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Original Article

Magnetic Resonance Imaging of Pubic Symphysis and Sacroiliac Joint after Vaginal Delivery in Comparison with Cesarean Delivery in the First Postpartum Week in Primiparous Women

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Abstract

Objectives: This study aimed to compare the changes in the pubic symphysis and sacroiliac joint (SIJ) in primiparous women who delivered vaginally versus those who had a cesarean section within the first postpartum week using magnetic resonance imaging (MRI).

Materials and Methods: A total of 52 healthy women were prospectively evaluated with MRI 3 days after delivery. The cohort included 26 women who delivered vaginally (mean age 33.2 ± 4 years) and 26 who underwent cesarean delivery (mean age 35.2 ± 5.6 years). Parameters assessed included bone marrow edema (location), joint fluid, joint space width, and stress fractures.

Results: There was no significant difference in mean height between the two groups (vaginal vs. cesarean delivery: 150.46 ± 5.62 cm vs. 150.31 ± 5.62 cm, P = 0.740). Similarly, mean weight was comparable between groups (vaginal: 52.24 ± 7.41 kg vs. cesarean: 51.82 ± 6.49 kg, P = 0.398), and the mean body mass index was 22.62 ± 2.95 kg/m² for vaginal delivery and 22.57 ± 2.52 kg/m² for cesarean delivery (P = 0.895). The mean gestational age at delivery did not differ significantly between groups (38 ± 1 week vs. 39 ± 1.57 weeks, P = 0.277). The mean birth weight was 2.90 ± 0.29 kg in the vaginal delivery group and 2.77 ± 0.37 kg in the cesarean delivery group (P = 0.14), which was also not significantly different. The incidence of pubic bone marrow edema was higher in the vaginal delivery group (23/26, 88.4%) compared to the cesarean group (17/26, 73.1%), though the difference was not statistically significant (P > 0.05). In addition, one patient in the vaginal delivery group had a sacral stress fracture.

Conclusion: The study showed a slightly higher occurrence of bone marrow edema in the pubic bones and SIJs following vaginal delivery, compared to cesarean section, though the difference was not statistically significant. This finding supports the hypothesis that even women who undergo planned cesarean deliveries may experience stress-related changes in the pubic and SIJs due to pregnancy, with vaginal delivery exhibiting a marginally higher incidence of these changes.

Key words: Magnetic resonance imaging, Postpartum period, Pubic symphysis, Sacroiliac joint

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INTRODUCTION

During pregnancy, both the pubic symphysis and sacroiliac joints (SIJs) experience physiological expansion, beginning around the 10th week and reaching its peak near term. Typically, these joints return to their pre-pregnancy state within 4–12 weeks postpartum. The pubic symphysis is

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a non-synovial joint, with hyaline cartilage covering the medial surfaces of the pubic bones. A fibrocartilaginous disk sits between the two bones, and the joint capsule is reinforced by ligaments: Superior, anterior, inferior, and posterior.[1] In addition, an aponeurosis connects the joint capsule to the tendons of the rectus abdominis and adductor longus muscles, providing stability during torso movements. Both the disk and the anterior pubic ligament play critical roles in maintaining the stability of the pubic joint. The SIJs are located between the sacrum and the iliac bones, serving as a mechanism for transferring forces from the spine to the lower extremities. These joints' stability is enhanced by the wedging of the sacrum between the iliac bones within the pelvic ring, reinforced by strong surrounding ligaments. The SIJ is composed of both cartilaginous (ventral) and ligamentous (dorsal) components.

Throughout pregnancy, the hormone relaxin increases the laxity of the musculoskeletal system, preparing the pelvis for childbirth. This increased flexibility allows for significant movement within the pelvic ring during delivery, subjecting the joints to considerable mechanical stress.[2] These hormonal and mechanical changes can lead to postpartum pelvic pain, often characterized by bone marrow edema, which may be indistinguishable from other conditions such as axial spondyloarthropathy or infections. Complications such as pubic diastasis (defined as a pubic bone separation >10 mm) or rupture (more than 25 mm), as well as sacral stress fractures, may present with symptoms including suprapubic pain, tenderness, swelling, and a waddling gait. While plain radiographs and computed tomography (CT) scans can detect certain bony injuries postpartum, they are unable to identify early changes such as bone marrow edema or ligament injuries. Ultrasound (USG) can assess pubic diastasis and fluid accumulation, but its sensitivity may be hindered by operator dependence and intraobserver variability. On the other hand, magnetic resonance imaging (MRI) provides superior visualization of soft-tissue alterations and injuries in the pelvic girdle after delivery.

Agten *et al*.[3] demonstrated that significant bone marrow edema in the pubic symphysis can occur even after planned cesarean deliveries, suggesting that the mechanical stress of pregnancy rather than the mode of delivery triggers this response. However, this study did not include assessments of the SIJs, and its sample size was relatively small. Therefore, the aim of this study is to evaluate the pubic symphysis and SIJs within a few days of uncomplicated childbirth and compare the effects of pregnancy and delivery method on these structures.

MATERIALS AND METHODS

Study Design

This was an observational analytical study.

Study Setting

The study was conducted at the Department of Radiodiagnosis, Pt. J. N. M. Medical College and the associated Dr. B. R. Ambedkar Memorial Hospital, Raipur, Chhattisgarh.

Study Subjects

Primiparous women were recruited from the postnatal ward after childbirth, either following a vaginal delivery or a cesarean section.

Inclusion Criteria

- Gestational age at childbirth of 36 weeks or later,
- Baby birth weight ranging from 2.5 to 3.5 kg,
- Written informed consent obtained from the participants.

Exclusion Criteria

- Contraindications to MRI,
- Claustrophobia,
- Known or suspected inflammatory conditions (e.g., rheumatoid arthritis, spondyloarthritis),
- Multiple gestations,
- Congenital anomalies in the newborn,
- Cesarean delivery due to obstructed labor,
- Instrumental deliveries.

MRI

Each eligible participant underwent an MRI during their hospital stay, ensuring the imaging occurred within the first postpartum week. The MRI was performed using a whole-body magnetic resonance system (SIEMENS MAGSKYRA) with a 3 Tesla field strength. Scans were conducted with the patient in the supine position, and multi-phased array coils were employed. The imaging protocol included:

- Short tau inversion recovery sequence in coronal oblique and axial oblique planes (TR: 4000 msec, TE: 60 msec, FA: 90°, slice thickness: 3 mm, gap: 0.6 mm, FoV: 270 mm, matrix: 512 × 512, inversion time: 150 ms), used to assess bone and soft-tissue, particularly for detecting bone marrow edema.
- T1 fast spin-echo sequences in coronal oblique planes for bone and soft-tissue characterization, focusing on detecting fatty infiltration and bone erosions, including backfill.
- T2 fast spin-echo sequences in coronal oblique planes for soft-tissue assessment and identifying fluid accumulation in the joint spaces.

The total scanning time was approximately 9.25 min. Care was taken to properly position the patient, ensuring adequate padding between the pubic symphysis and the anterior part of the coil.

Image Analysis

A semi-quantitative approach was used to assess the following parameters:

- Presence of bone marrow edema in the pubic bones and SIJs (categorized as no edema, right side only, left side only, or bilateral edema)
- Presence of fractures in the pubic bones and SIJs, defined as a hypointense linear signal within the bone marrow edema zone (categorized as no fracture, right side, left side, or bilateral fracture)
- Distension of the pubic joint and SIJ (yes/no)
- Fluid in the pubic symphysis joint (yes/no).

Statistical Analysis

Demographic data were compared between the two groups (vaginal delivery vs. cesarean delivery) using the *t*-test. The location of bone marrow edema was compared using the Chi-square test, fractures were analyzed using Fisher's exact test, joint distension was assessed using the Mann–Whitney U test, and joint fluid was compared using the Chi-square test. A joint distension of over 10 mm was considered abnormal, as recommended by Lindsey *et al*. IBM Statistical Packages for the Social Sciences Statistics version 24 (IBM Corp.) was used for all statistical analyses.

RESULTS

Demographics

A total of 52 participants were included in the study, with 26 women in each group (vaginal delivery and cesarean delivery). The mean age of participants in both groups was similar, with the vaginal delivery group having a mean age of 22.96 ± 2.57 years and the cesarean delivery group 23.69 ± 3.14 years, with no significant difference ($P = 0.313$). The mean height of participants was also comparable between the two groups, with the vaginal delivery group at 150.46 ± 5.62 cm and the cesarean delivery group at 150.31 ± 5.62 cm ($P = 0.740$). Regarding body weight, the average weight was 52.24 ± 7.41 kg for the vaginal delivery group and 51.82 ± 6.49 kg for the cesarean group, which was not significantly different ($P = 0.398$). The mean body mass index for the vaginal and cesarean delivery groups were 22.62 ± 2.95 kg/m^2 and 22.57 ± 2.52 kg/m^2, respectively, showing no significant difference ($P = 0.895$). The mean gestational age at delivery was comparable between the two groups, with the vaginal delivery group delivering at 38 ± 1 week and the cesarean delivery group at 39 ± 1.57 weeks ($P = 0.277$). The mean birth weight for the vaginal delivery group was 2.90 ± 0.29 kg, while the cesarean delivery group had a mean birth weight of 2.77 ± 0.37 kg, which was also not significantly different ($P = 0.14$) [Figures 1, 2 and Table 1].

Bone Marrow Edema and Fractures

The occurrence of pubic bone marrow edema was slightly higher in the vaginal delivery group (23/26, 88.4%) compared to the cesarean delivery group (17/26, 73.1%), although this difference was not statistically significant ($P = 0.159$). Similarly, SIJ marrow edema was more prevalent in the vaginal delivery group (25/26, 96%) than in the cesarean group (23/26, 88.4%), but again, this difference did not reach statistical significance ($P = 0.298$). The distribution of bone marrow edema in terms of laterality at the pubic symphysis and SIJ showed no significant differences between the two groups ($P = 0.186$ and $P = 0.847$, respectively) [Figures 3 and 4].

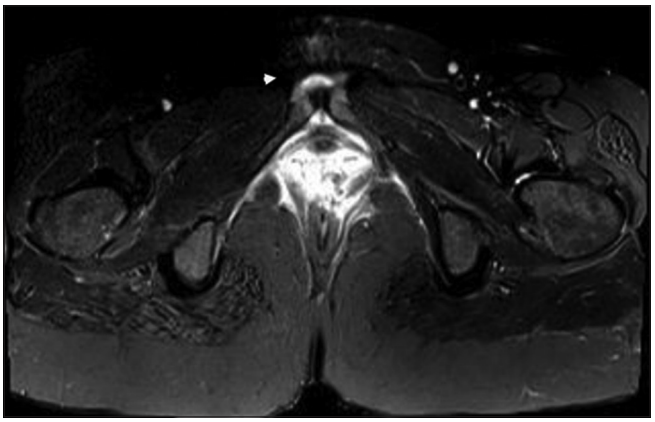

Figure 1: Transverse short tau inversion recovery image shows bilateral subchondral bone marrow edema at the pubic symphysis (arrows) in a 23-year-old primiparous female with uncomplicated normal vaginal delivery of 3.2 kg child at the gestation age of 38 weeks 2 days

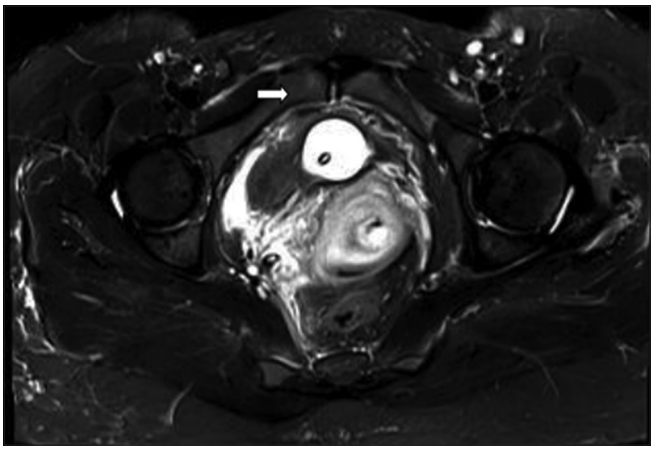

Figure 2: Transverse short tau inversion recovery image shows bilateral subchondral bone marrow edema at the pubic symphysis (arrows) in a 22-year-old primiparous female with lower segment cesarean section for of 3.1 kg child at the gestation age of 39 weeks 2 days

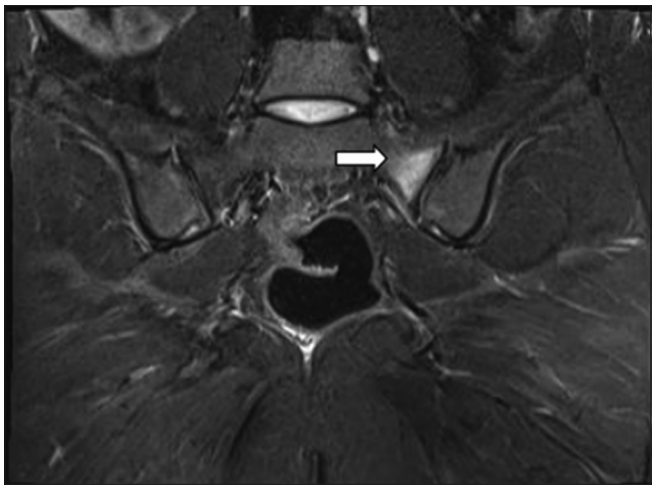

Figure 3: Coronal short tau inversion recovery image shows left-sided subchondral bone marrow edema at the sacroiliac joint (arrows) in a 23-year-old primiparous female with uncomplicated normal vaginal delivery of 3.2 kg child at the gestation age of 38 weeks 2 days

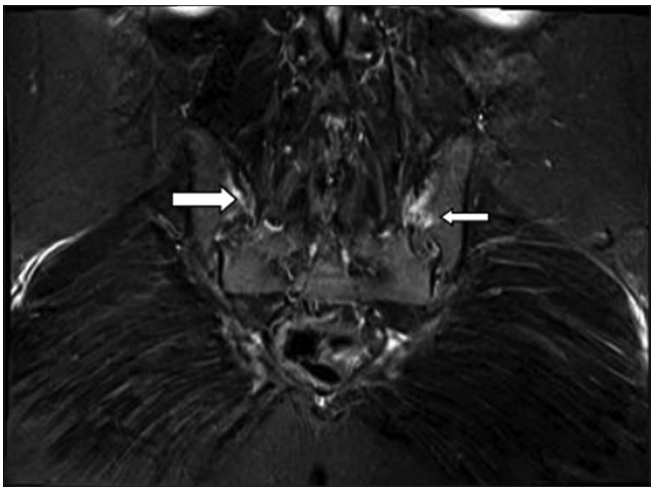

Figure 4: Coronal short tau inversion recovery image shows bilateral subchondral bone marrow edema at the sacroiliac joint (arrows) in a 22-year-old primiparous female with lower segment cesarean section for of 3.1 kg child at the gestation age of 39 weeks 2 days

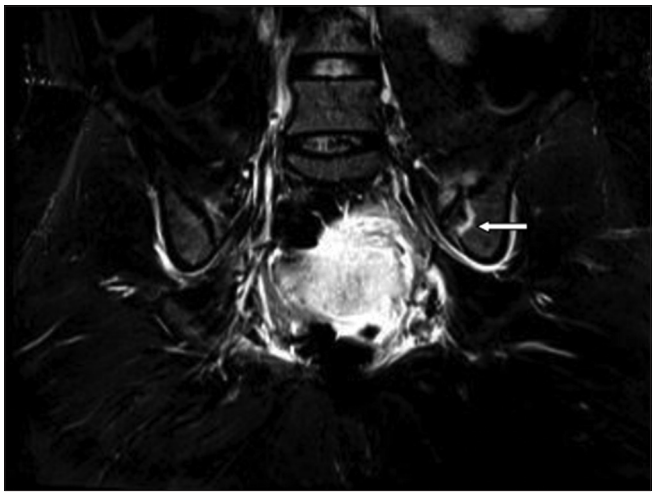

Figure 5: Left sacral bone shows an increased signal intensity on the coronal T2-weighted image (bottom) indicating a sacral stress fracture in a 23-year-old primiparous female with uncomplicated normal vaginal delivery of a 2.8 kg child at the gestation age of 40 weeks 1 day with no complaints of pain

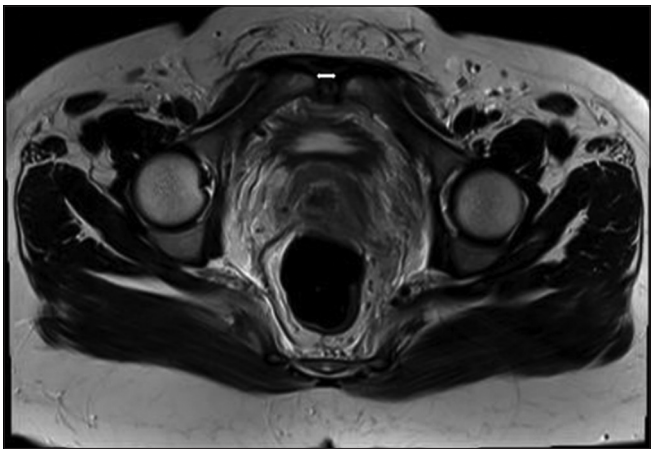

Figure 6: Axial T2-weighted magnetic resonance imaging demonstrating increased inter-pubic distance of 12 mm in a 22-year-old primiparous female with uncomplicated normal vaginal delivery of a 2.9 kg child at the gestation age of 39 weeks 1 day with no complaints of pain

Joint Distension and Fluid

The prevalence of fluid in the pubic symphysis was higher in the vaginal delivery group (6/26, 23.1%) compared to the cesarean delivery group (5/26, 19.2%), but this difference was not statistically significant ($P = 0.510$) [Figure 5]. Conversely, fluid in the SIJ was more common in the cesarean delivery group (13/26, 50%) compared to the vaginal delivery group (11/26, 42.3%), though this difference was also not statistically significant ($P = 0.265$). Pubic symphysis diastasis, defined as a joint space width >10 mm, and a sacral stress fracture were observed in one patient in the vaginal delivery group [Figure 6 and Table 1].

DISCUSSION

This study was conducted at the Department of Radiodiagnosis, Pt. J.N.M. Medical College and Dr. B.R.A.M. Hospital in Raipur, with the primary aim of comparing the changes in the pubic symphysis and SIJ between primiparous women who underwent vaginal delivery and those who had cesarean sections within the first postpartum week using MRI. While conventional imaging techniques such as plain radiography or CT are effective for detecting bony postpartum injuries, they do not capture early changes such as bone marrow edema or ligamentous injuries. Although ultrasonography (USG) can detect pubic diastasis

Table 1: Demographics comparison in both groups

Demographics	NVD	LSCS	*P*-value
Age (in years)	22.96±2.57	23.69±3.14	0.313
Height (in centimeters)	150.46±5.620	150.31±5.623	0.740
Weight (in kgs)	52.24±7.41	51.82±6.49	0.398
BMI (in kg/m^2)	22.62±2.95	22.57±2.52	0.895
Gestational age (in weeks)	38.54±0.99	38.77±1.36	0.277
Baby birth weight (in kg)	2.90±0.288	2.77±0.365	0.140

BMI: Body mass index, LSCS: Lower segment cesarean section

Table 2: MRI imaging findings in both groups

MRI imaging findings	NVD	LSCS
Pubic bone edema	24	18
SI joint edema	25	23
Pubic symphysis fluid	6	20
SI joint fluid	15	13
Pubic bone fracture	0	0
SI joint fracture	1	0
Pubic symphysis distension	1	0
SI joint distension	0	0

SIJ: Sacroiliac joint, LSCS: Lower segment cesarean section, MRI: Magnetic resonance imaging

and fluid accumulation, its sensitivity may be limited due to operator dependence and intra-observer variability. MRI, on the other hand, provides superior visualization of soft-tissue changes and potential injuries to the pelvic girdle joints post-delivery.

In our study, 52 women (26 in each group) were enrolled. The mean age of the participants was not significantly different between the two groups (vaginal delivery: 22.96 ± 2.57 years vs. cesarean delivery: 23.69 ± 3.14 years, $P = 0.313$), which aligns with the typical mean age of primiparous women in India, approximately 21 years (Statista.com) [Table 2].

Bone Marrow Edema and Fractures

Our study showed a higher incidence of pubic bone marrow edema in the vaginal delivery group (88.4%) compared to the cesarean delivery group (73.1%), but the difference was not statistically significant ($P = 0.159$). Similarly, SIJ marrow edema was more common in the vaginal delivery group (96%) than in the cesarean group (88.4%), though again, the difference did not reach statistical significance ($P = 0.298$). This finding suggests that the occurrence of bone marrow edema is not solely dependent on the mode of delivery but may be influenced by other factors, such as hormonal changes and the mechanical stresses experienced during pregnancy.[2]

The incidence of pubic diastasis (joint space width >10 mm) was observed in one patient with vaginal delivery, but it was absent in the cesarean delivery group. In contrast, Agten *et al.*[3] did not detect any pubic diastasis in their study, whereas Eshed *et al.* (2015)[4] reported frank symphysiolysis in 22% of their subjects, indicating a more frequent occurrence of this complication in some studies.

Fractures

In terms of fractures, we noted one sacral stress fracture in the vaginal delivery group, which aligns with findings from Eshed *et al.* (2015)[4] and Wurdinger *et al.* (2002),[5] who observed sacral insufficiency fractures in 9 and 1 subject(s), respectively. Notably, no pubic bone fractures were detected in our study, which contrasts with the study by Miller *et al.* (2010),[6] where they reported a much higher prevalence of pubic bone fractures (29%) in a high-risk sample. However, their study differed from ours in that MRI was conducted around 7 weeks postpartum, and it excluded women who had planned cesarean deliveries. Brandon *et al.* (2012)[7] also investigated pubic bone injuries in both high-risk and low-risk women, finding that 38% of the high-risk group exhibited pubic bone fractures compared to only 13% in the low-risk group [Table 2].

The imaging in our study was performed on the 3rd postpartum day, which is an important strength, as it minimized the likelihood of detecting late changes in bone structure. In addition, the demographic characteristics were similar in both groups, with an equal number of participants in each, which helped eliminate potential bias.

Strengths and Future Directions

One of the key strengths of our study was the careful selection of participants, ensuring that both groups were comparable and that the imaging was conducted early in the postpartum period. Future research could explore the lateral extension of bone marrow edema in both groups and further investigate potential correlations between ethnicity and delivery method, as these factors may influence the occurrence and severity of joint changes.

CONCLUSION

Changes in the pubic symphysis and SIJ during pregnancy and childbirth are commonly observed and occur in both vaginal and cesarean deliveries, even when the fetus does not pass through the pelvic cavity. In this study, we observed a slightly higher incidence of bone marrow edema in the pubic bones and SIJ following uncomplicated childbirth in the vaginal delivery group compared to the cesarean delivery group. However, the difference was not statistically significant. Similarly, pubic joint and SIJ distension, as well as fluid accumulation in the pubic joint, were more frequently observed in women after vaginal delivery, though these differences did not reach statistical significance.

These findings suggest that the changes in the pubic symphysis and SIJ are primarily attributed to the chronic mechanical stress placed on the pelvic ring and the physiological adaptations during pregnancy, rather than solely during the final stages of childbirth when the fetus moves through the pelvic cavity. Our results support the hypothesis that, even after a planned cesarean delivery, women can experience significant stress-related changes in the pubic joint and SIJ as a result of pregnancy. However, vaginal delivery appears to be associated with a slightly higher incidence of such stress-related changes.

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