5]

One study concluded there is poor correlation between arm and calf BP. They found calf BP was higher than arm BP, with an average difference in SBP of 18.3 ± 18.6 (95% CI: 14.0~22.6) before spinal anesthesia and

14.2 ± 21.0 (95% CI: 9.4~19.1) before incision/after spinal, and average difference in MAP of 4.8 ± 11.8 (95% CI: 2.1~7.6) before spinal anesthesia and 0.1 ± 13.6 (95% CI: 2.1~7.6) before incision/after spinal anesthesia.[6] In contrast, another study of healthy non pregnant volunteers demonstrated insignificant differences in average SBP differences (22.4 [95% CI: -2.7~47.4]) and average MAP differences (3.7 [95% CI: -12.3~ 19.7]) among both ankles and arm.[5] A recent study reported the incidence of maternal systolic hypotension at 5 min post-SAB to be 16.7% in the LUD group and 53.3% in the non-LUD group.[7] However, imaging findings have not existed in MRI studies with low risk parturients but possible at high-risk for SHS [8, 9] who may benefit from LUD and other aggressive preventive measures to avoid undesired consequences.[10, 11]

Nevertheless, none of studies have discussed issues related to SAB, LUD, SHS, and differences of between arm and ankle BP comprehensively. There are also the issues of sidedness of ankle BP measurements, as LUD tilts the body to the left side which may contribute to differences between arm and ankle BP.

Specific Aims

- To validate the effectiveness of LUD after SAB with simultaneous measurements of BP on the arm and left ankle during surgery in patients undergoing cesarean delivery (CD) at The Ohio State University Wexner Medical Center
- To determine whether ankle BP correlates more accurately than arm SBP with the incidence of nausea/vomiting and category II or III fetal heart tracing and bradycardia after SAB and LUD under no shivering conditions in patients undergoing C-Section at The Ohio State University Wexner Medical Center
- To determine the impact of body mass index and antepartum estimation of newborn weight on SHS[12] after the SAB

MATERIALS AND METHODS

Location:
The OSUWMC Labor & Delivery

Null Hypothesis:
The magnitude of the differences in arm and ankle SBP is consistent before and after spinal anesthesia.

Study design:

A single center prospective self-control study.

Study population: eligibility will be determined by the inclusion/exclusion criteria specified below. After eligibility has been confirmed, data from up to 100 subjects will be enrolled.

Inclusion Criteria:

a. Age ≥ 18 years old

b. Women undergoing cesarean delivery at The Ohio State University Wexner Medical Center under spinal anesthesia
c. American Society of Anesthesiologists Physical Status I-III
d. Body mass index during pregnancy ≥ 35 kg/m^2
e. Able to consent in English language
f. Singleton pregnancy

Exclusion criteria:

a. Women undergoing elective cesarean delivery at The Ohio State University Wexner Medical Center under anesthesia other than spinal anesthesia (i.e. general and/or epidural anesthesia)
b. Prisoners

Sample size:

For this pilot study, a sample size of 100 patients will offer valuable information on clinical outcomes for future randomized clinical trials on blood pressure monitoring in patients undergoing C-Section under SAB.

Outcomes:

- Primary outcome: difference of SBP measured between arm and ankle during elective CD before and after (pre-incision) SAB

- Secondary outcomes: incidence of nausea, vomiting and shivering, estimated blood lost, blood transfusion (e.g. packed red blood cells units), category II or III fetal heart tracing, fetal bradycardia, APGAR at 1 min and 5 min, neonatal intensive care unit admission rate, SBP differences between arm and ankle before and after LUD performed in before surgery and anesthesia (baseline), after spinal anesthesia, after the fetus delivered

Statistics:

Maternal and newborn parameters (e.g. age, weight, height, body mass index, gravida and parity, gestational age, newborn weight, and high-risk obstetrics factors), clinical parameters (e.g. degree of tilt, compression, and incidence of shivering) will be summarized using descriptive statistics (mean/standard deviation, median/IQR, frequencies/proportions) based on data characteristics.

In addition, descriptive statistics will be used to summarize differences between arm and ankle blood pressures taken at different time-points. Multivariable linear regression models will be used to evaluate associations between changes in the magnitude of difference in SBP/MAP measures from different time-points taking clinical factors such as degree of tilt, compression, shivering, and baby weight into account.

A Bland-Altman plot for arm and left ankle paired SBP taken during CD under spinal anesthesia will be created to identify bias and estimate 95% agreement limits.[6, 14, 15, 16] SBP and MAP will be obtained at 6 data collection points preoperatively/pre-spinal with and without LUD, after SAB in supine position and LUD, and right after the fetus delivery in LUD, and supine after the delivery.

Data collection:

1. Demographic data: age, weight, height, gestational age, newborn weight, HROB factors, locations of placenta, past medical history (i.e. cardiovascular disease), and circumferences of arm and ankle for BP measurements
2. Systolic and Mean Arterial Blood Pressure: measured concomitantly at different time points on arm (standard of care) and left ankle (research purposes)
    a. Pre-spinal: supine and after LUD with 15° tilt [17] (≥ 1 measurement as required by standard of care)
    b. Post-spinal: supine and after LUD (≥ 1 measurement as required by standard of care)
    c. After delivery: supine and after LUD (≥ 1 measurement as required by standard of care)
    d. Incidence of intraoperative shivering, nausea/vomiting, category II or III fetal heart tracing, fetal Bradycardia, intubation, and neonatal intensive care unit admission after cesarean delivery
3. Newborn's clinical variables documented in the medical records as standard of care (e.g. heart rate and APGARs at 1 min and 5 min)
4. Cord blood pH (if performed by standard of care)

Study procedures:

- Cuff size: large BP cuffs will be the default size for both arm and ankle measurements, but can be changed as clinically indicated based on circumferences of limbs
- Cuff location: BP cuffs will be placed on the contralateral arm to the main peripheral IV following standard procedures. Left ankle cuff will be placed underneath intermittent pneumatic compression cuffs
- Spinal anesthesia will be administered following standard of care anesthesia management for patients undergoing cesarean delivery at The OSUWMC
- Hypotension avoidance strategies (e.g. phenylephrine infusion beginning at 50 mcg/kg/min) will be implemented per anesthesia provider clinical criteria
- Fetal monitoring will be implemented as required by standard of care practices in patients undergoing cesarean delivery at The OSUWMC

- Ankle blood pressure monitor screen will be covered. Thus, anesthesia providers will not be able to make any clinical decisions based on ankle blood pressures but arm blood pressure (standard) instead.

ANTICIPATED IMPACT

Placement of BP cuffs on left ankle during CD after SAB may become standard of care and provide more comfort than the current standard of care. The difference between SBP or MAP in patients positioned supine and after LUD before SAB may become a simple method to identify parturients at high-risk for SHS and prevent perioperative complications.

ADVERSE EVENTS OR UNANTICIPATED PROBLEMS INVOLVING RISK TO PARTICIPANTS OR OTHERS

Any patient privacy/confidentiality breach will be recorded and reported following our Institutional Review Board (IRB) guidelines.

RISKS

No research-related invasive monitoring techniques/procedures are required in our study. Blood pressure values will be collected during surgery by IRB approved researchers. Demographics and past medical history will be collected from electronic medical records as documented per **standard of care** by health care providers. Breach of confidentiality is the only recognized risk. To protect patient privacy, a limited data set will be created. During data collection, team members will remove any patient identifiers except for the codified database which will be stored on a password secured OSUWMC server. Moreover, any paper documents will be locked in our research's office (Department of Anesthesiology, Clinical Research Office, The OSUWMC). All data will only be available to the PI and designated research personnel.

PRIVACY/CONFIDENTIALITY ISSUES

All reasonable efforts will be made to keep a patient's protected health information (PHI) private and confidential. There will be limited access to medical records and codification of all records. Federal privacy guidelines will be followed when using or sharing PHI.

Data will be stored electronically in our Department encrypted L-drive which is password protected and available only to IRB approved research personnel working on this study. The Ohio State University PCs have been compatible to the latest institutional Information System security policies. Computer databases will be maintained on password protected OSUWMC PCs at the Clinical research Office, Department of Anesthesiology (410 W 10th Ave. Doan Hall 520, Columbus, OH 43210).

All study staff have completed required institutional education regarding patient confidentiality, Good Clinical Practices, Human Subjects Protection and Responsible Conduct of research trainings as required by Office of Responsible Research Practices (ORRP).

RECORD RETENTION

Research Records will be retained for a period of six (6) years after the submission of the final report and close-out procedures on the research project for which the Research Records were prepared. The retention of the original Research Records shall be the responsibility of the Principal Investigator.

REFERENCES

1. 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 Anaesthesiologica Scandinavica. 2010 Sep;54(8):909-21

2. Hartmann B, Junger A, Klasen J, Benson M, Jost A, Banzhaf A, Hempelmann G. The incidence and risk factors for hypotension after spinal anesthesia induction: an analysis with automated data collection. Anesthesia & Analgesia. 2002 Jun 1;94(6):1521-9.

3. Bijker JB, van Klei WA, Kappen TH, van Wolfswinkel L, Moons KG, Kalkman CJ. Incidence of intraoperative hypotension as a function of the chosen DefinitionLiterature definitions applied to a retrospective cohort using automated data collection. Anesthesiology: The Journal of the American Society of Anesthesiologists. 2007 Aug 1;107(2):213-20.

4. Wódarski B, Chutkowski R, Banasiewicz J, Moorthi K, Wójtowicz S, Malec-Milewska M, Iohom G. Risk factors for shivering during caesarean section under spinal anaesthesia. A prospective observational study. Acta Anaesthesiologica Scandinavica. 2020 Jan;64(1):112-6.

5. Moore C, Dobson A, Kinagi M, Dillon B. Comparison of BP measured at the arm, ankle and calf. Anaesthesia. 2008 Dec;63(12):1327-31.

6. Zahn J, Bernstein H, Hossain S, Bodian C, Beilin Y. Comparison of non-invasive BP measurements on the arm and calf during cesarean delivery. Journal of clinical monitoring and computing. 2000 Nov 1;16(8):557-62

7. Chungsamarnyart Y, Wacharasint P, Carvalho B. Hemodynamic profiles with and without left uterine displacement: A randomized study in term pregnancies receiving subarachnoid blockade for cesarean delivery. Journal of Clinical Anesthesia. 2020 Sep 1;64:109796.

8. Higuchi H, Takagi S, Zhang K, Furui I, Ozaki M. Effect of lateral tilt angle on the volume of the abdominal aorta and inferior vena cava in pregnant and nonpregnant women determined by magnetic resonance imaging. Anesthesiology: The Journal of the American Society of Anesthesiologists. 2015 Feb 1;122(2):286-93.

9. Kienzl D, Berger-Kulemann V, Kasprian G, Brugger PC, Weber M, Bettelheim D, Pusch F, Prayer D. Risk of inferior vena cava compression syndrome during fetal MRI in the supine position–a retrospective analysis. Journal of perinatal medicine. 2014 May 1;42(3):301-6.

10. Mendonca, C , Griffiths, J , Ateleanu, B , Collis, RE. Hypotension following combined spinal-epidural anaesthesia for Caesarean section: left lateral position vs, tilted supine position. Anaesthesia 2003; 58:428–431.

11. Ngan Kee, WD , Khaw, KS , Ng, FF. Prevention of hypotension during spinal anesthesia for cesarean delivery. An effective technique using combination phenylephrine infusion and crystalloid cohydration. Anesthesiology 2005; 103:744–750

12. De-Giorgio, F., Grassi, V. M., Vetrugno, G., d'Aloja, E., Pascali, V. L., & Arena, V. (2012). Supine hypotensive syndrome as the probable cause of both maternal and fetal death. Journal of forensic sciences, 57(6), 1646-1649.

13. Harvey NL, Hodgson RL, Kinsella SM. Does body mass index influence the degree of pelvic tilt produced by a Crawford wedge?. International Journal of Obstetric Anesthesia. 2013 Apr 1;22(2):129-32.

14. Ross VH, Dean LS, Thomas JA, Harris LC, Pan PH. A randomized controlled comparison between combined spinal-epidural and single-shot spinal techniques in morbidly obese parturients undergoing cesarean delivery: time for initiation of anesthesia. Anesthesia & Analgesia. 2014 Jan 1;118(1):168-72.

15. Drake MJ, Hill JS. Observational study comparing non-invasive BP measurement at the arm and ankle during caesarean section. Anaesthesia. 2013 May;68(5):461-6.

16. Sanghera S, North A, Abernethy S, Wrench I. Arm and ankle BP during caesarean section. International Journal of Obstetric Anesthesia. 2006 Jan 1;15(1):24-7.

17. Rees, SGO , Thurlow, JA , Gardner, IC , Scrutton, MJL , Kinsella, SM. Maternal cardiovascular consequences of positioning after spinal anaesthesia for Caesarean section: left 15° table tilt vs. left lateral. Anaesthesia 2002; 57:15–20.