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Predictors of testicular viability in testicular torsion

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Abstract *Aim:* Testicular torsion (TT) requires prompt diagnosis and treatment to avoid testicular loss. Most studies have focused on the ideal work up to rule TT out in cases of acute scrotum. We attempted here to define objective criteria to select between orchidopexy and orchidectomy in patients undergoing surgery for TT.
Patients and methods: Fifteen boys with a median age at presentation of 7.8 (range 6.4—12) years undergoing surgical treatment for TT underwent color-Doppler ultrasound (CDU) preoperatively, and a bleeding test intraoperatively. Duration of preoperative history, degree of torsion, CDU findings and degree of bleeding were analyzed.
Results: Salvageability was independent of the degree of torsion. In patients with a history longer than 10 h, no flow on CDU and no bleeding, after orchidectomy all the testicles were necrotic on pathology. When all these variables were negative, all the testicles did well during follow up. In the group of patients with no agreement among the analyzed variables, the outcome was unpredictable. Five out of six underwent orchidopexy, but in two cases the testicle atrophied (in spite of flow on CDU in one).
Conclusions: No predictive parameters were found for testicular salvageability. Taken as a whole, the parameters studied can be of help in treatment choice. In patients with no agreement among the parameters, orchidopexy seems the appropriate option, but parents should be informed of the risk of testicular atrophy during follow up.

Introduction

Testicular torsion (TT) accounts for only about 25% of all cases of acute scrotum in children [1], but requires prompt diagnosis and treatment in order to avoid ischemic necrosis of the testis. Misdiagnosis or delayed diagnosis of TT with subsequent testicular loss is a relatively common subject of litigation [2].

Given such a need for prompt differential diagnosis with respect to other non-surgical conditions, it is not surprising that most studies have so far focused on the ideal diagnostic work up to rule out TT in the face of an acute scrotum [3]. Once the diagnosis has been established, the clinician can be faced with another dilemma, i.e. whether or not to remove the testicle. This decision is usually taken during surgical exploration, and the problem resides in the

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fact that no objective criteria exist to assess testicular viability.

In the present study, we analyzed some major indicators of TT to determine whether they could also serve as objective criteria to discern, intraoperatively or even preoperatively, between need for orchidectomy and testicular salvageability in patients with TT.

Materials and methods

Fifteen boys with a median age at presentation of 7.8 (range 6.4—12) years undergoing surgical treatment for TT at our institution from January 2002 to December 2005 were studied prospectively. Cases of neonatal torsion were excluded. All underwent ultrasound scan with color-Doppler ultrasound (CDU) preoperatively. This never delayed surgery by more than 30 min.

In no case was manual detorsion attempted before surgery. Surgical exploration was carried out through a scrotal incision. After detorsion all patients underwent a bleeding test, as follows. The tunica albuginea was incised and the onset of active arterial bleeding (bright blood) from the cut edge within 10 min evaluated. The following grading was used: grade I, bleeding observed immediately after incision; grade II, bleeding absent immediately after incision, but starting within 10 min; grade III, bleeding absent after 10 min.

Orchidectomy was carried out based on the apparent viability of the testicle after detorsion, and orchidopexy was performed in the remaining cases. All removed testes underwent histopathological examination. No biopsies were performed on the testicles of patients undergoing orchidopexy.

These patients underwent a median follow up of 2.6 (0.8—4.1) years. CDU was performed 1, 3, 6 and 12 months after surgery to assess testicular blood flow and volume. The latter was calculated using the formula 0.52 $\times$ length $\times$ width $\times$ thickness of the testicular ellipsoid. Testicular atrophy was defined as a difference >50% between the affected and the contralateral testes.

The following parameters were taken into consideration for the purposes of this study: (1) duration of symptoms before surgery; (2) testicular blood flow on CDU; (3) degree of torsion on intraoperative exploration; and (4) grade of bleeding on the bleeding test. For the statistical analysis, duration of symptoms was categorized as either longer or shorter than 10 h, testicular blood flow on CDU as absent or present, and degree of rotation as smaller or greater than 360 degrees. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of the parameters were computed as appropriate. The four parameters were compared in two groups of patients: those undergoing orchidectomy or developing testicular atrophy during follow up vs those undergoing orchidopexy without atrophy during follow up. To compare the two groups, Mann—Whitney *U*-test was used for non-paired continuous values and Fisher's exact test for categorical variables. A $p < 0.05$ was considered significant.

Results

Of the 15 enrolled boys, nine underwent orchidopexy and six orchidectomy (orchidectomy rate 40%). Patients' characteristics are summarized in Table 1. Pathology showed necrotic infarction in all the removed testes. Of the nine patients who underwent orchiopexy, two developed testicular atrophy during follow up. Of these, blood flow was absent in one and normal in the other on preoperative CDU. Both cases had a history of longer than 10 h and grade II testicular bleeding.

Interval between the onset of symptoms and surgical exploration

A history longer than 10 h was a very specific sign of testicular non-viability, and all the cases with this feature required orchidectomy (Table 1). Sensitivity and NPV were only 62% and 70%, respectively (Table 2). Hence, although all patients with a long history lost their testicles, this happened in some with a short history as well.

Table 1 Characteristics of patients undergoing surgery for testicular torsion

Pt	History >10 h	Flow on CDU	Degree of torsion	Bleeding grade	Surgical treatment	Outcome
1	Yes	No	540°	III	Orchidectomy	Single testis
2	Yes	No	540°	III	Orchidectomy	Single testis
3	Yes	No	360°	III	Orchidectomy	Single testis
4	Yes	No	540°	III	Orchidectomy	Single testis
5	Yes	No	540°	III	Orchidectomy	Single testis
6	No	No	720°	III	Orchidectomy	Single testis
7	No	No	360°	II	Orchidopexy	Atrophy
8	No	No	540°	II	Orchidopexy	Testes OK
9	No	Yes	360°	II	Orchidopexy	Atrophy
10	No	Yes	360°	II	Orchidopexy	Testes OK
11	No	Yes	540°	II	Orchidopexy	Testes OK
12	No	Yes	360°	I	Orchidopexy	Testes OK
13	No	Yes	540°	I	Orchidopexy	Testes OK
14	No	Yes	360°	I	Orchidopexy	Testes OK
15	No	Yes	540°	I	Orchidopexy	Testes OK

Table 2 Comparison of four parameters in predicting testicular viability

	Orchidectomy/ testicular atrophy ($N = 8$)	Orchidopexy ($N = 7$)	p value	Sensitivity	Specificity	PPV	NPV
History >10 h	5	0	<0.05	62%	100%	100%	70%
No flow on CDU	7	1	<0.05	88%	86%	88%	86%
Degree >360°	5	4	NS	—	—	—	—
Grade III (no bleeding)	6	0	<0.05	75%	100%	100%	78%

Testicular flow on CDU

Absence of flow on CDU had a sensitivity and specificity of 88% and 86%, respectively (Table 2). In one patient the testicle could be salvaged in spite of the absence of flow on CDU (false positive), whereas another had a normal blood flow, but testicular atrophy was present 3 months after orchidopexy (false negative). Detection of normal blood flow by preoperative CDU carries a probability of 86% (NPV of absence of flow) that the testicle is not damaged. If testicular blood flow is absent, in 88% of cases the twisted testicle cannot be salvaged.

Degree of torsion

The median degree of torsion was not statistically significantly different between the two groups (540°, $p > 0.05$), nor was there a difference comparing cases with torsion ≤360° to those with torsion >361° (Table 2).

Intraoperative testicular bleeding test

Grade I and III on bleeding test proved fully accurate predictors. All the patients with grade III bleeding required orchidectomy and presented necrotic tissue on pathology. All grade I cases were salvaged and did not develop atrophy during follow up. Of the five cases with grade II bleeding, all underwent orchidopexy but in two the testicle atrophied during follow up. Absence of bleeding had 75% sensitivity and 100% specificity (Table 2).

Overall

We could differentiate three groups of patients. In five (33%), the history was longer than 10 h, CDU did not show any blood flow and the bleeding test was grade III. All of these required orchidectomy and the testicle was necrotic on pathology. At the opposite end of the spectrum, in four cases (27%) history was shorter than 10 h, CDU did show blood flow and the bleeding test was grade I. All of these underwent orchidopexy and none developed testicular atrophy during follow up. In between, six patients (40%) presented no agreement among the three variables. In one, in spite of a history shorter than 10 h, there was no flow on CDU and no bleeding (grade III); hence the testicle was removed and proved necrotic. The five remaining patients underwent orchidopexy and in two the testicle atrophied during follow up.

Discussion

The acute scrotum in children is often a diagnostic puzzle with the need to differentiate, promptly and accurately, cases of TT from those of a number of other non-surgical conditions [1]. Radiological studies, such as CDU and scintigraphy [3,4], have been suggested to be of use in order to spare unnecessary surgery, but no agreement has been reached about the ideal work up of these patients, and some authors still advise surgical exploration in every case [5].

Clinical problems and medico-legal issues are not limited to the preoperative diagnosis of TT. In many cases, during exploration, the clinician faces the dilemma of whether to remove a testicle whose viability seems questionable and, in the absence of objective criteria, can only rely upon their own empirical experience. We decided therefore to evaluate some parameters commonly used in the assessment of patients with an acute scrotum to ascertain if they could be used as predictors of testicular salvageability.

Duration of symptoms before surgery is a well known predictor of outcome in TT [6]. Jefferson et al. reported that in their experience no testicle with a history >12 h could be salvaged [7], and Barada et al. warned that patients younger than 18 years old are at increased risk of delayed presentation [8]. Testicular infarction begins after 2 h of ischemia, becomes irreversible after 6 h and complete infarction is established after 24 h. Although our experience is consistent with such a natural history, we also observed testicular necrosis (or atrophy after orchidopexy) in patients undergoing early surgery (history <10 h). Similarly, Sessions et al. reported that 27% of their patients undergoing orchidopexy within 4 h of onset of symptoms developed testicular atrophy during follow up [6]. On the other hand, we acknowledge that the fact that in none of our cases with a history longer than 10 h could the testicle be salvaged may be due to the limited number of studied cases, a type II error. Others have reported testicles salvaged more than 24 h after onset of symptoms [9].

Three variables could account for the different effects of torsion on testicular outcome, the degree of torsion, the thickness of the cord and the degree of bell-clapper deformity (attachment of the mesorchium on the testicle) [10]. The latter determines whether torsion will occur, the possible degree of twisting and the likelihood of spontaneous detorsion. Cord thickness can explain why, for the same degree of twisting, blood flow is completely impaired in some testicles but preserved in others. The thicker the cord the greater the length over which twisting occurs.

Hence, thicker cords lead to formation of longer helices with a minor degree of blood flow impairment than thinner cords do for the same degree of twisting. Finally, the degree of torsion does not seem a critical factor in clinical practice as most of the torsions are in the range 360°–540°. We did not observe any statistically significant difference in the degree of torsion between patients undergoing orchidopexy and those requiring orchidectomy.

These anatomical observations can also explain the cases with preserved flow on CDU in spite of the presence of torsion [10]. Initial studies interpreted these cases as false positives [11], but this may not be correct. Of note, our cases with torsion and preserved flow had also a short history. Blood flow impairment proceeds in a step-wise fashion: obstruction of venous drainage with vascular engorgement of the testicle occurs first and arterial inflow is impaired only secondarily.

In contrast to these cases with torsion and preserved flow there are those with no flow on CDU but with a viable testicle. Technical reasons can account for these cases. It is essential to set the scanner for detection of slow flowing blood. The gain should be increased, the pulse repetition frequency decreased and a small color sample window used. In spite of these technical aspects, flow detection remains critically dependent on testicular size and can be difficult in pre-pubertal boys with a testicular volume of 1–2 cm^3. Ingram and Hollman noted that no flow is detectable in 38% of normal children younger than 13 years [12]. Use of contrast agents seems promising in this respect, although they would not be practical in the setting of an urgent evaluation [13].

In the current study, we evaluated only the presence/absence of flow as a predictor. Other features, such as the appearance of the testicle on grey-scale ultrasound scan, can drive the decision making [14,15]. Marked testicular enlargement and hypoechogenity are signs of ischemia, and a heterogeneous testicular structure of ongoing necrosis [14,15].

During surgical exploration, we perform a deep incision of the tunica albuginea after detorsion in order to evaluate active testicular bleeding. Only fresh bleeding should be considered. A 10-min wait is mandatory, especially in pubertal patients, who may need a long time to start bleeding due to parenchymal edema and hemorrhagic areas. In keeping with a previous report [16], this test seems to be an effective means to assess objectively testicular viability during surgery. The efficacy has been confirmed by the pathology finding of ischemic necrosis in all the removed testes with a bleeding test grade III. Similarly, all the testicles with grade I bleeding could be salvaged and did well. We could identify a grey area in those patients with a bleeding test grade II. Of five such patients, all had a history shorter than 10 h, blood flow on CDU was present in three, all underwent orchidopexy, but the testicle atrophied in two (one with flow and the other without flow on CDU).

In conclusion, as for the diagnosis of TT, there is no one history, physical, laboratory or radiological finding that might predict testicular salvageability. This can only be determined at surgical exploration and was, in our experience, independent of the degree of torsion. When the history is longer than 10 h, there is no flow on CDU and there is no bleeding from the testicle 10 min after incision of the tunica vaginalis, than orchiectomy is the appropriate option. Orchidopexy is appropriate when all these variables are negative. There is a group of patients in whom there is no agreement among these variables. For these, the indication for either orchidectomy or ochidopexy remains unclear, and parents should be informed of the risk of testicular atrophy after orchidopexy.

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