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ORIGINAL ARTICLE

A study of factors influencing surgical cesarean delivery times in an academic tertiary center

A. Gonzalez Fiol,[a] M-L. Meng,[b,#] V. Danhakl,[b] M. Kim,[b] R. Miller,[c] R. Smiley[b]
[a]*Department of Anesthesiology, Yale University School of Medicine, New Haven, CT, USA*
[b]*Department of Anesthesiology, Columbia University College of Physicians and Surgeons, New York, NY, USA*
[c]*Department of Obstetrics and Gynecology, Columbia University College of Physicians and Surgeons, New York, NY, USA*

ABSTRACT
Background: Knowledge of hospital-specific average cesarean delivery operative times, and factors influencing length of surgery, can serve as a guide for anesthesiologists when choosing the optimal anesthetic technique. The aim of this study was to determine operative times and the factors influencing those times for cesarean delivery.
Methods: We conducted a retrospective review of all 1348 cesarean deliveries performed at an academic hospital in 2011. The primary outcome was mean operative time for first, second, third and fourth or more cesarean deliveries. The secondary goal was to identify factors influencing operative time. Variables included age, body mass index, previous surgery, gestational age, urgency of cesarean delivery, anesthesia type, surgeon's seniority, layers closed, and performance of tubal ligation.
Results: Mean (standard deviation) operative times for first (n=857), second (n=353), third (n=108) and fourth or more (n=30) cesarean deliveries were 56 (19), 60 (19), 69 (28) and 82 (31) minutes, respectively ($P<0.0001$, all groups different). Emergency status of the case and later gestational age were associated with shorter operative times. Higher body mass index, a less senior surgeon, the number of layers closed, and tubal ligation, increased operative times. These factors accounted for 18% of the variability.
Conclusions: Third and fourth cesarean delivery or the presence of other factors that could increase operative time may warrant catheter-based anesthetic techniques or the addition of adjunctive medications to prolong spinal anesthetic block. Institutional and individual surgeon factors may play an even more important role in determining surgical time.

Keywords: Cesarean delivery; Neuraxial anesthesia; Operative time

Introduction

Cesarean delivery (CD) is the most common surgical procedure performed in the United States, and neuraxial anesthesia is the preferred anesthetic technique for CD.[1,2] The preference for neuraxial anesthesia for CD is due to increased morbidity and mortality associated with general anesthesia (GA) for CD.[3] General anesthesia is usually reserved for patients with contraindications to neuraxial anesthesia, for cases requiring rapid induction of anesthesia and for cases in which the neuraxial anesthesia has ceased working or failed. In order to avoid an unplanned conversion from neuraxial anesthesia to GA, the neuraxial technique chosen (spinal, epidural or combined spinal-epidural [CSE]) must take into consideration patient features (e.g. body mass index (BMI)),[4] the surgeon,[5] and other factors that may impact cesarean delivery operative times.

Factors affecting CD times, such as the surgeon's experience, the patient's BMI and race/ethnicity, the fetal gestational age, a history of a previous CD, concurrent bilateral tubal ligation, previous abdominal surgery other than CD, the CD indication and urgency, and the type of uterine incision (vertical versus low transverse), have been described[4,6,7] but differences in practices exist that make such results only moderately generalizable. In this single-center study, our primary aim was to determine institutional operative times for first, second, third and fourth or more CDs at our institution, which is a tertiary/quaternary care urban academic medical center.

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Corresponding author at: A. Gonzalez Fiol, Department of Anesthesiology, Yale University School of Medicine, 333 Cedar Street, New Haven, CT 06510, USA.
E-mail address: antonio.gonzalez-fiol@yale.edu
[#] Co-first author.

A secondary aim was to define and quantify institutional factors that influence operative times and anesthetic preferences among providers.

Methods

After Institutional Review Board approval, a retrospective review of all CDs performed from January 2011 to December 2011 was conducted. A total of 1348 CDs were performed in the defined study period. Using electronic anesthesia records and electronic medical records, patient data were collected and factors that might plausibly affect CD operative times were analyzed. Data collected included age, height, BMI, number of previous CDs, previous abdominal surgery, gestational age, trial of labor, urgency status, type of anesthesia, number of surgeons and level of training of the primary operating surgeon, anatomic layers closed and type of surgical closure, and performance of tubal ligation.

Total time from skin incision to time of skin closure was defined as the operative time. Cases were defined as elective CD or emergency CD. Elective CD included all cases performed as scheduled for the day, i.e. on the printed schedule. All non-scheduled CD were considered "emergency" cases. Surgeon experience was categorized using three groups that reflected the surgeon's level of training. Group 1 consisted of physicians in the first or second postgraduate year (PGY), group 2 consisted of surgeons in the third or fourth PGY and group 3 consisted of maternal fetal medicine fellows, attending physicians or physician assistants. At our institution, groups 1–3 (excluding physician assistants), as described above, perform surgery as primary surgeons under the direct supervision of the admitting attending. Under certain circumstances, for example in early July, the admitting attending will act as the primary surgeon, whereas the PGY1 will mainly act as the assistant. The same applies for any surgical technique for which the admitting attending deems that the training physician is not equipped or skilled enough to perform. Operative reports were examined to identify the anatomical layers closed (Camper's fascia, Scarpa's fascia, muscle or peritoneum) and type of surgical closure (subcuticular versus staples). Additionally, the need to excise or revise a previous scar incision, if present, was noted.

Statistical methods and analysis

Data are presented as mean (± standard deviation (SD)). The effects of first versus number of previous CDs on surgical times were compared by ANOVA. After the ANOVA, the means were compared using the Scheffe's test post hoc test. Other variables that could affect CD time were analyzed for an association with CD time with bivariate analysis. All factors with $P < 0.2$ for association were added to a linear regression model and those with $P < 0.05$ in the combined model, were retained in the final model. A t-test was performed to compare the association of type of anesthesia (CSE anesthesia versus spinal), and academic time of year (January–June versus July–December) on operative times.

Results

Over the study time period of January 2011 to December 2011, 1348 CD cases were analyzed. The operative times of 857 first, 353 second, 108 third and 30 fourth or more CDs were assessed. Total operative time in minutes was 56 (±19), 59.9 (±19), 69.3 (±28), and 81.7 (±31) for first, second, third and fourth or more cesarean deliveries respectively. Skin to uterine incision times were 9 (±4), 13 (±6), 15 (±6) and 17 (±9) min (Fig. 1). All groups were statistically significantly different from each other for both outcomes ($P < 0.0001$, Fig. 1). When comparing all emergency versus elective CD, a 3.5 min difference was noted ($P=0.0004$). However no difference was noted when comparing elective versus emergency CD within the first, second, third or fourth or more CD groups. No significant difference was noted when comparing operative times between the first and last six months of the academic year: (59.5 (±20) min and 57.9 (±22) min respectively ($P=0.16$).

Spinal anesthesia was the most commonly used method of anesthesia for elective first and second CDs, whereas a catheter-based technique (CSE) was preferred for third and fourth or more CDs. A total of 93 cases had operative times ≥90 minutes. Of these cases with long operative times, 29 were first CD, 33 were second CD, 22 were third CD and 9 were fourth cesarean deliveries. Detailed data for type of anesthesia are presented in Table 1. Combined spinal-epidural techniques were associated with longer operative times [65 (±25) min] when compared to epidural [55 (±18) min] and spinal anesthetic techniques [57 (±18) min], both $P < 0.0001$.

Linear regression demonstrated that BMI, performance of tubal ligation, closure of Camper's and/or Scarpa's fascia and less surgical experience contributed to increased operative times (Table 2).

Body mass index was noted to increase operative time by approximately two minutes per 10 BMI points ($\beta = 0.23$ 95% CI 0.07 to 0.38, $P=0.01$). The addition of a tubal ligation added approximately seven minutes of operative time ($\beta = 6.73$, 95% CI 3.13 to 10.34, $P=0.00$). Closure of Camper's/Scarpa's fascia increased operative time by seven minutes ($\beta = 7.06$ 95% CI 5.0 to 9.2, $P=0.00$). When the most junior surgeon assisting the primary attending was a PGY1 or PGY2, the operative time was increased by 14 minutes when compared to cases where the first assistant was an attending, fellow or physicians assistant ($\beta = 14$ 95%, CI 11.1 to 16.8, $P=0.00$). Similarly, the operative time was increased by approximately five minutes when an attending oper-

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