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ORIGINAL ARTICLE

Male Health

Torsion of the spermatic cord in adults: a multicenter experience in adults with surgical exploration for acute scrotal pain with suspected testicular torsion

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Acute scrotal pain (ASP) requiring surgical exploration is common in the pediatric population, but little has been reported on this subject with regard to the adult population. The aim of this study was to investigate the demographic and clinical characteristics and outcomes of scrotal explorations performed on adult patients. Patients over 21 years of age who underwent surgical exploration for ASP with suspected testicular torsion (TT) at 14 French hospitals between January 2005 and December 2019 were included in this study. The main outcome measures were demographic characteristics, pathology found during scrotal exploration, and perioperative outcomes. Logistic regression was used to perform univariate and multivariate analyses to identify predictors of TT. Data for 1329 men were analyzed. The median age was 30 (interquartile range [IQR]: 25–35; range: 21–89) years. Regarding the clinical examination, 867 (65.2%) patients presented with an elevation of the testicle, 613 (46.1%) patients with scrotal edema or erythema, and 211 (15.9%) patients with nausea or vomiting. Operative findings identified TT in only 684 (51.5%) patients, epididymo-orchitis in 112 (8.4%) patients, a tumor in 16 (1.2%) patients, and no causes in 475 (35.7%) patients. Orchiectomy for nonviable testes was required in 101 (7.6%) patients. In multivariate analysis, an elevation of the testicle, erythema/swelling, and the presence of nausea/vomiting were found to be associated with the occurrence of TT. Testicular torsion is not exclusive to children and adolescents, so must be considered in males of any age with acute scrotal findings. However, one-third of scrotal explorations in adults did not lead to a diagnosis.

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INTRODUCTION

Acute scrotal pain is a frequent reason for consultation. Although the incidence of acute scrotal pain is higher in children and adolescents, it is a frequent symptom in adults visiting the emergency department.¹ The spectrum of diagnoses integrates various etiologies.² Among those, testicular torsion (TT) requires the most urgent diagnosis and surgical management to prevent testicular necrosis and its potential fertility problems.³ In published pediatric data, the incidence of torsion

has been reported to be 4.5 per 100 000 males aged 1 year to 25 years annually in the USA.⁴

The most common management of acute scrotal pain is based on clinical examination with a low threshold for surgical exploration due to the risk of testicular damage. Additional investigations may include a Doppler ultrasound scan to demonstrate decreased perfusion of the testis.⁵ In children and young males, a range of clinical symptoms and signs, such as nausea or vomiting, a high position of the testicle,

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abnormal ipsilateral cremasteric reflex, and scrotal skin changes, have been identified to be associated with an increased likelihood of TT.^{6,7} Although widely studied in pediatric populations, little has been reported in the adult population, with only a few historical series^{8–10} and anecdotal case reports.^{11,12} Indeed, the management of the suspicion of TT in adults is mainly based on pediatric and adolescent population recommendations and reports. Despite its relative frequency in clinical practice, large cohort studies on adults are lacking.

Therefore, our aim was to investigate the demographic and clinical characteristics and outcomes of adult patients presenting with acute scrotal pain with suspected testicular torsion who underwent scrotal explorations.

PATIENTS AND METHODS

Patients

Patients over 21 years of age who underwent a surgical exploration for acute scrotal pain with suspected TT at 14 French hospitals (Toulouse University Hospital, Toulouse; Rennes University Hospital, Rennes; Poitiers University Hospital, Poitiers; Marseille North Hospital, Marseille; Bordeaux University Hospital, Bordeaux; Tours University Hospital, Tours; Dijon University Hospital, Dijon; Reims University Hospital, Reims; Nancy University Hospital, Nancy; Cochin Hospital, AP-HP, Paris; Grenoble University Hospital, Grenoble; Strasbourg University Hospital, Strasbourg; Pointre à Pitre University Hospital, Guadeloupe; and Lyon University Hospital, Lyon) between January 2005 and December 2019 were included in this study. The study was conducted following the principles of the Declaration of Helsinki and was falling within the scope of the French Reference Methodology MR-004 (No. 2211250V0) of “Commission Nationale de l’Informatique et des Libertés”, which require neither information nor consent of the included individuals.

All patients were initially assessed by an emergency department physician and referred to the urological department. According to each center’s emergency protocol, scrotal Doppler ultrasound (DUS) could have been requested. The final diagnosis of the cause of acute scrotal pain was always made intraoperatively.

Data collection

Encrypted data were collected in an electronic database and then held at the Torsion Study Association Française des Urologues en Formation (TORSAFUF) office in a central database. Patients older than 21 years admitted to an emergency department for suspicion of spermatic cord torsion and undergoing a surgical scrotal exploration were included in this analysis. Patients under 21 years of age, patients with no surgical exploration, or patients who underwent a scrotal exploration for another acute cause (such as trauma or abscess) were not included ($n = 1711$). The data collected included patient demographics, history, physical findings, radiographic results if any, operative findings, and outcome. Demographics included age, body mass index, a history of trauma, a history of genitourinary infection, a history of urological disease, and previous episodes of scrotal pain. Disease characteristics included time to consultation, time from the onset of symptoms to seeking medical attention, pain intensity, side, aspects of the physical examination, associated symptoms, urinalysis results, and the neutrophil-to-lymphocyte ratio.

Perioperative outcomes

The following variables were collected: time to surgery, operative findings, overall complication rate, major complication rate, readmission rate, and the length of stay. Postoperative complications were graded using the Clavien-Dindo classification.¹³ Major

complications were defined as those with a Clavien score of 3 or higher. Outcomes were recorded within 30 days after the procedure.

Statistical analyses

Descriptive statistics were reported as median and interquartile range (IQR) for continuous variables and frequency and percentage for categorical variables. Logistic regression was used to perform univariate and multivariate analyses to identify predictors of TT in this particular population. Multivariate models included covariates with $P < 0.2$ in univariate analysis. Finally, we performed an analysis to investigate the performance of DUS for the diagnosis of TT in adults. Statistical analyses were performed using Stata 14.1 statistical software (Stata, College Station, TX, USA). All tests were two-sided with a significance level at $P < 0.05$.

RESULTS

Overall, 1329 men required surgical exploration for acute scrotal pain with suspected testicular torsion. The number of patients per center is reported in **Supplementary Table 1**. The median age was 30 (IQR: 25–35; range: 21–89) years. The median BMI was 23 (IQR: 22–26) kg m^{-2} . A previous episode of testicular pain was reported by 263 men (19.8%), and 41 (3.1%) reported a past medical history of genitourinary infection. **Table 1** summarizes the characteristics of the study cohort.

The median time from the onset of symptoms to seeking medical attention and to surgical exploration was 5 h (IQR: 3–11 h) and 7 h (IQR: 5–14 h), respectively. Scrotal pain occurred on the left side in

Table 1: Characteristics of the study population

Variable	Value
Patient (<i>n</i>)	1329
Age (year), median (IQR)	30 (25–35)
BMI (kg m^{-2}), median (IQR)	23 (22–26)
History of urological disease, <i>n</i> (%)	
History of varicocele	10 (0.8)
History of cryptorchidism	24 (1.8)
History of hernia surgery	41 (3.1)
History of genitourinary infection	41 (3.1)
History of trauma to testes, <i>n</i> (%)	22 (1.7)
Previous scrotal pain, <i>n</i> (%)	263 (19.8)
Delay to emergency department presentation (h), median (IQR)	5 (3–11)
Delay to surgery (h), median (IQR)	7 (5–14)
Onset of pain, <i>n</i> (%)	
Sudden	1153 (86.8)
Insidious	176 (13.2)
Pain intensity (VAS), median (IQR)	7 (5–9)
Side, <i>n</i> (%)	
Right	760 (57.2)
Left	556 (41.8)
Bilateral	13 (1.0)
High position of testis, <i>n</i> (%)	867 (65.2)
Nausea/vomiting, <i>n</i> (%)	211 (15.9)
Erythema/swelling, <i>n</i> (%)	613 (46.1)
Diagnostic Doppler study, <i>n</i> (%)	461 (34.7)
Ultrasound findings TT, <i>n</i> (%)	305 (66.1)
Pathologic urinalysis, <i>n</i> (%)	56 (4.2)
Neutrophil-lymphocyte ratio, median (IQR)	3.9 (2.1–6.7)
CRP (ng ml^{-1}), median (IQR)	3.9 (1–14.6)

BMI: body mass index; CRP: C-reactive protein; IQR: interquartile range; TT: testicular torsion; VAS: visual analog scale

556 (41.8%) men and on the right side in 760 (57.2%) men. The pain was of sudden onset in 1153 men (86.8%) and gradual in only 176 (13.2%) men. Regarding the clinical examination, 867 (65.2%) patients presented with an elevation of the testicle, 613 (46.1%) with scrotal edema or erythema, and 211 (15.9%) with nausea or vomiting.

A preoperative DUS was performed in 461 patients (34.7%), of which 305 patients were identified with a hypovascular testicle that corroborated the preoperative diagnosis. In this subpopulation, DUS demonstrated a sensitivity of 82.5% (95% confidence interval [CI]: 78.3%–85.3%) and a specificity of 52.2% (95% CI: 48.5%–55.9%), yielding 70% accuracy (**Supplementary Figure 1**).

Operative findings identified TT in only 684 (51.5%) patients, epididymo-orchitis in 112 (8.4%) patients, a tumor in 16 (1.2%) patients, and no cause in 475 (35.8%) patients (**Table 2**). The age distribution of adults presenting with acute scrotal pain in the emergency department according to etiology is reported in

Table 2: Final diagnoses after scrotal exploration

Variable	Patient, n (%)
Torsion of testis	684 (51.5)
No cause identified	475 (35.7)
Epididymo-orchitis	112 (8.4)
Torsion of appendix testis	32 (2.4)
Tumors	16 (1.2)
Other	12 (0.9)
Urolithiasis	5 (0.4)
Inguinal hernia	3 (0.2)
Hydrocele	2 (0.2)
Varicocele	2 (0.2)

Table 3: Perioperative outcomes

Variable	Patient, n (%)
Orchidectomy	101 (7.6)
Overall complications	160 (12.0)
Major complications	14 (1.1)
Orchidectomy for tumor	6 (0.5)
Hematoma requiring reoperation	4 (0.3)
Infection requiring reoperation	4 (0.3)
Readmission	43 (3.2)
Length of stay (day), median (IQR)	1 (1–1)

IQR: interquartile range

Supplementary Figure 2. We observed two distinct peak periods of TT in 20–30 years and in 40–50 years.

Perioperative outcomes are reported in **Table 3**. Orchidectomy for nonviable testes was required in 101 (7.6%) patients. The incidence of overall postoperative complications was 12.0% ($n=160$), including 1.1% ($n=14$) with major complications (orchidectomy for tumor, hematoma, or infection requiring reoperation). The rate of readmission in the 30 days was 3.2%.

Finally, univariate and multivariate logistic regression analyses were carried out to identify independent predictors of TT among this adult population (**Table 4**). In both univariate and multivariate analyses, an elevation of the testicle (odds ratio: 1.81; 95% CI: 1.42–2.33; $P < 0.001$), erythema/swelling (odds ratio: 1.89; 95% CI: 1.49–2.39; $P < 0.001$), and the presence of nausea/vomiting (odds ratio: 2.29; 95% CI: 1.59–3.29; $P < 0.001$) were all significant predictors of TT.

DISCUSSION

Our study raises a major concern regarding the TT incidence among adult patients presenting to the emergency department with acute scrotal pain. We found a TT rate of 51.5% among adult patients undergoing surgical exploration due to acute scrotal pain, which is similar to the rate described in pediatric studies.¹⁴ Despite the preconceptions about TT, our results should alert clinicians to the relatively high frequency of this diagnosis in patients in whom there is diagnostic doubt and surgical management is required. Whereas the absence of a diagnosis after exploration is uncommon in children and adolescents,¹⁵ we report a high proportion of scrotal explorations that did not lead to any diagnosis. This overtreatment rate remains important, as there is still a relatively high postoperative morbidity of nearly 12.0%, and surgery may even lead to chronic pain or discomfort.¹⁶ These overtreatment rates remain a challenge and might be reduced in future by the improvement of diagnostic tools using artificial intelligence or new imaging modalities.

DUS could be a helpful tool for improving the sensitivity of the diagnosis. DUS is the imaging method of choice to explore the scrotum because of its high resolution, Doppler capabilities, availability, and lack of ionizing radiation.¹⁷ Nevertheless, the use of DUS in the case of acute scrotal pain is controversial, especially if TT might be the cause. Some clinicians advocate the routine use of DUS to improve the diagnostic process,¹⁸ while others fear that it will delay management and thus worsen testicular prognosis.¹⁹ In a series of 88 patients, Burud *et al.*²⁰ showed that the use of ultrasound combined with clinical findings allowed a 10% reduction in the rate of negative exploration. Even if TT cannot always be confirmed, ultrasound can be useful to avoid testicular cancer before surgical exploration.

Table 4: Univariate and multivariate analyses for variables associated with testicular torsion in adult population

Variable	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P	OR (95% CI)	P
Age (year)	0.99 (0.97–1.01)	0.06	0.98 (0.96–1.02)	0.09
BMI (kg m ⁻²)	0.98 (0.94–1.03)	0.52		
Previous scrotal pain	0.81 (0.62–1.05)	0.11	0.98 (0.73–1.32)	0.91
Rapid onset	1.28 (0.93–1.76)	0.12	0.78 (0.65–1.11)	0.17
Time to consultation	1.01 (0.99–1.02)	0.61		
High position of testis	2.26 (1.79–2.85)	<0.001	1.81 (1.42–2.33)	<0.001
Nausea/vomiting	3.55 (2.54–4.97)	<0.001	2.29 (1.59–3.29)	<0.001
Erythema/swelling	1.85 (1.47–2.33)	<0.001	1.89 (1.49–2.39)	<0.001
Pathologic urinalysis	1.03 (0.46–2.33)	0.93		
Neutrophil-lymphocyte ratio	0.98 (0.92–1.04)	0.63		
CRP	0.99 (0.99–1.01)	0.77		

CI: confidence interval; BMI: body mass index; CRP: C-reactive protein; OR: odds ratio



Indeed, in our study, 16 (1.2%) patients had a final diagnosis of testicular cancer. None of these patients underwent ultrasound examination before surgical exploration; ten tumors were discovered during surgical exploration, and the others were discovered during postoperative visits. The literature concerning TT and testicular cancer is controversial, relatively poor, and mainly based on case reports. Chilvers *et al.*²¹ showed that torsion did not have any role in the etiology of tumors; however, embryonal carcinoma, a type of testicular cancer, can mimic torsion.²² In a retrospective study including 32 patients who had a diagnosis of TT, Uguz *et al.*²³ showed the association of testicular torsion with testicular cancer to be up to 6.4%. Therefore, DUS for adults might be useful in the case of any doubt regarding tumors. This would prevent the risk of performing a direct scrotal-opening approach to limit the risk of local recurrence in cases of testicular tumors.²⁴

Finally, we tried to identify clinical and biological factors that could help to improve TT diagnosis in adults before surgery. Only clinical symptoms and physical examination criteria (erythema/swelling, a high position of the testicle, and nausea/vomiting) were found to be related to TT in adults. Our findings are in keeping with previous reports, notably on one recent clinical score developed from a pediatrician population and validated in an adult population.²⁵ These results emphasize the fundamental role of clinical examination and interrogation, which remain the cornerstones of TT diagnosis.

Our study has several limitations that should be acknowledged. The major shortcomings were those inherent to the retrospective design. The duration of symptom onset was based on an estimated time from the patient's memory instead of an accurately measured time period. As our study only included patients who underwent emergency scrotal exploration, we cannot exclude the possibility that some patients were not correctly diagnosed before surgery and therefore did not undergo surgical exploration, thus contributing to an underestimation of the TT rate. Forty percent of patients were missing data on the cremasteric reflex; consequently, this feature was not included in the analysis. Then, a significant limitation of the current study was that in almost one-third of the cases, the cause of testicular pain could not be determined. Finally, follow-up data on whether the attempted testicular salvage procedure was effective in preserving fertility or hormonal function are unknown. In other words, nonviable testes that were left in place were deemed saved. Hence, it is possible that the study testicular salvage rates were inflated.

CONCLUSIONS

In this multicenter study, testicular torsion was as frequent in adults as in pediatric populations. TT must be considered in males of any age with acute scrotal findings. However, one-third of scrotal explorations for suspected testicular torsion in adults did not lead to a diagnosis, leaving room for improvements in imaging diagnostic tools. Although rarely found, the diagnosis of a testicular tumor should be suspected in cases with atypical presentation in the adult population.

AUTHOR CONTRIBUTIONS

VTD, ZEK, BP, FL, and the TORSAFUF Global Study Group participated in the protocol and project development. VTD, CM, MC, VG, MF, I Duquesne, MV, KK, I Dominique, MS, ESDM, TG, LF, BGT, AMDV, NAB, WB, GM, CG, FB, MH, AM, UP, CP, WW, and XM performed data collection or management. VTD, ZEK, BP, and FL contributed to data analysis. VTD and all authors of the TORSAFUF Global Study Group help with manuscript writing and editing. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declare no competing interests.

Supplementary Information is linked to the online version of the paper on the *Asian Journal of Andrology* website.

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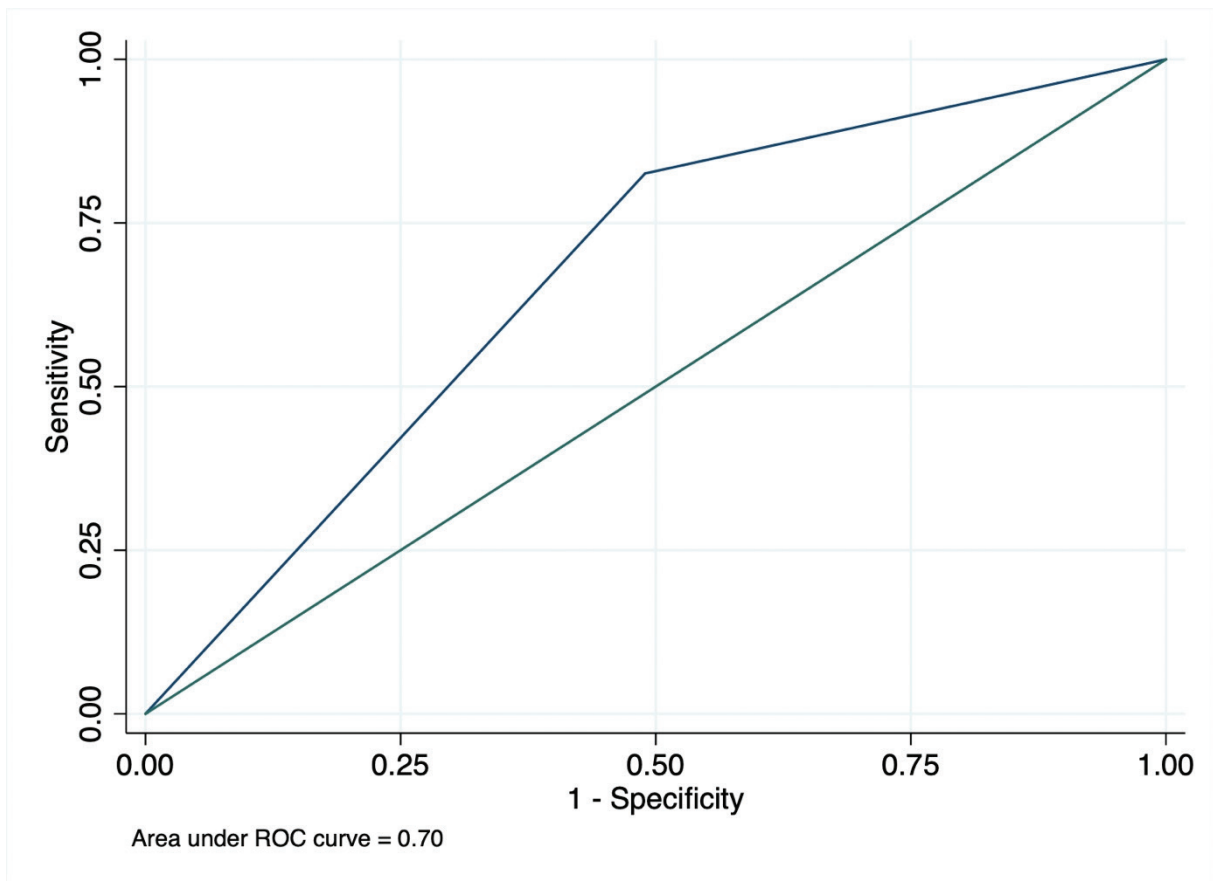
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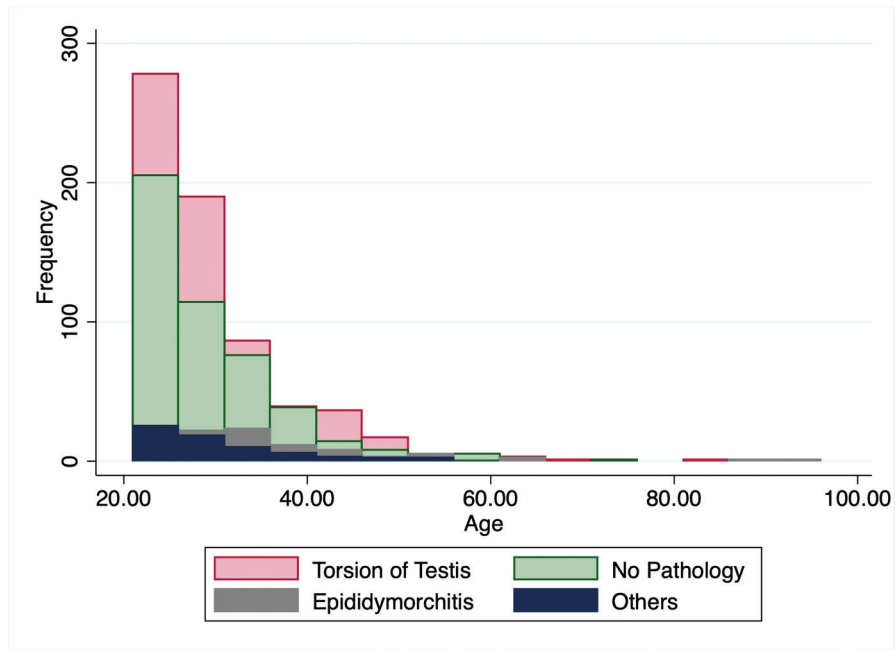


Supplementary Table 1: Number of patients per center

<i>Number center</i>	<i>Number of patients</i>
1	76
2	29
3	84
4	10
5	31
6	93
7	58
8	201
9	322
10	63
11	56
12	44
13	221
14	41



Supplementary Figure 1: ROC curves for diagnosis of TT after a DUS. DUS had a sensitivity of 82.5% and a specificity of 52.2% for TT diagnosis and the area under the ROC curve was 0.70. ROC: receiver operating characteristic; TT: testicular torsion; DUS: Doppler ultrasound.



Supplementary Figure 2: Age distribution of adults with surgical exploration for nontraumatic acute scrotal pain. Testicular torsion peaks in two periods: 20–30 years and 40–50 years.