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Management of testicular torsion <360° in children: a single-center, retrospective study

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Abstract

Objective: This study aimed to summarize clinical manifestations, and physical examination, laboratory examination, and ultrasound results of children with testicular torsion <360°.

Methods: We performed a retrospective study of children who were diagnosed with testicular torsion <360° between October 2007 and October 2017.

Results: There were 11 (19.2%) patients with testicular torsion of 90°, 33 (58.0%) with 180°, and 13 (22.8%) with 270°. The median age of onset was 5.7 years (range, 1–14 years) and the median duration of symptoms was 4.2 days (range, 0.5–5 days). Ultrasound showed low blood flow in 46 (80.8%) patients. The testis was retained in 41 (72.0%) patients and resected in 16 (28.0%). The testes appeared necrotic at 2 to 3 days after onset for patients with 270° torsion, appeared necrotic at 3 to 4 days after onset for those with 180° torsion, and were not necrotic at 4 to 5 days after onset for those with 90° torsion. The duration of symptoms in children decreased as the torsion angle increased.

Conclusion: Children with testicular torsion <360° are relatively young, while the duration of symptoms is relatively long. A high postoperative testicular survival rate is one of the clinical features in this study.

Keywords

Testicular torsion, atrophy, necrosis, Doppler ultrasound, children, cremasteric reflex

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Introduction

Testicular torsion is a common emergency in urology, with an incidence of approximately 1.1 to 4.5 per 100,000 person-years in men aged 18 to 25 years.[1–4] This type of torsion is caused by anatomical abnormality or increased mobility of the testis and spermatic cord, which leads to obstruction of venous return and compromised arterial flow and ischemia.[5,6] Testicular torsion often occurs in adolescents[7] and can lead to testicular necrosis.[5,7]

Time is important for treating testicular torsion.[5,7,8] Testicular ischemic necrosis due to testicular torsion is related to the duration and angle of torsion.[5,7,9,10] Anderson et al.[11] showed that testicular necrosis occurred in 4% of patients with a duration of testicular torsion <12 hours, while testicular resection was required in 75% of cases with a duration of testicular torsion >12 hours. Necrosis occurs within 12 to 24 hours in patients with testicular torsion of 360°, while it occurs within 2 hours in patients with testicular torsion of 720°.[9,10] Cuckow et al.[12] showed that testicular torsion >360° for >24 hours eventually led to testicular resection.

The risks of testicular necrosis according to testicular torsion of 360°, 540°, and 720° and according to the duration of torsion have been reported.[13] However, the effect of testicular torsion <360° (e.g., 90°, 180°, and 270°) on prognosis has not been well studied. Therefore, this study aimed to summarize the clinical manifestations, and physical examination, laboratory examination, and ultrasound results of children with testicular torsion <360°. Our results should improve the understanding of prognosis of testicular torsion, thereby providing predictive prognosis of patients with testicular torsion <360°.

Materials and methods

Study design

We performed a retrospective study of children who were diagnosed with testicular torsion <360° at Wuhan Children's Hospital, Tongji Medical College, Huazhong University of Science & Technology between October 2007 and October 2017. This hospital provides secondary and tertiary pediatric care, and is also a major pediatric referral center in Central China, with >2 million outpatients and >30,000 inpatients every year. This study was approved by the ethics committee of Wuhan Children's Hospital, Tongji Medical College, Huazhong University of Science & Technology. The requirement for individual consent was waived by the committee.

The inclusion criteria were as follows: 1) diagnosis of testicular torsion made by urologists according to a physical examination and color Doppler ultrasound (CDUS); and 2) an operation confirmed that testicular torsion was <360°. The exclusion criteria were 1) testicular torsion ≥360° and 2) torsion of the testicular appendage.

Data collection

Data on age, manifestations, duration of symptoms before treatment, history of fever, nausea, vomiting and trauma, and activities (e.g., playing football, basketball, swimming, running) at injury were collected. The results of a physical examination included testicular tenderness, scrotal erythema or edema, presence or absence of cremasteric reflexes, and location of the testes in the scrotum. Laboratory and CDUS examination results included blood samples for white blood cell counts, as well as CDUS. Follow-up results included testicular blood supply and testicular volume.

Management

All children underwent routine emergency surgery in the supine position and under general anesthesia by associate professors with many years of experience. An incision was made in the scrotal septum to explore the testes, and then the testes were repositioned and wrapped with hot saline gauze for 15 minutes to promote recovery of the blood circulation. Changes in testicular color were observed. Retainment of the twisted testes was determined according to the three-level scoring system proposed by Arda et al.[8] as follows. The testes were cut open until the medulla to observe exudation of arterial blood on the surface. Grade I refers to immediate oozing, grade II refers to oozing within 10 minutes, and grade III refers to no oozing within 10 minutes. Patients with Arda grade III underwent testicular resection. Patients with grade II or grade I underwent reduction and fixation of the testes, where the affected testis was fixed in the scrotum by absorbable sutures at the left and right sides of the twisted testis neck. The contralateral testis had routine testicular fixation.

Statistical analysis

SPSS 17.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Non-normally distributed continuous data are described as median (range), while normally distributed continuous data are described as mean ± standard deviation.

Results

Baseline characteristics

Fifty-seven patients were included in the study. The median age was 5.7 years (1–14 years), with a peak incidence of testicular torsion in the age groups of 2 to 4 years and 12 to 14 years (Table 1; Figure 1a).

Scrotal redness and swelling was the first symptom in 49 (85.9%) children and testicular pain was the first symptom in 20 (40.3%). The median duration of symptoms was 4.2 days, which ranged from 0.5 to 5 days, with a peak duration of 3 to 5 days. Most patients developed testicular tenderness, 26.3% of patients had an abnormal testicular position, and 61.4% had a positive cremasteric reflex. In the testicular CDUS examination, most patients showed a low testicular blood supply (Figure 1b). Eleven (19.2%) patients had normal testicular blood flow, but had a transverse position of the testis (Figure 1c).

Management

Intraoperative exploration showed that the testis was twisted by 90° in 11 (19.2%) patients, with a typical case shown in Figure 2a. The testis was twisted by 180° in 33 (58.0%) patients, with a typical case shown in Figure 2b. The testis was twisted by 270° in 13 (22.8%) patients (Figure 2c). Figure 2d–f shows blood supply to the testis after 90°, 180°, and 270° reduction.

Four days after reduction, no testicular necrosis was found in any of the patients who underwent 90° and 180° reduction, but obvious testicular necrosis was found in patients who underwent 270° reduction. Arda grades are shown in Table 1. According to the Arda score criteria, the testis was retained in 41 (72.0%) children, while a necrotic testis was resected in 16 (28.0%) (Table 1).

Association between the torsion angle and clinical characteristics

The mean duration of symptoms was 4.7 ± 0.2, 3.5 ± 0.3, and 2.3 ± 0.1 days in children

Table 1. Clinical manifestations, laboratory examination results, ultrasound evaluation, and intraoperative evaluation of the testes of children with testicular torsion $<360°$.

History of trauma or activities	39 (68.4%)
Duration of symptoms (days)	
0.5–1	2 (3.5%)
1–2	5 (8.7%)
2–3	6 (10.5%)
3–4	15 (26.3%)
4–5	29 (51.0%)
Testicular pain	20 (40.3%)
Scrotal redness and swelling	31(85.9%)
Abdominal pain	6 (10.5%)
Testicular tenderness	52 (91.2%)
Testicular swelling	16 (28.0%)
Fever	4 (6.7%)
Vomiting	8 (14.0%)
Left	44 (77.2%)
Right	13 (22.8%)
Positive cremasteric reflex	35 (61.4%)
Abnormal testicular position	15 (26.3%)
WBC count $>10^9$/L	26 (45.6%)
CDUS	
Scrotal wall edema	9 (15.8%)
Testicular swelling	19 (33.3%)
Testicular echo abnormality	7 (12.2%)
Epididymal swelling	14 (24.6%)
Hydrocele testis	8 (14.0%)
Testicular blood flow	
Normal	11 (19.2%)
Deficient	0
Reduced	46 (80.8%)
Increased	0
Direction of testicular torsion	
Counterclockwise	49 (85.9%)
Clockwise	8 (14.1%)
Testicular torsion angle	
90°	11 (19.2%)
180°	33 (58.0%)
270°	13 (22.8%)
Type of testicular torsion	
Intrathecal	52 (91.2%)
Extrathecal	5 (8.8%)
Color of the testis	
Normal	46 (80.7%)
Ischemic	11 (19.3%)
Arda score	
Grade I	34 (59.7%)
Grade II	9 (12.3%)
Grade III	16 (28.0%)
Testicular resection	16 (28.0%)

WBC: white blood cell; CDUS: color Doppler ultrasound; left: testicular torsion on the left; right: testicular torsion on the right.

with 90°, 180°, and 270° torsion, respectively (Figure 3). Necrosis was found at 2 to 3 days after torsion in children with testicular torsion of 270°, and the possibility of preserving the testicle was 0%. For children with testicular torsion of 180°, necrosis was found at 3 to 4 days after the torsion, and the rate of preserving the testicle was 75%, which was reduced to 50% at 4 to 5 days after torsion. For children with testicular torsion of 90°, no necrosis was found at 4 to 5 days after the torsion, and the possibility of preserving the testicle was 100%.

Follow-up

Among the 16 children with testicular torsion of 180° and a duration of symptoms of 4 days, the testis survived in 12 (75.0%), while the testis had to be resected in four (25.0%). Follow-up data from 55 children were available and two children were lost to follow-up (both children had testicular torsion of 270° and the testis were resected due to necrosis). The children were followed every 3 months after the operation for 1 year (from the day of the operation to the last follow-up). No torsion of the contralateral testicle was found. Testicular atrophy was found in two children ($2/41 = 4.8\%$), both with testicular torsion of 180°.

Discussion

Testicular torsion leads to interruption of blood supply to the testes, which is the most common cause of testicular resection,[8]

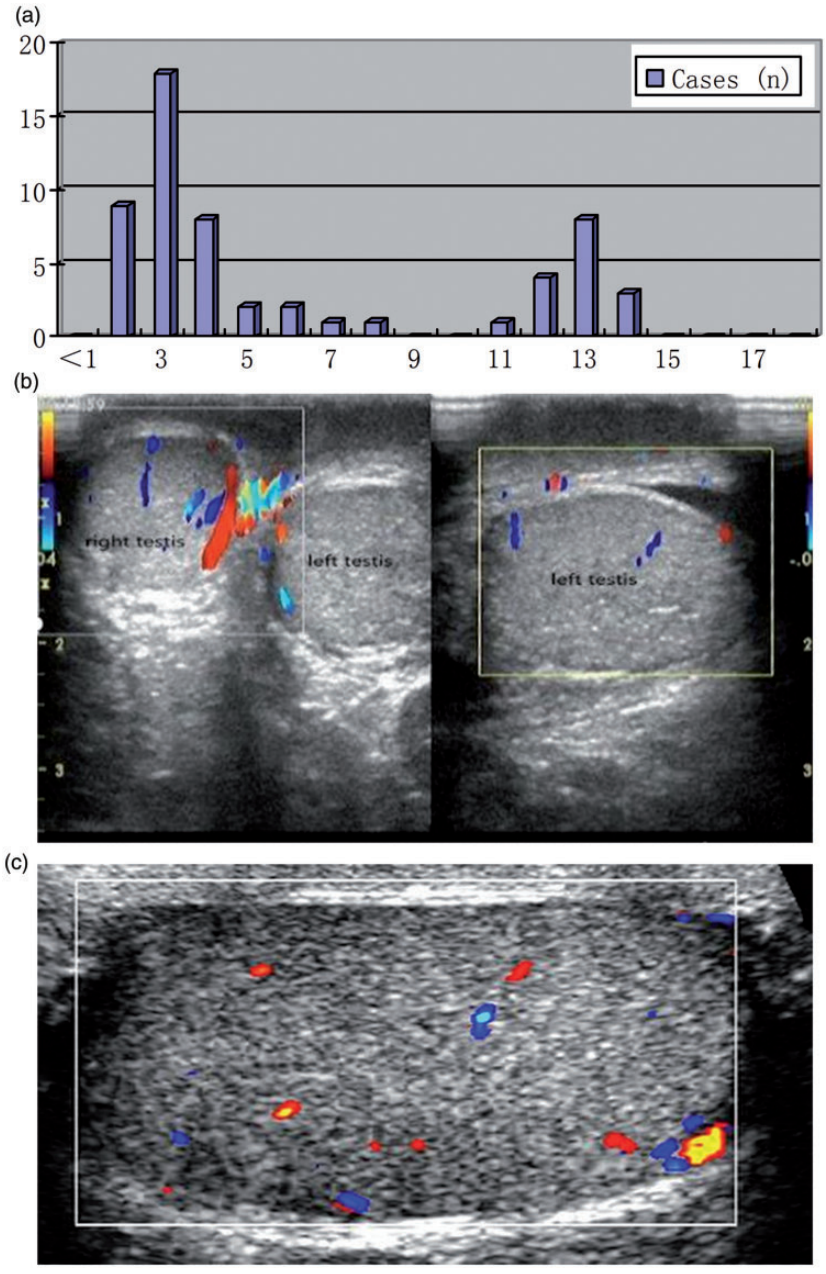

Figure 1. (a) Age distribution of children with testicular torsion <360°. (b) A blood flow signal is visible in the affected testis, but is reduced compared with the healthy side. (c) The blood flow signal in the testis is normal, but the testis is in a transverse position.

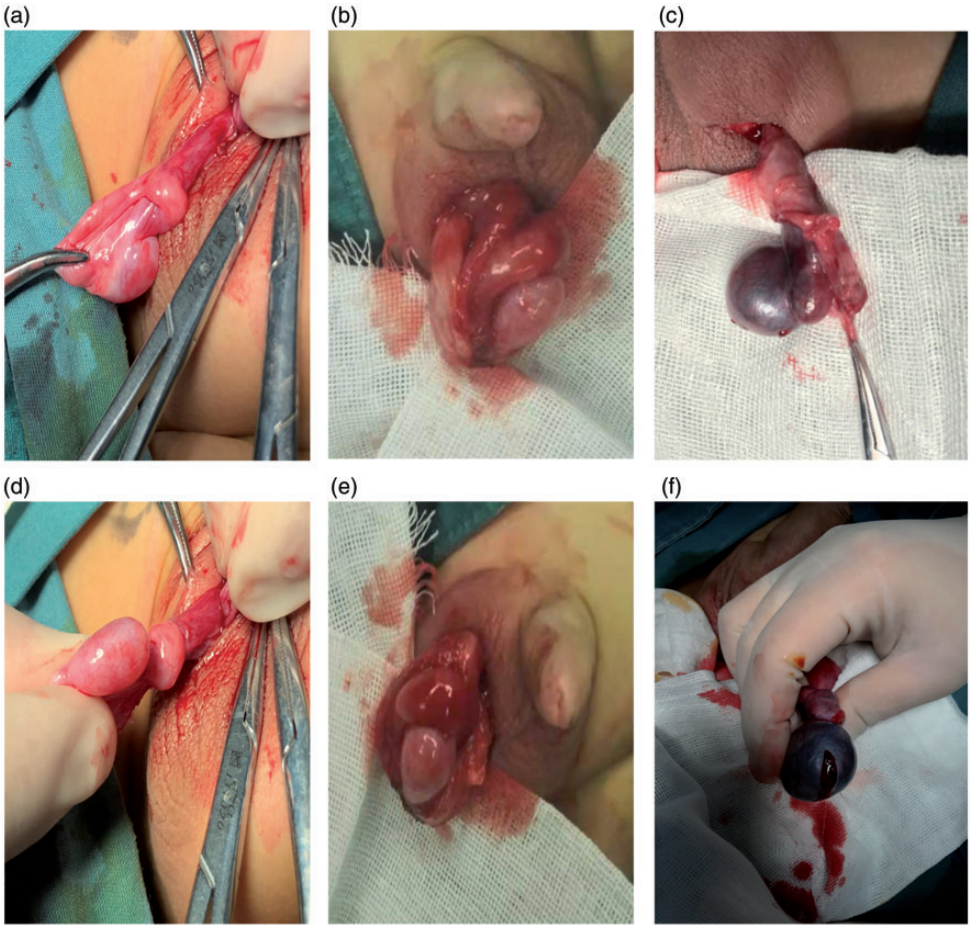

Figure 2. (a) Torsion of 90° for 4 days. (b) Torsion of 180° for 4 days. (c) Torsion of 270° for 4 days. (d) Reduction of 90° torsion. (e) Reduction of 180° torsion. (f) Reduction of 270° torsion.

and more than 80% of patients with testicular torsion have symptoms of testicular pain.[14] At a physical examination, Prehn's sign is usually positive when the testis is uplifted, and the cremasteric reflex disappears.[5–7] Nonetheless, in the present study, 49 (85.9%) patients had the first symptoms of scrotal redness and swelling, and 20 (40.3%) had the first symptoms of testicular pain, which is inconsistent with the literature.[5–7] Rabinowitz et al.[15] concluded that the cremasteric reflex was the most useful clinical sign for excluding testicular torsion. Nevertheless, in the present study, 35 (61.4%) patients with testicular torsion had the cremasteric reflex, which is also inconsistent with the results reported in the literature.[15,16] Therefore, testicular torsion should not be ruled out in children with the cremasteric reflex, and physicians should be alert to the possibility of testicular torsion <360°.

Gatti and Murphy[17] reported the relationship between testicular torsion and duration. They found that 90% to 100% of testes were retained if treatment was

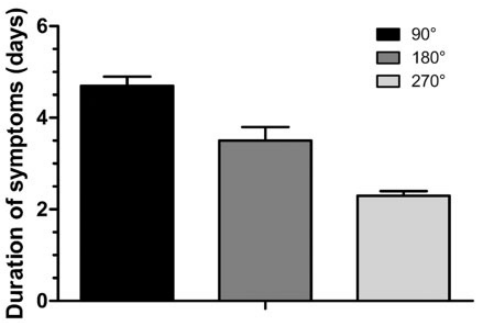

Figure 3. Association between the torsion angle and duration of symptoms.

implemented within 6 hours of testicular pain and 20% to 50% of testes were retained if treatment was implemented within 6 to 12 hours of testicular pain. Furthermore, the retention rate was reduced to 20% if treatment was implemented at >12 hours of testicular pain, and the retention rate was 0% if treatment was implemented at >24 hours after testicular pain. Sheldon[18] believed that survival of the testes could be up to 95% if the testes were treated at <4 hours after the onset of symptoms, and could be reduced to 90%, 80%, 40%, and 10% if the testes were treated at <8, <12, <24, and >24 hours after the onset of symptoms, respectively. Another study showed that the median duration of symptoms was 12 hours in testes that could be preserved and 90 hours in testes that had to be removed.[16] Therefore, scholars generally believe that the maximum time limit for the retention of testis is 6 hours. Prando[19] reported that, in some cases of testicular torsion, the testis might survive even after a few days of onset. In the present study, the median duration of testicular torsion symptoms was 4.2 days. Additionally, the testis was resected in 13 (22.8%) patients and retained in 44 (77.2%).

Notably, most previous literature has reported testicular torsion >360°. In fact, we found that the testes were not necrotic in patients with testicular torsion of 90° and 180° at 4 days of symptoms, but were significantly necrotic in patients with testicular torsion of 270°. This finding suggests that testicular damage is also related to the angle of torsion. Rattansingh et al.[20] proposed that the degree of testicular torsion was related to the angle of torsion and duration of torsion, with testicular necrosis occurring at 3 to 4 days for testicular torsion of 180°, at 12 to 24 hours for testicular torsion of 360°, and at 2 hours for testicular torsion of 720°. In the present study, the testes became necrotic at 2 to 3 days of testicular torsion in cases of 270° and at 3 to 4 days in cases of 180°, but necrosis was not found at 4 to 5 days for cases of 90°. Therefore, we provide some prognostic indication for patients with testicular torsion of 90°, 180°, and 270° according to their duration of symptoms. We found that, among the 16 children with testicular torsion of 180° and symptoms lasting for 3 to 4 days, the testis survived in 12 (75.0%) patients and was necrotic in four (25.0%). This finding indicates that testicular prognosis can be different for patients with the same angle of torsion and duration of torsion.

CDUS is convenient and efficient for diagnosing testicular torsion. The sensitivity and specificity of CDUS have been reported to be up to 96.8% and 97.9%, respectively.[21] Typical images of testicular torsion manifest as testicular enlargement, uneven texture, and loss of blood flow signals. For patients with incomplete testicular torsion, blood flow signals in CDUS are reduced or even normal, which may be due to obstruction of reflow due to low venous pressure. Furthermore, the testes are congested and swollen, resulting in insignificant attenuation of color Doppler flow imaging of arterial blood flow signals. When the vein is completely blocked, testicular pressure is significantly increased, arterial perfusion is reduced, and arterial blood

flow signals are weakened.[22] In the present study, preoperative scrotal CDUS showed low blood flow signals in the testes in 46 (80.8%) patients, which is consistent with the characteristics of incomplete testicular torsion reported in the literature.[23–25] Therefore, a reduction in blood flow signal in CDUS has important diagnostic value for testicular torsion of <360°. We also found that there were 11 (19.2%) patients who had normal blood flow signals of the testes, but the testes were in a transverse position, which suggests testicular torsion. These patients were confirmed as having testicular torsion during surgery. Therefore, testicular torsion cannot be excluded in patients with normal blood flow signals in CDUS and we should take into account the possibility of a special type of testicular torsion <360°. Shear wave elastography is useful for evaluating testicular torsion[26] and should be examined further in future studies.

This study has some limitations. First, this was a retrospective study. Any retrospective study design may lead to sampling errors or selection bias. Second, the follow-up duration was short. Further follow-up is required to determine the testicular atrophy rate after reduction and whether spermatogenic function is affected. Third, the sample size of the present study was small because only cases in our center were included. Therefore, further studies with a large sample size are required. Fourth, most of the cases in this study were children aged before school years. Children are characterized by an unclear medical history and not co-operating in physical examinations, which are prone to errors.

In conclusion, children with testicular torsion <360° have a long duration of symptoms, but have a high postoperative survival rate of the testes. The testes start to show necrosis at 2 to 3 days after onset of symptoms in patients with testicular torsion of 270°, but show necrosis at 3 to 4 days after onset of symptoms in patients with testicular torsion of 180°. A reduction in blood flow signal in preoperative CDUS is of significant diagnostic value for testicular torsion.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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