Clinical Predictors of Testicular Torsion in Children

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OBJECTIVE To distinguish the prognostic factors that decrease the probability of a negative exploration for "acute scrotum." In some institutes, patients with "acute scrotum" undergo immediate exploration after clinical evaluation. Because testicular torsion (TT) accounts only for a fraction of these cases, most infants can be treated conservatively.

METHODS We performed a retrospective study of all patients treated at our institute from January 2008 to December 2009 for the diagnosis of "acute scrotum." Differences between groups were calculated using the chi-square test or analysis of variance and Mann-Whitney-Wilcoxon test for univariate or multivariate analysis, expressed as odds ratios (ORs) and 95% confidence intervals (CIs).

RESULTS The data from 138 patients were analyzed. The mean age was 9 years, 8 months. Of the 138 patients, 19 (13.8%) had TT. This group was compared with the boys without TT at exploration. The patients with TT were older on average (11 years, 1 month vs 9 years, 1 month, $p = .035$). Pain for <24 hours (OR 4.2, 95% CI 1.3-13.4), nausea and/or vomiting (OR 21.6, 95% CI 4.9-93.4), abnormal cremasteric reflex (OR 4.8 95% CI 0.7-35.2), and a high position of the testis (OR 18.0 95% CI 1.8-177.1) were associated with an increased likelihood of torsion. In the group of boys with ≥2 of these findings present, 100% had TT at exploration, with 0% false-positive results.

CONCLUSION TT is uncommon among the group of boys treated for "acute scrotum." In particular, a pain duration <24 hours, nausea or vomiting, a high position of the testis, and an abnormal cremasteric reflex had a positive prognostic value for TT. A clinical score might help to avoid unnecessary explorations. In the future, we intend to test the diagnostic set described combined with ultrasonography. UROLOGY 79: 670–674, 2012. © 2012 Elsevier Inc.

Torsion, or rotation of the testis with twisting of the spermatic cord, is a surgical emergency. Late presentation or failure to diagnose and correctly manage this condition leads to loss of the testis on the affected side. The triggering reason for scrotal swelling, reddening, and pain without previous trauma is not always obvious. However, testicular torsion (TT), torsion of the appendages of the testis, and epididymo-orchitis (EO) will account for >90% of cases. Other diagnoses that can rarely mimic torsion include idiopathic scrotal edema, hydrocele, scrotal hernia, testicular tumor, thrombosed varicocele, and Schoenlein-Henoch purpura.

TT was first described by Hunter in 1776.[1] It can occur at any age but is most common in the adolescent age group, with a smaller peak in the neonatal age group.[2] This distribution results from the different types of torsion. TT in newborns results almost exclusively from extravaginal testicular torsion. Neonates present with swelling, discoloration of the scrotum on the affected side, and a firm painless mass in the scrotum. The testis is typically infarcted and necrotic at birth.[3] Pubertal boys develop intravaginal torsion that occurs within the tunica vaginalis. The predisposing factors include a long and narrow mesentery or a bell-clapper deformity.

TT is defined as a rotation of the longitudinal axis of the spermatic cord, resulting in strangulation of testicular blood flow. The extent of testicular ischemia depends on the degree of torsion, varying from 180° to 720°. The testicular salvage rate hinges on the degree of torsion and the duration of ischemia. Almost all testes are savaged within the first 6 hours after the onset of symptoms. With later treatment, the salvage rates rapidly decrease.[4,5]

Typically, TT presents with a sudden onset of severe pain followed by inguinal and/or scrotal swelling. Many patients also have gastrointestinal symptoms with nausea and vomiting. Often, a high riding testis with a transverse orientation is found. The absence of the cremasteric reflex in a patient with acute scrotal pain supports the diagnosis of TT.[6]

Torsion of the appendix testis and appendix epididymis occurs usually in 7-14 year-old boys. Patients present

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with acute scrotal pain but often have only a few physical symptoms. The typical finding is a small firm and tender nodule that is palpable on the anterosuperior aspect of the testis, the so-called blue dot sign.[7] Moreover, many patients will complain of pain on movement and will feature a wide-based gait.

Infective inflammation of the epididymis or testis, or both (EO), causes scrotal pain and swelling. It is usually associated with a gradual onset of pain, fever, and urinary tract symptoms, worsening within a period of days rather than hours. At physical examination, the epididymis can often be palpated as an enlarged tender structure separate from the testis.[8] Usually, the cremasteric reflex is present.

Until recently, at our department, the clinical diagnosis of an "acute scrotum" was followed by immediate scrotal exploration. However, considering that <20% of infants with an acute scrotum have TT, it seems obvious that most infants could be managed conservatively.[2,9] Therefore, the accurate selection for surgery should be directed to avoid unnecessary exploration. The aim of the present study was to analyze the reliability of the clinical features in the diagnostic workup of the acutely painful scrotum at our department.

MATERIAL AND METHODS

Study Design

A retrospective analysis of all patients treated for "acute scrotum" at the emergency department of the University Medical Center Hamburg-Eppendorf and Children's Hospital Altona from January 2008 to December 2009 was performed.

Patients with acute scrotum were selected from the hospital database. The data were collected using patient charts, operating theater records, office notes, and International Classification of Disease, 9th edition, and Current Procedural Terminology codes. The data gathered for the medical history included the duration of symptoms, associated symptoms, history of trauma, previous episodes of pain, medications, sexual activity (depending on age), and other medical problems.[9]

All participants had been examined physically by a pediatric surgery resident and attending physician. The aspects of the physical examination that were included were the side of the involved testis, presence of erythema, swelling, tenderness over the testis and epididymis, position of the testis, the presence of the blue dot sign, urethral discharge, and the presence of a normal cremasteric reflex. An absent or reduced cremasteric reflex was considered an abnormal findings.

Urinalysis was performed in the emergency department using a urine dipstick (Combur, Roche Diagnostics, GmbH, Mannheim, Germany). For analysis purposes, the test was considered abnormal if leukocytes, erythrocytes, or protein were at least double positive.

Owing to the local policy, Doppler ultrasonography was not yet a part of the diagnostic workup of the acute scrotum.

According to our guidelines, all patients presenting with scrotal symptoms and a clinical suspicion for testicular torsion underwent surgical exploration. Postoperatively, the patients received pain medication and, depending on the eventual diagnosis, antibiotic therapy.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences, version 16.0 (SPSS, Chicago, IL). The data are presented as the mean ± standard deviation. The differences between groups were calculated using the chi-square test or analysis of variance and Mann-Whitney-Wilcoxon test for univariate or multivariate analysis, respectively, to analyze the positive and negative predictive value of the various factors, and are expressed as odds ratios (ORs) and 95% confidence intervals (CIs).

RESULTS

The data from 138 patients were analyzed. The reported symptoms and clinical findings of the study population are summarized in Table 1.

Of the boys who presented with an acute scrotum, 19 patients (13.8%) had TT, 92 (66.7%) had torsion of the appendix (AT), and 27 (19.6%) had EO. All diagnoses were determined from the results of the surgical exploration.

The median age of the study population was 10 years (range 0-15). The patients with TT were older on average than the patients with AT or EO (11 years, 1 month vs 9 years, 1 month, $P < .05$). TT was rarely seen in prepubertal boys. In the prepubertal period, AT was the most frequently occurring diagnosis, with a peak at 6 to 12 years of age. EO was the most frequent in patients aged 9 to 14 years (Fig. 1).

TT had an inclination for the left side (63%) and AT for the right side (64%). EO had no preference (52% on the left side). The patients with TT and non-TT did not differ significantly ($P = .06$) regarding location. The pain duration at first was significantly lower in the patients with TT (17.2 ± 19.1 hours, $P < .05$) than in those affected by AT (39.0 ± 55.4 hours) or EO (39.2 ± 41.9 hours); 52.6% of the patients with TT presented within the first 12 hours.

Most patients with TT developed swelling (89.5%) and erythema (78.9%) of the hemiscrotum. Many patients complained of nausea and vomiting (47.4%) and right-sided abdominal pain (31.6%). On physical examination, a high riding testis was found in 47.4% of the patients. Of the patients with TT presenting <12 hours after symptom onset, 75% had a retracted testis. This sign was found in 1 other boy with AT. A pathologic cremasteric reflex was present in 21.1% of the patients with TT. A painful epididymis was very rarely present (15.7%). The urinalysis findings were always uneventful in the patients with TT.

The patients with AT also developed swelling (62.0%) and erythema (52.7%). Also, 4.4% of the boys with AT complained of abdominal pain. Only 3.3% reported nausea or vomiting; 13.2% reported painful epididymis. In 28.6%, the blue dot sign was found, and in 7.7%, the urinalysis findings were pathologic.

In the patients with EO, clinical signs were less dominant. Of the patients with EO, 66.7% presented with swelling and erythema. They did not report nausea and vomiting or abdominal pain. However, a painful epidid-

Table 1. Presenting symptoms and clinical findings (n = 138)

Characteristic	Value
Mean age (y)	9.4
Pain duration <24 h	71 (51.4)
Nausea/vomiting	12 (8.7)
Abdominal pain	11 (8.0)
Erythema	82 (59.4)
Swelling	93 (67.4)
High position of testis	10 (7.2)
Pathologic cremasteric reflex	6 (4.3)
Painful epididymis	31 (22.5)
Blue dot sign	29 (21.0)
Fever >38.5°C	6 (4.3)
Pathologic urinalysis	17 (12.3)

Data presented as number of patients, with percentages in parentheses, unless otherwise noted.

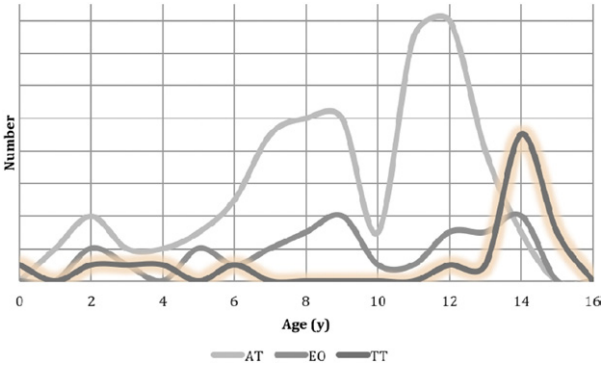

Figure 1. Age distribution of children presenting with acute scrotum at emergency department. TT is rare and peaks in pubertal period. AT and EO occur earlier than TT ($P < .05$).

ymis was found in 55.5% of these patients. Changes in the urinalysis findings were noted in 37.0%.

In 44.2% of all patients, intravenous antibiotics were administered postoperatively. The patients with EO (92.6%) more often received antibiotic treatment than those with AT and TT ($P < .05$).

Testicular salvage was high (94.7%). Only in 1 boy was detorsion unsuccessful. These patients had a rather long clinical history of about 48 hours.

Using univariate analysis, several factors were associated with an increased likelihood of TT, in particular, a short onset of pain (<24 hours, OR, 4.2, 95% CI 1.3-13.4), nausea and/or vomiting (OR 21.6, 95% CI 4.9-93.4), abnormal cremasteric reflex (OR 4.8, 95% CI 0.7-35.2), and a high position of the testis (OR 18.0, 95% CI 1.8-177.1) were linked with TT (Table 2). The 77 boys with ≥1 of these variables included all those with TT. In the 11 boys with ≥2 of these findings present, 100% had TT at exploration, with 0% false-positive results.

Additionally, factors were identified that made TT unlikely (Table 2), including a slow onset of symptoms (pain >24 hours, OD 0.94, 95% CI 0.95-0.98), the absence of swelling (OD 0.91, 95% CI 0.59-0.99), and erythema (pain >24 hours, OD 0.87, 95% CI 0.47-0.99). In patients with the combination of a long pain duration (>24 hours) and the absence of swelling, in retrospect, TT could have been excluded.

COMMENT

Analyzing the data from the present study and taking previous publications into account, we have identified 4 variables highly associated with TT and 3 variables highly associated with the absence of TT. Although no single clinical finding had 100% sensitivity for the presence of TT, all the patients with TT had ≥1 of the 4 identified risk factors (ie, nausea or vomiting, pain duration of <24 hours, a high position of the testis, and an abnormal cremasteric reflex). In contrast, none of the children with the absence of these 4 clinical variables had TT, for a high negative predictive value of the included factors. Moreover, in the present study, the combination of a short pain history (<24 hours) and absence of swelling appeared to exclude TT.

As in previous studies, a pain duration of <24 hours was associated with an increased likelihood of TT.[6,10,11] The shorter pain duration in patients with TT was probably resulting from the ischemic nature of the pain.[9] Consequently, a positive predictive value of 0.21% was found.[12] Beni-Israel et al[9] found an almost equal association between a short onset (<24 hours) and the occurrence of TT (OR 6.7) than in the present study (OR 4.2).

Nausea and vomiting, which is caused by reflex stimulation of the celiac ganglion, was significantly greater statistically in the TT group (47%), as mentioned in previous data, with rates varying from 26% to 69%.[6,10,11] The positive predictive value of this finding varies from 74%[10] to 96%.[11] It is highly significant, as shown by the present study (OR 21.6), and reproduces the findings from Beni-Israel et al[9] (OR 8.9). The presence of nausea and vomiting should be a high indication to the surgeon of the presence of TT.

The spiral cremasteric muscle fibers are wrapped around the spermatic cord and will move the testes upward and out of the scrotum. Thus, if twists occur within the spermatic cord, the cremasteric reflex will be absent. In previous reports, 51%-100% of patients with TT lacked a cremasteric reflex.[2,6,8,12] A pathologic cremasteric reflex had a positive predictive value of 43%[12] to 83%[10] and was highly specific for TT (OR 27.8).[9] In the present study, only 21% of patients with TT had an abnormal cremasteric reflex. We found a strong, yet not significant, correlation between this sign and TT (OR 4.8, 95% CI 0.7-35.2).

The testicular position can suggest torsion, because the torsed cord shortens, pulling the testis higher in the scrotum. However, this finding was only observed in 50% of patients with TT in the present study and a previous study.[9] It is possible that the sign was missed in some cases owing to massive swelling, in particular, if the patients present >12 hours after initial onset of symptoms. The overall positive predictive value has been reported to vary from 36%[12] to 80%.[10] The

Table 2. Variables with positive and negative association with testicular torsion

Feature	PPV	NPV
Pain duration <24 h	4.2 (1.3-13.5)	0.94 (0.95-0.98)
Nausea/vomiting	21.6 (4.9-93.4)	0.78 (0.79-0.94)
Abdominal pain	2.4 (0.5-11.9)	0.67 (0.38-0.88)
Erythema	2.2 (0.3-18.9)	0.91 (0.59-0.99)
Swelling	1.6 (0.2-13.6)	0.87 (0.47-0.99)
High position of testis	18.0 (1.8-177.1)	0.67 (0.41-0.86)
Pathologic cremasteric reflex	4.8 (0.7-35.2)	0.71 (0.44-0.90)
Fever >38.5°C	0.9 (0.1-8.0)	0.81 (0.71-0.89)

PPV, positive predictive value; NPV, negative predictive value.
Data presented as odds ratios, with 95% confidence intervals in parentheses.

association is vastly significant, as shown in the present study (OR 18.0) and a previous study[9] (OR 58.8).

TT, EO, and AT are the 3 most common causes of the acute scrotum.[2,9,13] In the present study, 14% of boys presenting with acute scrotum had TT. The results are comparable with those from other European series in which the diagnosis was determined by surgical exploration.[12,13] However, the incidence of TT varies largely in the published data. Proportions >25%[2,14] and <5%[9] have been reported.

The other reasons for an "acute scrotum" vary considerately. In the present study, AT occurred in 67% and EO accounted for 20% of the cases. The results were quite similar to those from previous reports.[12,13] A study from Israel found a very high number of cases of EO (32%) and only few cases of AT (8%).[9] This large difference might reflect selection bias but might also have been influenced by the strategy of determining the diagnosis using ultrasonography. It is well-recognized that imaging studies can give a falsely high incidence of EO, because AT can also be incorrectly diagnosed as EO.[12]

The distribution of disorders in our series was similar to those of published studies, with TT peaking in newborns and 14-year-old boys. AT and EO were most common in boys aged 10-14 years.[2,12-15] The more frequent involvement of the left side has also been reported in previous studies.[12,15] Not surprisingly, all patients with TT complained about a painful scrotum. In most series, it varied from 88% to 100%.[12,14] It is important to recognize that the absence of pain does not preclude the possibility of TT in a swollen scrotum, especially in small children. As previously published, in about one third of patients, associated abdominal pain is present.[3] In some cases, it is the predominant symptom at the start of the complaints.

Another important aspect is that the differential diagnosis among TT, TA, and EO using the physical examination is easier in the first 12 hours after symptom onset. In early torsion, the high riding, tender, swollen testis lies transversally and is larger than the opposite testis. In contrast, patients with early EO and TA have testes of approximately equal size and in a normal location. After 24 hours, significant erythema and thickening of the hemiscrotum will result in the loss of the anatomic landmarks of the testis.

For our future prospective study, we intend to use this clinical score to predict the final diagnosis, without changing our treatment paradigm. There are good arguments to add ultrasonography to this clinical evaluation.[16,17] Only if we have been able to show that our prediction does not miss any TT will we be able to reduce the necessity for a routine surgical exploration.

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