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ORIGINAL ARTICLE

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The impact of spinal anaesthesia for caesarean delivery on coagulation assessed by thromboelastography

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ABSTRACT

Background: Pregnancy and puerperium are associated with a hypercoagulable state. The aim of the study was to assess the impact of spinal anaesthesia on coagulation using thromboelastography in healthy term pregnant women undergoing elective caesarean delivery.

Methods: Thromboelastography was performed on 60 women undergoing elective caesarean delivery under spinal anaesthesia. As spinal anaesthesia has different effects on upper and lower extremity vasculature, venous blood samples were collected from both hand and foot, before and one hour after spinal injection.

Results: In the hand samples, R and K values decreased significantly from before to one hour after spinal injection (5.7 ± 1.9 min versus 3.6 ± 1.3 min, $P < 0.001$ and 2.1 ± 0.9 min versus 1.5 ± 0.4 min, $P < 0.001$, respectively). At the same times, significant increases in the alpha angle (58.6 ± 9.1 degrees versus 65.6 ± 7.5 degrees, $P < 0.001$), MA (85.1 ± 4.6 mm versus 87.0 ± 3.8 mm, $P < 0.001$) and CI (2.6 ± 2.1 versus 4.9 ± 1.5, $P < 0.001$) were seen. No significant changes were found in thromboelastography parameters in samples collected from foot veins before and one hour after spinal injection, with the exception of the alpha angle (62.1 ± 11.5 versus 66.5 ± 8.8 degrees, $P < 0.012$).

Conclusion: In women undergoing caesarean delivery under spinal anaesthesia, enhanced coagulation thromboelastography parameters were observed in blood collected from hand veins. No changes were detected in the majority of parameters collected from the foot. Spinal anaesthesia has different effects on coagulation parameters in the hand and foot in pregnant women undergoing caesarean delivery.

Keywords: Caesarean delivery; Blood coagulation; Thromboelastography; Spinal anaesthesia

Introduction

Pregnancy and puerperium are associated with a hypercoagulable state attributed to decreases in antithrombin III, proteins C and S, decreased plasma fibrinolytic activity, increased activity of coagulation factors, and enhanced platelet aggregation.[1] Thromboelastography (TEG) has been used to describe the coagulation state in different obstetric situations: in healthy pregnant women, pre-eclampsia, eclampsia, and postpartum healthy women.[2–5] TEG does not discriminate between platelet aggregation, platelet activation, fibrinogen concentrations, and plasmin–antiplasmin or thrombin–antithrombin complexes. Nevertheless, the test is useful in monitoring the overall coagulation state of a single blood sample, and in surgical patients allows assessment and treatment of coagulation disorders while avoiding empirical interventions.[6] It has also demonstrated that coagulation is unchanged after caesarean delivery with spinal or epidural anaesthesia.[7]

Perioperative hypercoagulability at the time of caesarean delivery may impart higher risk to women after general anaesthesia when compared to neuraxial anaesthesia.[3] In a meta-analysis that included 141 trials of general surgery, vascular surgery, urology, obstetrics, gynaecology and orthopaedics, central neuraxial anaesthesia was associated with a lower incidence of deep vein thrombosis and pulmonary embolism.[8] Spinal anaesthesia influences the sympathetic innervation and therefore blood flow in the upper and lower extremities is expected to differ. When administered as part of an anaesthetic technique in abdominal surgery, epidural drug administration increased the mean velocity at the popliteal vein during surgery and recovery.[9]

We hypothesized that spinal anaesthesia in women undergoing caesarean delivery would attenuate hypercoagulability, as assessed by TEG, before and one hour after induction of anaesthesia. We further hypothesized that the effect may be exerted differently in the lower extremity (exposed to the changes produced by spinal anaesthesia) than in the upper extremity.

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Methods

Approval for this study was obtained from the Institutional Review Board of the Aretaieio University Hospital, Athens, Greece. Sixty healthy, American Society of Anesthesiologists physical status I or II women with singleton term pregnancies scheduled for elective caesarean delivery were recruited. All women gave written informed consent to participate, allowing blood sample collection from the hand and foot before, and one hour after, spinal injection. Exclusion criteria were pre-eclampsia or eclampsia, thrombophilia, and women receiving anticoagulants or with known coagulation disorders. We also excluded women with a body weight increase of 20 kg or more during pregnancy because coagulation changes related to obese parturients have been identified.[10] Indications for caesarean delivery were previous caesarean delivery, breech presentation, oligohydramnios, previous myomectomy, patient request and intrauterine fetal growth restriction.

In the operating room patients were positioned supine with 15 degree left uterine displacement. Each received three separate intravenous catheters: one 16-gauge in the hand, one 18-gauge in the contralateral hand and an 18-gauge in the foot. Standard monitoring, consisting of oxygen saturation, electrocardiogram, and non-invasive blood pressure, was applied to all patients (Datex-Ohmeda S/5™ Anaesthesia Monitor, Helsinki, Finland). Preoperatively all patients received intravenous metoclopramide 10 mg and ranitidine 50 mg. Lactated Ringer's solution 500 mL was given as a fluid co-load. After skin infiltration with 2% lidocaine, an 18-gauge Tuohy needle was introduced into the epidural space at the L2–3 or L3–4 level, through which a 27-gauge spinal needle was inserted into the subarachnoid space. When free flow of cerebrospinal fluid was observed, 0.75% ropivacaine 1.8–2.0 mL was injected. The spinal needle was removed and an epidural catheter advanced 3–4 cm into the epidural space for postoperative analgesia. The level of sensory block was determined using cold and pinprick perception. All patients received an intravenous dose of second-generation cephalosporin before skin incision. A sensory block, defined by loss of pinprick sensation at the T4 dermatome in a caudad to cephalad direction, was considered adequate for surgery to proceed. After delivery, all patients received oxytocin as a 3-IU slow bolus followed by an infusion of 15 IU in Ringer's lactate solution 1000 mL given over 24 h. After skin closure all patients were transferred to the post-anaesthesia care unit.

Blood samples were taken from the right-hand cannula and intravenous fluid and drugs were administered into the left-hand cannula; the blood pressure cuff was also placed on the left arm. Blood was collected from each catheter using a two-syringe technique, with the initial 4–5 mL of withdrawn blood discarded to avoid tissue contamination. The same technique was used to collect blood from the upper and lower limbs. Tourniquets were not used. The first blood samples were collected simultaneously from the hand and foot before the spinal injection. The co-loading infusion which began after collection of the first samples from hand and foot, was standardized for all patients and was included in the 1500 mL of crystalloid fluids administered during surgery. The flow rate was adjusted manually. The second blood samples were collected 1 h after spinal injection, before the block wore off, but during abdominal wall closure. Hypotensive episodes, defined as a systolic arterial pressure $\leqslant$90 mmHg, were treated with intravenous ephedrine and/or phenylephrine.

Immediately after sampling, 1 mL of native whole blood was added to a kaolin vial (TEG® Hemostasis Analyzer Kaolin, Haemoscope Corporation, Niles IL, USA) and mixed according to the manufacturer's guidelines. Subsequently, 360 μL of the blood/kaolin mixture were pipetted into disposable plastic cups (Disposable Cups and Pins, TEG® Hemostasis Analyzer) and placed in a pre-warmed (37°C) TEG® machine. Samples collected from hand and foot were analyzed simultaneously using both channels of a TEG® 5000 (Haemoscope Corporation, Niles IL, USA) and Version 4.2.3 TEG® Analytical Software (TAS™). The physician who performed the TEG analysis was blinded to the sample origin.

The coagulation parameters recorded included the reaction time (R), representing the time from the beginning of measurement until the initial fibrin formation (normal values 4–8 min), the K-time (K), representing the time from the end of R (beginning of clot formation) until a fixed level of clot firmness is reached (normal values 0–4 min), the α angle, formed by the slope of the TEG tracing from the R to the K value and denoting speed at which solid clot forms (normal values 47–74°), the maximum amplitude (MA), which reflects the strength of the clot (normal values 54–72 mm). These parameters are directly measured by the thromboelastograph.[11] The coagulation index (CI), which describes the patient's overall coagulation derived from the R, K, angle α and MA was also recorded (normal values -3 to $+3$).[11]

Statistical analysis

It was felt that a change of 25% in MA would represent a clinically significant difference. Initial sample size estimation showed that 43 patients were needed to detect a difference of 25% in MA with a power of 0.80 and level of significance of 5%. Sixty patients were included to allow for dropouts due to technical or medical reasons. Parametric paired t tests were used to assess differences between the two time points (before and after spinal injection) for normally distributed measures, and