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ORIGINAL RESEARCH REGIONAL ANESTHESIA

Rationale of modified paraspinous / paramedian technique for spinal anesthesia in prevention of post dural puncture headache after cesarean section

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Abstract

Background & Objective: The spinal anesthesia in cesarean sections is still marred by post dural puncture headache (PDPH) and low backache. Both complaints sometimes becomes very troublesome for the patient and the anesthesiologists. This study evaluated the incidence of PPDH with modified paraspinous paramedian and median traditional approaches for spinal anesthesia during cesarean sections.

Methodology: For this randomized, controlled double-blind study, 60 primigravida parturients undergoing cesarean section under spinal anesthesia were randomized into 2 groups (30 each). Group 1 received spinal anesthesia with the classic median approach and Group 2 received spinal anesthesia with the modified paraspinous paramedian approach. All the patients were followed up to 7 days postoperatively. The incidence of PDPH and low backache was observed in each group.

Results: The present study showed a statistically significant lower incidence and lower severity of PDPH in Group 2 in which a modified paraspinous paramedian approach was used, compared to Group 1 ($p < .05$) in which median classic approach was used. The difference in the incidence of back pain was non-significant.

Conclusion: Spinal anesthesia with the modified paraspinous/ paramedian approach for cesarean section is associated with a lower incidence of PDPH when compared to the standard median approach.

Key words: Post Dural Puncture Headache; Spinal anesthesia; Median classic approach; Modified paraspinous paramedian approach

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1. Introduction

The headaches following interventions that disrupt meningeal integrity are labeled post dural puncture headaches (PDPHs).[1] The pathophysiology of PDPH remains incompletely understood. It has been thought to result from the loss of CSF through a persistent leak in the meninges after the spinal.[1,2] The loss of approximately 10% of the total CSF volume predictably results in the development of PDPH, which resolves with reconstitution of this deficit. The CSF hypotension generates headache due to a bimodal mechanism involving both loss of intracranial support and cerebral vasodilation (predominantly venous).[1] Risk factors that influence PDPH are; gender , age,

pregnancy, the needle tip , needle size, bevel orientation, number of lumbar punctures, the approach of lumbar punctures, type of local anesthetic used, and clinical experience of the operator.[3]

Because of its simplicity and high success rate, spinal anesthesia (SA) is regarded as a standard method of anesthesia for cesarean section (CS).[4] There are two common approaches used in SA, median and paramedian.[5,6] The median approach is the most common technique used. The paramedian approach has faster catheter insertion and possibility of performing the procedure in an unflexed spinal position; however, the oblique direction is likely to cause problems when inserting the catheter-over-needle system through the epidural needle.[6] A paramedian approach is believed to decrease the risk of PDPH, but this has not been verified in clinical trials.[5]

The current study assessed the incidence of PDPH with modified paraspinous paramedian and median traditional approaches for SA during CS.

2. Methodology

This randomized, double-blind, controlled study, enrolled pregnant women with American Society of Anesthesiologists (ASA) physical status II, aged 24–38 y, primigravida with BMI ≤ 24, scheduled for elective CS under SA. The study period was between March 2018 and January 2020, in Alhamad Hospital, Riyadh, Saudi Arabia. Official approval by the local ethics committee was obtained. After proper counseling and discussion, written, informed consents were obtained from all parturients during preanesthesia clinic visits. Maternal age, height, weight, history of migraine or other headaches were recorded.

Parturients with pregnancy-induced hypertension, multiple pregnancies, or placenta previa were excluded, as were parturients with a contraindication to SA, such as coagulation disorder, spinal malformation, and infection at the puncture site, abnormal liver or kidney function, any systemic diseases, a history of drug hypersensitivity, expected intraoperative blood loss more than 500 ml, or failure of the spinal puncture.

Sixty-five patients were included in the current study. These patients were randomly divided into 2 groups: Group 1 of 32 cases (SA with the median classic approach) and Group 2 of 33 cases (SA with the modified paraspinous paramedian approach). The primary outcome of the current study was to assess the incidence of PDPH following SA, while requirement for epidural blood patch (EBP) and back pain were a secondary outcome

2.1. Pre-anesthesia preparation

All patients were fasted for about 10 hours before CS, and no one was premedicated. Venous access was established in the upper extremities. Ringer lactate infusion (10 mL/kg/h)) was started. Routine monitoring (SpO_2, 3-lead ECG, and NIBP) was applied. Baseline measurements were obtained while patients were in the supine position. Following rehydration with Ringer's lactate solution, SA was done for all studied women by the same anesthetist (Dr. Zenat M). SA was induced with hyperbaric bupivacaine 0.5% (15 mg) (Mylan Co, France) at a rate of 0.2 mL/s injected via a 25 G pencil-point spinal needle (Egemen, Turkey).

2.2. Technique in Group 1 (median approach)

SA was conducted in the sitting position at the L3–4 or L4-5 intervertebral space using median approach. The median approach involves passage of needle through the supraspinal and interspinal ligaments and the ligamentum flavum, at the level of the interspace. Local anesthetic solution was injected 3 mL of 0.5% bupivacaine heavy. Patients were then positioned in a 10-15° left-lateral tilt.

2.3. Technique in Group 2 (Modified paraspinous /paramedian approach)

First we palpate the interspinous space and the border of L5 spinous process is identified by using the iliac crest as a landmark. Secondly, mark a point at superior border crossing the lateral edge of the L5 spinous process. Now, a finger is moved 1 cm inferiorly and laterally (at approximately 1.0 to 1.5 cm) and a skin wheal is raised with 2 ml of 2% lignocaine, the skin is slowly punctured slightly perpendicular to the skin, and the spinal needle guided at a 5-10° angle lateral to medial and 0-5° angle cranially so as to penetrate the canal at approximately 1 cm lateral to the midline. Once the needle hits the bone, which is the facet joint, the needle tip is redirected incrementally in a cranial

direction to walk off lamina into interlaminar space until clear cerebrospinal fluid reflux is seen. Then 3 mL of 0.5% bupivacaine heavy is injected into the subarachnoid space. Patients are then positioned in a 10-15° left-lateral tilt.

In our study, repeated puncturing of more than 3 times was considered failure and the procedure was completed by general anesthesia excluding the patient from the study. After successful anesthesia by either technique, with the patient supine, oxygen was delivered at 2 L/min by conventional mask. Hypotension (systolic blood pressure < 90 mmHg or > 30% of baseline value before anesthesia) was treated by inj. phenylephrine (25–100 mg) and ringer lactate 500 mL. Hypertension (SBP > 160 mmHg or SBP increased by > 30% base blood pressure) was managed by inj. labetalol 5–10 mg. Bradycardia (HR < 50 beats/min) was managed with inj. atropine 0.5 mg; while tachycardia (HR > 120 beats/min was managed with esmolol 0.5 mg/kg IV. Surgery was initiated when the sensory block level reached at T4.

Postoperative analgesia protocol was as follows: in. pethidine 2 mg/kg IV 12 hourly and inj. paracetamol 10 mg/kg IV 6 hourly. All CS procedures were done by the same surgeons. The duration of surgical procedure was recorded and if any deviation from the usual surgical technique was recorded.

2.4. Post-operative data collection

PDPH was defined as a headache located in the occipital and/or frontal areas, which was worsened by standing or sitting, and alleviated by lying down. The severity of PDPH was assessed using a 10 cm visual analog scale (VAS), in which 0 signifies no headache, and more than 7 stands for severe headache. Trained nurses, who were unaware of the objectives of the study, asked the patients about any occurrence of headache every 24 h for 72 h and informed the anesthetist who assessed the patient PDPH according to the International Classification of Headache Disorders (ICHD-II) diagnostic criteria. Subsequently, the patients were contacted daily by phone after discharge for a minimum of 7 days after dural puncture if they remained headache free. Subjects who developed PDPH were followed for a minimum of 3 days after resolution of the headache.

Twenty-four hours after operation, we interviewed patients and assessed their level of low back pain. If

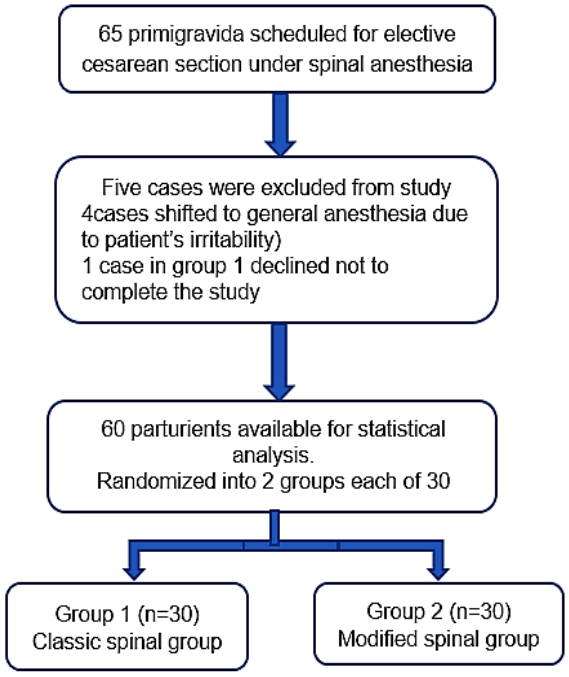

Figure 1: CONSORT flow diagram

patients had newly occurring back pain after first 24 hours till 7 days postoperative; we inquired about the characteristics, aggravating factors, and degree of pain using a numeric rating scale. After patient discharge follow up was done daily by phone till 7th day postoperatively.

2.5. The treatment protocol used for PDPH

All mild postural headaches (VAS < 4) were treated conservatively with oral hydration, increased oral caffeine intake and oral analgesics as needed. Subjects with severe headaches (VAS ≥ 7) were managed with EBP or nerve blocks (occipital nerve block, sphenopalatine ganglion block). Intractable pain after 24 h of onset was treated with EBP in the operating room.

2.6. Statistical analysis

Statistical analyses were performed with SPSS 15.0 software (SPSS Institute, Chicago, IL, USA). Student's *t*-test, Chi-square test and Fisher's exact test were used as appropriate for statistical analysis. Data are presented as mean ± standard deviation, median, or numbers and frequencies, as appropriate. Statistical significance was determined at a $p < 0.05$.

3. Results

Sixty-five primigravida parturients were scheduled for elective CS under SA during the study period. Sixty of them completed the study. They were randomized into 2 groups each of 30 cases. Five cases were excluded from study; four cases shifted to general anesthesia due to patient's irritability and one case in Group 1 was excluded as she declined not to complete the study due to personal reasons. Flow chart is given as Figure 1.

Demographic data (e.g., age, weight, height, body mass index), intraoperative blood loss, intraoperative hypotension episodes and duration of surgical procedures were comparable and no statistically significant differences were observed between the two studied groups (Table 1). In addition, there was no significant differences regarding the duration of SA procedure. There was a significant difference regarding number of lumber puncture (LP) attempts in Group 1 compared to Group 2 (3.3 ± 1.4 vs. 1.1 ± 0.7; $p < .05$). The overall operation time was equivalent. The ratio of successful subarachnoid punctures was lower in Group 1 compared with Group 2 (93.5% vs. 95.3%) as shown in Table 1.

Table 2 shows the frequency of the PDPH in the two studied groups over the 7 days duration. The Group 1 showed

Table 1: Demographic and clinical characteristics of the parturients

Variable	Group 1 (Classic technique)	Group 2 (Modified technique)	*p*-value
Age (y)	28,2 ± 6.3	28,5 ± 6.9	0. 864
Height (cm)	165.4 ± 7.1	164.8 ± 5.3	0.575
BMI (kg/m^2)	27 ± 6	27 ± 8	0.761
Gestational age (weeks)	38.4 ± 1.14	38.6 ± 1.2	0.378
Intraoperative blood loss (ml)	195.8 ± 29.6	185.2 ± 25.5	0.182
Duration of surgical procedure (min)	45 (25-90)	44 (25-80)	0.923
Intraoperative hypotensive episode	14 (48.0%)	15 (50.0%)	0.876
Number of LP attempts	2.3 ± 1.4	0.1 ± 0.7	0.001*
Duration of SA procedure (sec)	16 ± 10	15 ± 10	0.620
Success rate	93.5%	95.3%	0.380
Failure of spinal	2 (0. 6%)	0 (0.0%)	0.335

Data are presented as mean ± SD or n (%)
**p ≤ .05 is significant LP= lumber puncture*

Table 2: Postoperative frequency of PDPH [n (%)]

PDPH	Group 1 (Classic technique)	Group 2 (Modified technique)	*p*-value
Day 1	22 (73.3)	5 (16.6)	0.001
Day 2	15 (50.0)	7 (23.3)	0.087
Day3	11 (36.6)	2 (6.6)	0.001
Day 4	11 (36.6)	3 (10.0)	0.01
Day 5	8 (26.6)	5 (16.6)	0.4182
DAY 6	7 (26.0)	5 (16.6)	0.4081
DAY 7	2 (6.6)	6 (20.0)	0.950

Data presented as n (%).p < 0.05 = significant.

Table 3: Postoperative VAS scores [Mean ± SD]

PDPH	Group 1 (Classic technique)	Group 2 (Modified technique)	p-value
Day 1	1.72 ± 2.11	2.60 ± 2.35	0.08
Day 2	3.92 ± 2.53	3.55 ± 2.18	0.546
Day3	5.2 ± 2.0	2.8 ± 1.5	0.001
Day 4	7.62 ± 2.33	5.52 ± 2.18	<0.001
Day 5	3.2 ± 1.7	2.7 ± 2.3	0.154
DAY 6	3.5 ± 1.5	2.36 ± 1.46	0.147
DAY 7	1.7 ± 1.3	1.9 ± 1.9	0.870
Mean VAS over 7 days	4.4 ± 2.1	1.5 ± 1.8	0.001

significantly ($p < 0.05$) higher number of cases who developed PDPH on 3rd, 4th and 5th days post-operatively compared to the Group 2.

The severity of headache as detected by VAS was significantly higher in Group 1 compared to Group 2 ($p < 0.05$)

(Table 3). Table 3 also shows the mean VAS over the 7 days of the study duration was significantly high in Group 1 compared with Group 2(4.4 ± 2.1 vs. 1.5 ± 1.8; $p < 0.05$) and in most of the patients PDPH was mild to moderate and self-limiting for a few days. Table 4 shows that 6 patients (2 – intravenous neostigmine and atropine and 4 – topical sphenopalatine trans-nasal ganglion block) in Group 1 compared to 2 cases in Group 2, treated by topical sphenopalatine transnasal ganglion block with $p < 0.05$ (this represents a significant finding). The procedure duration using either technique was similar in both studied groups.

Table 4: Frequency of postoperative back pain and treatment

Variable	Group 1 (Classic technique)	Group 2 (Modified technique)	p-value
Patient received interventional treatment	6 (20.0%))	2 (6.6%))	0.19
Incidence of back pain 24 h postop	8 (26.6%)	6 (20.0%)	0.569
Incidence of back pain 7 days postop	6 (20.0%)	5 (16.6%)	0.777

*Data are presented as n (%) and analyzed using Fisher's exact test. *p < 0.05 = Statistically significant*

Table 5: Postoperative back pain on numeric rating scale (VAS)

Variable	Group 1 (Classic technique)	Group 2 (Modified technique)	p-value
Back pain 24 h postop; VAS	3.5 ± 0.9	4.16 ± 1.1	0.829
Back pain 7 days postop; VAS	3.93 ± 1.1	3.8 ± 1.0	0.095

*Data are presented as Mean ± SD. *p < 0.05 = Statistically significant*

The incidence of back pain and the intervention required were not significantly different in both studied groups after 24 h and post–procedure as well as after 7 days of the procedure (Table 4).

The intensity of back pain on VAS was not significantly different in both studied groups after 24 h post–procedure as well as after 7 days of the procedure (Table 5).

4. Discussion

PDPH is the commonest complication of SA. PDPH is defined as bilateral headache that develops within 7 days after a lumbar puncture and disappears within 14 days. The headache worsens within 15 min of resuming the upright position, and disappears or improves within 30 min of resuming the recumbent position. This definition helps to avoid confusion with migraine or simple headache after lumbar puncture.[7]

PDPH is less common in children and the elderly compared with adults aged 20 to 40. Obstetric patients are particularly at high risk of PDPH. The type and gauge of the needle may also affect the PDPH.[8,9] The direction of the bevel of the needle, whether it is perpendicular or parallel to the spinal axis, is another risk factor for headache.[10] Sharp-ended spinal needles were reported to reduce the incidence of PDPH when they were directed parallel to the spinal axis instead of being perpendicular.[9]

In the current study, to rule out the effect of multiple risk factors of PDPH; SA was administered by the same anesthetist, who used the same type of needle. All participants belonged to the age group from 28 and 35 y and all were primigravidae. We chose a 25 G pencil point spinal needle to exclude the effects of needle properties on the incidence of PDPH.

Comparing median with paramedian approach, Behary and Mohammed reported that the frequency of PDPH was less if subarachnoid block was administered by paramedian approach as compared to the median approach. They stated that in the paramedian approach, perforation of the dura and arachnoid maters occurs at different angles which produces a valvular mechanism that prevents the loss of CSF to the epidural space.[6] In one study the authors

concluded that the use of paramedian approach in pregnant women, who have difficulty in positioning, is acceptable and without an increased risk of headache and hemodynamic changes.[10] Sagadai also reported that 4% in the paramedian group had PDPH as compared to 28% in the median group.[12] In contrast, another study by Janick et al. on 250 patients undergoing transurethral prostate surgery under SA reported a significantly higher rate of PDPH with the paramedian approach than with the median approach in relatively older patients, while no significant difference was observed in younger patients.[5]

Paramedian approach is associated with less technical problems as compared to midline approach.[13] The paramedian approach avoids the supraspinous and interspinous ligaments and hits the ligamentum flavum directly after passing through the para-spinal muscles. Consequently, success rate with paramedian approach was 100% with the first attempt.[13] In paramedian approach, there is less chance of bending or kinking of needle as tough ligaments are avoided and it does not require flexed position as in the midline approach.[14] Podder et al. concluded that with a patient sitting in an unflexed position it is usually possible to insert needle in paramedian approach than in the median approach.[15] Behzad et al. reported the distance from skin to subarachnoid space was more in the paramedian group.[16] With the advent of ultrasound guidance in regional anesthesia, the number of attempts of spinal puncture and with it the incidence of PDPH is likely to be reduced.[17] Very soon, ultrasonography will make the suggested modified paramedian approach easier and so will be a preferred technique.

In the current study, we get benefit of combination of paramedian approach with slight modification as we performed spinal puncture at L5–S1 intervertebral space with sliding of the needle over the bony lamina making the technique easier and applicable with good success rate in the first attempt.

In our study, the frequency of back pain was found to be 4.3% in the Group 1 and 2.04% in Group 2. We found the incidence of PDPB was lower in both groups (Group 1 and Group 2) as compared to previous studies. The reason of low incidence of PDPB in our study may be because of the type and duration of surgery, immobilization time in operation, and the use of 25G pencil point needle. The incidence of PDPB in the Group 2 was significantly less than the Group 1 because in our modified technique we avoided cutting through the ligament supraspinous and interspinous ligament.

5. Limitations

The limitation of this study is that the comparison between the two approaches was made in parturients, which is a known risk factor for PDPH, and in turn may be considered as a confounder. So, a comparison is recommended in different population samples including non-pregnant females to get a more authentic evidence.

6. Conclusion

The results of our study show that the application of spinal anesthesia with the modified technique paraspinous/ paramedian approach for cesarean section has lower incidence of PDPH as compared to the conventional median approach. However, we also consider that there is a need for more extensive studies on this subject, involving different patient populations to support our findings.

7. Conflict of interests

None declared by the authors.

8. Authors' contribution

ZE: Main author

MFS: Co-author

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