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The paradox of the 24–48-hour window: Ovarian viability and the role of menarchal status in pediatric adnexal torsion

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ABSTRACT

Objective: Symptom duration is widely considered the primary determinant of ovarian viability in pediatric adnexal torsion. This study aimed to evaluate the relationship between time to surgery and intraoperative ovarian viability, and to identify additional factors influencing outcome in a pediatric population.

Materials and Methods: A retrospective review was conducted of all patients aged ≤18 years who underwent surgery for adnexal torsion at a tertiary pediatric surgical center between 2012 and 2026. Patients were stratified into three groups based on symptom duration: <24 hours, 24–48 hours, and >48 hours. Demographic, clinical, ultrasonographic, and operative data were analyzed. Intraoperative ovarian appearance determined viability. Fisher's exact test and Mann–Whitney U test were used for group comparisons. Odds ratios with 95% confidence intervals were calculated for potential predictors of ovarian loss.

Results: Twenty-five patients with a median age of 12 years (IQR 10–15; range 4–17) were included. Ovarian viability was preserved in 18 patients (72%) and lost in 7 (28%). A paradoxical pattern was observed across symptom duration groups: viability rates were 100% in the < 24-hour group (n=3), 53.8% in the 24–48-hour group (n=13), and 88.9% in the >48-hour group (n=9). Postmenarchal patients showed a non-significant trend toward higher odds of ovarian loss compared to premenarchal patients (OR 5.00, 95% CI 0.74–33.78, p=0.177), paralleling the paradoxical outcome in the 24–48-hour group, which contained 7 of the 11 postmenarchal patients in the cohort. Symptom duration as a continuous variable was not significantly associated with viability (p=0.266).

Conclusion: Symptom duration alone is an insufficient predictor of ovarian viability in pediatric adnexal torsion. Menarchal status may act as a modifying factor, particularly within the 24–48-hour window, although this association was not statistically significant and is discordant with several previous series. These hypothesis-generating findings support individualized surgical decision-making that considers menarchal status alongside time to presentation.

Keywords: Adolescent, child, fertility preservation, menarche, ovarian torsion, organ sparing treatments

Introduction

Adnexal torsion is a surgical emergency in which twisting of the ovarian pedicle causes progressive ischemia and, if left untreated, irreversible necrosis of the adnexal structures. The incidence of ovarian torsion in the pediatric population is estimated at approximately 4.9 per 100000 females aged 1 to 20 years, with reported mean ages at presentation varying across series, most commonly between 9 and 14.5 years (1-3). Given its rarity and frequently atypical presentation, diagnostic delay remains a major clinical challenge, and delayed recognition significantly increases the risk of ovarian loss and long-term reproductive consequences (4,5).

The relationship between symptom duration and ovarian viability is central to clinical decision-making in pediatric adnexal torsion, yet remains poorly defined. No duration of symptoms has been shown to reliably predict ovarian viability (6,7). The ovary's dual blood supply confers a degree of resilience to ischemic injury, and successful ovarian preservation has been reported even after prolonged symptom duration. An upper limit of 34 hours from symptom onset to surgical detorsion has been proposed as a possible viability threshold, though this remains institution-specific and not universally validated (8). Multiple series have reported that pain duration alone did not determine whether children ultimately underwent conservative treatment or oophorectomy, underscoring the inadequacy of symptom duration as a standalone surgical decision-making parameter (9).

Menarchal status has emerged as an important variable that modifies the clinical presentation and surgical outcome of pediatric adnexal torsion. Premenarchal patients are more likely to present with diffuse pain, longer symptom duration, and a discolored ovary at surgery, and are at higher risk for diagnostic delay and ovarian necrosis compared to their postmenarchal counterparts. In a single-center series of 127 pediatric patients, premenarchal status was significantly

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associated with higher rates of diagnostic delay (38% vs. 20%, p=0.042), ovarian necrosis (34% vs. 17%, p=0.036), and absence of an adnexal mass (44% vs. 0%, p<0.001) (2). An international multicenter study further confirmed that postmenarchal age was independently associated with conservative surgical management (p=0.001), reinforcing the prognostic relevance of menarchal status in determining surgical outcome (9).

Despite growing awareness of these distinctions, few studies have systematically examined how the interaction between symptom duration and menarchal status jointly influences intraoperative ovarian viability in a purely pediatric surgical cohort. Most available series either pool pediatric and adult patients or focus primarily on ultrasonographic predictors of torsion rather than viability outcomes. Delayed diagnosis and oophorectomy continue to represent significant missed opportunities for fertility preservation in the pediatric population, making it imperative to identify factors beyond symptom duration that govern ovarian fate (4,6). This study aimed to evaluate the relationship between time to surgery and intraoperative ovarian viability across symptom duration strata, and to identify the contribution of menarchal status in a single-center tertiary pediatric surgical cohort spanning 14 years.

Materials and Methods

Study design

This was a single-center retrospective cohort study conducted at Zeynep Kamil Maternity and Children's Diseases Health Training and Research Center in Türkiye.

Patient identification and inclusion criteria

Medical records were screened using surgical procedure codes and International Classification of Diseases (ICD-10) codes for adnexal torsion. All female patients aged 0–18 years who underwent surgery for suspected adnexal torsion between January 2012 and May 2026 and in whom torsion was confirmed intraoperatively were eligible for inclusion. As our institution exclusively manages patients aged 18 years and under, no upper age exclusion was required. Neonatal cases (age <28 days) were excluded given the distinct etiopathogenesis and clinical trajectory of antenatal torsion in this population. No patients were excluded due to incomplete clinical records.

Data collection

The following variables were extracted from medical records: age at presentation, menarchal status (premenarchal vs. postmenarchal), symptom duration (defined as the time elapsed from onset of abdominal pain to surgical incision, in hours), side of abdominal pain as reported by the patient, intraoperatively confirmed torsion laterality, presence of an adnexal mass or cyst on preoperative ultrasonography, ultrasonographic ovarian dimensions, Doppler flow status (present, absent, or indeterminate), surgical approach (laparoscopic, open, or converted), intraoperative ovarian appearance, surgical procedure performed, oophoropexy application, histopathological diagnosis of the resected specimen, postoperative ultrasonographic ovarian presence and dimensions, recurrence of torsion, and total follow-up duration. Where the reported side of pain differed from the confirmed torsion laterality, the intraoperative finding was used as the reference variable for laterality.

Ultrasonographic assessment

Preoperative ultrasonographic evaluation was performed in all patients by radiologists at our institution using a standardized transabdominal technique. Transvaginal ultrasonography was not performed given the pediatric age of the study population. Color Doppler ultrasonography was routinely performed in all cases as part of the standard imaging protocol. Doppler flow status was categorized as present, absent, or indeterminate; the latter category was assigned in cases where the radiologist was unable to confidently characterize flow due to technical limitations or patient-related factors. Ultrasonographic reports followed a standardized institutional format, with radiologists familiar with the clinical requirements of the pediatric surgical team.

Symptom duration stratification

Patients were stratified into three groups based on symptom duration: less than 24 hours (<24 h), 24 to 48 hours (24–48 h), and greater than 48 hours (>48 h). These thresholds were defined a priori on the basis of commonly used clinical time points in the management of adnexal torsion, with 24 hours distinguishing early from delayed presentation and 48 hours denoting prolonged symptom duration.

Definition of ovarian viability

Intraoperative ovarian appearance was used as the primary determinant of viability. An ovary was classified as viable if it could be detorsed without structural disintegration and demonstrated color improvement toward a normal hue following detorsion. An ovary was classified as non-viable if it demonstrated complete structural disintegration upon attempted detorsion, or if it remained entirely necrotic with no color change following detorsion. This assessment was made by the attending pediatric surgeon. Given the institutional context of a tertiary teaching hospital, intraoperative collegial consultation among surgeons was performed in cases of uncertain viability, ensuring a consensus-based assessment. Oophorectomy was performed for non-viable ovaries; detorsion with or without cystectomy was performed for viable ovaries.

Statistical Analysis

Continuous variables were expressed as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Between-group comparisons of continuous variables were performed using the Mann–Whitney U test. Categorical variables were compared using Fisher's exact test, applied in preference to the chi-square test given the small sample size. Odds ratios (OR) with 95% confidence intervals (CI) were calculated for potential predictors of ovarian loss using standard 2×2 contingency tables. A two-tailed p value of less than 0.05 was considered statistically significant. All statistical analyses were performed using jamovi (version 2.5; The jamovi project, 2024; https://www.jamovi.org).

Results

Patient characteristics

Twenty-five patients with surgically confirmed adnexal torsion were included. The median age was 12 years (IQR 10–15; range 4–17). Fourteen patients (56.0%) were premenarchal and 11 (44.0%) were postmenarchal. The median symptom duration was 48 hours (IQR 24–96; range 10–216). Pain was localized to the right side in 10 patients (40.0%), to the left side in 5 (20.0%), and was reported as bilateral in 10 (40.0%). Intraoperatively confirmed torsion laterality was right-sided in 14 patients (56.0%) and left-sided in 11 (44.0%). One patient reported right-sided pain but was found to have left-sided torsion intraoperatively. An adnexal mass or cyst was identified on preoperative ultrasonography in 15 patients (60.0%). Doppler flow was present in 6 patients (24.0%), absent in 13 (52.0%), and indeterminate in 6 (24.0%). The surgical approach was laparoscopic in 15 patients (60.0%), open in 9 (36.0%), and converted from laparoscopic to open in 1 (4.0%). Median follow-up duration was 65 months (IQR 36–82). Patient characteristics are summarized in Table I.

Ovarian viability and surgical outcomes

Ovarian viability was preserved in 18 patients (72.0%) and lost in 7 (28.0%). Detorsion alone was performed in 8 patients (32.0%) and detorsion with cystectomy in 10 (40.0%). Oophorectomy was performed in 7 patients (28.0%), all of whom had histopathologically confirmed hemorrhagic infarction; in one of these patients a coexisting mature cystic teratoma was identified within the necrotic ovary. On postoperative ultrasonography, ovarian presence was confirmed in 18 patients (72.0%) and absent in 7 (28.0%). Among the 18 patients with a preserved ovary, the maximum ovarian diameter decreased markedly from a preoperative median of 66 mm (IQR 52–82) to a postoperative median of 29 mm (IQR 24–36) on follow-up ultrasonography, with a reduction observed in every case ($p<0.001$). Oophoropexy was performed in one patient (4.0%) at the index operation due to an elongated ovarian pedicle with high torsion risk. One patient (4.0%) developed recurrent torsion at 15 months postoperatively and underwent repeat detorsion with oophoropexy at the time of the second operation.

Histopathological findings

Histopathological examination was available for all 25 patients. Among the 18 patients with preserved ovaries who underwent cystectomy or detorsion, an underlying cystic lesion was resected in 10: follicular cyst in 5 (20.0%), mature cystic teratoma in 4 (16.0%), and benign mucinous cyst in 1 (4.0%). The remaining 8 patients with preserved ovaries had isolated torsion without an associated cystic lesion and did not undergo cystectomy. Among the 7 oophorectomy specimens, 6 demonstrated pure hemorrhagic infarction and 1 showed hemorrhagic infarction with a coexisting mature cystic teratoma. Overall, a mature cystic teratoma was identified in 5 patients (20.0%), 4 of whom retained a viable ovary. No borderline or malignant lesion was identified in any specimen.

Comparison of viable and non-viable groups

The results of between-group comparisons are presented in Table II. Median age was 11 years (IQR 10–13) in the viable group and 15 years (IQR 13–16) in the non-viable group ($p=0.059$). Median symptom duration was 48 hours (IQR 24–120) in the viable group and 24 hours (IQR 24–48) in the non-viable group ($p=0.266$). The presence of an adnexal mass

Table I: Demographic, clinical, ultrasonographic, operative, and histopathological characteristics of the study cohort.

Variable	Value (n=25)
Age (years)*	12 (10–15)
Range	4–17
Menarchal status†	
Premenarchal	14 (56.0)
Postmenarchal	11 (44.0)
Symptom duration (hours)*	48 (24–96)
Range	10–216
Side of pain†	
Right	10 (40.0)
Left	5 (20.0)
Bilateral	10 (40.0)
Torsion laterality (intraoperative)†	
Right	14 (56.0)
Left	11 (44.0)
Adnexal mass/cyst on ultrasonography	15 (60.0)
Doppler flow status†	
Present	6 (24.0)
Absent	13 (52.0)
Indeterminate	6 (24.0)
Surgical approach†	
Laparoscopic	15 (60.0)
Open	9 (36.0)
Converted	1 (4.0)
Surgical procedure†	
Detorsion alone	8 (32.0)
Detorsion + cystectomy	10 (40.0)
Oophorectomy	7 (28.0)
Oophoropexy at index operation	1 (4.0)
Ovarian viability†	
Viable	18 (72.0)
Non-viable	7 (28.0)
Follow-up duration (months)*	65 (36–82)
Histopathology†	
Hemorrhagic infarction (pure)	6 (24.0)
Follicular cyst	5 (20.0)
Mature cystic teratoma	4 (16.0)
Isolated torsion (no cystic lesion)	8 (32.0)
Benign mucinous cyst	1 (4.0)
Hemorrhagic infarction+mature cystic teratoma	1 (4.0)

**: median (IQR), †: n(%)*

Table II: Comparison of viable and non-viable groups.

Variable	Viable	Non-viable	p
Total number of patients	18	7	-
Age (years)*	11 (10–13)	15 (13–16)	0.059
Symptom duration (hours)*	48 (24–120)	24 (24–48)	0.266
Postmenarchal status†	6 (33.3)	5 (71.4)	0.177
OR for ovarian loss (postmenarchal)†	-	5.00 (95% CI 0.74–33.78)	0.177
Adnexal mass/cyst on ultrasonography†	10 (55.6)	5 (71.4)	0.659
Preoperative ovarian maximum diameter (mm)*	66 (52–82)	84 (53–89)	0.586
Doppler flow present†	5 (38.5)‡	1 (16.7)‖	0.605

: median (IQR) (Mann–Whitney U test), †: n(%) (Fisher's exact test), ‡: Total (n=13), ‖: Total (n=6),* ***OR:* *Odds ratio,* ***CI:*** *Confidence interval.*

Table III: Ovarian viability and menarchal status distribution across symptom duration groups.

Symptom duration group	Viable*	Non-viable*	Postmenarchal*	Median age (years)
<24 hours (n=3)	3 (100.0)	0 (0.0)	2 (66.7)	12
24–48 hours (n=13)	7 (53.8)	6 (46.2)	7 (53.8)	13
>48 hours (n=9)	8 (88.9)	1 (11.1)	2 (22.2)	11

:** *n(%),* ***Within the 24–48-hour group: *ovarian loss occurred in 4 of 7 postmenarchal patients (57.1%) and in 2 of 6 premenarchal patients (33.3%).*

on preoperative ultrasonography did not differ significantly between groups (55.6% vs. 71.4%, p=0.659). Doppler flow status was not significantly associated with viability outcome (p=0.605). The maximum preoperative ovarian diameter on ultrasonography did not differ significantly between the viable and non-viable groups (median 66 mm, IQR 52–82 vs. 84 mm, IQR 53–89; p=0.586). Postmenarchal status was more prevalent in the non-viable group (71.4%) compared to the viable group (33.3%), with higher odds of ovarian loss in postmenarchal patients (OR 5.00, 95% CI 0.74–33.78, p=0.177); given the wide confidence interval and lack of statistical significance, this observation should be regarded as hypothesis-generating.

Viability across symptom duration groups

Symptom duration stratification revealed the following distribution (Table III). All three patients presenting within 24 hours (100.0%) had viable ovaries. In the 24–48-hour group, 7 of 13 patients (53.8%) had viable ovaries and 6 (46.2%) had non-viable ovaries. In the >48-hour group, 8 of 9 patients (88.9%) had viable ovaries and 1 (11.1%) had a non-viable ovary. The 24–48-hour group contained the largest number of postmenarchal patients, accounting for 7 of the 11 postmenarchal patients in the cohort and for 7 of its own 13 patients (53.8%); the corresponding proportions were 2 of 3 (66.7%) in the <24-hour group and 2 of 9 (22.2%) in the >48-hour group. Within the 24–48-hour group, ovarian loss occurred in 4 of 7 postmenarchal patients (57.1%) and in 2 of 6 premenarchal patients (33.3%).

Discussion

This study examined the relationship between symptom duration and intraoperative ovarian viability in a single-center pediatric cohort spanning 14 years, and identified menarchal status as a clinically relevant modifying factor. The principal finding was a paradoxical non-linear pattern in viability rates across symptom duration groups, with the lowest viability observed in the 24–48-hour group rather than in those presenting beyond 48 hours. Further analysis revealed that this group contained the largest number of postmenarchal patients (7 of the 11 in the cohort), raising the possibility that menarchal status rather than time alone contributes to ovarian outcome. It should be noted, however, that the small <24-hour group had an even higher proportion of postmenarchal patients (2 of 3) yet uniformly viable ovaries, so this explanation remains tentative. Moreover, the number of patients within each symptom-duration subgroup was small (particularly the <24-hour group, n=3), and the paradoxical distribution may therefore be substantially influenced by chance; these observations should be interpreted with corresponding caution.

The observation that symptom duration did not linearly predict viability is consistent with a growing body of literature challenging the concept of a strict temporal viability threshold. In our cohort, median symptom duration was paradoxically shorter in the non-viable group (24 hours, IQR 24–48) compared to the viable group (48 hours, IQR 24–120), and the difference was not statistically significant. In a multicenter study of 97 pediatric patients, pain duration did not determine whether children underwent conservative or non-conservative surgical management (9). A possible upper temporal limit of 34 hours has been proposed based on ROC analysis, yet the biological basis for irreversible ischemic damage remains undefined and the threshold is not universally validated (8). The resilience of the ovarian parenchyma to ischemic injury, attributable to its dual arterial blood supply, likely explains why prolonged symptom duration does not invariably predict necrosis (1). Consistent with this, all 42 preserved ovaries in one series of 39 girls retained normal anatomy and folliculogenesis after detorsion, with no significant difference in outcome according to the degree of intraoperative ischemia; signs of folliculogenesis were already evident in 78.6% of ovaries at 4–6 weeks, and folliculogenesis with restored blood flow was documented in all patients followed beyond 12 weeks (10). Our follow-up data are concordant with this pattern: the maximum ovarian diameter of every preserved ovary decreased substantially after detorsion (median 66 to 29 mm), providing objective sonographic evidence of structural recovery.

The role of postmenarchal status as a risk factor for ovarian loss is a central finding of our study. Postmenarchal patients had a fivefold higher odds of non-viability compared to premenarchal patients (OR 5.00, 95% CI 0.74–33.78), although statistical significance was not reached, likely due to the limited sample size. This finding is biologically plausible: cyclic hormonal stimulation in postmenarchal girls promotes follicular development and functional cyst formation, predisposing the ovary to torsion around an enlarged and heavier pedicle, and potentially increasing the degree of ischemic insult (9). It should be emphasized, however, that the direction of this association runs counter to much of the existing pediatric literature. Single-center series have reported higher rates of diagnostic delay and ovarian necrosis among premenarchal rather than postmenarchal girls, ischemic torsion has been associated with younger age, and an international multicenter study found post-menarchal age to be associated with a greater likelihood of ovarian-sparing surgery (2,9,11). Our discordant result must therefore be interpreted with caution: it derives from a small surgical cohort, did not reach statistical significance, and may reflect referral and presentation patterns specific to a single tertiary center rather than a true biological effect. In a large French multicenter cohort of 502 prepubertal girls, diagnostic delay was identified as a major challenge, with only 5% of diagnoses made within 6 hours and 85% beyond 12 hours of symptom onset; despite this delay, the authors of that series emphasised that a blue-black ovary is not synonymous with necrosis and that systematic oophorectomy should no longer be performed on the

basis of intraoperative appearance alone (12). Substantial differences in clinical and radiologic presentation between premenarchal and postmenarchal patients at the time of torsion have been well documented, reinforcing that a single prognostic framework cannot apply equally to both groups (13,14).

The overall ovarian preservation rate of 72% in our cohort is consistent with contemporary pediatric series. Ovarian salvage has been confirmed to be safe and associated with recovery of follicular function in the majority of cases, with no evidence of thromboembolic complications following detorsion (15,16). A decreasing trend in oophorectomy rates over time has been reported using national database analyses, reflecting growing recognition that intraoperative appearance alone should not determine the decision to perform oophorectomy (6). In our series, all 7 patients who underwent oophorectomy had histopathologically confirmed hemorrhagic infarction, providing objective validation of our intraoperative viability classification. Notably, an underlying mature cystic teratoma was present in 5 patients (20%) and was managed with ovary-sparing cystectomy in 4 of them, in keeping with reports that benign neoplasms most commonly mature cystic teratomas frequently underlie pediatric adnexal torsion and can usually be excised without sacrificing the ovary (4,15,17). No borderline or malignant lesion was encountered, supporting a conservative ovary-preserving approach even when a cystic mass is present. In cases where viability was uncertain, collegial intraoperative assessment within our tertiary teaching hospital ensured a consensus-based approach.

Doppler flow status was not significantly associated with viability outcome in our series, with 6 of 25 patients (24%) having indeterminate flow. This is consistent with established evidence that Doppler ultrasonography has limited reliability in both confirming and excluding ovarian torsion; preserved Doppler flow does not exclude torsion, particularly in early or intermittent cases (1,18,19). In a pediatric emergency cohort, the presence of Doppler flow was found to be insufficient to exclude ovarian torsion, while its absence remained a significant diagnostic marker (18). An adnexal mass was reported on preoperative ultrasonography in 15 patients (60.0%), whereas a discrete cystic lesion was confirmed histologically in 11. This discrepancy was confined to the non-viable group: of the 5 oophorectomy patients with a sonographic mass, only one harboured a true lesion (mature cystic teratoma), the remaining four most likely reflecting the enlarged, oedematous and haemorrhagically infarcted ovary being interpreted as a mass. By contrast, all 10 sonographically detected masses in the viable group corresponded to a resected cystic lesion. Right-sided torsion predominated in our cohort (56%), consistent with the known anatomical predisposition attributable to the protective effect of the sigmoid colon on the left adnexa (15). One patient presented with right-sided pain but was found to have left-sided torsion intraoperatively a discordance that has been previously documented and underscores that pain laterality cannot reliably localize the affected adnexa (13).

Regarding recurrence and oophoropexy, one patient (4%) developed ipsilateral torsion at 15 months and underwent repeat detorsion with oophoropexy at the second operation. A second patient with an elongated ovarian pedicle identified at the index operation underwent prophylactic oophoropexy without subsequent recurrence during follow-up. The indications for oophoropexy in pediatric ovarian torsion remain debated. Favorable short-term outcomes have been reported with combined utero-ovarian and round ligament oophoropexy for recurrent torsion of otherwise normal adnexa, while current evidence does not support routine oophoropexy after a single episode of torsion, reserving it for anatomical risk factors such as an elongated infundibulopelvic ligament or a history of recurrence (15,20).

Limitations

This study has several limitations. The retrospective single-center design and the small sample size (n=25) preclude multivariate analysis, limiting the ability to determine independent predictors of ovarian loss. The small number of events (7 non-viable ovaries) renders OR estimates imprecise, as reflected by the wide confidence intervals. Patients in the <24-hour group were too few (n=3) to draw firm conclusions. Intraoperative viability assessment, while supplemented by collegial consensus, remains inherently subjective and macroscopic; it may not fully reflect long-term functional ovarian reserve, which was not assessed in the present study. Future prospective multicenter studies stratifying patients by menarchal status and incorporating postoperative follow-up ultrasonography as a secondary viability endpoint would significantly strengthen the evidence base.

Conclusion

Symptom duration alone is an insufficient predictor of intraoperative ovarian viability in pediatric adnexal torsion. A paradoxical pattern of viability across time-based strata was observed in this cohort, paralleled by a concentration of postmenarchal patients in the intermediate symptom duration group. Postmenarchal status was associated with a fivefold higher odds of ovarian loss; this did not reach statistical significance in our small cohort and should be regarded as hypothesis-generating rather than confirmatory, particularly as it contrasts with several previously published series. These findings suggest that menarchal status may be considered alongside symptom duration in the surgical decision-making of pediatric adnexal torsion, rather than relying on time-to-surgery as a standalone prognostic parameter. Larger prospective multicenter studies are needed to confirm menarchal status as a predictor of ovarian viability and to guide individualized management strategies in this population.

Presented

Part of this study was presented as an oral presentation at the 44th National Zeynep Kamil Gynecopathology Congress, Istanbul, Türkiye, June 2026.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Zeynep Kamil Hospital (06.05.2026, reference number: 53).

Contribution of the authors

Study conception and design: SC, SM; data collection: SC, ÖB; analysis and interpretation of results: SC, ÖB, SM; draft manuscript

preparation: SC. All authors reviewed the results and approved the final version of the article.

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Conflict of interest
The authors declare that there is no conflict of interest.

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During the preparation of this work we used Claude (Anthropic) in July 2026 in order to assist with language editing, reference formatting, and editorial assistance. After using this tool, we reviewed and edited the content as needed and take full responsibility for the content of the publication.

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