ОРИГИНАЛЬНАЯ СТАТЬЯ

BETWEEN ORCHIOPEXY AND ORCHIECTOMY CAN ULTRASOUND PLAY A ROLE? SURGICAL CORRELATIONS OF ULTRASOUND FINDINGS IN TESTICULAR TORSION

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Spermatic cord torsion (SCT) is a condition of spermatic cord (SC) structures twisting, accompanied by venous-congestion, arterial inflow losing and subsequent ipsilateral testis ischemia. Ultrasound is a diagnostic modality of SCT, with 93% sensitivity and 100% specificity.

Purpose. To assess the validity of ultrasound in rolling-out between orchiopexy and orchiectomy in patients with SCT and to evaluate the correlation between ultrasound findings in testicular torsion and surgical approaches.

Materials and methods. A prospective study was conducted in the Radiology department. A total of 57 male patients aged between 5 years to 35 years referred for suspected having testicular torsion. Radiological images of the scrotum were performed in all cases using a Color Doppler with a 9-15 MHz linear-array transducer.

Results. The mean age was 19.07±8.61 years with median of 17 years. Regarding to the scrotal US indices, the following positive findings noticed as followed: in 29 cases (50.9%) – testicular heterogeneity, in 23 cases (40.4%) – presence of blood flow to affected testis, in 45 cases (78.9%) – enlarged epididymis, in 31 cases (54.4%) – heterogeneous epididymis, in 44 cases (77.2%) – blood flow to epididymis, in 31 cases (54.4%) – thickened scrotal wall, in 14 cases (24.6%) – hydrocele, in 9 cases (15.8%) – varicocele, in 6 cases (10.5%) – necrosis and in 5 cases (8.8%) – hemorrhage. In addition, Whirl pool sign was found in 29 cases (50.8%), Resistive index (RI) was elevated in 22 patients (38.6%) and peripheral testicular re-vasculation was found in 25 patients (43.9%). Out of 57 cases, 44 patients (77.2%) underwent orchiopexy whereas 7 patients (12.3%) underwent orchiectomy and 6 patients (10.5%) underwent detorsion.

Discussion. Shields et al. studied male aged one year to 18 years diagnosed with TT. Of the 140 cases with TT, 56 patients (40%) had a non-viable testis and underwent an orchiectomy, while 84 (60%) had a viable testis and orchiopexy. Burud et al. studied 88 cases with acute pain of scrotum. Only 53 patients completed the enrollment, their mean age was 18.11 years and swelling has a positive predictive value for TT. Out of 53 patients, 33 (65.5%) required orchidectomy. They found that the pain duration was not a significant factor in determining TT. However, orchidectomy was more common in patients with pain duration >24 hours and pain duration within 6-24 hours. In a large cohort involved 1005 men surgically exploration for suspected TT done by Yi et al., found that the age group with the greatest number of TT surgeries was 12-18 years old (mean age=17.67±8.51 years) with frequent symptoms were scrotal swelling and pain. In the current study, the scrotal US and Doppler findings are testicular heterogeneity, presence of blood flow to affected testis, enlarged epididymis, heterogeneous epididymis, blood flow to epididymis, thickened scrotal skin, hydrocele, necrosis and hemorrhage. These are agree with Shields et al. that observed 3 signs on the US were significantly associated with a non-viable testis by univariate study, which were testicular heterogeneity, epididymis heterogeneity and thickened scrotal wall. Similarly, Burud et al. reported echogenicity on US showed that heteroechogenicity was more in TT. Doppler US showed reduced perfusion of the affected testis to be more in the TT. The testis size on US had a significant difference in TT and non-TT group.

Conclusions. Testicular heterogeneity, presence of blood flow to affected testis, enlarged epididymis, heterogeneous epididymis, blood flow to epididymis and thickened scrotal wall are main features of scrotal US in TT. Whirl pool sign, Resistive index (RI) elevated and peripheral testicular revasculation are main feature of colour Doppler in TT. Testicular heterogeneity, blood flow to affected side, enlarged epididymis and thickened scrotal skin positively impact the decision of surgery types. The perfusion reduction rate in orchiectomy is lower than in patients underwent orchiopexy. Testicular size post orchiopexy decreased more in comparison to post orchiectomy. Ultrasound when combined with clinical presentations, lead to the reduction of the rate of negative surgical exploration.

Keywords: orchiopexy, orchiectomy, color doppler ultrasound, testicular torsion, cremasteric reflex.

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МОЖЕТ ЛИ УЛЬТРАЗВУКОВОЕ ИССЛЕДОВАНИЕ СЫГРАТЬ РОЛЬ ПРИ ВЫБОРЕ МЕЖДУ ОРХИПЕКСИЕЙ И ОРХИЭКТОМИЕЙ? КОРРЕЛЯЦИЯ УЗИ И ХИРУРГИЧЕСКИХ ДАННЫХ ПРИ ПЕРЕКРУТЕ ЯИЧКА

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Перекрут семенного канатика (ПСК) – это состояние перекрута структур семенного канатика (СК), сопровождающееся венозным застоем, потерей артериального притока и последующей ипсилатеральной ишемией яичка. Ультразвуковое исследование (УЗИ) является методом диагностики перекрута семенного канатика с чувствительностью 93% и специфичностью 100%.

Цель исследования. Оценить роль ультразвукового исследования при перекруте яичка при выборе между орхипексией и орхиэктомией, а также оценить корреляцию между результатами УЗИ при перекруте яичка и хирургическими доступами.

Материалы и методы. Проспективное исследование было проведено в отделении лучевой диагностики. Обследовано 57 пациентов мужского пола в возрасте от 5 до 35 лет с подозрением на перекрут яичка. Визуализация мошонки во всех случаях выполнялась с помощью цветного допплеровского картирования с линейным датчиком 9–15 МГц.

Результаты. Средний возраст пациентов составил 19,07±8,61 года, медиана – 17 лет. При ультразвуковом исследовании мошонки отмечены следующие результаты: в 29 случаях (50,9%) – неоднородность яичка, в 23 случаях (40,4%) – наличие кровотока в пораженном яичке, в 45 случаях (78,9%) – увеличение придатка яичка, в 31 случае (54,4%) – неоднородность придатка яичка, в 44 случаях (77,2%) – наличие кровотока в придатке яичка, в 31 случае (54,4%) – утолщение стенки мошонки, в 14 случаях (24,6%) – гидроцеле, в 9 случаях (15,8%) – варикоцеле, в 6 случаях (10,5%) – некроз и в 5 случаях (8,8%) – кровоизлияние. Кроме того, у 29 пациентов (50,8%) был выявлен симптом «водоворота», у 22 пациентов (38,6%) был повышен индекс резистентности (ИР), а у 25 пациентов (43,9%) наблюдалась периферическая реваскуляризация яичек. Из 57 случаев 44 пациентам (77,2%) была выполнена орхипексия, 7 пациентам (12,3%) – орхиэктомия, а 6 пациентам (10,5%) – деторсия.

Обсуждение. Shields и соавторы исследовали мужчин в возрасте от одного года до 18 лет с диагнозом перекрут семенного канатика. Из 140 случаев перекрута семенного канатика у 56 пациентов (40%) было нежизнеспособное яичко и им была выполнена орхиэктомия, в то время как у 84 (60%) было жизнеспособное яичко и им была выполнена орхипексия. Burud и соавторы изучили 88 случаев с острой болью в мошонке. Только 53 пациента завершили исследование, их средний возраст составил 18,11 лет, было выявлено, что отек имеет положительное прогностическое значение для перекрута семенного канатика. Из 53 пациентов 33 (65,5%) потребовалась

орхиэктомия. Исследователи обнаружили, что продолжительность боли не была значимым фактором в определении перекрута семенного канатика. Однако орхиэктомия чаще проводилась у пациентов с продолжительностью боли >24 часов и в течение 6–24 часов. В большой когорте, включавшей 1005 мужчин, хирургическое исследование по поводу предполагаемого перекрута семенного канатика, проведенное Yi et al., показало, что возрастная группа с наибольшим количеством операций была в возрасте 12–18 лет (средний возраст = 17,67 ± 8,51 года), а частыми симптомами были отек мошонки и боль. В текущем исследовании результаты УЗИ мошонки и допплерографии включают в себя гетерогенность яичка, наличие кровотока в пораженном яичке, увеличенный придаток яичка, гетерогенность придатка яичка, приток крови к придатку яичка, утолщенную кожу мошонки, гидроцеле, некроз и кровоизлияние. Эти данные согласуются с данными Shields et al., которые наблюдали 3 признака на УЗИ, которые были достоверно связаны с нежизнеспособным яичком по однофакторному исследованию: гетерогенность яичка, гетерогенность придатка яичка и утолщенная стенка мошонки. Аналогичным образом, Burud et al. охарактеризовали эхогенность при УЗИ и показали, что гетероэхогенность была более выражена при перекруте семенного канатика. Допплерография показала снижение перфузии пораженного яичка, более выраженное при перекруте семенного канатика. Размер яичка по УЗИ значительно различался в группах с перекрутом яичка и без перекрута яичка.

Заключение. Гетерогенность яичек, наличие кровотока в пораженном яичке, увеличенный придаток яичка, неоднородность придатка яичка, кровоток в придатке яичка и утолщение стенки мошонки являются основными признаками перекрута семенного канатика при УЗИ мошонки. Симптом «водоворота», повышенный индекс резистентности и периферическая реваскуляризация яичек являются основными признаками перекрута семенного канатика при цветном допплеровском картировании. Гетерогенность яичек, кровоток в пораженной стороне, увеличенный придаток яичка и утолщение кожи мошонки влияют на выбор вида хирургического вмешательства. Скорость снижения перфузии при орхиэктомии ниже, чем у пациентов, перенесших орхипексию. Размер яичек после орхипексии уменьшился в большей степени по сравнению с размерами после орхиэктомии. Ультразвуковое исследование в сочетании с клиническими проявлениями приводит к снижению частоты отрицательных результатов хирургического исследования.

Ключевые слова: орхипексия, орхиэктомия, цветное допплеровское картирование, перекрут яичка, кремастерный рефлекс.

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Introduction. Spermatic cord torsion (SCT) is a condition of spermatic cord (SC) structures twisting, accompanied by venous-congestion, arterial inflow losing and subsequent ipsilateral testis ischemia. It is a urologic emergency situation; it necessitates urgent expeditious investigation and management to preserve testicular vitality. The testicular salvage rate significantly decline if management is late by more than 6 hrs from symptoms onset [1]. Scrotal examination is recommended in all males presenting with lower abdominal pain, to prevent delay in diagnosis [2]. By examination, the testicle may be in an abnormal or transverse lie and maybe in a high position. It be swollen, erythematous, and absence of the normal cremasteric reflex. Torsion of the testicular appendages during early onset, can differentiated from SCT by maximal tenderness to palpation near the head of the epididymis or testis, as isolated tender nodule, and/or a blue dot appearance on the testis [3].

Primarily, ultrasound is the diagnostic modality of SCT beyond the physical exam, with approximately 93% sensitive and 100% specific rates [4]. When a low suspicion of SCT exist, color Doppler and power Doppler ultrasound can be used to demonstrate arterial blood flow to the testicle while providing information about scrotal anatomy and other testicular disorders [3]. Ultrasonographic findings suggestive of acute SCT include: absent or decreased blood flow in the affected testicle, decreased flow velocity in the intra-testicular arteries, increased resistive indices in the intra-testicular arteries, hyper-vascularity with a low resistance flow pattern (after partial torsion-detorsion), twisting of the spermatic cord (complete and incomplete), whirlpool sign (lamellated mass with concentric layering just cephalad to the testes as coiled spermatic cord components), whirling on color or power Doppler, enlargement size of the testis and epididymis, homogeneous echo-texture (before necrosis), heterogeneous echo-texture (after 24 hrs), hypo-echoic (necrosis), hyper-echoic (hemorrhage), hydrocele, reactive thickening of the scrotal skin and hyperemia and peripheral testicular neovascularization [5, 6, 7].

The point-of-care ultrasound technique to evaluate the testicle involve the high-frequency transducer (5-10 MHz), ample ultrasound gel and proper patient positioning [4]. Color flow Doppler applied to both the affected and unaffected testes. Begin with the unaffected testicle to gain a sense of what normal vascular flow looks-like [4]. Power Doppler is useful in the evaluation of vascular flow as well. Power Doppler has greater sensitivity for vascular flow however it don't allow the examiner to discern between arterial and venous flow [3].

Doppler can be employed to evaluate for both venous and arterial flow by placing the Doppler gate on regions of vascular flow and evaluating for both venous and arterial Doppler waveforms [4]. Arterial waveforms will have large spikes due to the peaks of arterial blood pressure, while venous waveforms typically seen as plateaus of Doppler flow. Applying Doppler and checking for both venous and arterial flow can further demonstrate the severity of the torsion [3, 4].

When SCT is clinically suggested, performing immediate surgical exploration, regardless of laboratory studies, because a negative result upon scrotum exploration is more acceptable than the loss of a salvageable testis [3].

Aims of the study to assess the validity of ultrasound in rolling-out between orchiopexy and orchiectomy in patients with SCT and to evaluate the correlation between ultrasound findings in testicular torsion and surgical approaches.

Methods.

Study design and setting.

Under an approval of Institutional Review Board Committee of the College of Medicine, University of Thi-Qar, a prospective study was conducted in the Radiology Department of the Al-Haboubi Teaching Hospital. A total of 57 male patients aged between 5 years to 35 years referred for suspected having testicular torsion due to acute scrotal pain were enrolled in the study during the period from 12th September 2024 to 20th April 2025.

Ethical considerations.

Written informed consent was obtained from the patients and parents for participating in this study. The study conform to the 2000 Helsinki declaration-updated and was approved by the Medical Ethical Committee of College of Medicine, University of Thi-Qar (no. 7/54/676 date: 09.09.2024 and 7/54/142 on 27.02.2025); Thi-Qar Health Directorate (151/2025 on 27.04.2025).

Inclusion Criteria:

• Suspected patients with TT (acute scrotal pain and/or swelling).

• Not undergoing surgical intervention.

• Accept for the including in the study.

Exclusion Criteria:

• Previously underwent Orchiectomy or Orchiopexy.

• Unconfirmed suspension of TT during examination.

• Missing data.

Doppler scrotal ultrasound (US) protocol.

Radiological images of the scrotum performed in all cases using a Color Doppler (Voluson E6, GE healthcare, Austria, GmbH & CO OG, D62439) with a 9-15 MHz linear-array transducer. Scrotal US in the case of suspected TT, palpation should be performed in a standing position. The scrotum and con¬tents elevated with a hand, and the raising pain associated with TT (Prehn's sign) [8]. In the examination looking for normal US anatomy of testis (both sides), epididymis and scrotum. Patient is supine or may be upright in case of inguinal hernia. Scrotum is supported on a towel laid over the thighs. Testes evaluated in both long and short axes. Looking for a mass weather intra-testicular or extra-testicular. Enough gel using to get-out gas trapped in the skin folds of the scrotum.

In normal testis, it has homogeneous echogenicity and with slightly decreased echogenicity in early prepubertal age. The diameter in adult testis measure between 3-5 cm (volume=20 mL). The tunica vaginalis appear like an echogenic outline. Tunica invaginates seen as linear echogenic testicular mediastinum. Rete testis can be identified as hypoechoic area beside the mediastinum when more dilated. Appendix testis usually seen in torsion. In Doppler, testis demonstrate a low-resistance arterial waveform.

The epididymis examined for head weather round or oblong structure. It situated beside the superior testicular pole as iso-echoic (mildly hyper-echoic) compared to the testis. It measure 5-12 mm. The body extend down toward posterior portion of testis, measure 2-4 mm. The tail is curved structure at the inferior testicular pole as the proximal ductus deferens measure 2-5 mm. The appendix epididymis which attach at head and not normally seen unless TT present. By Doppler, the epididymis demonstrate a low-resistance arterial waveform. The scrotum skin thickness measure between 2-8 mm [9, 10].

Data collection.

All patients devoted to scrotal US examination, medical and surgical history, and physical evaluation. Clinical data collected including age, symptoms and signs (Fever, nausea, vomiting, dysuria, and swelling), previous trauma, previous undescended testicle, previous TT, previous history surgery, family history of torsion and side of lesion (right or left). Scrotal US findings included: Testicular heterogeneity (necrosis or hemorrhage), Testicular volume (size), Enlarged epididymis (size), Heterogeneous epididymis, Blood flow to epididymis, Thickened scrotal wall (skin), Hydrocele and Varicocele). The doppler criteria including: Presence of blood flow to affected testis, Whirl pool sign (Twisted spermatic cord), Resistive index (RI) elevation (>0.75) and peripheral testicular revasculation. The types of surgery (detorsion or Orchiectomy or Orchiopexy). Surgical findings including: Bell-clapper deformity, high investment of tunica vaginalis, twisted spermatic cord, ischemic testis, edema, hemorrhage, and necrosis. All the studied subjects went for scrotal US protocols, which were done prior to any surgical intervention.

Follow-up (short period) for saved salvage testicle.

The study investigated for blood flow restoration (complete or partial), swelling of testis, echo-texture of testicle (normal or necrosis or edema), atrophy testis, infarction and fibrosis.

Statistical analysis.

Statistical package for social science (SPSS statistics for windows, Chicago: SPSS, Inc.) software version 26 was used. Data were described in the form of frequencies and percentage for qualitative data, and mean and SD for quantitative data. Levene's test was used to estimated differences between the groups. Bars, pia and scatter plots charts used to figure the data. A one-sided P value of 0.05 or less was considered statistically significant [10, 11].

Results.

General characteristics.

In total, 57 males with testicular torsion (TT) were enrolled by studied the findings of scrotal US in relation to their characters. The mean age was 19.07±8.61 years with median of 17 years. The frequent age group was (5-20) in 33 patients (57.9%), followed by 21-30 years in 18 cases (31.6%). In relation to residence, 57.9% of patients lived in urban regions and 42.1% lived in rural areas. In regard to symptom and sign documented, one patient suffered from dysuria, six (10.5%) had swelling scrotal, seven (12.3%) complained from pain and 16 (28.1%) had nausea and vomiting. In addition, 43 cases (75.4%) complained from more than one. Left sided effected more than right (27 vs. 30). In addition, 15 cases (26.3%) were with previous trauma, 4 cases (7.2%) – with previous undescended testicle, 1 patient (1.8%) – with previous TT, 5 patients (8.8%) – with previous history surgery and with family history of torsion were 7 patients (12.3%) (Table 1).

Scrotal US and Doppler findings.

Regarding to the scrotal US indices, the following positive findings noticed as followed: in 29 cases (50.9%) – testicular heterogeneity, in 23 cases (40.4%) – presence of blood flow to affected testis, in 45 cases (78.9%) – enlarged epididymis, in 31 cases (54.4%) – heterogeneous epididymis, in 44 cases (77.2%) – blood flow to epididymis, in 31 cases (54.4%) – thick-

Table №1. General characters of this study (n=57).

Characteristics		No.	%
Age (years) Mean±SD (Median)= 19.07±8.61 (17)	5-20	33	57.9
	21-30	18	31.6
	>30	6	10.5
Residence	Urban	33	57.9
	Rural	24	42.1
Symptom and sign	Dysuria	1	1.8
	Swelling	6	10.5
	Pain	7	12.3
	Nausea and vomiting	16	28.1
	More than one	43	75.4
Side effected	Right	27	47.4
	Left	30	52.6
Previous trauma		15	26.3
Previous undescended testicle		4	7.2
Previous TT		1	1.8
Previous history surgery		5	8.8
Family history of torsion		7	12.3

ened scrotal wall, in 14 cases (24.6%) – hydrocele, in 9 cases (15.8%) – varicocele, in 6 cases (10.5%) – necrosis and in 5 cases (8.8%) – hemorrhage. In addition, Whirl pool sign was found in 29 cases (50.8%), Resistive index (RI) was elevated in 22 patients (38.6%) and peripheral testicular re-vasculation was found in 25 patients (43.9%).

The mean and median of testicular right and left volumes were 15.82±4.26 mL (15 mL) and 14.14±4.03 mL (14 mL), respectively (Table 2) (Fig. 1-5).

Results of the surgery.

Out of 57, 44 patients (77.2%) underwent Orchiopexy whereas 7 patients (12.3%) underwent orchiectomy and 6 (10.5%) – underwent detorsion. The most common findings seen was edema in 73.7% of cases (Table 3).

Scrotal US findings in relation to the surgery of TT.

The relationship between Scrotal US findings and the surgery of TT was listed in Table 4. The Levene's test analyzed that only testicular heterogeneity (p=0.003) showed significant differences. All the rest parameters didn't showed difference.

TT surgeries in relation to the outcome and testicular size by Scrotal US.

The scrotal US worse signs listed in Table 5. The reduction in perfusion reported in two cases underwent orchiectomy and 12 patients (27.3%) underwent orchiopexy with a high significant difference (p<0.0001). Hypoechogenicity was documented in 3 patients (42.9%) underwent orchiectomy while in it reported 10 patients (22.7%) underwent orchiopexy with a high significant difference (p=0.001). One patient showed heteroechogenicity by doppler post orchiectomy while 6 patients (13.6%) showed that in orchiopexy with a significant difference (p=0.05). One patient showed multiple US signs after orchiectomy and in 16 patients (36.4%) after orchiopexy with a high significant difference (p=0.0001).

Testicular size post orchiopexy decreased in 36 (81.8%) of patients and in seven patients (100%) post orchiectomy (Table 6).

Discussion.

In this study, 57 males with testicular torsion (TT), the mean age was 19.07±8.61 years with median of 17 years, 57.9% of patients lived in urban regions and 42.1% lived in rural areas. In addition, 43 cases (75.4%) complained from more than one symptoms like scrotal swelling, pain and nausea and vomiting. Left sided testicle effected more than right. Several cases presented with previous trauma, with previous undescended testicle, with previous TT, with previous history surgery and with family history of torsion. Out of 57, 44 patients (77.2%) underwent orchiopexy whereas 7 patients (12.3%) underwent orchiectomy. Shields et al. studied male aged one year to 18 years diagnosed with TT [12]. Of the 140 cases with TT, 56 (40%) had a non-viable testis and underwent an orchiectomy, while 84 (60%) had a viable testis and orchiopexy. Burud et al. studied 88 cases with acute pain of scrotum [13].

Table №2. Scrotal US findings of this study (n=57).

Findings		No.	%
Testicular heterogeneity		29	50.9
Presence of blood flow to affected testis		23	40.4
Testicular right volume Mean±SD (Median)=15.82± 4.26 (15)	<15	30	52.6
	≥15	27	47.4
Testicular left volume Mean±SD (Median)=14.14± 4.03 (14)	<15	40	70.2
	≥15	17	29.8
Enlarged epididymis		45	78.9
Heterogeneous epididymis		31	54.4
Blood flow to epididymis		44	77.2
Thickened scrotal skin		31	54.4
Hydrocele		14	24.6
Necrosis		6	10.5
Hemorrhage		5	8.8
Whirl pool sign		29	50.8
Resistive index (RI) elevation (>0.75)		22	38.6
Peripheral testicular re-vasculation		25	43.9

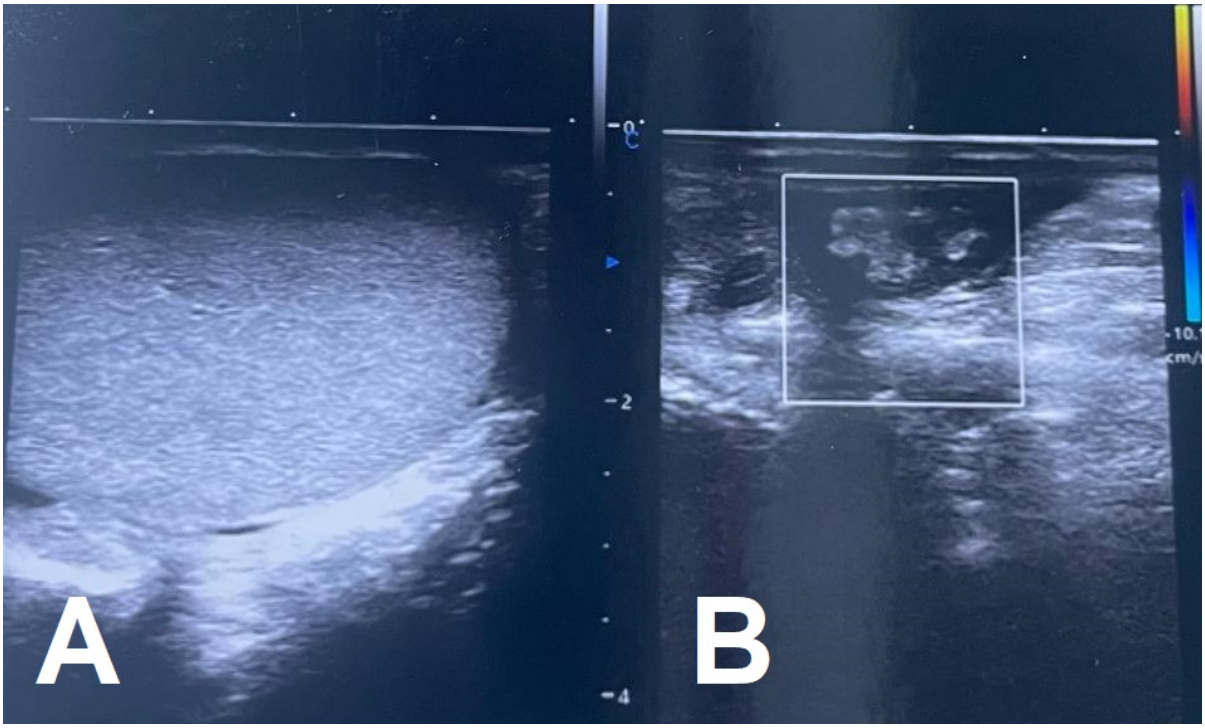

Fig. 1 (Рис. 1)

Fig. 1. Scrotal US.

Patient M., 21 years old, presented with nausea, vomiting, dysuria and swelling. A – Normal right testicular; B – left testicular: atrophy and heterogeneity.

Рис. 1. УЗИ мошонки.

Пациент М., 21 год, обратился с жалобами на тошноту, рвоту, дизурию и отёк.А – Нормальное правое яичко; В – левое яичко: признаки атрофии и гетерогенности.

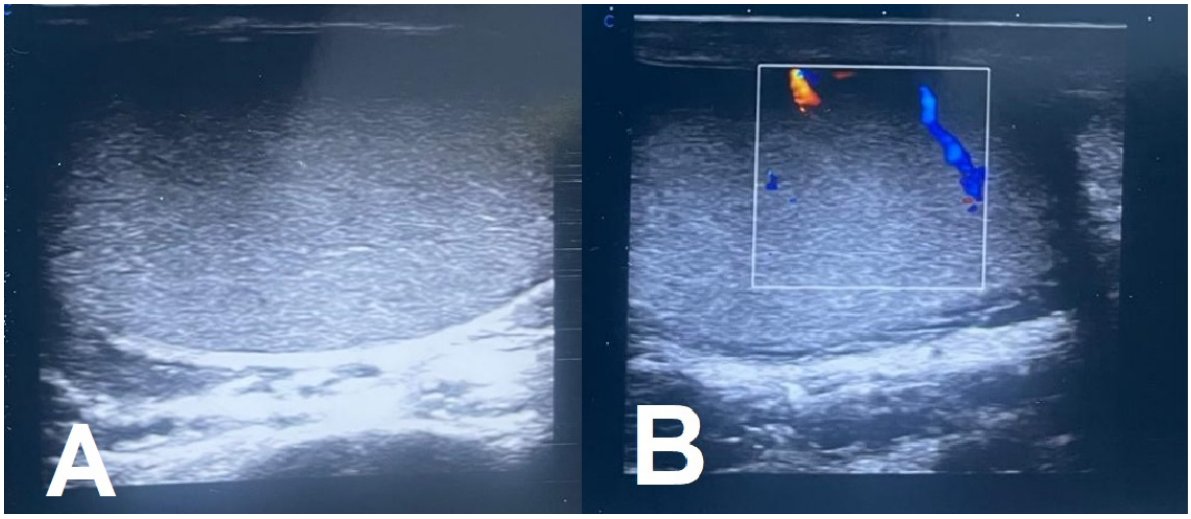

Fig. 2 (Рис. 2)

Fig. 2. **Scrotal US.**

Patient A., 15 years old, presented with nausea and swelling. A – left testicular heterogeneity; B – decrease testicular size after orchiopexy.

Рис. 2. **УЗИ мошонки.**

Пациент А., 15 лет, обратился с жалобами на тошноту и отёк. А – гетерогенность в области левого яичка; Б – уменьшение размеров яичка после орхипексии.

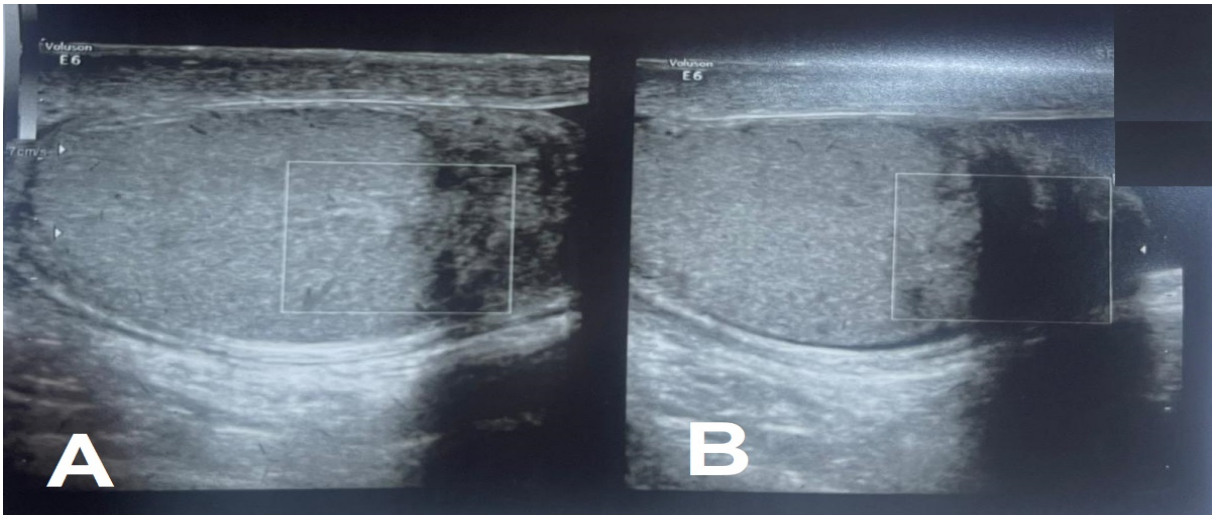

Fig. 1 (Рис. 1)

Fig. 3. **Scrotal US.**

Patient K., 25 years old, presented with nausea, dysuria and swelling. A – Right testicular heterogeneity and necrosis; B – decrease testicular size after orchiopexy, reduce perfusion, hypoechogenicity and heteroechogenicity.

Рис. 3. **УЗИ мошонки.**

Пациент К., 25 лет, обратился с жалобами на тошноту, дизурию и отёк. А – признаки гетерогенности и некроза в области правого яичка; Б – уменьшение размера яичка после орхипексии, снижение перфузии, гипо- и гетероэхогенность.

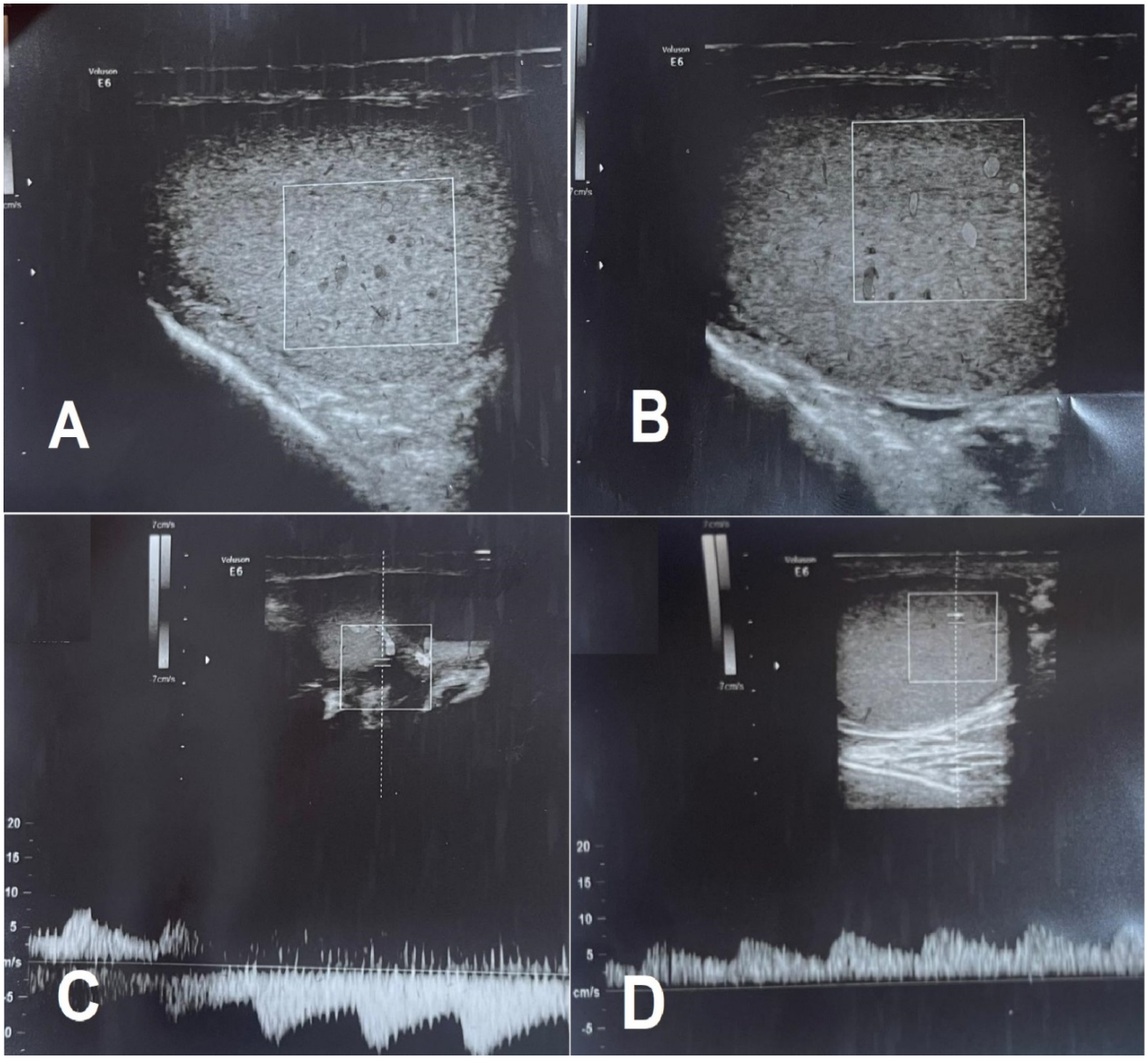

Fig. 4 (Рис. 4)

Fig. 4. Scrotal US.

Patients O., 30 years old, presented with dysuria. A – Presence of blood flow to affected testis; B – blood flow to epididymis; C – enlarged epididymis (right=14 ml; left=16 ml); D – revasculation.

Рис. 4. УЗИ мошонки.

Пациент О., 30 лет, обратился с жалобами на дизурию. A – Признаки наличия кровотока в пораженном яичке; B – наличие кровотока в придатке яичка; C – увеличение придатка яичка (справа = 14 мл; слева = 16 мл); D – признаки реваскуляризации.

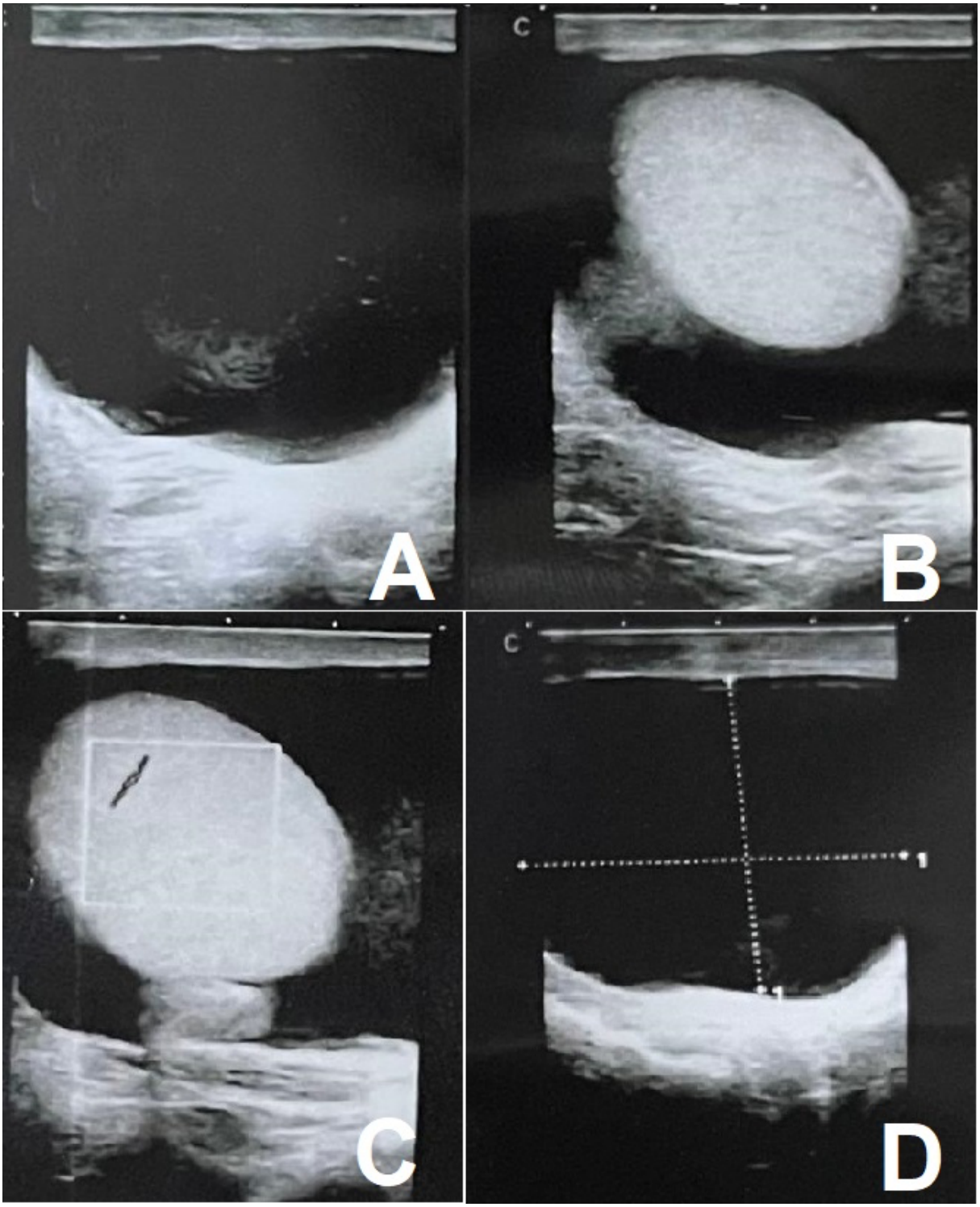

Fig. 5 (Рис. 5)

Fig. 5. **Scrotal US, right testicle.**

Patient D., 25 years old, presented with scrotal pain and swelling. Hydrocele, scrotal fluids collected about 35 mL with fine echogenic debris.

Рис. 5. **УЗИ мошонки, правое яичко.**

Пациент Д., 25 лет, обратился с жалобами на боль и отек мошонки. Гидроцеле, собрано около 35 мл жидкости с мелкими эхогенными включениями.

Table №3. Surgical findings of this study (n=57).

Variables		No.	%
Type of surgery	Orchiopexy	44	77.2
	Orchiectomy	7	12.3
	Detorsion	6	10.5
Surgical findings	Bell-clapper deformity	11	19.3
	High investment of tunica vaginalis	15	26.3
	Twisted spermatic cord	14	24.6
	Ischemic testis	6	10.5
	Edema	42	73.7
	Hemorrhage	6	10.5
	Necrosis	6	10.5

Table №4. Scrotal US findings in relation to the surgery of TT.

Findings	Orchiopexy	Orchiectomy	Levene's Test	P value
	No. (%)			
Testicular heterogeneity (n=29)	22 (75.9)	7 (24.1)	9.5	0.003
Presence of blood flow to affected testis (n=23)	17 (73.9)	6 (26.1)	0.03	0.86
Testicular right volume (mean)	15.9±4.2	14.4±3.7	0.25	0.61
Testicular left volume (mean)	14.2±3.9	13.4±5.2	0.22	0.64
Enlarged epididymis (n=45)	38 (84.4)	7 (15.6)	3.04	0.08
Heterogeneous epididymis (n=31)	27 (87.1)	4 (12.9)	0.01	0.9
Blood flow to epididymis (n=44)	39 (88.6)	5 (11.4)	0.46	0.5
Thickened scrotal wall (n=31)	28 (90.3)	3 (9.7)	0.47	0.49
Hydrocele (n=14)	12 (85.7)	2 (14.3)	0.18	0.67
Varicocele (n=9)	7 (77.8)	2 (22.2)	0.65	0.42
Necrosis (n=6)	4 (66.7)	2 (33.3)	2.3	0.13
Hemorrhage (n=5)	3 (80)	2 (20)	3.1	0.08

Table №5. Scrotal US findings of TT surgeries in relation to the outcome and testicular size.

Outcome	Orchiectomy (n=7)	Orchiopexy (n=44)	P value
	No. (%)		
Reduce perfusion	2 (28.6)	12 (27.3)	<0.0001
Hypoechogenicity	3 (42.9)	10 (22.7)	0.001
Heteroechogenicity	1 (14.3)	6 (13.6)	0.05
More than one	1 (14.3)	16 (36.4)	0.0001

*6 cases not reported

Table №6. Scrotal US findings of TT surgeries in relation testicular size.

Testicular size	Orchiectomy (n=7)	Orchiopexy (n=44)	P value
	No. (%)		
Decrease	7 (100)	36 (81.8)	0.003

*6 cases not reported

Only 53 patients completed the enrollment, their mean age was 18.11 years and swelling has a positive predictive value for TT. Out of 53, 33 patients (65.5%) required orchidectomy. They found that the pain duration was not a significant factor in determining TT. However, orchidectomy was more common in patients with pain duration >24 hours and pain duration within 6-24 hours.

In a large cohort involved 1005 men surgically exploration for suspected TT done by Yi et al., found that the age group with the greatest number of TT surgeries was 12-18 years old (mean age = 17.67±8.51 years) with frequent symptoms were scrotal swelling and pain [14].

In the current study, the scrotal US and Doppler findings are testicular heterogeneity, presence of blood flow to affected testis, enlarged epididymis, heterogeneous epididymis, blood flow to epididymis, thickened scrotal skin, hydrocele, necrosis and hemorrhage. These are agree with Shields et al. that observed 3 signs on the US were significantly associated with a non-viable testis by univariate study, which were testicular heterogeneity, epididymis heterogeneity, and thickened scrotal wall [12]. Similarly, Burud et al. reported echogenicity on US showed that heteroechogenicity was more in TT [12]. Doppler US showed reduced perfusion of the affected testis to be more in the TT. The testis size on US had a significant difference in TT and non-TT group.

Here, also the Whirl pool sign was found, Resistive index elevated and peripheral testicular re-vasculation seen. McDowall and co-authors reported that the whirlpool sign is a definitive sign for SCT in pediatric and adult cases. In their meta-analysis, the whirlpool sign had a pooled sensitivity and specificity of 0.73 and 0.99, respectively [15].

The surgical exploration based on clinical examination is around 50%. Many authors suggested that clinical examination alone would decline the negative exploration rate by 55%. Whereas, it is reduced by 60% when combining clinical assessment with US findings [13, 16].

Previously published series enrolled 1140 cases found the risk of undergoing orchiectomy to be 5% (0-6 hrs), 20% (7-12 hrs), 40% (13-18 hrs), 60% (19-24 hrs), and 90% (>24 hrs) and >48 hrs after symptom onset, respectively [17]. Recently, the study found that younger age at presentation and longer duration from symptom onset to surgery were significant risk factors for orchiectomy, but that ethnicity, referral pattern, health insurance and timing of seasonal or daily timing of presentation were not significant risk factors. The sensitivity of color Doppler examination with US equipment in diagnosing SCT is 90-100% with the specificity of technically adequate studies being essentially 100% [18-20]. As a results, for accurate diagnosis of TT, the good medical and surgical history, appropriate clinical examination and professional US investigation of scrotum are required. US is a common radiological modality in cases with acute pain of scrotum. The affected testis appear as a heterogeneous echogenicity [13]. Color Doppler technique of TT demonstrate a decline of blood flow within the affected side [13].

Different pathological observations may be seen on the US with TT involve the testes, cord and epididymis. The changes of morphology include an altered course and whirlpool ap-

pearance of the spermatic cord, raised testicular size, development of ipsilateral hydrocele, testicular echotexture variations, enlarge epididymus and a thickened scrotal skin [21]. An enlargement of testis and heterogeneous echotexture, decline perfusion, scrotal skin thicken and long duration of onset of pain in relation to the hospital admission (more six hours) are lead to testicular non-viability [13]. The vascular congestion and edematous changes caused testicular swelling which is larger in the volume than other side [22].

In early stages of TT, the affected testis noted with normal echogenicity on the US, then often subsequently become enlarged and heterogeneous due to excessive hemorrhage and necrosis [12, 13].

Burud and co-authors noted US findings of heteroechogenicity are more in TT and Doppler showed reduced perfusion of the affected testis [13]. They concluded that heteroechogenicity is at higher risk of having TT as compared to hypoechogenicity. This is agree with the findings of this study. They said early detection and timely intervention are important in salvaging the testis and time losing in the investigations can lead to treatment delay.

In the present study, Levene's test analyzed that only testicular heterogeneity ($p=0.003$) showed significant differences in relation to surgery types. These findings different from studies of Shields et al. and Burud et al. [12, 13]. This could explained by different sample size and long cohort duration of these studies with this study.

Shields et al. concluded that the clinical features of TT is challenging due to the overlapping observations of TT and other pathologies [12]. The Doppler US provide excellent anatomical details. Accurately, the ability to assess acute scrotum and masses, US is a beneficial radiological modality to distinguish between surgical emergencies and conditions that can be managed medically. As testicular and epididymal heterogeneity and thickened scrotal skin are given the strong association between time-dependent factors and testicular non-viability, prompt scrotal ultrasonography followed by expedited surgical exploration offers the highest likelihood of restoring testicular perfusion and preserving testicular function [12, 21, 22].

In this study, the findings of surgery are include Bell-clapper deformity, high investment of tunica vaginalis, twisted spermatic cord, ischemic testis, edema, hemorrhage and necrosis. The most common findings seen was edema in 73.7% of cases. The reduce in perfusion reported in two cases underwent orchiectomy and 12 patients (27.3%) underwent orchiopexy ($p<0.0001$). Hypoechogenicity was documented in 3 patients (42.9%) underwent orchiectomy while in it reported 10 patients (22.7%) underwent orchiopexy ($p=0.001$). One patient showed heteroechogenicity by doppler post orchiectomy while 6(13.6%) patients showed that in orchiopexy ($p=0.05$). One patient showed multiple US signs after orchiectomy and 16 patients (36.4%) after orchiopexy difference ($p=0.0001$). Testicular size post orchiopexy decreased in 36 (81.8%) of patients and in seven patients (100%) post orchiectomy. Later on, the 2022 EAU Pediatric Urology Guidelines reported that early surgical exploration (13 hours) with de-torsion was found to preserving the fertility [13, 14]. With the extended of time from symptom onset to treatment, the rate of orchidectomy exhibited a noticeably upward trend [14]. The orchidectomy rate was 5.9% in patients who underwent surgery within 6 hours after onset of symptoms, while it increased to 82.1% in cases who underwent surgery at 24 hours post onset of symptoms [14].

Surgically speaking, as a time-sensitive detection, early distinguish and definitive treatment of TT are critical [23]. The findings of the multivariate logistic regression analysis demonstrated that the misdiagnosis, non-urologist first-consultant surgeon, absent blood flow in DUS, non-manual de-torsion, fever and degree of cord twisting >180 were risk factors for orchidectomy. Nausea and vomiting, and right-sided TT were protective factors for orchidectomy [14].

Manivel and Mirmiran concluded that training emergency physicians in scrotal US and manual de-torsion of a twisted testicle can drop the time to detection and reperfusion [24]. They suggested that fever is a risk factor for TT, indicating advanced disease and more severe testicular ischemic-necrosis status, lead to a higher removal rate.

Yi et al. concluded that misdiagnosis higher rate of TT was found among non-senior title doctors and non-tertiary hospitals, beside, non-urologist first-consultant doctor, absent blood flow in Doppler, non-manual de-torsion, fever, cord twist degree more than 180°, and the initial diagnosis in tertiary hospitals were risk factors for orchidectomy [14].

In early 2025, Mao et al. developed a nomogram to predict risk factors for orchiectomy after TT in pediatrics. They studied retrospectively, 468 cases with TT [25]. A good agreement showed by calibration curves between predicted and observed values, and data indicated that the constructed nomogram had a high benefits clinically. It is effectively predict the risk of orchiectomy post TT in pediatrics,

provide clinicians with a valuable decision-making tools.

Recently, two studies by Zhang et al. and Chen et al. established a nomograms for predicted the probability of testicular salvage post TT in pediatrics and they obtained the corresponding probability of testicular salvage according to the clinical characters of different cases with TT, provided a reference for clinicians and parents, in addition, it is strongly concordance between predict and actual outcomes suggested the model's utilities in clinical decision-makings and it demonstrate robusting calibration and differentiation abilities [26, 27].

Conclusions.

Testicular heterogeneity, presence of blood flow to affected testis, enlarged epididymis, heterogeneous epididymis, blood flow to epididymis, and thickened scrotal wall are main features of scrotal US in TT. Whirl pool sign, Resistive index elevated and peripheral testicular re-vasculation are main feature of colour Doppler in TT. The mean testicular right volumes are greater than left volumes. Laterality and age of patients negatively impact the decision of surgery types. Testicular heterogeneity, blood flow to affected side, enlarged epididymis, and thickened scrotal skin positively impact the decision of surgery types. The perfusion reduction rate in orchiectomy is lower than in patients underwent orchiopexy. Testicular size post orchiopexy decreased more in comparison to post orchiectomy. Ultrasound when combined with clinical presentations, lead reduce the rate of negative surgical exploration.

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