

Weighing the Risks: A Clinical Evaluation of MRI Safety and Diagnostic Value During Pregnancy

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Study conducted at the Department of Radiology, Medanta – The Medicity, Gurugram, India, under the supervision of Pratap Narayan Mishra (Chief Technologist) and Dr. Lalit Kumar Gupta, Professor & Dean, University School of Physiotherapy and Radiology, Rayat Bahra University

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Abstract: Background: Magnetic resonance imaging (MRI) is an important diagnostic modality during pregnancy because it provides detailed anatomical information without the use of ionizing radiation. Nevertheless, concerns regarding fetal exposure to static magnetic fields, radiofrequency energy, acoustic noise, and the use of contrast agents continue to influence clinical decision-making. Objective: To evaluate the safety and diagnostic value of MRI performed during pregnancy and to assess maternal and neonatal outcomes following MRI exposure. Methods: A retrospective observational study was conducted using records of 25 pregnant women who underwent MRI at Medanta – The Medicity, Gurugram, over a four-month period. Examinations were performed on 1.5-T and 3-T Siemens systems without gadolinium-based contrast. Gestational age, indication, MRI protocol, and pregnancy and neonatal outcomes were reviewed and summarized using descriptive statistics. Results: Mean maternal age was 28.1 ± 4.8 years (range 19–40) and mean gestational age at MRI was 22.6 ± 6.3 weeks. MRI was performed in the first trimester in 3 women (12%), second trimester in 14 (56%), and third trimester in 8 (32%). Indications were fetal in 11 cases (44%), maternal obstetric in 8 (32%), and maternal non-obstetric in 6 (24%). Twenty-four pregnancies (96%) resulted in live births; one neonatal death occurred in association with severe placental abruption and was not attributed to MRI exposure. Two neonates had transient complications (hypoxia and tachycardia) that resolved fully. No maternal or neonatal adverse outcome was identified as attributable to MRI. Conclusion: In this retrospective cohort, non-contrast MRI performed during pregnancy was not associated with an identified adverse maternal or neonatal outcome and provided clinically relevant diagnostic information across all trimesters. When clinically justified, MRI may be considered an important diagnostic option during pregnancy, with appropriate attention to scanning protocols and avoidance of unnecessary gadolinium exposure.

Keywords: Magnetic resonance imaging; pregnancy; fetal MRI; MRI safety; maternal imaging; neonatal outcome

1. Introduction

Diagnostic imaging during pregnancy requires careful consideration of both maternal benefit and fetal safety. Unlike radiographic and computed tomography techniques, MRI does not use ionizing radiation, and it can provide detailed assessment of fetal, placental, pelvic, abdominal, and other maternal abnormalities when ultrasound findings are inconclusive or insufficient.

Despite its clinical advantages, concerns remain regarding fetal exposure to the static magnetic field, radiofrequency energy, and acoustic noise generated during scanning. These concerns are particularly relevant during early pregnancy, when the developing fetus is most sensitive to external influences. The use of gadolinium-based contrast agents is generally avoided during pregnancy unless the expected diagnostic benefit clearly outweighs the potential risk, since gadolinium is water-soluble and may cross the placenta.

Previous evidence has been broadly reassuring regarding non-contrast MRI during pregnancy. In a large population-based study, Ray et al. found no increased risk of adverse fetal or childhood outcomes following first-trimester MRI exposure, although gadolinium-enhanced MRI at any stage of pregnancy warranted additional caution [1]. Current

professional recommendations from the American College of Obstetricians and Gynecologists and the Canadian Association of Radiologists similarly emphasize that MRI should be performed when clinically justified, using appropriate technical protocols, and that unnecessary gadolinium administration should be avoided [2,3].

The present study evaluates MRI exposure and associated pregnancy and neonatal outcomes in a retrospective cohort of pregnant women who underwent MRI for a range of fetal, maternal obstetric, and maternal non-obstetric indications at a tertiary care centre in India, with the aim of contributing India-specific clinical data to a literature that remains dominated by Western cohorts.

2. Materials and Methods

2.1 Study Design and Setting

A retrospective observational study was conducted using clinical records from the Department of Radiology, Medanta-The Medicity, Gurugram/New Delhi region. The study included all pregnant women who underwent an MRI examination during a four-month study period and met the eligibility criteria described below.

2.2 Study Population and Sample

The study population comprised pregnant women referred for MRI for any clinical indication- obstetric, non-obstetric, or fetal- during the study period. A total of 25 pregnant women met the inclusion criteria and were included in the final analysis (Inclusion criteria: every individual who underwent an MRI scan while pregnant, for any obstetric, non-obstetric, or fetal indication. Exclusion criteria: cases in which fetal cardiac activity had not been documented by the eighth week of gestation). Given the low frequency with which MRI is performed during pregnancy, a consecutive, non-probability sampling approach was used, and all eligible cases occurring

within the study period were included rather than a pre-calculated subset.

2.3 MRI Equipment and Protocol

Examinations were performed using 1.5-T and 3-T Siemens MRI systems. Imaging sequences were selected according to gestational age and clinical indication. No gadolinium-based contrast agent was administered in any of the reviewed examinations. The technical parameters used for early pregnancy and for the second and third trimesters are summarized in Tables 1 and 2.

Table 1: MRI protocol used for early pregnancy (first-trimester) examinations

Sequence	Imaging Plane	TR/TE (ms)	Flip Angle	FOV (mm)	Matrix	NSA	Acquisition Time
T1W TSE	Axial, Coronal	600 / 13	90°	400–450	256 × 224	2	~1240 ms
T2W TSE	Axial, Coronal, Sagittal	4750 / 120	90°	400–450	256 × 224	2	~1260 ms

Table 2: MRI protocol used for second- and third-trimester examinations. SSFP = steady-state free precession; SSH = single-shot half-Fourier; GRE = gradient echo; SAR = specific absorption rate

Sequence	TR/TE (ms)	Flip Angle	NSA	Acquisition Time	Principal Merit	Principal Limitation
SSFP	04-Feb	60°	2	17–20 s	High SNR, fast, low SAR	Sensitive to susceptibility artefact
SSH T2W	3500 / 80	90°	2	8–15 s	Minimizes motion artefact	Relatively high SAR
T1 GRE	170 / 5	80°	3	10–12 s	Low SAR, breath-hold capable	Sensitive to susceptibility artefact

2.4 Data Collection

Patient records were reviewed for maternal age, gestational age at the time of MRI, clinical indication for examination, MRI field strength and sequences used, and pregnancy and neonatal outcomes, including birth outcome and neonatal condition at birth. The principal outcome of interest was the occurrence of any adverse maternal or neonatal event temporally associated with MRI exposure.

2.5 Statistical Analysis

Continuous variables (maternal age, gestational age at MRI) are presented as mean $\pm$ standard deviation with range. Categorical variables (trimester of examination, indication category, pregnancy outcome) are presented as frequencies and percentages. Given the descriptive, single-cohort design, no inferential hypothesis testing was performed; findings were supplemented with a narrative review of the published literature to contextualize this small cohort within the broader evidence base.

2.6 Ethical Considerations

Participant information sheets and informed consent for use of obstetric records were obtained as part of the original data collection, and patient identifiers (name, address, contact details) were anonymized prior to analysis. Participation was voluntary, and participants retained the right to withdraw without providing a reason. [Author to insert the Institutional Ethics Committee / IRB approval reference number here prior to journal submission, as required by target journal policy.]

3. Results

Twenty-five pregnant women met the inclusion criteria and were included in the analysis. Mean maternal age was 28.1 ± 4.8 years (range 19–40 years). Mean gestational age at the time of MRI was 22.6 ± 6.3 weeks (range 9–32 weeks; two cases in which gestational age was recorded only as an approximate trimester rather than an exact week were excluded from this specific calculation).

Table 3: Distribution of MRI examinations by trimester of pregnancy (n = 25).

Trimester	n	%
First	3	12%
Second	14	56%
Third	8	32%

Of the three examinations performed in the first trimester, two were undertaken before the pregnancy had been clinically recognized (i.e., incidental fetal exposure), and one was performed for a known indication (acute appendicitis) after pregnancy had already been confirmed.

Table 4: Distribution of MRI examinations by category of clinical indication (n = 25).

Indication Category	n	%
Fetal	11	44%
Maternal (obstetric)	8	32%
Maternal (non-obstetric)	6	24%

Table 5: Specific clinical indications for MRI. Totals sum to 26 rather than 25 because one case met the criteria for two overlapping indication categories

Specific Indication	n
Vaginal bleeding	4
Acute appendicitis	3
Confirmation of ultrasound abnormality	3
Suspected chromosomal abnormality	3
Bad obstetric history	2
Suspected Down syndrome	2
Trauma	2
Familial genetic disorder	1
Positive Kleihauer–Betke (KB) test	1
Suspected intrauterine growth restriction (IUGR)	1
Stroke (non-obstetric)	1
Fetal tachycardia	1
High-risk pregnancy	1
Oligohydramnios	1

Table 6: Pregnancy and neonatal outcomes (n = 25 pregnancies; 24 live births).

Outcome	n	%
Live birth	24	96.00%
Neonatal death	1	4.00%
Live births - uncomplicated at birth	22	91.7% of live births
Live births - transient hypoxia, resolved within 4 hours	1	4.2% of live births
Live births- neonatal tachycardia, resolved within 36 hours	1	4.2% of live births

The single neonatal death occurred in a pregnancy complicated by severe placental abruption, which had been confirmed on MRI after an initial ultrasound suggested only partial abruption. The fetal demise was attributed to the abruption itself- with consequent compromise of oxygen and nutrient supply- rather than to MRI exposure. One neonate required supplemental oxygen for four hours after birth for mild hypoxia, after which oxygen saturation normalized and no further abnormality was detected on clinical examination. A second neonate was found on fetal MRI to have tachycardia; this infant was transferred to a specialized paediatric cardiac facility, treated, and had fully recovered within 36 hours of delivery. All other live-born neonates were clinically well at birth, with no abnormality of birth weight, skin, or sex-specific findings identified as attributable to MRI exposure. No maternal complication was identified as attributable to MRI exposure at any point during the study period.

All 25 examinations were performed without gadolinium-based contrast, consistent with current recommendations to avoid gadolinium during pregnancy unless the expected diagnostic benefit clearly outweighs the theoretical risk [2,3].

4. Discussion

The findings of this study provide supportive evidence for the use of non-contrast MRI during pregnancy. In the present

cohort, MRI was performed across all three trimesters, including three first-trimester examinations, without an identified adverse outcome attributable to MRI exposure itself. This is consistent with the broader literature: in a large population-based study, Ray et al. reported no increased risk of fetal or childhood harm following MRI exposure in the first trimester of pregnancy [1], and current professional guidance from the American College of Obstetricians and Gynecologists and the Canadian Association of Radiologists supports the use of MRI when clinically justified, provided appropriate scanning protocols are followed and unnecessary exposure is minimized [2,3].

The diagnostic value of MRI in this cohort was substantial. Nearly half of all examinations (44%) were performed for fetal indications, most commonly suspected chromosomal abnormality or confirmation of an ambiguous ultrasound finding, underscoring MRI's role as a problem-solving tool rather than a first-line screening modality. Among maternal obstetric indications, vaginal bleeding was the most frequent trigger for MRI; the study's single neonatal death occurred in this context, where MRI clarified the severity of a placental abruption that ultrasound had understated- consistent with prior reports that ultrasound has comparatively low sensitivity for placental abruption, with reported false-negative rates as high as 25–50% [Fadl et al., 2019]. Among maternal non-obstetric indications, acute appendicitis was the leading cause, reflecting the well-documented advantage of MRI over graded-compression ultrasound for appendix visualization during pregnancy, where the gravid uterus and bowel displacement often limit sonographic assessment.

Gadolinium administration deserves separate consideration. No gadolinium was administered in any examination in this cohort, in line with current recommendations that gadolinium-based contrast agents be reserved for situations in which the expected diagnostic benefit clearly outweighs the theoretical risk of fetal exposure [2,3]. This cautious, non-contrast-first approach likely also explains why every examination in this series could still yield diagnostically useful information without contrast enhancement.

These findings should be interpreted with appropriate caution. The retrospective design and small sample size (n = 25) limit the study's ability to detect uncommon adverse outcomes or to establish long-term childhood safety, and the single-centre setting may limit generalizability to other populations and imaging protocols. Larger, prospective, multi-centre studies with extended childhood follow-up remain necessary to more definitively establish the long-term safety profile of MRI exposure in utero, particularly for non-obstetric indications and for examinations performed in early pregnancy before pregnancy has been clinically recognized.

5. Limitations

- Small, single-centre sample (n = 25), which limits statistical power to detect uncommon adverse outcomes.

- Retrospective design, which relies on the completeness and accuracy of existing clinical records rather than prospectively standardized data collection.
- Absence of a comparison group of pregnant women not exposed to MRI, which limits causal inference regarding outcomes.
- Follow-up was limited to the immediate neonatal period; longer-term childhood developmental outcomes were not assessed.
- All examinations were performed without gadolinium contrast, so these findings cannot be extrapolated to gadolinium-enhanced MRI during pregnancy.

6. Conclusion

In this retrospective cohort of 25 pregnant women, clinically indicated, non-contrast MRI was not associated with any identified adverse maternal or neonatal outcome. MRI was used across all trimesters and provided clinically meaningful diagnostic information for fetal, maternal obstetric, and maternal non-obstetric indications alike- most notably in cases of suspected placental abruption and acute appendicitis, where MRI findings materially informed patient management. These findings support the continued use of MRI as an important diagnostic modality during pregnancy when clinically indicated, with appropriate attention to scanning protocols and continued avoidance of unnecessary gadolinium exposure. Larger, prospective, multi-centre studies with longer-term follow-up are needed to further strengthen the evidence base for fetal and childhood safety.

Declarations

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Conflict of Interest

The author declares no conflict of interest.

Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request, subject to institutional data-sharing policy.

Author Contributions

S.M.I. conceived the study, collected and analyzed the data, and drafted the manuscript, under the supervision of P.N. Mishra and Dr. L.K. Gupta. [Author to confirm final author list, order, and individual contributions in accordance with target journal policy and co-author consent.]

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