Original Article
Central Eur J Paed 2023;19(1):1-12
DOI: 10.5457/p2005-114.331

Adnexal Torsion in Adolescents – a Retrospective Analysis from a Tertiary Centre in Latvia

Jelizaveta Gurmane[1], Lasma Lidaka[2]

[1]Riga Stradins University, Riga, Latvia; [2]Department of Paediatric Gynaecology, Children's Clinical University Hospital, Riga, Latvia; Department of Obstetrics and Gynaecology, Riga Stradins University, Riga, Latvia.

Correspondence: *jelizaveta.gurmane@gmail.com*; Tel. + 371 28 676932

Received: October 5 2022; **Accepted:** December 31 2022

Abstract

Objective – To review the data of cases of adnexal torsion in the paediatric population in a national level centre in Latvia and examine the pitfalls of diagnostic and therapeutic strategies. **Methods** – A retrospective review of medical records was performed on 61 cases of suspected and/or confirmed adnexal torsion in a national level paediatric centre. **Results** – In 85.5% of cases the initial diagnosis was made correctly. The age of the patient was a significant contributor to a shorter time until surgery (P=0.016). Abdominal pain was the most common symptom (90.6%), followed by nausea (58.5%) and vomiting (52.8%). Only 62.3% of the torsion patients had an elevated WBC and 69.4% had no elevated body temperature. The shorter the duration of symptoms, the more likely it was that the organ salvage procedure was performed (P=0.021). The sensitivity of ultrasound for the correct diagnosis was 71.4%. In almost a third of the torsion cases, no pelvic lesion was detected on ultrasound (26.5%). When ultrasound suspected torsion, the time before operation was significantly shorter (P<0.001), the presence of blood flow in the ovary extended the time until surgery (P=0.026). Organ-sparing surgery was performed in 73.6% of the cases. **Conclusion** – Medical professionals should not exclude the diagnosis of adnexal torsion in the absence of fever or leucocytosis, as well as in the case of normal adnexa on ultrasound. A delay in surgery increases the risk of irreversible ischemic damage leading to organ loss.

Key Words: Adnexal Torsion ▪ Adolescent ▪ Paediatrics ▪ Adnexal Diseases ▪ Surgery.

Introduction

Adnexal torsion in the paediatric population is one of the causes of abdominal and pelvic pain that leads to a potential loss of organ function and affects 4.9/100,000 women aged 1 to 20 years (1). There is no single reliable test to establish a clear diagnosis and it remains a diagnostic challenge, first due to the unspecific clinical signs and ultrasound findings. Almost half of adnexal torsions in paediatric population occur without radiological findings suggesting torsion (2). Furthermore, paediatric patients are often unable to describe their symptoms in detail and provide relevant medical information (3). Due to these reasons, admission to surgery can be delayed and this threatens to lead to permanent organ damage.

Preservation of the ovary is the main goal of the treatment of adnexal torsion. A delayed diagnosis and irreversible ischemic damage can affect female fertility later in life. To improve the rate of ovarian preservation, medical professionals must be educated and informed that the long duration of symptoms before operation or a blue-black ovary intraoperatively does not always indicate a nonviable and non-salvageable organ (4, 5); that being said, timely diagnosis is crucial to minimise ischemic injury.

The accuracy rate of the diagnosis of adnexal torsion before surgery is around 60% (6). More

research is needed to elevate the index of suspicion for this diagnosis and prevent delay in treatment. Furthermore, due to the small sample sizes of the conducted studies and the lack of longitudinal studies, there is no reliable method for assessing the vitality of the adnexa after adnexal torsion, and there are no criteria to determine whether oophorectomy, salpingectomy or adnexectomy is indicated, because in clinical practice it is impossible to distinguish between reversible ischemia and irreversible tissue necrosis (5). Finally, there are no reports on the situation in Latvia that have focused on diagnostic and therapeutic strategies in the treatment of paediatric patients with adnexal torsion.

The aim of this study is to examine the pitfalls of diagnostic and therapeutic strategies used in the Children's Clinical University Hospital in Riga, Latvia, and to compare the data gathered with the results of other studies.

Materials and Methods

A retrospective review of the medical records of all patients with initially suspected and/or surgically confirmed adnexal torsion was performed. Medical records were included in the study, if the initial or final diagnosis was N83.5 according to the International Classification of Diseases, 10th edition ("Torsion of ovary, ovarian pedicle and fallopian tube"), and patients were admitted to the Children's Clinical University Hospital between 1 January 2015 and 31 May 2021 composing 6 years and 5 months. A total of 68 patients with admission and/or discharge diagnosis of ovarian, ovarian pedicle, and fallopian tube torsion (ICD-10 code N83.5) were selected for the study. Children's Clinical University Hospital, Riga, Latvia is the main provider of services for paediatric and adolescent gynaecological cases in Latvia. Patients in the emergency department of the Children's Clinical University Hospital are primary examined and operated by paediatric surgeons and gynaecologists are called for more difficult cases.

Data were obtained from hospital electronic medical records including basic demographic characteristics, presentation of clinical signs, duration of symptoms, relevant physical examination findings, laboratory and imaging findings at presentation, surgical management, operator specialty, intraoperative findings, and pathological findings (if any tissue was resected). We also calculated the accuracy of the initial diagnosis, the time from admission to operation, the time interval from the imaging study to surgery, and the days spent in the hospital. All laboratory tests were performed on site in a certified hospital laboratory. Leucocytosis was confirmed when the WBC was greater than the upper limit of the laboratory range for the patient's age. CRP levels greater than 5 mg/L were considered elevated (according to the cutoff level established by the laboratory).

The duration of symptoms was extracted from the information in the medical records and, for descriptive purposes, divided into three groups (24 hours or less, 24 to 48 hours, 48 hours or longer). Ultrasound examination was performed by a radiologist and/or gynaecologist. Each patient was first examined by a single examiner, and in difficult cases a second opinion was sought. Both radiologists and gynaecologists are well-trained to perform pelvic ultrasound, which was performed with high resolution ultrasound machines, not older than 7 years. Transvaginal ultrasound was performed for sexually active patients, transabdominal or transrectal ultrasound was performed for patients who had not been sexually active. Ultrasound findings were considered suggestive of adnexal torsion if the examiner's suspicion was documented in the medical record. In the cases of inconclusive ultrasound examination or suspected malignancy magnetic resonance imaging was performed on a 1.5T Philips Ingenia device.

Ethics Statement

The study protocol was approved by the Research Ethics Committee of Riga Stradins University (No. 22-2/367/2021), as well as the Children's Clinical University Hospital (No. SP-44/2021). Informed consent from the patients was not obtained as such is not required for retrospective types of studies (involving no risk to the subjects), according to Latvian state legislation.

Statistical Analysis

Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the data for a normal distribution. In the cases of non-normal data distribution (P<0.05), the median was reported with the interquartile range (IQR). Pearson's Chi square test or Fisher's exact test were used to analyse the distribution of categorical variables. If 20% of expected cell counts were less than 5, the chi-square test was used; if >20% of expected cell counts were less than 5, Fisher's exact test was used (7). To compare continuous variables between two groups, the Mann-Whitney U test was used. The Spearman correlation coefficient (r_s) was used for correlation analysis. The correlation coefficients were interpreted as follows: $r \leq 0.20$ – non-significant correlation; $0.20 < r < 0.40$ - weak correlation; $0.40 \leq r \leq 0.69$ - moderately close correlation; $r \geq 0.70$ - close correlation (7). A P value less than 0.05 was considered statistically significant. For the statistical analysis mentioned above, SPSS statistical software (version 28.0.1.0., IBM Corp.) was used.

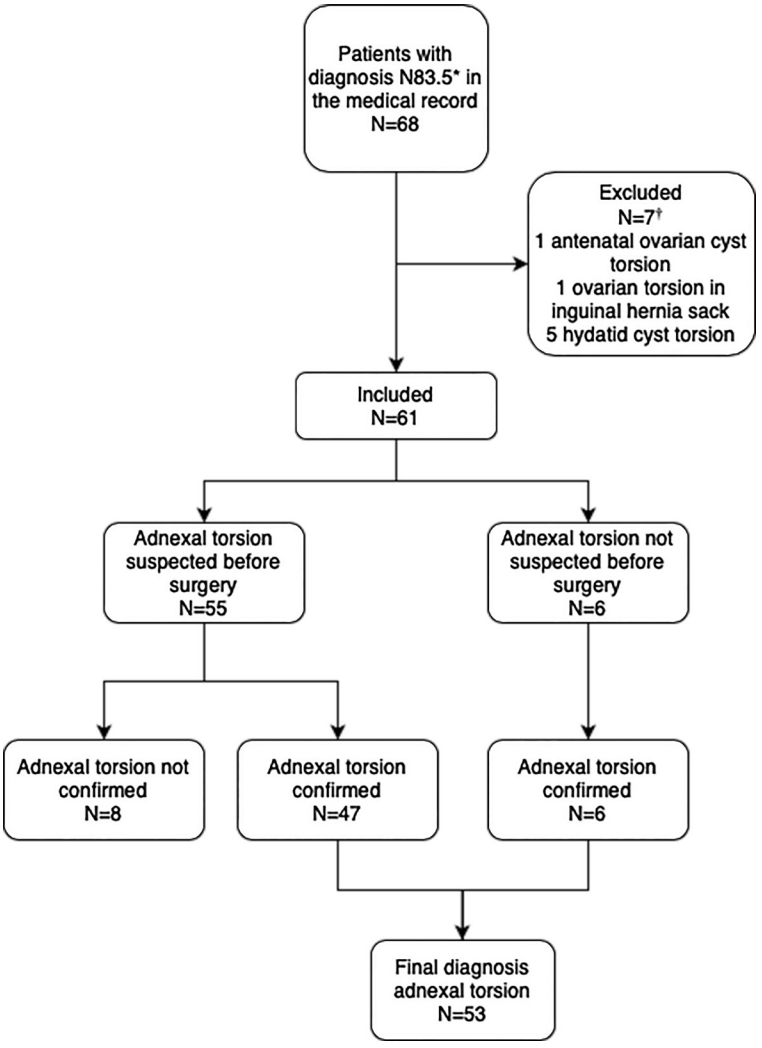

Fig. 1. *Flow chart of inclusion of patients in the study.*

Data are presented as numbers. *N83.5 – ICD-10 code for torsion of the ovary, ovarian pedicle, and fallopian tube; †Patients were excluded from the study due to the specificity and rarity of the cases.

Results

In general, 7 patients were excluded from the analysis due to the specificity and rarity of these cases (1 patient with antenatal ovarian cyst torsion, 1 patient with ovarian torsion in the inguinal hernia sac, and 5 patients with fallopian tube hydatid cyst torsion). In general, 61 cases were included in the study; in 53 of them, the diagnosis of adnexal torsion was confirmed intraoperatively. Patients were also classified into two groups according to initial diagnosis: 55 with suspected adnexal torsion before surgery and 6 patients without suspected adnexal torsion before surgery (Fig. 1).

Demographic and clinical characteristics of the patients, Laboratory characteristics

In 85.5% of cases, the initial diagnosis was made correctly (N=47). In 11.3% of intraoperatively confirmed cases of adnexal torsion, the initial diagnosis before surgery was different (N=6). Seven patients with surgically confirmed adnexal torsion were admitted to the hospital for planned surgery due to a cystic lesion found on outpatient

pelvic ultrasound, 5 of them were asymptomatic, and 2 of them had abdominal pain that started just before surgery.

The median age in the group of patients with intraoperatively confirmed adnexal torsion was 14.00 years (IQR 3.0), 80.3% (N=49) of the patients were 12 years or older and 19.7% (N=12) were prepubescent, respectively (younger than 12 years old) (Fig. 2). The age did not differ significantly between the groups of patients with and without surgically confirmed adnexal torsion (P=0.983). Furthermore, the age of the patients did not differ between the cases of adnexal torsion with a correct and incorrect preoperative diagnosis (P=0.079), which means that the age in this study cohort did not affect the precision of the initial diagnosis. The duration of symptoms before surgery was not significantly correlated with the age of the patients (r_s=-0.27, P=0.058).

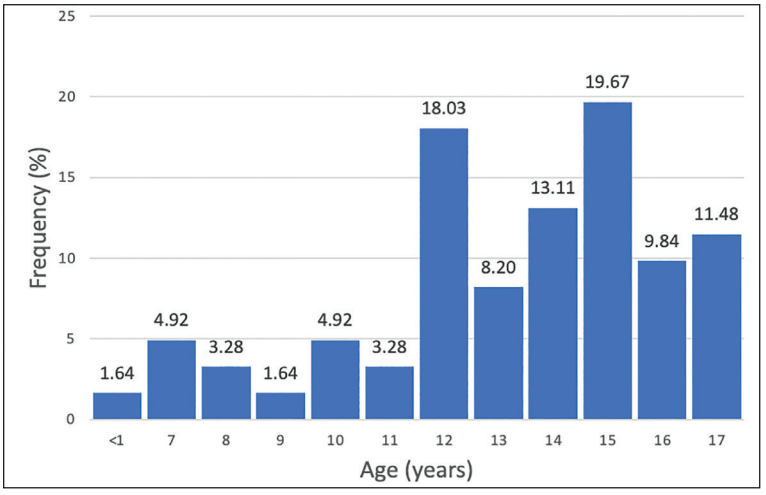

Fig. 2. *Age distribution of patients with intraoperatively confirmed adnexal torsion.*

The comparison of clinical and laboratory characteristics between patients with and without intraoperatively confirmed adnexal torsion is shown in Table 1. 90.6% (N=48) of patients with intraoperatively confirmed adnexal torsion diagnosis reported abdominal pain on

Table 1. Clinical Signs and Laboratory Characteristics of Patients with Intraoperatively Confirmed Adnexal Torsion and without It*

Clinical sign or symptom	Group		P value
	Torsion N=53 (%)	Without torsion N=8 (%)	
Abdominal pain	48 (90.6)	6 (85.7)	0.541†
Nausea	31 (58.5)	3 (42.9)	0.454†
Vomiting	28 (52.8)	2 (28.6)	0.424†
Diarrhoea	5 (9.4)	0 (0.0)	1.000†
Dysuria	2 (3.8)	0 (0.0)	1.000†
Signs of peritoneal irritation	6 (12.5)	1 (25.0)	0.450†
Body temperature			
Body temperature in degrees Celsius, (IQR‡)	36.7 (36.6-37.2)	37.2 (36.8-37.4)	0.148§
<37 °C	25 (69.4)	1 (25.0)	0.115†
37-37.9 °C	10 (27.8)	3 (75.0)	0.092†
38 °C	1 (2.8)	0 (0.0)	1.000†
Laboratory findings			
Elevated CRP‖	9 (18.8)	0 (0.0)	0.574†
Leucocytosis¶	33 (66.0)	3 (50.0)	0.655†

*Data are presented as a number (%) unless otherwise specified. †Fischer's exact test was used; ‡IQR – interquartile range; §Mann-Whitney U test; ‖CRP levels higher than 5 mg/L were considered elevated (according to cutoff level set by the laboratory); ¶According to the thresholds set by the standards used by the laboratory of the Children's Clinical University Hospital.

admission, most of them reporting localised pain (N=45; 84.9%) rather than diffuse (Table 1). Five patients had no pain at admission and the adnexal torsion was first confirmed during surgery; these patients were admitted for planned surgery due to a large cystic lesion previously diagnosed in the ovary on pelvic ultrasound.

Diagnostic Procedures

A preoperative imaging study was performed in 91.8% of the patients (N=56). It included ultrasound in 90.2% (N=55) of the cases (49.1% transabdominally or transrectally, 18.2% transvaginally, 32.7% for both procedures). Pelvic magnetic resonance imaging was performed in 6.6% (N=4) and pelvic CT in 3.3% (N=2) of the cases. The time from admission to surgery was longer in cases where more than one imaging procedure was performed, and this difference reached the significance level (8.00 h IQR=16.77 vs 21.5 hours IQR=101.25; P=0.010). In 4 cases, none of the diagnostic imaging methods were used before surgery due to the severity of pain, and in two of them the adnexal torsion was confirmed intraoperatively. In two other cases, both adnexa were intact: One patient had a post ovulation sign in the left ovary, which could be the cause of severe pain and no other surgical pathology was found; another patient had a paraovarian cyst on the right side, as well as an inflamed appendix covered with fibrinous exudate; in this case, cyst enucleation and appendectomy were performed.

Ultrasound Findings

The ultrasound sensitivity for the correct diagnosis of adnexal torsion was calculated to be 71.4%. In the cases where adnexal torsion was suspected (N=41) after ultrasound, the diagnosis was surgically confirmed in 85.4% (N=35) of the cases. After comparing ultrasound findings between groups with and without surgically confirmed adnexal torsion, no statistically significant differences in ultrasound and Doppler signs were found. The comparison of ultrasound findings between patients with and without intraoperatively confirmed adnexal torsion is presented in Table 2.

Timings

The timings were separately analysed for symptomatic patients with intraoperatively confirmed adnexal torsion, 5 patients (9.4%) reported no symptoms before surgery; therefore, they were not included in this analysis, as these patients were admitted due to a planned surgical intervention. The duration of symptoms was 24 to 48 hours in almost half of the cases (48.0%, N=23), in 31.2% of the patients (N=15), the duration from the onset of symptoms to admission was more than 48 hours, and 20.8% attended the emergency department during the first 24 hours after the onset of pain (N=10). The time interval from the onset of symptoms to surgery was found to correlate significantly with the age of the patients, showing a moderately close negative correlation (r_s=-0.4; P=0.016), showing that the older the patient, the shorter the time to operation.

The median time from admission to surgery was 8.5 hours (IQR 18.0), ranging from 0.5 to 141 hours, in 76.5% of cases <24 hours (N=39), 17.6% 24-48 hours, and 5.9% of cases >48 hours (N=3). The median duration from admission to the first

Table 2. Ultrasound Results Compared between Patients with and without Surgically Confirmed Adnexal Torsion*

Ultrasound finding	Adnexal torsion confirmed N=49 (%)	Adnexal torsion not confirmed N=6 (%)	P value
US suggestive of torsion	35 (71.4)	6 (100)	0.320†
Free pelvic fluid	20 (40.8)	3 (50.0)	0.686†
Reduced or absent blood flow in the ovary	18 (36.7)	3 (50.0)	0.644†
Pelvic lesion	36 (73.5)	6 (100.0)	0.320†

*Only patients to whom ultrasound was performed before surgery are included (N=55); †Fischer's exact test.

incision in the operating room was shorter in patients with leucocytosis than in those with normal WBC (6.00 hours, IQR 14.78 vs 16.00 hours, IQR 17.23, respectively, P=0.037). Other clinical symptoms and laboratory findings did not influence the time from admission to surgery. Most of the torsions occurred on the right side (69.8%, N=37), but the operating time did not appear to be significantly different compared to the confirmed adnexal torsion on both sides (P=0.502).

In cases where adnexal torsion was suspected after ultrasound examination, the time from admission to the operation and from imaging to the operation was significantly shorter (6 hours IQR=11.75 vs 23.75 hours IQR=20.65; P=0.008 and 2 hours IQR=2.05 vs 13.75 hours ICQ=34.55; P<0.001 respectively). Patients who had reduced/absent blood flow detected on ultrasound were also sent significantly faster to the operating room compared to the time from imaging to operation in patients with normal blood flow in the ovary (2.00 hours IQR=1.30 vs 3.50 hours IQR=13.38; P=0.026).

Management

In 8 cases (13.1%) with an initial diagnosis of adnexal torsion that was not surgically confirmed, the findings were the following: ovarian or paraovarian cystic mass without torsion, signs of recent ovulation, phlegmonous appendicitis, ruptured haemorrhagic ovarian cyst. Treatment was analysed separately for patients with intraoperatively confirmed adnexal torsion. Comparison between the groups managed by the gynaecologist or paediatric surgeon did not reveal significant differences in the cystectomy (86.4%, N=19 vs. 94.1%, N=16; P=0.618) or organ salvage rate (68.6%, N=24 vs. 83.3%, N=15, P=0.333). Only one patient underwent a laparotomy, because a precise surgical examination of the pelvic organs was necessary to differentiate between a malignant tumour and an adnexal torsion due to a non-malignant lesion.

The operative findings and the types of surgical procedures performed are presented in detail (Table 3). Organ preservation surgery, mainly detorsion with or without cystectomy, was performed in 39 of 53 patients (73.6%), although in 56.6% of cases (N=30) black-bluish adnexal tissue was observed. The shorter the duration of symptoms, the more likely the organ salvage procedure could be performed (1.00 days, IQR 0.67 vs 3.00 days, IQR 3.5; P=0.021). After comparing clinical signs and symptoms, nausea was found to be more common in cases of adnexal torsion when an organ preservation procedure was performed (38.5% vs 7.1%; P=0.041). Decreased blood flow in the ovary on ultrasound, as well as black-bluish adnexal tissue intraoperatively, were more common in cases where an organ was surgically removed (83.3% vs 46.7%; P=0.03 and 85.7% vs 46.2%; P=0.01, respectively).

More than half of the patients with surgically confirmed adnexal torsion were discharged within 3 days after the day of the operation (56.6%,

Table 3. Intraoperative Findings and Procedures Performed for 53 Patients with Surgically Confirmed Adnexal Torsion

Intraoperative findings and procedures performed	N (%)
Operating service	
Paediatric gynaecologist	35 (66.0)
Paediatric surgeon	18 (34.0)
Surgery type	
Laparoscopy	52 (98.1)
Laparotomy	1 (1.9)
Operative finding – affected organ	
Ovary	15 (28.3)
Fallopian tube	6 (11.3)
Both	32 (60.4)
Operative finding – risk factor for torsion	
Unknown (torsion of the intact adnexa)	9 (16.9)
Ovarian cyst / lesion	26 (49.1)
Paraovarian cyst / paratubar cyst	12 (22.6)
Hydrosalpinx	6 (11.3)
Surgical procedure	
Detorsion only	12 (22.6)
Detorsion and immediate cystectomy	27 (51.0)
Oophorectomy	2 (3.8)
Salpingectomy	5 (9.4)
Oophorosalpingectomy	7 (13.2)

N=30). None of the patients included in the study had recurrent adnexal torsion or adnexal torsion on the other side.

Pathology

In the group of patients with initially suspected adnexal torsion that was not confirmed during surgery, the pathology results were the following: 3 patients had a follicular ovarian cyst, 1 patient had a haemorrhagic ovarian cyst, 1 patient had a dermoid ovarian cyst, 1 patient had a paraovarian cyst, in 2 cases there was no pathology on the ovary or fallopian tube. Histopathological findings of the cases where immediate enucleation of the cystic lesion or organ resection was performed are presented in Table 4.

Table 4. Pathology Results for 41 Cases with Surgically Confirmed Adnexal Torsion when Enucleation of the Lesion or Organ Resection Was Performed

Histopathological results	N (%)
Paraovarian / paratubar cyst	11 (26.8)
Follicular ovarian cyst	9 (22.0)
Dermoid ovarian cyst	7 (17.1)
Hydrosalpinx	6 (14.6)
Haemorrhagic ovarian cyst	5 (12.2)
Necrotic tissue	2 (4.9)
Fibroma	1 (2.4)

Discussion

Principal findings and interpretation. The current study reviews data on cases of adnexal torsion in the paediatric and adolescent population in Latvia. Our findings represent aspects of clinical presentation and highlight some possible explanations for the delay in the care of patients with adnexal torsion, including data on the organ salvage rate in a central paediatric hospital in the country. In most of our cases, the most common presentation of adnexal torsion was acute abdominal pain (90.6%) with nausea (58.5%) and/or vomiting (52.8%), which can be the presentation of many other acute pathologies, making diagnosis and timely operation more difficult. We did not find any crucial symptom or clinical sign that is more common in patients with adnexal torsion than without it, but possibly a larger sample size would have allowed us to obtain different results with a statistical significance. In this study, we did not find a statistically significant association of the duration of symptoms before admission with the age of the patient. However, after admission, older patients were operated on sooner than younger children. In the other studies, the interval from the presentation of symptoms to admission was longer in premenarchial patients (8, 9) but the trend to operate on older patients earlier is similar to the findings of Ashwal et al. (8). Possible explanations for the delay in care of younger patients reported by other authors are the inability of paediatric patients to describe their symptoms and provide precise medical information (3), the prioritisation of other differential diagnoses, or a reluctance to operate on younger patients (8). We can speculate that another explanation for the delay in diagnosis is multiple radiological studies that in this study appeared to significantly prolong the time interval from admission to surgery (r_s=0.4; P<0.001), which corresponds to the findings of Chang YJ (10).

Our study population showed that the time from admission to operation and from radiological examination to operation in cases of adnexal torsion was statistically longer in the group of patients without ultrasound findings suggestive of torsion. This is consistent with others who noted that normal-appearing ovaries on ultrasound in the emergency department in the case of torsion are common and can cause a delay in the diagnosis of ovarian torsion in adolescent girls, while an adnexal mass or cyst can raise suspicion and prompt diagnosis (2, 11, 12). According to other authors, absent arterial Doppler flow, as well as enlarged ovarian volume were found to be predictive of adnexal torsion, although no single factor can be used for diagnosis and multiple factors should be interpreted together (13–15). Importantly, the presence of blood flow in the ovary in the case of torsion also significantly prolongs the time from imaging

to operation, leading to a delay in the diagnosis of adnexal torsion. In this study, blood flow in the ovary was present in more than half (63.3%) of confirmed cases of torsion, confirming that vascular flow does not rule out torsion and that imaging is not reliable in identifying this pathology, which has already been mentioned by other authors (2, 16–18). Other recent studies suggest the use of contrast-enhanced ultrasound in the diagnosis of ovarian torsion, showing a sensitivity of 94,1%, a specificity of 100% and an overall accuracy of 95%, despite the fact that this type of contrast medium is still considered off-label in the paediatric population (19).

Some authors suggest that various laboratory parameters may be helpful in the preoperative diagnosis of adnexal torsion, specifically increased CRP level, white blood cell count, neutrophil/lymphocyte ratio and platelet/lymphocyte ratio (20–24). These parameters are important inflammatory markers of ischemia that, together with the corresponding clinical characteristics, may serve as predictive factors for tissue necrosis in cases of adnexal torsion and shorten the time to surgical intervention. In our study, we found that patients with leucocytosis were operated earlier than patients with normal white blood cell count. Elevated inflammatory markers, as well as increased body temperature on admission, may indicate intrabdominal pathology and may help clinicians make the decision on the urgency of surgical intervention, although it is not always in correlation with the severity of the underlying disease (25, 26).

Most of the cases of adnexal torsion in this study were associated with pelvic mass (83.0%, N=44), suggesting that the incidental finding of an ovarian cystic lesion on ultrasound should raise the suspicion of clinicians for the diagnosis of adnexal torsion. It is well known that adnexal torsions are more common in the case of adnexal pathology, including benign cysts, dermoids, cystadenomas, or hydrosalpinx due to the increased weight and size of the affected pedicle, making the torsion more likely to occur (27–29). According to A.E.Lawrence and colleagues, patients with ovarian mass >5 cm have twice the odds of torsion (18). This information can be used to diagnose patients with benign adnexal masses, educate these girls and their families about the risk and initial symptoms of torsion, and ensure that they seek medical help as soon as possible.

Organ preservation surgery was performed within our study sample in 73.6% of adnexal torsion cases (N=39). However, this number is smaller than that reported by Adeyemi-Fowode O. or Sarah K. Walker in the United States, who reported an organ salvage operation in 95% and 86% of patients with adnexal torsion, respectively (30, 31). However, it does not differ significantly from the findings of other researchers, and this number varies greatly from one piece of research to another. The percentage of cases of adnexal torsion when the affected organ needs to be resected varies significantly between studies and can range from 5% to 67% depending on the study (1, 4–7). We found that a long duration of symptoms due to delayed presentation to the hospital can increase the risk of losing an organ (P=0.021), which has already been mentioned by other authors (32), again confirming that a precise diagnosis and management strategy are vitally important for preventing complications, especially infertility. R. A. Saberi et al. reported that adnexal sparing surgery was more common in teaching hospitals, patients <13 years of age, and those from high-income households (33).

In this current study, the comparison between the groups managed by the gynaecologist or paediatric surgeon did not reveal significant differences in organ salvage rate (68.6% vs 83.3%, P=0.333). These results do not differ from previous reports (9, 27, 34), but, contrary to our finding, there is some evidence suggesting that paediatric surgeons were more likely to perform an oophorectomy (35, 36) or that there was a higher rate of ovarian preservation performed after adding a gynaecologist to the surgical team (37). Gynaecologists at the Children's Clinical University Hospital are always called to consult and perform the most complicated gynaecological cases, furthermore, the high organ salvage rate could also be the result of extensive work

to educate medical professionals at the Children's Clinical University Hospital in Riga and to inform other non-gynaecological specialists of this hospital about the presentation and treatment of adnexal torsion.

Relevance of the findings: implications for clinicians. The reported rate of (salpingo/) oophorectomies and the significant impact of the time from admission to operation on organ salvage rate highlight the need to understand the most common clinical and laboratory parameters and imaging features that can raise suspicion of adnexal torsion. We recognise that education and awareness of hospital personnel, as well as parents, is required to improve the care of these patients and prevent complications.

Strengths and weaknesses of the study. Future research. This study has several strengths. Analysing all diagnostic procedures and management strategies in a central children's hospital in the country, where most cases are treated, ensures that a significant number of cases are concentrated. We have reviewed not only surgically confirmed cases of adnexal torsion, but also patients who had suspected torsion that was not confirmed, adding to a more comprehensive analysis of predictive values of clinical and laboratory characteristics. Data from this study are important because they address a rare but serious adnexa pathology in the paediatric population, providing more information for general understanding, as well as significant associations that may be important for clinical practice and improve the quality of surgical care, as well as reproductive health in the future. Additionally, this topic has rarely been studied in patients from Latvia.

Limitations of the Study

Our study has several limitations. First, due to the retrospective study design, data were collected from medical records that were originally not designed to collect data for research, which could lead to information bias and some missing data. However, to minimise this impact on statistical analysis and to represent the results more clearly, missing data were excluded and a valid percentage was used. Furthermore, since it was a retrospective study with a limited time interval, no follow-up ultrasound examinations and long-term fertility could be analysed and evaluated. Future research would be required to address this unanswered aspect of long-term fertility to report a rate of preservation of fertility in patients after the adnexal torsion episode in Latvia. Another weakness is the relatively small sample size of the study. The reason for this omission is that adnexal torsion is a relatively rare pathology. The possibility of obtaining different results with a larger study sample cannot be excluded. However, due to the rarity of this pathology, it can take many years for researchers to explore this problem only in Latvia, so the Baltic states should collaborate and conduct a common study on this topic with larger cohorts, recruit more patients and improve treatment pathways by developing predictive scores with high sensitivity for the diagnosis of adnexal torsion. This can also help confirm the results obtained here and possibly reveal other valuable associations. Other authors have already developed some predictive scores. For example, Philipp Bolli and colleagues from Germany and Switzerland in 2017 presented a positive predictive score for ovarian torsion (sensitivity 0.81), using vomiting, short duration of pain, and elevated CRP level as predictive values (38). Cyrille Huchon and colleagues from France have analysed adult patients with acute pelvic pain and developed a simple score to predict adnexal torsion based on the size, character and duration of the ovarian cyst, the absence of leucorrhoea or metrorrhagia, and vomiting (39). R.Meyer and colleagues attempted to develop a clinical prediction model for the preoperative diagnosis of adnexal torsion and underlined that the absence of tenderness in the right quadrant, elevated platelets, and neutrophil levels are independent predictors of this pathology (40). Although the scores and models mentioned above may be useful for the diagnosis of adnexal torsion, more studies must be conducted with paediatric patients and larger cohorts to develop a predictive score with high sensitivity and confirm its diagnostic precision by applying to the prospective cohort.

Another weakness is that the duration of the symptoms was self-reported and it is possible that recollection bias could have influenced the analysis of time and treatment. To minimise this risk, all data available from medical records were cross-checked and the electronic records from the admission point were additionally analysed for correlations.

Conclusions

Adnexal torsion with its unspecific presentation is, without a doubt, a surgical emergency. Early intervention without delay in diagnosis is of great importance for the preservation of patient fertility. This pathology should not be excluded in the event of normal body temperature or normal inflammatory parameters, as well as normal adnexa that appears on ultrasound. The longer duration of symptoms, multiple radiological studies before surgery, and non-specific ultrasound findings significantly contributed to the delay in surgical treatment, increasing the risk of losing an organ.

Acknowledgements: We express our gratitude to all our colleagues who participated in the care of the study patients.

Sources of Funding: No specific funding was allocated to the study.

Authors' Contributions: Conception and Design: JG and LL; Acquisition, analysis, and interpretation of data: JG; Drafting the article: JG; Critically reviewing important intellectual content: LL; Approved final version of the manuscript: LL.

Conflict of Interest: The authors declare that they have no conflict of interest.

References

1. Guthrie BD, Adler MD, Powell EC. Incidence and trends of pediatric ovarian torsion hospitalizations in the United States, 2000-2006. Pediatrics [Internet]. 2010 Mar [cited 2021 May 5];125(3):532–8. Available from: https://pubmed.ncbi.nlm.nih.gov/20123766/.
2. Karaman E, Beger B, Çetin O, Melek M, Karaman Y. Ovarian torsion in the normal ovary: A diagnostic challenge in postmenarchal adolescent girls in the emergency department. Med Sci Monit [Internet]. 2017 Mar 15 [cited 2021 Apr 22];23:1312–6. Available from: /pmc/articles/PMC5363456/.
3. Poonai N, Poonai C, Lim R, Lynch T. Pediatric ovarian torsion: Case series and review of the literature. Can J Surg [Internet]. 2013 [cited 2021 Apr 30];56(2):103–8. Available from: https://pubmed.ncbi.nlm.nih.gov/23351494/.
4. Oelsner G, Cohen SB, Soriano D, Admon D, Mashiach S, Carp H. Minimal surgery for the twisted ischaemic adnexa can preserve ovarian function. Hum Reprod [Internet]. 2003 [cited 2022 Feb 16];18(12):2599–602. Available from: https://pubmed.ncbi.nlm.nih.gov/14645177/.
5. Geimanaite L, Trainavicius K. Ovarian torsion in children: Management and outcomes. J Pediatr Surg [Internet]. 2013 Sep [cited 2021 Apr 26];48(9):1946–53. Available from: https://pubmed.ncbi.nlm.nih.gov/24074673/.
6. Melcer Y, Maymon R, Pekar-Zlotin M, Pansky M, Smorgick N. Clinical and sonographic predictors of adnexal torsion in pediatric and adolescent patients. J Pediatr Surg [Internet]. 2018 Jul 1 [cited 2021 May 3];53(7):1396–8. Available from: https://pubmed.ncbi.nlm.nih.gov/28760458/.
7. Field A. Discovering Statistics Using IBM SPSS Statistics | SAGE Publications Ltd. 2017.
8. Ashwal E, Hiersch L, Krissi H, Eitan R, Less S, Wiznitzer A, et al. Characteristics and management of ovarian torsion in premenarchal compared with postmenarchal patients. Obstet Gynecol [Internet]. 2015 Sep 20 [cited 2021 Apr 30];126(3):514–20. Available from: https://pubmed.ncbi.nlm.nih.gov/26244532/.
9. Alberto EC, Tashiro J, Zheng Y, Sandler A, Kane T, Gomez-Lobo V, et al. Variations in the management of adolescent adnexal torsion at a single institution and the creation of a unified care pathway. Pediatr Surg Int [Internet]. 2021 Jan 1 [cited 2021 May 5];37(1):129–35. Available from: https://pubmed.ncbi.nlm.nih.gov/33242170/.
10. YJ C, DC Y, MS K, CT W, HC C, CC L, et al. Adnexal torsion in children. Pediatr Emerg Care [Internet]. 2008 Aug [cited 2021 Sep 9];24(8):534–7. Available from: https://pubmed.ncbi.nlm.nih.gov/18645541/.
11. Tsafrir Z, Azem F, Hasson J, Solomon E, Almog B, Nagar H, et al. Risk factors, symptoms, and treatment of ovarian torsion in children: the twelve-year experience of one center. J Minim Invasive Gynecol [Internet]. 2012 Jan [cited 2022 May 11];19(1):29–33. Available from: https://pubmed.ncbi.nlm.nih.gov/22014543/.
12. Karaca SY, İleri A. Ovarian Torsion in Adolescents with and without ovarian mass: A Cross-sectional Study. J Pediatr Adolesc Gynecol [Internet]. 2021 Dec 1 [cited 2022 Nov 28];34(6):857–61. Available from: https://pubmed.ncbi.nlm.nih.gov/34044177/.

13. Schwartz BI, Mercier R, Gould S, Saul D, Loiselle C, Weerasooriya N, et al. Clinical and radiologic factors associated with adnexal torsion in premenarchal and menarchal children and adolescents. J Pediatr Surg [Internet]. 2022 [cited 2022 Nov 28]; Available from: https://pubmed.ncbi.nlm.nih.gov/36008196/.

14. Roberts B, Golden J, Kallis M, Denning NL, Lipskar AM, Rich BS. Operative Findings in Pediatric and Adolescent Patients With Presumed Adnexal Torsion. J Surg Res [Internet]. 2022 Sep 1 [cited 2022 Nov 28];277:84–91. Available from: https://pubmed.ncbi.nlm.nih.gov/35472725/.

15. Hartman SJ, Prieto JM, Naheedy JH, Ignacio RC, Bickler SW, Kling KM, et al. Ovarian volume ratio is a reliable predictor of ovarian torsion in girls without an adnexal mass. J Pediatr Surg [Internet]. 2021 Jan 1 [cited 2022 Nov 28];56(1):180–2. Available from: https://pubmed.ncbi.nlm.nih.gov/33121739/.

16. Peña JE, Ufberg D, Cooney N, Denis AL. Usefulness of Doppler sonography in the diagnosis of ovarian torsion. Fertil Steril [Internet]. 2000 May [cited 2022 May 11];73(5):1047–50. Available from: https://pubmed.ncbi.nlm.nih.gov/10785237/.

17. Shadinger LL, Andreotti RF, Kurian RL. Preoperative sonographic and clinical characteristics as predictors of ovarian torsion. J Ultrasound Med [Internet]. 2008 [cited 2022 May 11];27(1):7–13. Available from: https://pubmed.ncbi.nlm.nih.gov/18096725/.

18. Lawrence AE, Fallat ME, Hewitt G, Hertweck P, Onwuka A, Afrazi A, et al. Factors Associated with Torsion in Pediatric Patients with Ovarian Masses. J Surg Res [Internet]. 2021 Jul 1 [cited 2022 Nov 28];263:110–5. Available from: https://pubmed.ncbi.nlm.nih.gov/33647800/.

19. Trinci M, Danti G, Di Maurizio M, Tursini S, Briganti V, Galluzzo M, et al. Can contrast enhanced ultrasound (CEUS) be useful in the diagnosis of ovarian torsion in pediatric females? A preliminary monocentric experience. J Ultrasound [Internet]. 2021 Dec 1 [cited 2022 Nov 28];24(4):505–14. Available from: https://pubmed.ncbi.nlm.nih.gov/34176094/.

20. Nissen M, Sander V, Rogge P, Alrefai M, Tröbs RB. Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio Might Predict Pediatric Ovarian Torsion: A Single-Institution Experience and Review of the Literature. J Pediatr Adolesc Gynecol [Internet]. 2021 Jun 1 [cited 2022 Nov 28];34(3):334–40. Available from: https://pubmed.ncbi.nlm.nih.gov/33316415/.

21. Tobiume T, Shiota M, Umemoto M, Kotani Y, Hoshiai H. Predictive factors for ovarian necrosis in torsion of ovarian tumor. Tohoku J Exp Med [Internet]. 2011 [cited 2022 Nov 28];225(3):211–4. Available from: https://pubmed.ncbi.nlm.nih.gov/22041520/.

22. Lee JY, Shin W, Kim JS, Park JH, Cho SH. Combination of clinical and laboratory characteristics may serve as a potential diagnostic marker for torsion on mature cystic teratomas. Obstet Gynecol Sci [Internet]. 2018 May 1 [cited 2022 Nov 28];61(3):386–94. Available from: https://pubmed.ncbi.nlm.nih.gov/29780782/.

23. Tsai J, Lai JY, Lin YH, Tsai MH, Yeh PJ, Chen CL, et al. Characteristics and Risk Factors for Ischemic Ovary Torsion in Children. Child (Basel, Switzerland) [Internet]. 2022 Feb 1 [cited 2022 Nov 28];9(2). Available from: https://pubmed.ncbi.nlm.nih.gov/35204926/.

24. Kaplanoglu D, Bulbul M, Odemis G, Kaplanoglu M. Can various complete blood count parameters helpful in preoperative diagnosis of adnexal torsion? Rev Assoc Med Bras [Internet]. 2021 [cited 2022 Nov 28];67(6):873–7. Available from: https://pubmed.ncbi.nlm.nih.gov/34709333/.

25. Sack U, Biereder B, Elouahidi T, Bauer K, Keller T, Tröbs RB. Diagnostic value of blood inflammatory markers for detection of acute appendicitis in children. BMC Surg [Internet]. 2006 Nov 28 [cited 2022 Dec 1];6. Available from: https://pubmed.ncbi.nlm.nih.gov/17132173/.

26. Andersson RE, Hugander A, Ravn H, Offenbartl K, Ghazi SH, Nyström PO, et al. Repeated clinical and laboratory examinations in patients with an equivocal diagnosis of appendicitis. World J Surg [Internet]. 2000 Apr [cited 2022 Dec 1];24(4):479–85. Available from: https://pubmed.ncbi.nlm.nih.gov/10706923/.

27. Rossi B V., Ference EH, Zurakowski D, Scholz S, Feins NR, Chow JS, et al. The Clinical Presentation and Surgical Management of Adnexal Torsion in the Pediatric and Adolescent Population. J Pediatr Adolesc Gynecol [Internet]. 2012 Apr [cited 2021 May 28];25(2):109–13. Available from: https://pubmed.ncbi.nlm.nih.gov/22206683/.

28. Otjen JP, Stanescu AL, Alessio AM, Parisi MT. Ovarian torsion: developing a machine-learned algorithm for diagnosis. Pediatr Radiol [Internet]. 2020 May 1 [cited 2021 Apr 22];50(5):706–14. Available from: https://pubmed.ncbi.nlm.nih.gov/31970456/.

29. Ngo AV, Otjen JP, Parisi MT, Ferguson MR, Otto RK, Stanescu AL. Pediatric ovarian torsion: a pictorial review. Pediatr Radiol [Internet]. 2015 Nov 1 [cited 2022 May 12];45(12):1845–55. Available from: https://pubmed.ncbi.nlm.nih.gov/26209957/.

30. O A-F, EG L, F S, H S-H, H Z, JE D. Adnexal Torsion in Children and Adolescents: A Retrospective Review of 245 Cases at a Single Institution. J Pediatr Adolesc Gynecol [Internet]. 2019 Feb 1 [cited 2021 Aug 7];32(1):64–9. Available from: https://pubmed.ncbi.nlm.nih.gov/30012428/.

31. Walker SK, Lal DR, Boyd KP, Sato TT. Management of pediatric ovarian torsion: evidence of follicular development after ovarian preservation. Surg (United States) [Internet].

2018 Mar 1 [cited 2021 Apr 22];163(3):547–52. Available from: https://pubmed.ncbi.nlm.nih.gov/29329768/.

32. Weng X, Xie X, Liu C, Hong X, Yi J. Ovarian preservation and prognosis in adnexal torsion surgery - a retrospective analysis. Ginekol Pol [Internet]. 2020 [cited 2022 Nov 28];91(5):277–80. Available from: https://pubmed.ncbi.nlm.nih.gov/32495934/.

33. Saberi RA, Gilna GP, Rodriguez C, Quiroz HJ, Urrechaga EM, Cioci AC, et al. Ovarian Preservation and Recurrent Torsion in Children: Both Less Common Than We Thought. J Surg Res [Internet]. 2022 Mar 1 [cited 2022 Nov 28];271:67–72. Available from: https://pubmed.ncbi.nlm.nih.gov/34844056/.

34. Julania S, Chown I, Gera S, Hunter T. Management of Adnexal Torsion in the Pediatric and Adolescent Population at Western Australia's Single Tertiary Children's Hospital over the Last 10 Years: Retrospective Study. J Minim Invasive Gynecol [Internet]. 2020 [cited 2021 May 5]; Available from: https://pubmed.ncbi.nlm.nih.gov/32911087/.

35. Campbell BT, Austin DM, Kahn O, McCann MC, Lerer TJ, Lee K, et al. Current trends in the surgical treatment of pediatric ovarian torsion: We can do better. J Pediatr Surg. 2015 Aug 1;50(8):1374–7.

36. Peeraully R, Henderson K, Fairbrother K, Patel R, Fraser N, Shenoy M, et al. Effect of Surgical Specialty on Management of Adnexal Masses in Children and Adolescents: An 8-Year Single-Center Review. J Pediatr Adolesc Gynecol [Internet]. 2020 Feb 1 [cited 2022 Nov 28];33(1):89–92. Available from: https://pubmed.ncbi.nlm.nih.gov/31254617/.

37. GE T, H C, EA T, R D, V G-L. Rate of Oophorectomy for Benign Indications in a Children's Hospital: Influence of a Gynecologist. J Pediatr Adolesc Gynecol [Internet]. 2017 Apr 1 [cited 2021 Aug 8];30(2):234–8. Available from: https://pubmed.ncbi.nlm.nih.gov/27769688/.

38. Bolli P, Schädelin S, Holland-Cunz S, Zimmermann P. Ovarian torsion in children. Med (United States) [Internet]. 2017 Oct 1 [cited 2021 Apr 26];96(43). Available from: https://pubmed.ncbi.nlm.nih.gov/29069000/.

39. Huchon C, Staraci S, Fauconnier A. Adnexal torsion: a predictive score for pre-operative diagnosis. Hum Reprod [Internet]. 2010 [cited 2022 May 27];25(9):2276–80. Available from: https://pubmed.ncbi.nlm.nih.gov/20605899/.

40. Meyer R, Meller N, Mohr-Sasson A, Toussia-Cohen S, Komem DA, Mashiach R, et al. A clinical prediction model for adnexal torsion in pediatric and adolescent population. J Pediatr Surg [Internet]. 2022 Mar 1 [cited 2022 Nov 28];57(3):497–501. Available from: https://pubmed.ncbi.nlm.nih.gov/33902897/.