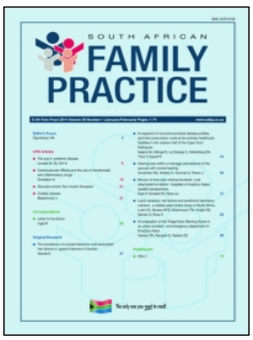

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RESEARCH

Factors associated with failed spinal anaesthesia for Caesarean sections in Mthatha general hospital, Eastern Cape, South Africa

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Background: The use of spinal anaesthesia has increased in the last three decades, given that it is the recommended anaesthetic of choice for better foetal and maternal outcomes in Caesarean section. Failed spinal anaesthesia (FSA) exposes patients to unfavourable experience of pain and the potential complications of general anaesthesia that are being avoided in the first instance. This study determines the incidence and the predictors of failed spinal anaesthesia in pregnant women presenting for Caesarean section at Mthatha General Hospital, Eastern Cape.
Methods: This descriptive cross-sectional study included 197 pregnant women scheduled for Caesarean section under spinal anaesthesia at Mthatha General Hospital from May 1 to August 30, 2013. A standard proforma was utilised for data collection on items of demographic, surgical and anaesthetic records of each parturient. The main outcome measure was the incidence of failed spinal anaesthesia (defined as partial or incomplete spinal block requiring conversion to general anaesthesia).
Results: The incidence of failed spinal anaesthesia was 11.7%, which was slightly higher in emergency Caesarean sections. In univariate analysis, previous anaesthesia, obesity, dry tap of cerebrospinal fluid (CSF), bloody CSF and duration of work experience less than one year were significantly associated with FSA in the cohort.
Conclusion: The study found a high incidence of failed spinal anaesthesia during Caesarean section in this setting. Upskilling of doctors in spinal anaesthesia is urgently needed in the study setting.

Keywords: blocked height, bloody CSF, Caesarean section, spinal anaesthesia failure, South Africa

Introduction

Globally, there is an increasing Caesarean section rate, and spinal anaesthesia is the anaesthetic of choice for this operative procedure.[1] In South Africa, the Caesarean section rate increased by 6.3% between 2001 and 2009[2] with spinal anaesthesia being the most common method of anaesthesia in district and regional hospitals in the country.[3,4] Previous studies have shown the safety of this method over general anaesthesia[1,5,6] but spinal anaesthesia is not without complications. One disadvantage of spinal anaesthesia is the possibility of failed spinal block.[7,8] Failed spinal anaesthesia (FSA) is defined as partial or incomplete spinal block requiring supplemental analgesia or conversion to general anaesthesia.[9]

The incidence of FSA varies from one country to another, from centre to centre and from time to time within the same centre. Kinsella *et al.*[6] reported an FSA rate of 6% in United States in 2008, which is similar to findings from Nigeria by Adenekan *et al.*[10] in 2011. However, there is limited information on the incidence of FSA in South Africa in the past two decades.

The success of spinal anaesthesia depends on the competence of the anaesthetic provider.[10,11] Many studies reported obesity as an independent predictor of FSA[7,12] while others found no association.[13,14] Other reported factors, which include inadequate concentration of anaesthetic agents in the cerebrovascular fluid (CSF) from the spinal needle being partly inside the subdural space or leakage of anaesthetic agents and displacement of the spinal needle from the subarachnoid space, contribute to FSA.[15]

In Eastern Cape Province, there is a paucity of data on the incidence and factors contributing to FSA among pregnant women undergoing caesarean section. This information will be relevant for prioritising training needs of doctors towards improving the clinical outcomes from Caesarean sections in the district hospitals in the province. The aim of the study was to determine the incidence of failed spinal anaesthesia in pregnant women presenting for Caesarean sections and to identify the contributory factor(s) to the failure in Mthatha General Hospital, Eastern Cape.

Method

Study area and design

A descriptive cross-sectional study at Mthatha General Hospital, a district hospital in the OR Tambo district, Eastern Cape, South Africa was conducted from May 1 to August 30, 2013.

Study population

The study population comprised pregnant women scheduled for Caesarean section, who had no contraindications to spinal anaesthesia and had already consented to Caesarean section. A total of 200 consecutive pregnant women were enrolled into the study.

Data collection

A previously validated data collection form adapted from Lamacraft *et al.*[8] was utilised to obtain relevant data for the study. All the lumbar punctures were performed in a seated position except for a woman presenting with a footling breech who received the anaesthetic in a lateral position. Quincke spinal needles sizes 27G, 25G and 22G were the only available type in the hospital during the study period. The lumbar punctures were performed using a midline approach at L2/3, L3/4 or L4/5 depending on provider preference. Bupivacaine in a concentration of 0.5% was used with the dose ranging from 1.8 ml to 2 ml being injected into the cerebrospinal space, and the pregnant women were positioned in the wedge supine position.

The provider used loss of cold and touch perception to assess the level of spinal block. Ice was applied above the patient clavicle as the reference point, and each patient was asked what she felt. Ice was then applied to the L1 dermatome, moving it cephalad until the patient could feel the cold sensation. The point at which the patient started feeling icy cold was documented as the block height. Any experience of pain and intervention instituted during the Caesarean section was also documented. After determination of the height of sensory block by the provider, the surgeon also tested for pain sensation using the non-tooth forceps to pinch the skin at the site of the incision. Those women experiencing pain after 10 min of administering spinal anaesthesia were classified as failed spinal anaesthesia, and intravenous ketamine was used solely as the anaesthetic agent. For those who experienced pain during the operation pethidine was administered, and if the pain persisted they received ketamine and were regarded as a failed spinal anaesthesia.

Ethical consideration

Ethical clearance was obtained from University of KwaZulu-Natal Ethical Review Committee (BE282/12) and Eastern Cape Department of Health. Written informed consent was obtained from the participants alongside the consent for Caesarean section.

Statistical analysis

Data were analysed by Statistical Package for Social Science (SPSS®) version 21 for Windows (SPSS Inc., Chicago, IL, USA). We employed simple descriptive statistics in the data analysis. Data were expressed as mean values ± standard deviations (SD) for continuous variables. Counts (frequency = *n*) and proportions (%) were reported for categorical variables. We compared proportions between groups of failed spinal anaesthesia and successful spinal anaesthesia with a chi-square test. Student's t-test was used to compare means between the groups. Significant associations between FSA and independent variables were computed by relative risk (RR) and 95% CI using chi-square tests. A p-value < 0.05 was considered statistically significant.

Results

Of the 197 parturients included in the final analysis, incomplete data for three were excluded. The mean age of parturients was 23.8 years (SD ± 5.5). Height ranged from 1.22 to 1.760 metres and weight ranged from 38.5 to 98 kg. The mean body mass index (BMI) was 27.5 kg/m^2 (SD ± 5.4). Table 1 provides the baseline characteristics of the participants.

Table 2 provides the procedure-related characteristics of the participants. Higher proportions of the participants underwent emergency Caesarean section, had had previous anaesthesia, had at least two or more needle puncture attempts and had lumbar puncture at the L3/L4 intervertebral disc during spinal anaesthesia (Table 2). The spinal anaesthesia was performed by 2 family physicians, 6 family medicine registrars, 10 medical officers and 2 community service doctors during the study period. Each of the doctors performed between 2 and 19 spinal anaesthetics; family physicians 19 (9.6%), registrars 80 (40.6%), medical officers 90 (45.7%) and community service doctors 8 (4.06%), respectively.

Table 1: Baseline characteristics of the pregnant women

Variables	Frequency, *n* (%)
Age (years)	
15–24	120 (60.9)
25–34	70 (35.5)
35–44	7 (3.6)
Mean height (metres)	1.58 (SD±0.064)
Mean weight (kg)	69.4 (SD±12.3)
BMI (kg/m^2)	
>30	50 (25.4)
25 to 29.9	78 (39.6)
18.5 to 24.9	65 (33)
< 18.5	4 (2.1)

Notes: BMI = body mass index, kg = kilogram, SD = standard deviation.

Table 2: Procedure-related variables

Variable	Frequency (%)
Emergency CS	154 (78.1)
Elective CS	43 (21.8)
Previous anaesthesia	
Yes	136 (69)
No	61 (31)
Needle puncture attempts	
1	79 (40.1)
2	87 (44.1)
3	31 (15.7)
Intervertebral space for LP	
L2/L3	7 (3.5)
L3/L4	169 (85.8)
L4/L5	21 (10.7)
Block height	
T4 to T5	158 (80)
T6 to T7	27 (13.7)
T8 to T10	3 (1.5)
None	9 (4.6)
Clear CSF	174 (88.3)
Bloody CSF	20 (10.2)
Free flow CSF	194 (98.4)
No free flow	3 (1.5)
Spinal needle size	
22G	151 (76.6)
25G	66 (33.5)

Note: CS = Caesarean section.

Table 3: Determinants of failed spinal anaesthesia

Variables	Incidence of FSA, *n* (%)	RR (95% CI)	*p*-value
Previous anaesthesia			
Yes	21/136 (15.4%)	4.7 (1.1–19.5)	0.014
No	2/61 (3.3%)		
Obesity (kg/m²)			
Yes	18/41 (43.9%)	13.7 (5.4–34.7)	<0.0001
No	5/156 (3.2%)		
Free flow of CSF			
Absent	2/3 (66.7%)	6.2 (2.5–15.1)	0.003
Present	21/194 (10.8%)		
Appearance of CSF			
Bloody	8/20 (40.0%)	7.2 (2.6–20.4)	<0.0001
Clear	15/177 (8.5%)		
Duration of work experience			
<1 year	3/7 (42.9%)	4.1 (1.6–10.5)	0.005
>1 year	20/170 (10.5%)		

Notes: FSA = failed spinal anaesthesia, RR = relative risk, CSF = cerebrospinal fluid, *n* = total number.

Incidence of failed spinal anaesthesia

The incidence of failed spinal anaesthesia (either no block or a block height less than T7) in our setting was 11.7% (*n* = 23) and higher among the emergency Caesarean section group (12.3%). However, there was no statistical difference in the incidence of FSA between those with or without previous spinal anaesthesia.

Factors associated with failed spinal anaesthesia

Table 3 shows the significant factors of failed spinal anaesthesia in the study sample.

Category and experience of doctors

Specialist family physicians performed one of the failed spinal anaesthesia incidents, registrars performed 9 (39.1%); medical officers performed 11 (47.8%); and the remaining 2 (8.7%) failed spinal anaesthetics were performed by community service medical officers (COSMO), respectively. However, the difference in the incidence of FSA by the cadre of doctors did not reach statistical significance ($p > 0.05$). The duration of experience of the doctors was a significant predictor of FSA (Table 3).

Positioning and lumbar puncture level

Nearly all the parturients (*n* = 196) had spinal anaesthesia conducted in the sitting position with 22 FSAs documented among them. One pregnant woman had spinal anaesthesia in the lateral decubitus position due to a footling breech presentation, which ended as FSA.

Seven pregnant women had a lumbar puncture at L2/L3 and all of these were successful. One hundred and forty-seven pregnant women had the lumbar puncture at the L3/L4 inter-vertebral space and the remaining 43 had it at L4/L5. There was a higher incidence of FSA among parturients with the lumbar puncture in the L3/L4 inter-vertebral space (14.2%) in comparison with L4/L5 (10.5%).

Number of skin punctures

Of the 79 parturients who had a single puncture attempt, 6 cases of FSAs (7.6%) were documented. Multiple skin punctures occurred in 60% of the parturients with FSA. Of 87 parturient who had two puncture attempts, 8 cases of FSA (9.2%) were documented, and the remaining 9 cases of FSA (29.0%) occurred in 31 parturients with three or more puncture attempts.

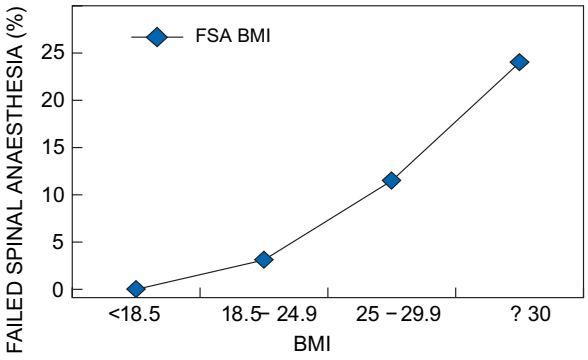

Figure 1: Body mass index and outcomes of spinal anaesthesia.

Cerebrospinal fluid flow and characteristics

Free flow of CSF before the injection of bupivacaine was documented in 194 parturients (98.5%) while there was a dry tap in 3 (1.5%) of the pregnant women, despite adjustment of the spinal needle.

Spinal needle

Of the 134 parturients (68%) who had lumbar punctures performed with size a 22G Quincke needle, 17 experienced FSA (12.7%). A size 25 G Quincke needle was used in 63 parturients with 6 FSA (9.5%).

Dose of bupivacaine

A dose of 1.8 or 2 ml of 0.5% hyperbaric bupivacaine was used depending on the provider's choice. Of the 151 parturients who received 2 ml of bupivacaine, 18 FSA were documented. FSA occurred in five of the 41 parturients who received 1.8 ml of bupivacaine.

Association of failed spinal anaesthesia with body mass index

Obesity was a significant factor in failed spinal anaesthesia (Table 3). There was a positive linear association between FSA and increasing BMI (Figure 1).

The following complications of spinal anaesthesia were reported hypotension (39.1%), shivering (16.2%), vomiting (6.9%), mortality (4.3%), pain (2.9%) and headache (2.9%).

Discussion

The study sought to determine the incidence and associated factors of failed spinal anaesthesia among pregnant women utilising Mthatha general hospital with a view to prioritising training needs of clinicians towards improving the care of patients. The incidence of failed spinal anaesthesia was 11.7% with a higher rate of 12.3% for emergency Caesarean section compared with elective Caesarean section of 9.35%. This therefore suggests that doctors performing spinal anaesthesia, especially for emergency Caesarean section, should anticipate the possibility of FSA and prepare adequately to convert to general anaesthesia.

The incidence of FSA in this study is higher than the rates recommended by the Royal College of Anaesthetists of less than 1% for elective and less than 3% for emergency Caesarean

section.[16] Currently, there are limited data on acceptable national standards for benchmarking FSA for district hospitals in South Africa, though the safety of mothers during Caesarean section has been advocated nationally. Benchmarking the indicators for successful spinal anaesthesia will have a significant impact on the post-spinal anaesthesia morbidity (painful experience) of pregnant women during Caesarean section. The incidence of FSA in this study is higher than the rates of 2.7, 6.0, and 0.5% reported in the UK, USA, and Singapore, respectively.[6,17,18] The difference in outcomes might reflect the level of care, skills of anaesthetists and health systems in those countries. However, the incidence of FSA in this study is similar to the 9.1% failure rate reported in University College Hospital, Ibadan, Nigeria.[19]

Our study was conducted over four months and involved 197 participants (small sample); hence, the findings should be interpreted with caution. Notwithstanding, the study identified the academic and training objectives for doctors in the hospital. Hyperbaric bupivacaine was used as a sole regional anaesthetic agent for all the pregnant women, unlike in other studies, where the use of opiates in combination with bupivacaine was associated with fewer cases of failed spinal block.[20] Perhaps the addition of low-dose fentanyl (opioid) to bupivacaine might have further reduced the incidence of FSA. Local protocols for the management of spinal anaesthesia might need revision in light of the high incidence of FSA reported in this study.

Bloody CSF from an initial attempt was significantly associated with FSA in our study. This finding has significant clinical and academic implications; there is a greater likelihood of inaccurate placement of the spinal needle into a vessel and, hence, higher FSA and other complications following intravascular injection of bupivacaine.

Three of the lumbar punctures did not have free flow CSF, and two of them had failed spinal block. There are mixed reports in the literature concerning the association of free flow of CSF and FSA. Munhall *et al.*[21] reported a lack of correlation between the free flow of CSF and FSA while Levy *et al.*[22] reported a significantly higher failure rate among patients who had a dry tap of CSF.

The age of pregnant women was not significant in predicting the incidence of failed block. This is contrary to the finding of Ruzman *et al.*[23] where first puncture success was associated with younger age. Yet Munhall *et al.*[21] reported an inverse relationship between patient's age and FSA. Obesity demonstrated a positive linear association with the incidence of FSA.

Obese pregnant women were at higher odds of resulting in FSA. Several reasons could be advanced for the higher incidence of FSA among obese pregnant women, such as the anatomical challenges of accessing the intervertebral disc and skills of the doctors performing the spinal anaesthesia. The obscured landmark in obese pregnant women makes the identification of the landmark for spinal anaesthesia difficult to locate.[24] However, some studies did not report any difficulty in performing spinal anaesthesia in obese pregnant women.[13,14]

The competency of doctors providing anaesthesia assessed by the clinical rank and duration of training in anaesthesia was not significant in our study. However, a significant association exists between duration of working in the hospital and FSA: doctors who have worked for less than one year were four times more likely to achieve FSA. This is true for the experience gained by the doctors working in the hospital, where there are many opportunities to gain skills in performing spinal anaesthesia.[10,25]

Only one pregnant woman with breech presentation had the spinal anaesthesia in the lateral position, making the number too small to establish statistical significance. Higher complication rates and difficulties in locating the landmarks were noted with the use of the lateral position.[27,28]

The current study did not show any statistically significant difference in failure rates between the sites of lumbar puncture. Notably, all the spinal inductions at L2–L3 were successful, while a failure rate of 14.2% and 10.5% was observed with use of L3–L4 and L4–L5, respectively. This is consistent with the study by Munhall *et al.*,[21] where 0.0% failure rate was noted when L2–L3 was used compared with a failure rate of 7.3% at L4–L5. Patients who achieved a block height of T8–T10 had 100% failure rate, while 33.3% and 1.3% failure rates were seen at block heights T6–T7 and T4–T5 respectively. Complete FSA (those without any sensory block) was observed in nine participants who were converted to general anaesthesia. A block height of T5 was found to be adequate for Caesarean section in previous studies.[18,26] There was a higher incidence of FSA in pregnant women that had spinal anaesthesia with a size 22 G Quincke needle in comparison with a size 25 G Quincke needle. The provider's skills and other factors rather than the gauge of the needles might be a plausible explanation for the difference in results.

Multiple skin punctures were associated with higher failure rate. Doctors performing spinal anaesthesia should be calling for assistance after two failed puncture attempts. This will reduce avoidable complications associated with spinal anaesthesia. Low BMI, low weight and younger age are predictors of successful first puncture.[23] This study found hypotension and shivering to be the commonest complications of spinal anaesthesia, which were managed in accordance with the local protocols.

Strength and limitations of the study

It should be noted that the sample size is very small and sampling took place in one hospital. Therefore, a larger study involving multiple centres drawn across different settings will provide a clearer picture on the practice of spinal anaesthesia in South Africa. Also, the time of failure of spinal anaesthesia was not documented in the study. We also do not have data on the number of FSAs which were repeated. Accurate confirmation of the intervertebral disc space cannot be objectively ascertained.

Notwithstanding, this study highlighted the important clinical and academic issues for clinicians performing spinal anaesthesia in this hospital and other district hospitals across the country. The importance of correct technique, puncture of the dural mater, free flow of CSF, subarachnoid injection of an anaesthetic agent and effective spinal block are crucial steps that clinicians must observe in performing spinal anaesthesia. The study also identified other complications of spinal anaesthesia that doctors must be prepared to manage intraoperatively.

Conclusion

The findings of this study highlight the high incidence of FSA and the factors contributing to this failure in our setting. Revision of the local protocol for spinal anaesthesia is advised in light of the high incidence of FSA in this study. Bloody CSF, dry tap, and multiple attempts at lumbar puncture, obesity and block height below T6–T7 were associated with failed spinal anaesthesia. The hospital management should prioritise anaesthetic training among junior doctors, especially interns, as well as periodic

up-skilling of senior doctors. Significantly, hypotension and shivering occurred at higher rates in the study; hence, doctors should be skilled in managing the complications of spinal anaesthesia.

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