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Maternal and perinatal effects of ramadan fasting in pregnancy: A multicenter retrospective cohort study

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Abstract

This study aimed to evaluate the association between Ramadan fasting during pregnancy and maternal and neonatal outcomes in a large multicenter cohort. A retrospective cohort study including 13,709 singleton deliveries at three state hospitals in Türkiye. Women were classified as fasting (n = 2,166; 15.8%) or non-fasting (n = 11,543; 84.2%) during Ramadan based on antenatal records. Primary outcomes were preterm birth, birthweight, and small for gestational age (SGA). Secondary outcomes included cesarean delivery, gestational age at delivery, gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), 5-minute Apgar score, and neonatal intensive care unit (NICU) admission. Multivariable regression models were adjusted for maternal age, body mass index (BMI), parity, smoking, chronic disease, and trimester of Ramadan exposure. Baseline characteristics were largely comparable between groups. Fasting women had higher rates of GDM (5.4% vs. 5.1%) and HDP (3.9% vs. 3.2%) and a higher cesarean delivery rate (51.4% vs. 48.2%). Mean gestational age at delivery was marginally lower in the fasting group (38.1 ± 1.6 vs. 38.3 ± 1.7 weeks). No significant differences were found in preterm birth, very preterm birth, SGA, or NICU admission. After multivariable adjustment, Ramadan fasting remained associated with GDM (adjusted OR: 1.06; 95% CI: 1.01 – 1.12) and HDP (adjusted OR: 1.12; 95% CI: 1.01 – 1.25). After adjustment, fasting was not associated with cesarean delivery (adjusted OR: 1.08; 95% CI: 0.98 – 1.19), but remained associated with low 5-minute Apgar score (< 7) (adjusted OR: 1.52; 95% CI: 1.08 – 2.14). The apparent increase in birthweight seen in unadjusted analysis was not sustained after adjustment. Ramadan fasting during pregnancy was not associated with most major adverse perinatal outcomes after adjustment for confounders. However, the associations with GDM and HDP were modest, and the association with low 5-minute Apgar score was based on a small number of events; these findings should be interpreted cautiously and do not establish causality. Individualized counseling and clinical monitoring are recommended, particularly for women with metabolic or vascular risk factors.

Keywords: Ramadan, fasting, gestational diabetes mellitus, hypertensive disorders of pregnancy, perinatal outcomes, cesarean delivery

Introduction

Each year, approximately 1.8 billion Muslims observe Ramadan, abstaining from all food and fluid between dawn and sunset for around 30 days. Estimates from population-based surveys indicate that between 43% and 90% of Muslim pregnant women continue to fast during Ramadan, with rates varying substantially by country, trimester, and level of religiosity [1]. Religious guidance exempts pregnant women from fasting when harm to mother or fetus is anticipated, yet a substantial proportion continue to fast for cultural, spiritual, or personal reasons. Fear of social stigma, the desire for spiritual completeness, and limited access to individualized prenatal counseling are among the most commonly reported barriers to exemption. Notably, only approximately one-third of pregnant women discuss their fasting intentions with a healthcare provider, and many prefer guidance from family or community religious leaders over medical professionals [2]. Clinicians in Muslim-majority settings - and increasingly in Western countries - regularly encounter this scenario without clear, evidence-based guidance on how to counsel affected patients [3]. From a metabolic standpoint, Ramadan fasting differs from other forms of dietary restriction in two important respects: fluid is completely withheld during fasting hours, and large caloric loads are typically consumed in compressed post-

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sunset windows. This pattern of prolonged daytime restriction followed by nocturnal hyperphagia generates pronounced diurnal fluctuations in glucose, insulin, and free fatty acids. Continuous glucose monitoring studies in pregnant women during Ramadan have demonstrated post-Iftar hyperglycemic spikes exceeding acceptable postprandial thresholds in up to 70% of participants, alongside pre-Iftar hypoglycemic nadirs a combination that is physiologically distinct from conventional caloric restriction [4]. Pregnancy itself is characterized by progressive insulin resistance, heightened lipolysis, and escalating fetal energy demands. The interaction between these two physiological states raises legitimate questions about maternal and fetal safety [5,6]. Published data are reassuring in broad terms: most systematic reviews and meta-analyses find no consistent increase in preterm birth or major reductions in birthweight but the evidence base has important weaknesses [7]. Study populations are heterogeneous, confounder control is often inadequate, and fasting duration varies with season and latitude. A further concern is that the absence of overt neonatal harm does not necessarily mean the absence of physiological stress. Several studies report measurable changes in maternal glucose metabolism, gestational weight gain, and amniotic fluid volume even when birth outcomes appear unaffected [8]. An emerging body of evidence from long-term follow-up studies links in utero Ramadan exposure to adverse offspring outcomes including higher infant mortality, increased rates of learning disabilities, elevated pulse pressure in young adulthood, and symptoms of coronary heart disease in later life, findings that caution against interpreting a normal delivery outcome as evidence of physiological neutrality [9,10]. Large, well-adjusted real-world datasets are needed to move beyond the current inconclusive picture. We report here a multicenter retrospective cohort study of 13,709 deliveries in Türkiye aimed at quantifying the association between Ramadan fasting and a comprehensive set of maternal and neonatal outcomes. We hypothesized that, after adjustment for key confounders, fasting would not remain associated with major adverse perinatal events.

Material and Methods

Study design and setting

This retrospective cohort study was conducted at three state hospitals. Ethical approval was obtained from the Clinical Research Ethics Committee of the University of Health Sciences, Gazi Yaşargil Training and Research Hospital, Diyarbakır Provincial Health Directorate, Türkiye (approval date: 13 May 2026; Decision No: 213). The study was conducted in accordance with the Declaration of Helsinki, and the requirement for informed consent was waived due to the retrospective design. Clinical data were extracted from electronic medical records using a standardized collection form. Participants were classified as fasting or non-fasting during Ramadan based on documented patient-reported history in antenatal records. Women were classified as fasting if Ramadan fasting was documented in their antenatal records based on patient self-report. The exact number of fasting days and whether fasting was continuous or intermittent throughout Ramadan were not available in the medical records. A total of 14,638 pregnant women were assessed for eligibility. After exclusions - multiple pregnancies (n = 215), major fetal anomalies (n = 74), intrauterine fetal death prior to Ramadan (n = 31), pre-existing gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP) (n = 208), and missing outcome data (n = 401) - the final analytic cohort comprised 13,709 women. The patient selection process is summarized in Figure 1. Maternal variables included age, parity, body mass index (BMI) at first antenatal visit, smoking status, chronic diseases, and prior cesarean delivery. Neonatal outcomes were gestational age at delivery, birthweight, preterm birth (< 37 weeks), very preterm birth (< 32 weeks), small for gestational age (SGA) (birthweight below the 10th percentile for gestational age), intrauterine growth restriction (IUGR; estimated fetal weight persistently below the 10th percentile on serial ultrasound), 5-minute Apgar score (with a score < 7 considered low), and neonatal intensive care unit (NICU) admission.

Statistical analysis

Analyses were performed using IBM SPSS Statistics v26.0 (IBM Corp., Armonk, NY, USA). Normality was assessed with Kolmogorov–Smirnov and Shapiro–Wilk tests. Continuous data are presented as mean ± SD or median (IQR) and compared with the independent-samples t-test or Mann–Whitney U test. Categorical data are presented as n (%) and compared with the chi-square or Fisher's exact test. For the multivariable analyses, Ramadan fasting status was considered the main exposure, with the non-fasting group serving as the reference category. Binary outcomes, including preterm birth, very preterm birth, SGA/IUGR, NICU admission, GDM, HDP, pre-eclampsia, cesarean delivery, and low 5-minute Apgar score (< 7), were analyzed using multivariable logistic regression. Birthweight, as a continuous outcome, was evaluated using multiple linear regression. The prespecified covariates included maternal age, BMI, parity, smoking status, chronic maternal disease, and trimester of Ramadan exposure. The cesarean delivery model was additionally adjusted for prior cesarean delivery. Adjusted odds ratios were reported for binary outcomes and β coefficients for birthweight, together with their 95% confidence intervals and p values. A two-sided $p < 0.05$ was considered statistically significant.

Results

Of 14,638 women assessed, 13,709 met inclusion criteria and were analyzed (Figure 1). Of these, 2,166 (15.8%) reported fasting during Ramadan. Maternal age, BMI, and parity were similar between groups (all $p > 0.05$). Fasting exposure was most common in the second trimester (43.7%), followed by the third (29.3%) and first (27.1%). Smoking rates were numerically lower among fasting women (9.1% vs. 11.3%; $p = 0.003$). GDM and HDP were numerically more frequent in the fasting group, but these differences were not statistically significant in unadjusted comparisons (GDM: 5.4% vs. 5.1%, $p = 0.56$; HDP: 3.9% vs. 3.2%, $p = 0.10$). Pre-eclampsia rates were also similar between groups (2.1% vs. 1.9%, $p = 0.58$) (Table 1).

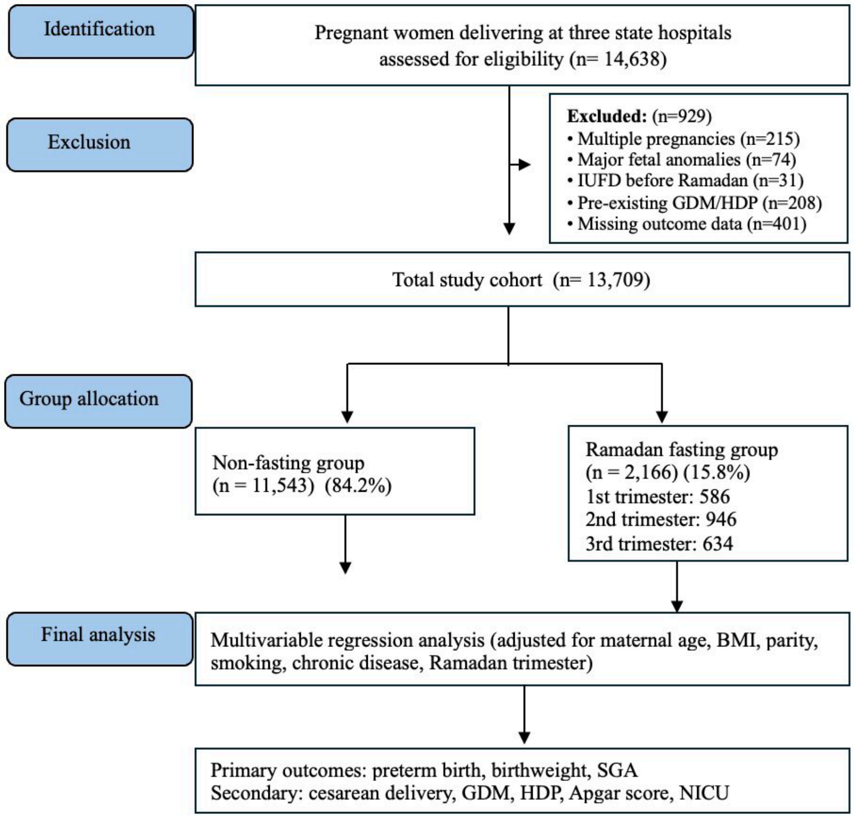

Figure 1. Study flow diagram; BMI: body mass index, GDM: gestational diabetes mellitus, HDP: hypertensive disorders of pregnancy, IUFD: intrauterine fetal death, NICU: neonatal intensive care unit, SGA: small for gestational age

Table 1. Baseline and clinical characteristics according to Ramadan fasting status

Variable	Non-fasting (n = 11,543) mean ± SD or n (%)	Fasting (n = 2,166) mean ± SD or n (%)	p
Age (years)	26.9 ± 5.4	27.1 ± 5.7	0.08
BMI (kg/m²)	27.3 ± 4.5	27.7 ± 4.1	0.07
Parity	2.3 ± 0.8	2.2 ± 0.7	0.07
1st trimester exposure	-	586 (27.1%)	-
2nd trimester exposure	-	946 (43.7%)	-
3rd trimester exposure	-	634 (29.3%)	-
Smoking, n (%)	1,302 (11.3%)	197 (9.1%)	0.003
GDM, n (%)	589 (5.1%)	117 (5.4%)	0.56
HDP, n (%)	369 (3.2%)	84 (3.9%)	0.10
Pre-eclampsia, n (%)	219 (1.9%)	45 (2.1%)	0.58

Comparisons: independent-samples t-test or chi-square / Fisher's exact test; BMI: body mass index, GDM: gestational diabetes mellitus, HDP: hypertensive disorders of pregnancy, SD: standard deviation.

Maternal and neonatal outcomes are presented in Table 2. Cesarean delivery was more frequent among fasting women (51.4% vs. 48.2%; $p = 0.006$). Mean gestational age at delivery was slightly lower in the fasting group (38.1 ± 1.6 vs. 38.3 ± 1.7 weeks; $p = 0.03$). Unadjusted birthweight was higher among fasting women (3,429 ± 435 g vs. 3,216 ± 395 g; $p < 0.001$). No between-group differences emerged for preterm birth (5.3% vs. 5.1%; $p = 0.69$), very preterm birth (1.2% vs. 1.4%; $p = 0.46$), SGA (5.1% vs. 4.7%; $p = 0.44$), or NICU admission (2.7% vs. 2.5%; $p = 0.64$). Low 5-minute Apgar scores were more common in the fasting group (2.5% vs. 1.4%; $p < 0.001$).

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Table 2. Maternal and neonatal outcomes according to Ramadan fasting status

Outcome	Non-fasting (n = 11,543) mean ± SD or n (%)	Fasting (n = 2,166) mean ± SD or n (%)	p
Cesarean delivery, n (%)	5,562 (48.2%)	1,114 (51.4%)	0.006
Gestational age at delivery (weeks)	38.3 ± 1.7	38.1 ± 1.6	0.03
Birthweight (g)	3,216 ± 395	3,429 ± 435	< 0.001
Preterm birth (< 37 wk), n (%)	589 (5.1%)	115 (5.3%)	0.69
Very preterm birth (< 32 wk), n (%)	162 (1.4%)	26 (1.2%)	0.46
5-min Apgar score < 7, n (%)	162 (1.4%)	54 (2.5%)	< 0.001
NICU admission, n (%)	289 (2.5%)	58 (2.7%)	0.64
SGA / IUGR, n (%)	542 (4.7%)	110 (5.1%)	0.44

Values are presented as mean ± SD or n (%); IUGR: intrauterine growth restriction, NICU: neonatal intensive care unit, SGA: small for gestational age, SD: standard deviation

Multivariable results are shown in Table 3. After adjustment, Ramadan fasting remained associated with GDM (adjusted OR: 1.06; 95% CI: 1.01 – 1.12; p = 0.032) and HDP (adjusted OR: 1.12; 95% CI: 1.01 – 1.25; p = 0.028). No associations were found with preterm birth, very preterm birth, SGA, or NICU admission (all p > 0.05). After adjustment, Ramadan fasting was not associated with cesarean delivery (adjusted OR: 1.08; 95% CI: 0.98 – 1.19; p = 0.12), but remained associated with low 5-minute Apgar score (< 7) (adjusted OR: 1.52; 95% CI: 1.08 – 2.14; p = 0.016). The birthweight difference did not persist after adjustment (β: +35 g; 95% CI: -10 to 80; p = 0.13), and pre-eclampsia was not associated with fasting after adjustment (p = 0.60).

Table 3. Multivariable regression analysis - association between Ramadan fasting and pregnancy outcomes

Outcome	Adjusted OR or β	95% CI	p
Preterm birth (< 37 wk)	1.03	0.84 – 1.26	0.74
Very preterm birth (< 32 wk)	0.91	0.56 – 1.47	0.70
SGA / IUGR	1.07	0.89 – 1.29	0.45
NICU admission	1.04	0.81 – 1.33	0.75
Gestational diabetes mellitus	1.06	1.01 – 1.12	0.032
Hypertensive disorders of pregnancy	1.12	1.01 – 1.25	0.028
Pre-eclampsia	1.10	0.76 – 1.60	0.60
Birthweight (g) [β coefficient]	+ 35	-10 to 80	0.13
Cesarean delivery	1.08	0.98 – 1.19	0.12
5-min Apgar score < 7	1.52	1.08 – 2.14	0.016

All models were adjusted for maternal age, BMI, parity, smoking, chronic maternal disease, and trimester of Ramadan exposure; The cesarean delivery model was additionally adjusted for prior cesarean delivery; BMI: body mass index; CI: confidence interval; IUGR: intrauterine growth restriction; NICU: neonatal intensive care unit; OR: odds ratio; SGA: small for gestational age; β: beta coefficient; wk: weeks.

Discussion

This study followed 13,709 singleton pregnancies across three Turkish hospitals and found that women who fasted during Ramadan had higher adjusted odds of GDM, HDP, and low 5-minute Apgar score, whereas no significant adjusted association was observed with cesarean delivery. Most neonatal outcomes - preterm birth, birthweight, SGA, and NICU admission - were not significantly different after adjustment. Taken together, these data suggest that Ramadan fasting may not be entirely physiologically neutral in pregnancy, even when major adverse neonatal outcomes are not markedly elevated. The trimester distribution of fasting exposure in our cohort - predominantly second (43.7%) and third (29.3%) trimester - has practical significance. These are periods of peak fetal growth and increasing maternal insulin resistance, when prolonged caloric and fluid restriction may have greater metabolic impact than in the first trimester. Third-trimester fasting has been linked to reductions in fetal movement frequency and amniotic fluid volume in earlier clinical series, and the marginal decrease in gestational age at delivery observed here may partly reflect these dynamics [11]. Systematic reviews and umbrella reviews of the literature generally show no strong increase in preterm birth or birthweight reduction with Ramadan fasting, but consistently note substantial heterogeneity and poor confounder control across primary studies. Our results fit this broad picture while adding a large, well-adjusted dataset from a Muslim-majority country. The adjusted associations with GDM and HDP observed in our cohort are supported by a smaller but coherent body of mechanistic and observational work [12,13]. Although statistically significant, the adjusted associations were modest (adjusted OR: 1.06 for GDM and 1.12 for HDP), and the absolute between-group differences were small, at 0.3 and 0.7 percentage points, respectively. Therefore, these estimates should not be interpreted as indicating large clinical effects or causality. Biologically, the GDM association is plausible. Prolonged fasting through the day is followed at Iftar by rapid consumption of calorie-dense, high-glycemic foods, producing exaggerated postprandial glucose excursions in a pregnant woman who is already physiologically insulin-resistant. These glucose oscillations may contribute to GDM development in susceptible women [14]. A complicating factor highlighted by Carrasco et al. is that the timing of the oral glucose tolerance test relative to Ramadan may itself alter diagnostic rates, raising the possibility that some cases in our cohort reflect test-timing bias rather than true metabolic deterioration [13]. Therefore, the small adjusted association with GDM should be interpreted cautiously. The HDP association may involve different mechanisms. Complete fluid restriction during daylight hours, often exceeding 15 hours in Turkish summer months, may lead to progressive hemoconcentration and elevated blood viscosity. Activation of the renin–angiotensin–aldosterone system, endothelial stress, and disrupted diurnal cortisol rhythms secondary to nocturnal meal timing have all been proposed as pathways linking prolonged fasting to elevated blood pressure in pregnancy. The adjusted association with HDP was also modest (adjusted OR: 1.12), and although it remained statistically significant after adjustment for the measured confounders, the small effect size and the possibility of residual or unmeasured confounding should be considered. Cesarean delivery was more frequent among women who fasted during Ramadan. This finding is clinically noteworthy in Türkiye, which has one of the highest cesarean delivery rates worldwide [15]. Nevertheless, the available evidence regarding Ramadan fasting and mode of delivery remains inconsistent, and current evidence does not establish an increased risk of cesarean delivery attributable to fasting [7]. The higher unadjusted rate may have reflected metabolic or obstetric factors, including GDM or concerns regarding fetal and intrapartum status. However, after adjustment for the measured covariates, Ramadan fasting was not significantly associated with cesarean delivery (adjusted OR: 1.08; 95% CI: 0.98–1.19; $p = 0.12$). Therefore, the higher unadjusted cesarean delivery rate should be interpreted cautiously, and no causal relationship can be inferred. Altered intrapartum fetal heart rate patterns from maternal metabolic changes are another plausible contributor, as is simple selection: women who fast during pregnancy may access different levels of clinical surveillance than those who do not. Low 5-minute Apgar scores were more prevalent in the fasting group, though absolute numbers were small. This association remained statistically significant after adjustment (adjusted OR: 1.52; 95% CI: 1.08-2.14; $p = 0.016$); however, it should still be interpreted cautiously because of the small number of events. During extended fasting, mild maternal hypoglycemia and rising ketone bodies may reduce fetal metabolic reserve, particularly in late gestation. Any compromise of uteroplacental circulation secondary to maternal dehydration could further limit fetal tolerance to the stresses of labor. These are speculative pathways, but they align with broader experimental and observational data on fetal responses to maternal nutrient restriction [16,17]. The higher birthweight observed in the fasting group in the unadjusted analysis did not persist after adjustment, suggesting that the crude difference may have been influenced by maternal BMI, parity, and GDM. This finding underscores the importance of accounting for maternal and metabolic characteristics when evaluating the relationship between Ramadan fasting and birthweight. An emerging literature links in utero Ramadan exposure to longer-term offspring outcomes including differences in growth trajectories, cardiovascular parameters, and timing of puberty [1,18] . Our study did not assess offspring beyond the neonatal period, but these findings are a reason to take modest short-term physiological perturbations seriously. Even if no acute harm is apparent at delivery, early metabolic programming effects remain a plausible concern. Several strengths support confidence in our results: the large cohort, three geographically distinct hospitals, and comprehensive adjustment for demographic and clinical confounders. These findings have direct clinical implications. Current international guidance does not prohibit Ramadan fasting in pregnancy but emphasizes individualized risk assessment. Women with pre-existing metabolic risk factors, such as a high BMI, a family history of diabetes, or prior GDM, and those with a history of hypertensive disorders merit proactive counseling before and during Ramadan. Practical recommendations include adequate hydration during non-fasting hours, nutritionally balanced Suhoor and Iftar meals, blood glucose self-monitoring where GDM risk is elevated, and blood pressure surveillance. Women fasting in the third trimester should receive guidance on fetal movement awareness and should have a low threshold for additional antenatal assessment. A collaborative approach involving obstetrics, nutrition, and endocrinology best serves complex cases.

Limitations

The retrospective design is the principal limitation. Fasting status was based on patient-reported history and

may be subject to recall bias. Detailed fasting pattern data, including the exact number of fasting days and whether fasting was continuous or intermittent throughout Ramadan, were unavailable. Information on daily fasting duration, fluid intake, dietary composition, and sleep quality was also not consistently recorded, precluding assessment of a dose–response relationship. The timing of the oral glucose tolerance test, GDM diagnosis, and HDP onset in relation to Ramadan was not consistently available and therefore could not be evaluated. The Ramadan

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period during the study years fell in summer, with fasting durations likely exceeding 15 hours; findings may not generalize to populations fasting in shorter winter months or at lower latitudes. The hospitals were located in regions with different climatic conditions, daylight fasting durations, temperatures, altitudes, and humidity levels, all of which may affect maternal hydration; therefore, center-specific environmental effects could not be evaluated separately. Finally, our study was conducted at state hospitals in Türkiye; the extent to which results apply to other healthcare systems or ethnic populations remains to be established.

Conclusion

Ramadan fasting in pregnancy was not associated with most major adverse neonatal outcomes after adjustment in this large multicenter cohort. The associations of Ramadan fasting with GDM, HDP, and low 5-minute Apgar score remained after adjustment, whereas no significant adjusted association was observed with cesarean delivery. These findings suggest that fasting may be associated with modest physiological effects and may be acceptable in selected low-risk pregnancies; however, they do not support universal reassurance. Individualized counseling addressing nutrition, hydration, glucose monitoring, and blood pressure surveillance is recommended, with heightened vigilance for women with metabolic or vascular risk factors.

Ethical Approval
Ethical approval was obtained from the Clinical Research Ethics Committee of Sağlık Bilimleri University Gazi Yaşargil Training and Research Hospital, Diyarbakır Provincial Health Directorate, Türkiye (Approval Date: 13 May 2026; Decision No: 213). The study was conducted in accordance with the Declaration of Helsinki.

Patient Consent
Due to the retrospective design, informed consent was waived.

Conflict of Interest
The authors confirm the absence of any conflicts associated with this work.

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