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Central Sagittal Angle of the Sacrum as a New Risk Factor for Patients with Persistent Low Back Pain after Caesarean Section

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Study Design: Retrospective.
Purpose: This study investigated the possible association of persistent low back pain (LBP) with caesarean section (CS) under spinal anesthesia.
Overview of Literature: Many women suffer from LBP after CS, which is commonly performed under spinal anesthesia. However, this type of LBP is poorly understood, and there is poor consensus regarding increased risk after spinal anesthesia.
Methods: We examined two groups of patients who underwent cesarean delivery under spinal anesthesia. Group I included patients who presented to a neurosurgical clinic complaining of LBP for at least 6 months. Group II was a control group with patients without LBP. We analyzed clinical and sagittal angle parameters, including age, body mass index, parity, central sagittal angle of the sacrum (CSAS), and sacral slope (SS).
Results: Fifty-three patients participated in this study: 23 (43.1%) in Group I and 30 (56.9%) in Group II. Non-parametric Mann–Whitney U-tests showed that age, parity, and CSAS significantly differed between the two groups at 6 months.
Conclusions: Age, parity, and CSAS appear to be associated with increased risk for LBP after CS under spinal anesthesia. Future prospective studies on this subject may help validate our results.

Keywords: Caesarean section; Low back pain; Spinal anesthesia

Introduction

1. Background/rationale

Low back pain (LBP) is one of the most common complaints among adults [1-6] during medical visits [7] because it can lead to serious medical and social problems worldwide [8]. LBP also has major socioeconomic implications [9]. LBP is a very common pregnancy symptom [10], and disc bulging and herniation are occasionally evident on imaging examinations. In some cases, LBP persists after delivery.

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Delivery by the cesarean section (CS) has beome increasingly common. Most CSs are performed under spinal anesthesia, which reduces the risk of complications associated with intubation and general anesthesia. Some women experience persistent LBP after CS under spinal anesthesia. Pregnancy-induced mechanical and structural spinal changes may contribute to persistent LBP during the postpartum period. Moreover, the increased lordotic posture in the parturient and weight gain during pregnancy may lead to LBP. Understanding of spinal–sagittal alignment is essential for treating spinal disorders [11]. However, the impact of spinal–sagittal balance on LBP after CS under spinal anesthesia is unknown.

2. Objectives

Today, neurosurgical practices are confronted with overwhelming technological advancements [12,13], including catalytic advances in diagnostic imaging for spinal surgery [14]. Our understanding of spinal biomechanics and bone physiology, as well as the development of spinal fixation instrumentation has allowed exponential growth in this field [15]. Despite these recent technological developments [16], increased risk for LBP after spinal anesthesia remains controversial. Spinal anesthesia is generally preferred over general anesthesia for CS. However no reports have examined the effects of age, parity, weight, height, and spinal–sagittal balance parameters (i.e., sacral slope [SS] and central sagittal angle of the sacrum [CSAS]) on persistent LBP. In this study, we aimed to identify associations between spinal anesthesia and the risk of new-onset and persistent LBP and determine parameters that induce persistent LBP as much as 6 months after CS under spinal anesthesia.

Materials and Methods

1. Study design

The Institutional Review Board (IRB no., 2016/72) has approved this retrospective study. This study was conducted in a neurosurgical outpatient clinic between April 1, 2014 and April 1, 2016.

2. Participants

Participants's consent was not obtained because of the retrospective nature of this study. Exclusion criteria were refusal to participate in the study, comorbidities, fetal abnormalities, spinal anesthesia contraindications, or hypersensitivity to study drugs. Women who before pregnancy had a history of back pain or lumbar disc herniation requiring medical attention were excluded because there is evidence that such pain may be an independent risk factor for postpartum back pain. We further divided the participants into two groups: Group I included patients who presented to a neurosurgical clinic with a complaint of LBP for at least 6 months and Group II included a control group of women who underwent CS under spinal anesthesia who did not develop LBP.

3. Variables and data collection

We collected information on potential confounding variables, such as age; parity; body mass index (BMI); birth weight; and spinal sagittal balance parameters, such as SS and CSAS; from both groups. Fig. 1 shows the angles used in this study; same angle can be measured using lumbar magnetic resonance imaging (MRI) (Fig. 1). The lumbosacral parameters were analyzed using MRI (Fig. 1) because MRI is the investigation of choice for LBP when symptoms of LBP persist for several months. Modic changes are reported to range from 12% to 58% [17]. We evaluated Modic changes frequently seen in patients with LBP because their presence may relate to clinical symptoms. To minimize random errors, we repeated each measurement twice and recorded the average value. The vertical angle of the sacrum is the angle created between the intersection of the upper surface of S1 vertebra and a vertical line. SS is the value of the angle between the superior plate of S1 and a horizontal line [18,19]. We defined CSAS as the angle created between the intersection of a line running centrum of sacral curvature (S3 vertebra) and a vertical line (Fig. 1).

All patients underwent CS at our institution. On arrival at the operating theatre, patients were administered 15 mL/kg of isotonic solution prior to induction of spinal anesthesia. Standard monitoring included continuous electrocardiography, pulse oximetry, and blood pressure. We established spinal anesthesia with 2.5 mL (12 mg) 0.5% hyperbaric bupivacaine at the L3–4, L4–5, or L5–S1 interspace tested by cold sensation or pinprick with the parturients in the lateral or sitting position. We used a 25-G Quincke needle and monitored for hypotension as-

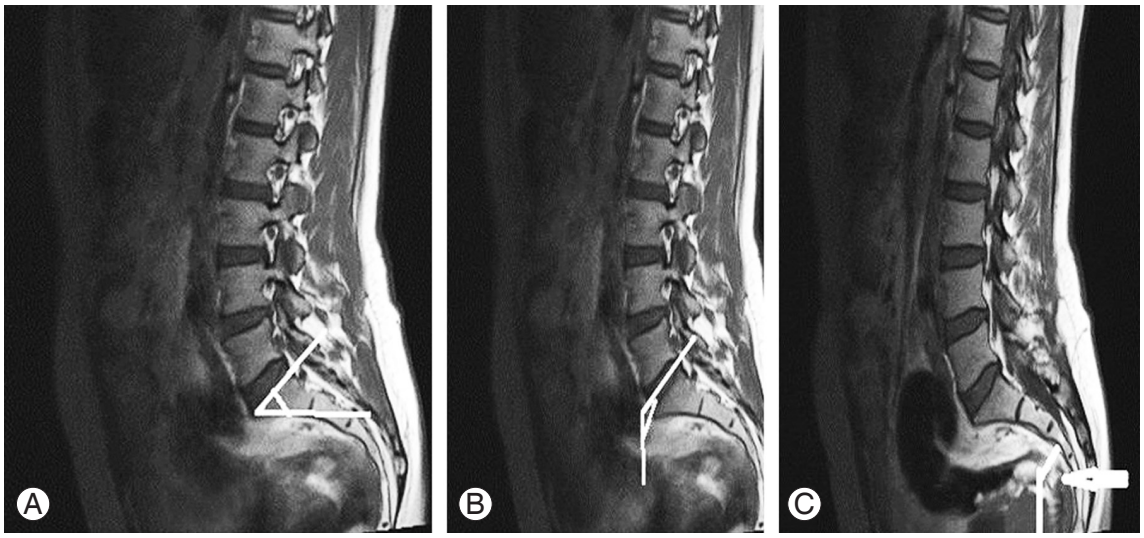

Fig. 1. Magnetic resonance imaging angles used in this study. **(A)** Sacral slope. **(B)** Vertical angle of sacrum. **(C)** Central sagittal angle of the sacrum.

sociated with spinal anesthesia during elective CS. Maternal hypotension (systolic blood pressure, <80% of baseline or <90 mm Hg) and severe hypotension (systolic blood pressure, <80 mm Hg) were treated with 10 mg ephedrine boluses, respectively. The primary outcome variable was development of postpartum LBP (yes/no) at 6 months following CS.

4. Statistical analysis

Statistical analysis was performed using the Predictive Analytics SoftWare (PASW) Statistics ver. 18.0 for Windows (SPSS Inc., Chicago, IL, USA). The statistical significance was set at $p<0.05$. We examined nonparametric relationships using the Mann–Whitney U test.

Results

1. Participants

The study included a total of 53 adult parturients. All received spinal anesthesia for CS. Twenty-three female patients (Group I; 23/53; 45.09%) complained of new onset backache and 30 (Group II; 30/53; 58.82%) had no complains of LBP at 6 months following CS. Table 1 shows the data of patients in Groups I and II.

2. Descriptive data

The mean age of patients in Groups I and II was 36.70 years and 30.0 years, respectively (Table 1). The mean age was statistically different between the two groups ($p<0.05$); however, BMI was not statistically different. No differences in BMI and infant weight at delivery between patients in Groups I and II were found using the Mann–Whitney U test (Table 2).

3. Main results

Group I had mean measures for CSAS (138.87) and parity (3.17) that were significantly higher than those of Group II (CSAS, 129.53; parity, 2.83).

Discussion

1. Key results

Patients in Group I had significantly higher measures of all variables of interest. Increased baby weight following delivery could possibly cause LBP; therefore, we compared baby weights after delivery in both groups and found no significant differences. Group I had significantly higher measures of age, parity, and CSAS. CSAS is correlated with the vertical angle of sacral curvature.

2. LBP and CS

There is increasing interest in identifying the pain mechanisms that contribute to chronic LBP, and the reasons some patients suffer from chronic LBP after CS with

Table 1. Patient demographic data

Variable	No.	Mean	Standard deviation	Standard error	95% Confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
Age								
Control group (group 1)	30	36.70	4.893	0.893	34.87	38.53	22	41
4	23	30.00	5.334	1.112	27.69	32.31	21	37
Total	53	33.79	6.052	0.831	32.12	35.46	21	41
Body mass ındex								
Control group (group 1)	30	27.19	6.340	1.158	24.82	29.56	19	47
Patient group (group 2)	23	26.33	4.689	0.978	24.31	28.36	19	35
Total	53	26.82	5.648	0.776	25.26	28.38	19	47
Parity number								
Control group (group 1)	30	2.83	0.791	0.145	2.54	3.13	1	5
Patient group (group 2)	23	3.17	1.230	0.257	2.64	3.71	1	4
Total	53	2.98	1.009	0.139	2.70	3.26	1	5
Sacral slope								
Control group (group 1)	30	43.47	8.492	1.550	40.30	46.64	23	57
Patient group (group 2)	23	40.18	8.340	1.739	36.57	43.78	24	55
Total	53	42.04	8.506	1.168	39.70	44.39	23	57
Central angle of sacral curvature								
Control group (group 1)	30	129.53	11.380	2.078	125.28	133.78	101	150
Patient group (group 2)	23	138.87	9.157	1.909	134.91	142.83	122	153
Total	53	133.58	11.381	1.563	130.45	136.72	101	153
Baby delivery weight (g)								
Control group (group 1)	30	3688.00	313.392	57.217	3570.98	3805.02	3000	4100
Patient group (group 2)	23	3639.35	451.181	94.078	3444.24	3834.45	3100	4600
Total	53	3666.89	376.151	51.668	3563.21	3770.57	3000	4600

Table 2. Nonparametric relationships of groups using the Mann–Whitney U test

Test	Age	Body mass ındex	Parity number	Sacral slope	Central angle of sacral curvature	Baby delivery weight
Mann-Whitney U	113.500	335.000	225.000	278.000	181.500	299.500
Wilcoxon W	389.500	611.000	690.000	554.000	646.500	575.500
Z	–4.179	–0.180	–2.300	–1.204	–2.937	–0.819
2-tailed	0	0.857	0.021	0.228	0.003	0.413

spinal anesthesia remain unclear. The lumbar spine supports the upper body, transmitting upper body weight to the pelvis and lower limbs [3]. Increased loading of the lumbar spine that results from pregnancy-related weight gain may cause the intervertebral discs to lose height and force-absorbing capacity, resulting in excessive loading of the surrounding facet joints and spinal ligaments. These changes may produce LBP following CS under spinal anesthesia. Consequently, BMI may independently predict LBP in these patients. BMI did not significantly differ be-

tween the two groups.

3. Age and LBP

In this study, mean age of patients in Groups I and II was 36.70 years and 30.0 years, respectively. This difference was statistically significant ($p<0.05$). This finding is not surprising as LBP can be caused by structural problems that relate to age. Patients in Group I had LBP and were significant ly older ($p<0.05$).

4. LBP, sagittal balance, and CSAS

Normal alignment of the spine depends on structural, muscular, bony, and articular factors [20]. Therefore, spinal sagittal plane and balance are important. The pelvis is the central component for sagittal alignment, acting in concert with pelvic structures to provide stability [21]. Sagittal balance of the spine is a fundamental element necessary for understanding spinal disease, patient evaluation, and treatment [22]. Abnormal spinal sagittal alignment can cause persistent LBP [7]. Sacral curvature (SC), represented by the angle between the first and the last sacral vertebrae, is a feature that differentiates the human pelvis from that of other animals [23]. A vertical sacrum is described by a low value, and a horizontal sacrum is described by a high value [24]. In this study, mean CSAS was 129.53 in Group II (control group), whereas Group I patients with persistent LBP following CS under spinal Anastasia had a mean CSAS of 138.78. This suggests a potential association between LBP after CS and increased CSAS. This result requires verification by other studies. Pregnancy-related degredations in biomechanical function may lead to persistent LBP following CS under spinal Anastasia. Treatment of spinal pathologies should consider anatomical and physiological rules [25]. To the best of our knowledge, there are no previous reports of age, parity, and CSAS as contributing factors for LBP after CS. Recognizing this, our results should be interpreted with caution [26,27]. CSAS may be an important factor deserving of attention from anesthetists who treat this population. Pain is subjective and varies relative to perception, threshold, and variety, according to numerous factors [28]. Why did the patients in Group I develop LBP? The sacrum of a representative patient with LBP following CS under spinal anesthesia appears more vertical (greater CSAS) than that of a patient without LBP. A more vertical sacrum, with corresponding increases in CSAS could relate to disc degeneration and LBP, following CS under spinal anesthesia. Findings of this study indicate the importance of CSAS as a focus for further prospective study.

5. Study limitations

Because this study is retrospective in nature, it has some limitations. For example, occupation, smoking, and sitting position are other possible risk factors that we did not examine. There are wide ranges of reported incidences of LBP after CS, potentially explained by differing study methodologies. Furthermore, we lack comprehensive characterization of pain quality.

The most important limitation of our study is the retrospective design that involved reviewing patients' sagittal parameters instead of prospectively measuring variables of interest. However, we wanted to use objective parameters. Computed tomography and MRI of the spine are now possible because of advances in imaging technology. MRI scans are an excellent, noninvasive means of imaging the entire lumbar spine [29]. It is very sensitive and specific to tissue disruptions [15]. It has recently become the most commonly used method for diagnosing spinal disorders [30]. Measurement of pelvic parameters using MRI involves putting the patient into a supine position within the scanner. This position does not reflect the influence of real human body weight biomechanics. Some may question examining spinal–sagittal balance parameters, such as SS, central sacrum sagittal angle, and vertical angle of the sacrum. It is impossible to calculate pelvic tilt or pelvic incidence from lumbar MRI. In addition, we did not want to subject patients to unnecessary radiation present in conventional X-rays; therefore, we used MRI. We evaluated the Modic changes and patients' disc herniation using MRI, even though it was possible to evaluate these variables by conventional X-ray.

Other questions may arise from calculating CSAS from MRI images in the supine position. Position will not affect these measures because the sacrum is the undistorted part of the spine and its angle is unchanged by position.

Future studies should include groups of patients who underwent CS under general anesthesia or normal vaginal delivery without anesthesia who did and did not develop LBP. Sacral anatomy alone may predispose a patient to post-cesarean LBP, with the type of anesthesia playing no role. The sample size of this study was relatively small. Fu-

ture prospective studies with more patients are warranted.

Conclusions

We performed a retrospective analysis of two groups of patients presenting to a neurosurgical clinic. Patients in Group I complained of LBP after CS with spinal anesthesia and those in Group II were admitted with LBP, but did not have LBP after CS. After comparing variables between the groups, we found those complaining of LBP were significantly younger and had significantly higher parity and larger CSAS. Age, parity, and CSAS are important factors for LBP following CSs with spinal anesthesia. Patients with increased CSAS might be discouraged from receiving spinal anesthesia. Future studies should further investigate these factors to improve intervention outcomes and pain management. As the first pilot study, our findings will aid in the planning of future studies on this subject. Prospectively designed studies with large patient populations are needed.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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