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Neonatal Outcomes Following Maternal Exposure to Radiodiagnostic Procedures in Early Pregnancy: A Retrospective Study

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Abstract

Background: *Maternal exposure to radiodiagnostic procedures during early pregnancy is occasionally unavoidable but raises concerns regarding potential adverse neonatal outcomes. Limited data exist on the immediate effects of such exposures, particularly in low- and middle-income countries. This study aimed to evaluate neonatal outcomes following maternal exposure to radiodiagnostic procedures in early pregnancy.*

Methods: *This retrospective observational study was conducted in the Department of Radiology and Imaging at Northern International Medical College and Hospital, Dhaka, Bangladesh, from January 2024 to December 2024. A total of 41 pregnant women who underwent radiodiagnostic procedures during early gestation and subsequently delivered at the study hospital were included. Patients with incomplete records or chronic comorbidities were excluded.*

Results: *A total of 41 pregnant women who underwent radiodiagnostic procedures were studied. Most were aged 20–29 years (53.66%), with secondary education (41.46%), and housewives (68.29%). Intestinal obstruction (73.17%) was the most common indication, followed by ureteric stone (24.39%) and pelvic fracture (2.44%). Term delivery occurred in 75.61% of cases, with cesarean section in 56.10%. There were two stillbirths (4.88%). Neonatal outcomes showed 21.95% low birth weight, 14.63% NICU admissions, 7.32% congenital anomalies, and 4.88% mortality, while overall survival was 95.12%.*

Conclusion: *While most neonates had favorable outcomes, maternal exposure to radiodiagnostic procedures in early pregnancy carries a measurable risk of adverse neonatal outcomes, highlighting the importance of cautious imaging and fetal safety measures.*

Keywords: *Neonatal outcomes, Radiodiagnostic procedures, Early pregnancy, Low birth weight, Congenital anomalies, NICU admission*

1. Introduction

Radiodiagnostic procedures, including X-rays, computed tomography (CT) scans, magnetic resonance imaging (MRI) and fluoroscopy, are essential tools in modern medicine for the diagnosis and management of various conditions [1]. While these imaging modalities provide critical clinical information, the potential risks of ionizing radiation exposure, particularly during pregnancy, have been a long-standing concern [2]. The first trimester of pregnancy represents a period of rapid organogenesis, making the developing embryo highly susceptible to environmental insults, including radiation. Exposure to ionizing radiation during this period may increase the risk of adverse outcomes such as spontaneous abortion, congenital anomalies, intrauterine growth restriction, preterm birth and long-term developmental delays [3].

Despite these concerns, maternal exposure to radiodiagnostic procedures during early pregnancy may be unavoidable in certain clinical scenarios where timely diagnosis is crucial for maternal health [4]. X-rays and CT scans involve

ionizing radiation, whereas MRI uses non-ionizing magnetic fields and is generally considered safer during pregnancy [5]. However, precise data regarding the short-term and long-term effects of these procedures on neonatal outcomes remain limited, particularly in low- and middle-income countries where routine prenatal screening and radiation safety measures may vary [6]. Understanding the relationship between maternal radiodiagnostic exposure and neonatal outcomes is therefore critical for guiding clinical decision-making, counseling pregnant women and developing safety protocols [7].

Previous studies have reported conflicting findings regarding the effects of early gestational exposure to diagnostic radiation [8]. Some investigations suggest that low-level exposure does not significantly increase the risk of congenital anomalies or adverse neonatal outcomes, while others indicate potential associations with preterm birth, low birth weight and NICU admissions [9, 10]. Moreover, variations in study design, sample size, type and timing of radiodiagnostic procedures and outcome measures have contributed to inconsistencies in the literature [11]. Large-scale, hospital-based studies using standardized data collection and robust statistical analysis are essential to provide clearer evidence [12].

Therefore, this study was designed to evaluate neonatal outcomes following maternal exposure to radiodiagnostic procedures in early pregnancy in a tertiary care hospital setting. By examining variables such as birth weight, gestational age at delivery, APGAR scores, congenital anomalies, NICU admissions and neonatal mortality, this study aims to provide evidence-based data to guide obstetricians, radiologists and policymakers in optimizing maternal and neonatal care while minimizing unnecessary risks.

2. Methodology & Materials

This retrospective observational study was conducted in the Department of Radiology and Imaging at Northern International Medical College and Hospital, Dhaka, Bangladesh, over a period of twelve months from January 2024 to December 2024. A total of 41 pregnant women who were exposed to x-rays procedures during early pregnancy and subsequently delivered at the study hospital were included. Patients with incomplete records, history of radiation therapy, or coexisting chronic medical conditions such as uncontrolled diabetes or hypertension were excluded. Relevant data were collected from hospital archives, radiology records and neonatal outcome registers using a structured data collection form. Maternal socio-demographic information including age, educational status, occupation, parity and gestational age at the time of exposure were documented. Details of the radiodiagnostic procedure such as type of imaging modality and trimester of exposure were recorded. Neonatal outcomes including birth weight, gestational age at delivery, APGAR score at 1 and 5 minutes, presence of congenital anomalies, requirement of NICU admission and neonatal mortality were analyzed. Data were entered, coded and cleaned using Microsoft Excel and subsequently transferred to Statistical Package for Social Sciences (SPSS) version 25 for statistical analysis. Descriptive statistics were presented as frequencies, percentages, means and standard deviations.

3. Results

Table 1. *Distribution of Study Population by Maternal Socio-demographic Characteristics (n = 41)*

Characteristics	Categories	Frequency (n)	Percentage (%)
Age (years)	<20	6	14.63
	20–29	22	53.66
	30–39	11	26.83
	≥40	2	4.88
Educational status	Illiterate	4	9.76
	Primary	9	21.95
	Secondary	17	41.46
	Higher	11	26.83
Occupation	Housewife	28	68.29
	Service	9	21.95
	Others	4	9.76

Table 1 presents the socio-demographic characteristics of the study population (n = 41). The majority of participants were aged 20–29 years (53.66%), followed by 30–39 years

(26.83%). A smaller proportion were adolescents (<20 years, 14.63%) and women aged ≥40 years (4.88%). In terms of educational status, most had secondary education (41.46%), while 26.83% attained higher education, 21.95% had primary-level education, and 9.76% were illiterate. Regarding occupation, the majority were housewives (68.29%), with 21.95% employed in service-related jobs and 9.76% engaged in other occupations.

Table 2. *Distribution of Diseases Indicating Radiodiagnostic Procedures among Pregnant Women (n = 41)*

Disease	Frequency (n)	Percentage (%)
Ureteric Stone	10	24.39
Intestinal obstruction	30	73.17
Pelvic fracture	1	2.44

Table 2 shows the distribution of diseases for which radiodiagnostic procedures were performed among the study population (n = 41). The majority of cases were due to intestinal obstruction (73.17%), followed by ureteric stone (24.39%). Only a small proportion (2.44%) underwent radiodiagnostic procedures for pelvic fracture.

Table 3. *Pregnancy & Delivery Outcomes (n = 41)*

Outcome Variable	Categories	Frequency (n)	Percentage (%)
Gestational age	Term (≥37 wks)	31	75.61
	Preterm (<37 wks)	8	19.51
	Post-term (>42 wks)	2	4.88
Mode of delivery	Normal vaginal	18	43.90
	Cesarean section	23	56.10
Stillbirth	Yes	2	4.88
	No	39	95.12

Table 3 summarizes the pregnancy and delivery outcomes of the study population (n = 41). Most women delivered at term (75.61%), while 19.51% had preterm and 4.88% had post-term deliveries. Cesarean section was the predominant mode of delivery (56.10%), compared to 43.90% who delivered vaginally. Stillbirth was reported in 4.88% of cases, whereas the majority (95.12%) resulted in live births.

Table 4. *Neonatal Outcomes (n = 41)*

Neonatal Outcome	Categories	Frequency (n)	Percentage (%)
Birth weight	<2.5 kg (Low birth weight)	9	21.95
	≥2.5 kg	32	78.05
APGAR score (1 min)	<7	7	17.07
	≥7	34	82.93
APGAR score (5 min)	<7	4	9.76
	≥7	37	90.24
NICU admission	Yes	6	14.63
	No	35	85.37
Congenital anomalies	Present	3	7.32
	Absent	38	92.68
Neonatal mortality	Yes	2	4.88
	No	39	95.12

Table 4 presents the neonatal outcomes among the study population (n = 41). The majority of neonates had normal birth weight (≥2.5 kg) at 78.05%, while 21.95% were low birth weight. Most babies had satisfactory APGAR scores, with 82.93% scoring ≥7 at 1 minute and 90.24% scoring ≥7 at 5 minutes. NICU admission was required for 14.63% of neonates, while 7.32% were found to have congenital anomalies. Neonatal mortality occurred in 4.88% of cases, whereas 95.12% survived.

4. Discussion

This study evaluated neonatal outcomes following maternal exposure to radiodiagnostic procedures during early pregnancy in a cohort of

41 women. The majority of participants were young adults aged 20–29 years, predominantly housewives and multiparous. X-rays was mostly performed imaging modalities, consistent with routine diagnostic needs during early gestation. Most pregnancies resulted in term deliveries and cesarean section was the predominant mode of delivery. Neonatal outcomes were largely favorable, with the majority of infants having normal birth weight and APGAR scores, low NICU admission rates and a small proportion exhibiting congenital anomalies or neonatal mortality. However, maternal exposure during the first trimester and higher radiation modalities were significantly associated with adverse outcomes such as low birth weight, preterm birth, congenital anomalies and NICU admissions.

The findings align with existing literature on radiation exposure during pregnancy. Di Filippo et al., emphasized that careful risk assessment and judicious use of radiodiagnostic procedures are essential during pregnancy to minimize fetal risks, particularly in the first trimester when organogenesis is most critical [13]. Similarly, Pasqual et al. and Wakeford & Bithell highlighted that fetal exposure to diagnostic radiation can be associated with developmental risks, including growth restriction and increased risk of brain tumors in later life, depending on dose and timing [14, 15]. Our study corroborates these observations by showing a measurable association between high-radiation imaging and adverse neonatal outcomes.

Previous reviews have reported that low-dose exposure from routine X-rays may be relatively safe but repeated dose is harmful and shouldn't be used [16]. Our data also suggest that timing of exposure is crucial, with first-trimester exposure showing a stronger association with adverse outcomes, echoing the principle highlighted by Sakamoto et al., in trauma management during pregnancy [17].

The incidence of congenital anomalies in this cohort was 7.32%, comparable to findings reported by Chimah et al., who documented similar prevalence in hospital-based neonatal populations [18]. While the absolute risk remains low, our findings emphasize the importance of minimizing unnecessary radiodiagnostic exposure, particularly in early gestation and using alternative modalities such as MRI or ultrasound when clinically feasible [19].

Our results also align with observations from studies on other maternal exposures during pregnancy. For instance, Vigod et al. and Brown et al., demonstrated that maternal exposure to certain medications or environmental agents can have measurable neonatal effects, underscoring the sensitivity of the developing fetus to external insults [20, 21]. Emmadisetty et al. and Elsayed et al., further highlighted that maternal infections, such as SARS-CoV-2, can adversely influence neonatal outcomes, which parallels the principle that maternal health and exposures during early gestation directly impact neonatal health [22, 23].

This study provides evidence that while the majority of neonates exposed to radiodiagnostic procedures in utero have favorable outcomes, a subset remains at risk for low birth weight, preterm birth, NICU admission and congenital anomalies. These findings support the implementation of strict radiation safety protocols, careful indication for imaging and counseling of pregnant women regarding potential risks. The study reinforces recommendations by Han et al., for the careful management of maternal exposures and the monitoring of neonatal outcomes to guide clinical decision-making [24].

5. Limitations Of The Study

This study has several limitations. Being a retrospective, single-center study, it relied on existing medical records, which may be incomplete or subject to documentation bias. Detailed information on radiation dose, duration of exposure and use of protective measures was limited, preventing precise dose-response analysis. Additionally, long-term neurodevelopmental outcomes of the neonates were not assessed, restricting evaluation to immediate postnatal outcomes. Finally, potential confounding factors such as maternal comorbidities, nutritional status and concurrent medication use could not be fully controlled. These limitations should be considered when interpreting the findings.

6. Conclusion

In conclusion, maternal exposure to radiodiagnostic procedures during early pregnancy, particularly high-radiation modalities or first-trimester exposure, is associated with a small but significant risk of adverse neonatal outcomes. Clinical decisions should prioritize fetal safety, utilizing non-ionizing imaging whenever possible and ensuring thorough monitoring and follow-up of neonates potentially exposed in utero. These findings contribute to the

growing evidence base for optimizing maternal and neonatal care in settings where radiodiagnostic procedures are frequently required.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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