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ORIGINAL RESEARCH **OBSTETRIC ANESTHESIA**

Comparison of successful spinal puncture between pendant position and traditional sitting position for cesarean deliveries

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Abstract

Background & objectives: Several positions are used for performing subarachnoid block with varying difficulty of spinal access. Pendant position is known to reduce lumbar lordosis in patients' especially pregnant patients making spinal access easier. The most ideal position for the easy spinal access is yet to be determined. This study was planned to compare ease of spinal access in pendant position vs. traditional sitting position (TSP) in pregnant females, and to establish the superiority of the former.

Methodology: This randomized controlled trial was conducted in our hospital on 232 subjects over 6 month period. Parturients undergoing elective lower segment cesarean section (LSCS) were randomly divided into two groups: Group A (pendant group) and Group B (TSP group). Spinal puncture was performed at L3-L4 interspace, randomly making one of the two positions. Time for successful spinal, number of needle-to-bone contacts and total number of attempts were recorded.

Results: The median age of the patients was 29 yrs with the interquartile range (IQR) 7. The number of needle-to-bone contacts in Group A was significantly higher compared to Group B (59.48% vs. 33.62%, p = 0.000). Mean time for successful spinal puncture was less in Group A than Group B (17.69 sec vs. 25.54 sec, p = 0.001). The difference in number of attempts for spinal in both positions was not significant.

Conclusion: Pendant position is better than traditional sitting position in achieving successful spinal puncture in terms of needle-to-bone contacts and the time to puncture. However there is no difference in number of attempts for both positions.

Key words: Traditional sitting position; Pendant position; Spinal anesthesia; Cesarean section

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1. Introduction

Spinal anesthesia is favored over general anesthesia for cesarean deliveries as it is associated with lower risk of aspiration, no difficult or failed intubation, less frequency of thromboembolism, while providing adequate post-operative analgesia.[1-3] Spinal puncture can be performed in sitting or lateral position.[4] Patient position can predict difficulty of placing spinal needle into subarachnoid space. Poor positioning can result into multiple needle pricks and needle-to-bone contacts, thus increasing risk of backache, epidural hematoma, neural trauma and post-dural puncture headache (PDPH).[5-8] Lumbar spine curvature increases significantly in the last trimester of pregnancy, shifting center of gravity towards abdomen causing lumbar hyperlordosis.[9] Hyperlordosis produces vertebral space narrowing; while lumbar flexion is difficult to achieve in pregnant patients making median approach for spinal puncture very difficult.[8]

Sitting position has several modifications, i.e. traditional sitting position (TSP), pendant position, squatting position (SP), hamstring stretch position (HSP) and crossed-leg sitting position (CLSP). Each position has its own advantages.[5] TSP is the most commonly used position by the anesthetist, providing uninterrupted access to median area of vertebrae without being restricted by upper part of the table.[5] In pendant position propped underarms reduce vertical pressure (gravity) on the vertebrae, thus increasing intervertebral and inter-spinous distance and inter-lamina gap.[5,10]

A study by Pryambodho et al. compared pendant position with TSP in Indonesian population for cesarean section; they concluded that pendant position is much better for achieving spinal puncture in first attempt ($p = 0.0007$), number of needle-to-bone contact ($p = 0.0005$) and less time for successful spinal (9 sec vs. 12 sec, $p = 0.001$).[8] Fisher et al. claimed that number of needle-to-bone contacts was equal in both positions during epidural labor analgesia.[6, 11] Ease of spinal access was studied in population other than pregnant females by Soltani Mohammadi et al., they found that needle-bone contacts were lower in SP than TSP (222 vs. 230 respectively, $p = 0.01$).[6, 12] In a study by Tashayod et al., HSP was marked as the best position for reducing lumbar lordosis, they also studied non-pregnant population coming for lower abdominal and lower limb surgeries.[6, 13]

Best sitting position for performing spinal block is still unknown, especially in pregnant females. Pendant position helps to reduce lumbar hyperlordosis seen in pregnant females making spinal access easier and minimizing multiple attempts. In pregnant females, influence of positions on successful spinal needle placement had not been studied in South Asian population yet. This study was designed to compare ease of spinal access in pendant position with TSP in pregnant females in terms of mean time for successful spinal puncture and frequency of needle-to-bone contacts and number of attempts.

2. Methodology

This single blind, randomized controlled trail was conducted at gynecology & obstetric operating rooms of our hospital from 6th December, 2018 till 5th June, 2019. After approval from hospital ethical committee, patients who met the inclusion criteria, e.g., parturients aged 18-45 yrs, undergoing cesarean delivery with ASA physical status II to III and body mass index (BMI) of 18-35 kg/m^2, were randomized to one of the two groups. Patients with language barrier, any relative or absolute contra-indication to spinal anesthesia, obstetric emergencies and non-palpable bone landmarks were excluded from the study.

In Group A (pendant position group) patients sat on the table with both legs fully stretched and patients underarms propped up with the help of a hard pillow fitting well between patient's legs and underarms; while in Group B (TSP group) patients sat with legs hanging by the table side, knees flexed at 90°, hips adducted, feet resting on a stool and back facing towards the anesthetist.

Sample size was calculated using WHO Sample Size Calculator # 2.2a Hypothesis test for two sample proportions (one-sided test) with level of significance 5% and Power of Test 90%. Anticipated population proportion 1 with zero needle-bone contact in pendant position was 0.54% and anticipated population proportion 2 for zero needle-bone contact in TSP was 0.35%.[8] 232 patients were enrolled.

Written informed consent was taken for enrollment in study. Study data were collected by the researchers themselves. Spinal punctures were performed by the researcher who had experience of more than 200 spinal blocks. Spinal was performed after securing IV access, pre-hydration and complete aseptic preparation at L3-L4 space. 25 gauge pencil point spinal needle were used. Researcher performing spinal block collected data for number of attempts and number of needle-to-bone contacts. Time for spinal from insertion of spinal introducer needle to free flow of CSF in needle hub was measured with the help of a co-researcher. If researcher failed to obtain spinal puncture at L3-L4, L4-L5 space was used. In case of no CSF flow in the needle hub or poor flow, needle was rotated clockwise 90^o and waited for 5 sec, sequence of rotation continued for other three quadrants of 90^o and 5 sec wait for each followed by advancing needle by 2 mm and then withdrawing needle till subcutaneous tissue and re-directing it if there was no CSF despite previous maneuvers. After obtaining free flow of CSF, 0.5% hyperbaric bupivacaine 2 ml was injected, the patient was placed in supine position with 15º left tilt. Successful spinal block was checked by using gentle pinprick with sterile hypodermic needle of 27G. The surgery was allowed to commence when the spinal block level reached T6.

Data were entered and analyzed in SPSS version 22. Qualitative variables like ASA status, number of needle-bone contacts, number of attempts and patient's comfort were measured as frequency and percentage. Quantitative variables like time to successful spinal, patient height, weight and BMI were described as mean ± standard deviation. Chi-square test was used to analyze number of needle-bone contacts, Fisher's Exact test was used to analyze number of attempts. Time for spinal anesthesia was compared between two groups by Independent Sample Mann-Whitney U Test. Significance value used was 5% with 90% power.

3. Results

A total of 252 patients were assessed for eligibility to be enrolled in study, 20 patients were excluded (12 patients had BMI > 35 kg/m^2, 3 patients declined to participate, one patient had language barrier and 4 patients landmarks were not palpable). Out of 252 patients 232 were randomly allocated into two groups i.e. Group A (Pendant) and Group B .This study was done on 232 patients equally divided into two groups i.e. Group A (n = 116) and Group B (n = 116). All participants completed the study (Figure 1). Demographic date of both groups are given in Table I. The participants in both of the group had equivalent ages [Median (Interquartile range)], height, weight

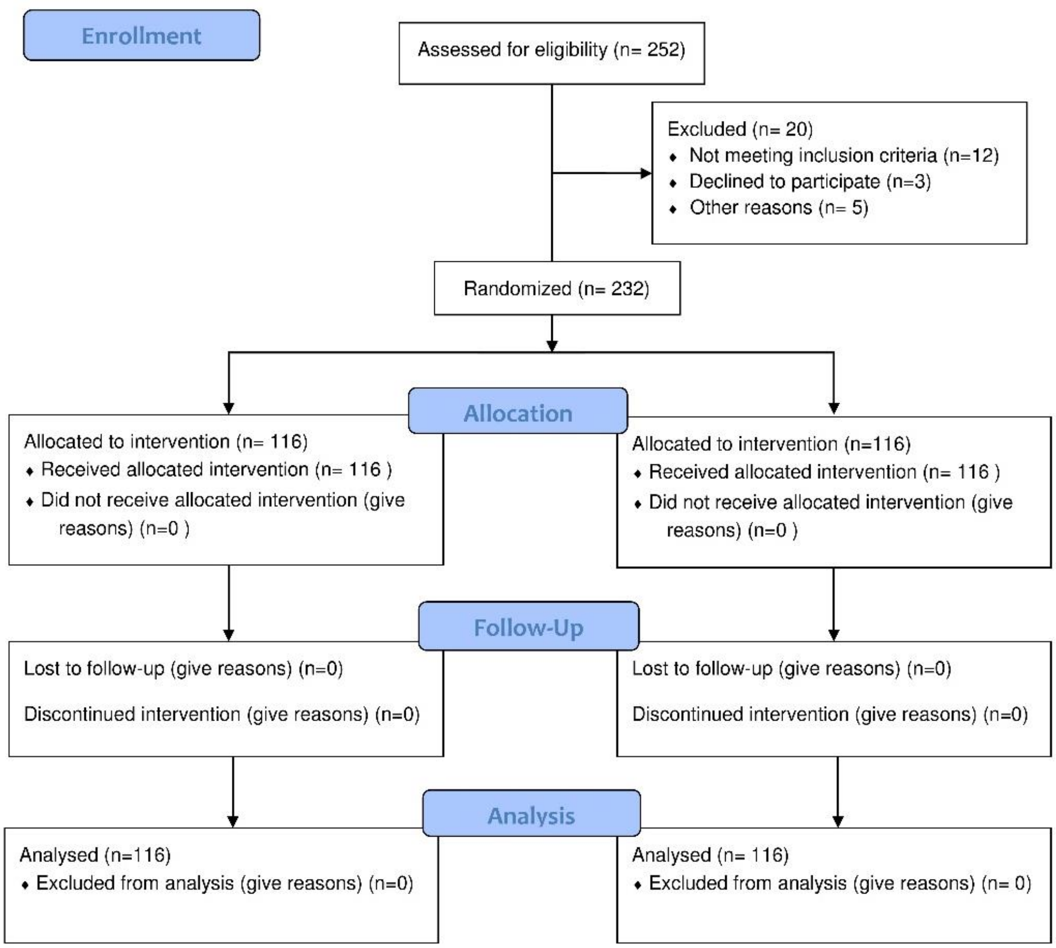

Figure 1: CONSORT flow diagram

and BMI (mean ± SD), and the differences were statistically not significant.

Spinal puncture was performed in first attempt in 112 (96.55%) patients in Group A and in 110 (94.82%) patients in Group B. Difference in number of attempts was not statistically significant among two groups after applying Fisher's Exact test (p = 0.374). Mean time for achieving successful spinal puncture in Group A was 17.69 sec ± 14.399 and for Group B it was 25.54 sec ± 19.366. Independent sample Mann Whitney U test showed statistically significant less mean time for achieving successful spinal puncture in Group A as compared to Group B (p = 0.001) as shown in Table 3.

Table 1: Demographic Profile of patients in two groups

Parameter		Group A (N = 116)	Group B (N = 116)	p-value
Age (yrs)[a]		28 (6)	30 (8)	0.051[d]
Height (m)[b]		1.5978 ± 0.0736	1.5914 ± 0.0656	0.340[d]
Weight (kg)[b]		73.93 ± 11.14	75.09 ± 12.16	0.236[d]
BMI (kg/m^2)[b]		28.90 ± 3.81	29.56 ± 3.81	0.114[d]
ASA status (n)	I	70	78	0.339[e]
	II	46	48	

[a] Values are presented as Median (Interquartile range)
[b] Values are presented as Mean ± SD
[d] p > 0.05 (Independent Samples Mann-Whitney U Test)
[e] p > 0.05 (Fischer Exact Test)

Table 2: Relationship between position and Needle to bone contacts. N (%)

Position	Needle to Bone Contacts			p-value
	No	Few (1-3)	More (>3)	
Group A (Pendant Position)	69 (59.48)	43 (37.06)	4 (3.44)	< 0.001[a]
Group B (TSP)	39 (33.62)	65 (56.03)	12 (10.34)	

a Chi-square Test; power 90 %

Table 3: Ease of spinal needle placement among two groups

Parameter	Group A (Pendant Position)	Group B (TSP)	p-value
Number to Needle to Bone Contacts [a]	0 (1)	1 (2)	0.000 [c]
Number of Attempts [a]	1 (0)	1 (1)	0.746 [c]
Time for spinal needle insertion (sec) [b]	17.69 ± 14.399	25.54 ± 19.366	0.000[c]

[a] Values are expressed as Median (Interquartile range)
[b] Values are expressed as Mean ± SD
[c] Independent Sample Mann Whitney U Test, Power 90%

4. Discussion

As there is ever-rising trend of cesarean sections worldwide, the anesthetists must be well versed with obstetric anesthesia and the associated risks and challenges.[14] Neuraxial anesthesia is being favored over general anesthesia in obstetrics owing to increased morbidity and mortality associated with the latter, mostly due to difficulties with airway management and aspiration.[2, 15, 16]

Neuraxial anesthesia for cesarean deliveries requires successful spinal puncture followed by administration of adequate amount of local anesthetic to produce desired effect. Factors which predict successful spinal puncture include, patient factors e.g., quality of landmarks and patient position, technical factors e.g., median vs. paramedian approach, spinal needle gauge, use of introducer needle and use of radiological interventions (fluoroscopy and ultrasound) and expertise of anesthetist.[17,18] Assessment of spine by means of radiological interventions are not always available or routinely practiced. Quality of landmarks is determined by patients' age, gender, weight, BMI, spinal anatomy, and previous spinal surgery.[19] As quality of landmarks can't be altered, special attention should be paid to proper patient positioning.

Sitting position is preferred over lying/lateral as it provides good exposure to the anesthetist and is more comfortable for the patient. Secondly, it pushes dura mater more superficially due to greater CSF pressure in sitting vs. lying position (50 cmH_2O vs. 12 cmH_2O respectively), as a result inadvertent epidural spread of drug can be prevented.[4] Lastly, sitting position with flexed back helps to reduce lumbar lordosis making palpation of intervertebral spaces easy.[12]

Various studies have been done using different sitting positions with aim of successful spinal puncture in minimum attempts. We studied effectiveness of pendant position over TSP for performing successful spinal puncture for cesarean deliveries. Few factors that affect successful spinal puncture like experience of anesthetist and use of introducer were kept constant in all patients. Factors affecting level of sensory block like needle size, dose of LA administered, site and speed of injection were also kept constant. Patient factors were comparable in both groups, therefore results are comparable in both groups.

With increasing age there is decreased lumbar flexion and intervertebral disc spaces become narrow making spinal access difficult therefore only patients' of age 18 to 45 years were enrolled in study.[20] As the BMI of patient increases, lumbar lordosis is enhanced due to obesity and fat distribution around abdomen, palpation of landmarks become difficult and patients are mostly unable to flex their back causing difficult spinal puncture with multiple attempts and repeated needle-to-bone contacts.[19] We excluded the patients with BMI > 35 kg/m2 to cater for this.

Mean time noted in our study was longer than that noted by Pryambodho et al.[21] This is because we included time to insert the introducer and then the spinal needle. Both studies, however, show that spinal access is achieved in less mean time in pendant position.

Number of needle-to-bone contacts have been associated with patient anxiety and apprehension which effect patient's hemodynamics i.e. tachycardia and occasionally hypertension. Our results (Table 2) were almost equivalent to that found by Pryambodho et al. (54% vs. 35% for Group A and B).[21]

Pryambodho et al. found that in pendant position approximately 92% patients had spinal puncture in 1st attempt as compared to 78% for TSP.[8] However 96.55% and 94.82% patients had spinal puncture in 1st attempt for pendant position and TSP respectively in our research with $p = 0.374$ (not significant). This difference might have occurred due to use of introducer needle and pencil point needle.[21]

Soltani et al. in their first study compared two positions i.e. TSP and SP. They concluded that there are less needle-to-bone contacts with SP as compared to TSP (222 vs. 230 respectively, $p = 0.01$), however, ease of space identification was comparable in both groups. In SP patient's buttocks and feet rest on table and patient hugs her knees, while doing so lumbar flexion is increased reducing lumbar lordosis and increasing disc space. When patient hugs her knees, there is forward bending of underarms as well (the maneuver which is the basis of pendant position). But it is very difficult for a term parturient to sit in ideal squatting position due to presence of gravid uterus that is why Soltani et al. excluded pregnant patients from their study.

In another study by Soltani et al. TSP was compared with HSP and SP. Needle-to-bone contacts and ease of space identifications were parameters measured. They found no statistical difference among these positions for spinal access. HSP also increases tension of supraspinous ligament to achieve more lumbar flexion. This tension cause obliteration of intervertebral disc depression making palpation of disc spaces and hence spinal puncture difficult.[12] HSP can be applied on obstetric patient and compared with pendant position for ease of spinal access and comfort to sit in either position.

In a study by Manggala et al. CLSP was compared with TSP for ease of spinal access in urology patients undergoing neuraxial anesthesia. Number of successful first attempts, difficulty in palpating landmarks and number of needle-to-bone contacts were used to assess ease of spinal access. Success rate of spinal needle placement was higher in CLSP as compared to TSP, but the difference was not statistically significant.[5] CLSP used by Manggala et al. was made by making the patient sit on operating table with both legs crossed causing flexion at hip and knee joints. In addition they also used a pillow which they placed between patients under arm and crossed legs just like pendant position used in our study. Pillow in these cases was placed perpendicularly unlike slanting in our case. This position can be labelled as modified pendant position. The result of above mentioned study was not significant possibly because they included non-obese males and females in their study and they also excluded pregnant females from their study. Male patient and non-obstetric female patient having BMI < 32 kg/m^2 have easily palpable landmarks and intervertebral spaces resulting in easier spinal access. It can be hypothesized that pendant position and CLSP have impact on reducing needle-to-bone contacts in patients who have exaggerated lumbar lordosis due to obesity or pregnancy. Further studies are required to study effect of these positions in obstetric vs. non-obstetric patients.

There is no standardized definition of pendant position so far. Shabanian et al. achieved this position by supporting patient’s underarms with cantilever or a plank.[10] We used pillows of various sizes that fit adequately between patients under arms and legs, since cantilever was uncomfortable for patients with gravid uterus when tested on few patients from our population before starting study. Pryambodho et al. didn’t explain in their article about exactly how they made full term patients to sit in pendant position (cantilever or pillows). More studies are not available on pendant position, therefore, we suggest using this position in non-obstetric patients as well undergoing neuraxial anesthesia to study this position in detail. Furthermore, radiologic interventions can be used to study effects of pendant position on vertebral column dynamics in obstetric and non-obstetric patients.

5. Limitations

In all of the above mentioned studies the outcome of successful spinal puncture indicated by free flow of CSF in needle hub, none of the study including ours assessed level of motor blockade in various positions which is best criteria for successful spinal block. Adverse effects of spinal anesthesia and LA were also not recorded in our study. Level of motor block and incidence of PDPH and other adverse effects should be studied in various positions, only then any position can be labelled as best position for performing subarachnoid block.

We suggest further studies to investigate postural differences among pendant position and TSP using objective parameters like vertebral angulation and interspinous gap using radiological interventions so that these positions can be described on basis of scientific basis.

6. Conclusion

On the basis of the results of the present study, we conclude that for cesarean deliveries in pregnant patients, the pendant position is better as compared to traditional sitting position as there are less chances of needle-to-bone contacts and shorter time to successful spinal puncture. However, there is no difference in number of attempts for successful spinal puncture and comfort of patient for sitting in either of the two positions.

7. Acknowledgement

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8. Declaration of interest

The authors declare that they have no conflicts of interest.

9. Authors' contribution

QA: Study concept and design, data collection and analysis, manuscript preparation
HJ, AR: Critical revision of content for improvement and intellectual input
ZF, YAS: Data Analysis and Literature review

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