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ARTICLE

Doppler ultrasound improves diagnostic accuracy for testicular torsion

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ABSTRACT

Background: Doppler ultrasound can diagnose testicular torsion with high sensitivity and specificity but may delay surgical treatment. This study aims to assess whether the use of doppler ultrasound, in cases with intermediate clinical suspicion of testicular torsion, can improve diagnostic accuracy compared to clinical assessment alone.

Methods: We implemented a new clinical algorithm where patients with intermediate suspicion of testicular torsion undergo doppler ultrasound within 60 min. This study compared the patients that presented within one year prior to the implementation (group 1) to the patients who presented within one year after the implementation (group 2). The primary outcome measure was failure to confirm testicular torsion upon surgical exploration (negative surgical exploration). Missed testicular torsion was one of the secondary endpoints.

Results: 590 consecutive patients were included. 322 (55%) in group 1 and 268 (45%) in group 2. There were 9 (2.8%) testicular torsions in group 1 vs 9 (3.4%) in group 2 ($p = 0.69$) and 2 (0.6%) missed testicular torsions in group 1 vs 0 in group 2 ($p = 0.50$). Doppler ultrasound was performed in 65 patients (24.2%) in group 2 vs 0 in group 1 ($p < 0.01$). Negative surgical exploration was performed in 27 (8.4%) patients in group 1 vs 8 (3.0%) in group 2 ($p < 0.01$).

Conclusion: Doppler ultrasound assessment of patients at intermediate clinical risk of testicular torsion significantly reduced the frequency of negative surgical explorations without increased rate of missed testicular torsions.

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Introduction

Testicular torsion (TT) is a twisting of the spermatic cord due to a rotation of the testis around its own axis. TT leads to testicular ischemia, the severity of which is determined by the level of circulatory compromise [1].

The annual incidence of TT is 3.8 per 100 000 patients under 18 years of age [2] and 3.5 per 100 000 patients under 25 years of age [3]. Immediate surgery is the gold standard for treatment of TT and is required in order to avoid testicular damage or testicular loss [1]. It has been shown that 96% of testicles can be salvaged when surgery is performed within 6 h from symptom onset as opposed to only 60% and 7% being viable after 18 and 48 h, respectively [4]. This adds to the importance of a rapid assessment of patients presenting to the emergency room (ER) with scrotal pain and identification of those requiring emergency surgery [1,5].

The actual rate of TT found upon surgical exploration (SE) has varied greatly and has been reported to be in the 9%–30% range [6–9] with a complication rate of 8% [9]. The low rates of true TT found when performing SE and the relatively high rate of complications clearly motivates the need of improved preoperative diagnostics in order to avoid unnecessary surgery while still identifying all cases of TT. Doppler ultrasound (DUS) may diagnose TT with high sensitivity and specificity [10,11]. There are, however, subjects of controverse regarding the use of DUS, the main concern being the risk of delay of treatment and thereby increased risk of testicular loss [12,13]. Therefore, as a mean of selecting cases for either SE, DUS or dismissal, several scoring systems for stratification of risk of TT have been developed. The one most commonly used, Testicular Workup for Ischemia and Suspected Torsion (TWIST score) is based on five clinical parameters (testicular swelling, hard testicle, absent cremasteric reflex, nausea/vomiting and high riding testis) and the authors recommend DUS for the intermediate risk group [12]. The TWIST score has been validated in multiple studies [12–17].

During the fall of 2018 two cases of TT were missed after presenting at our ER. To avoid further cases of missed TT, we implemented a new algorithm for patients presenting with scrotal pain (Figure 1) in 2019). According to this algorithm, cases with high suspicion of TT based on clinical examination with or without the help of a scoring system are planned for immediate SE, whereas cases with an intermediate suspicion of TT are examined by doppler ultrasound (DUS) within 60 min of seeing a physician at the ER.

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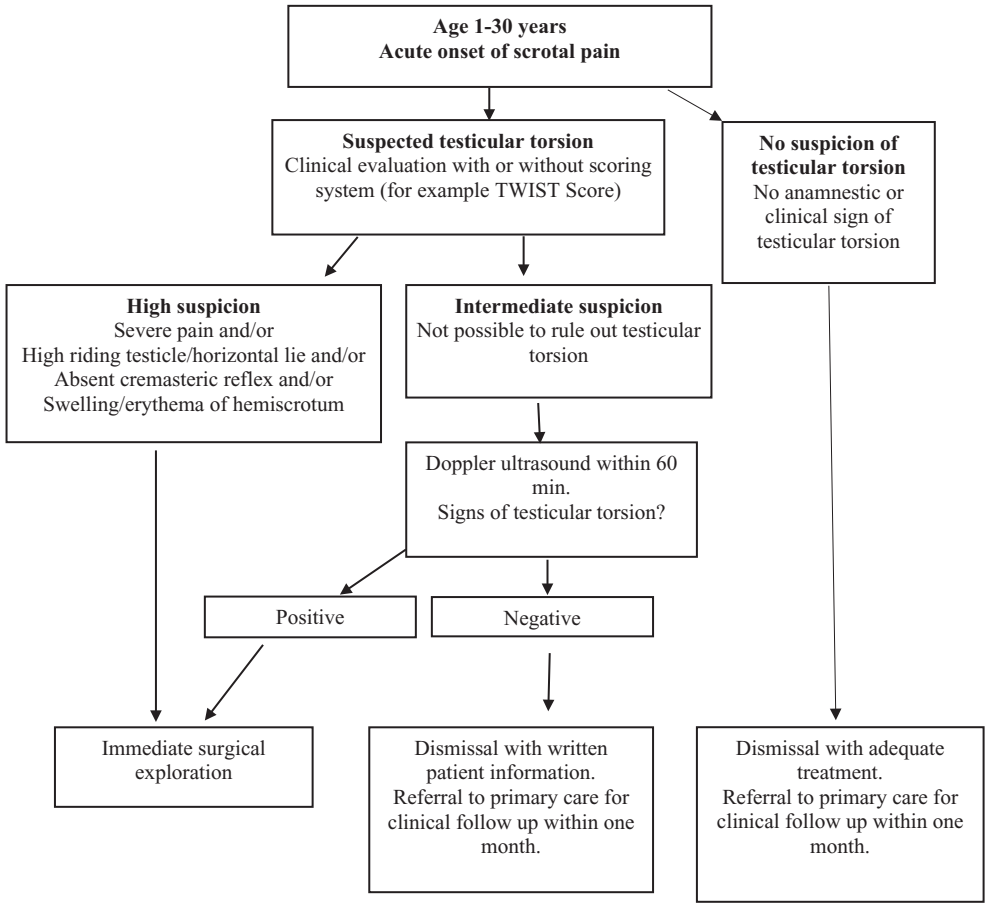

Figure 1. Memorandum – scrotal pain. Inclusion criteria: Scrotal pain $\leq$ 48 h (Longer duration of symptoms does not exclude testicular torsion but shall be assessed outside of this algorithm.) Age 1–30 years (Testicular torsion is rare, but may occur, in age $>$ 30 years. If suspected: patient shall be assessed outside of this algorithm. Patients $<$ 1 year of age with suspected testicular torsion shall be assessed at pediatric surgical center. No surgical procedures are performed on patients $<$ 1 year of age/$<$ 10 kg weight at Helsingborg hospital.)

The aim of this study is to assess whether the use of doppler ultrasound, in cases with intermediate clinical suspicion of testicular torsion, can improve diagnostic accuracy compared to clinical assessment alone.

Material and methods

This is a single-center non-randomized controlled trial comparing two different management procedures for scrotal pain. In this study, we compared those patients that presented with scrotal pain at Helsingborg hospital, Helsingborg, Sweden, during the first year after introducing a new diagnostic algorithm (1st of June 2019 to 31st of May 2020) (Figure 1), with a cohort of patients that presented with scrotal pain one year prior to the introduction of the algorithm (1st of June 2018 to the 31st of May 2019). Data was retrospectively collected from patient charts and surgical reports and the diagnosis of TT was validated by chart and surgical report review of two independent physicians specialized in urology.

This study was approved by the Swedish Ethical Review Authority, ref. 2019-06337.

On the 1st of June 2019, Helsingborg hospital adopted a new memorandum for assessment of patients presenting to the ER with scrotal pain (Figure 1). The algorithm gives that all patients age 1–30, presenting with scrotal pain within 48 h of symptom onset, undergo a primary clinical assessment. Patients safely diagnosed with a diagnosis other that TT are managed as required. In cases where TT is suspected on primary assessment, patients are categorized by the clinician in the ER as having high-risk or intermediate risk for TT. The decision is based on either clinical scoring systems or by clinical examination alone. While patients considered being at high risk for TT are immediately transferred to the operating theatre for SE, the intermediate risk patients are designated for DUS within 60 min after being examined by a physician.

Ultrasound and operative technique

DUS was defined as an exam designed to answer solely the question whether or not TT was present. Six areas of interest were assessed - doppler signal of the testis, rotation of the spermatic cord, redundant spermatic cord [18], testicular swelling, parenchymal anomalies and hydrocele. Ultrasound exam (US) was defined as a broader exam where a full morphological exam of the scrotal contents was conducted and doppler perfusion was not necessarily recorded. US performed within 48 h of presentation were considered as emergency exams. SE was performed under general anesthesia

via scrotal incision. If TT was found or intermittent TT was suspected, a contralateral incision was performed followed by bilateral orchidopexy.

Outcomes and definitions

The primary outcome measure for this study was the failure to confirm TT upon surgical exploration (negative surgical exploration (NSE)). Missed TT was regarded as a secondary endpoint. TT was defined as torsion of the spermatic cord or clear evidence of intermittent TT (testicular ischemia) observed *via* SE. Missed TT was defined as a case where a patient had presented to the ER with scrotal pain and been misdiagnosed as not having TT. Patients delay leading to testicular loss did not count as missed TT. Time from presentation at the ER until arrival at the operating theatre for patients undergoing SE was regarded as another secondary endpoint as well as hospitalization rate.

Statistical analysis

Categorial variables were presented as numbers and percentages. Continuous data were reported as median and interquartile range (IQR) and groups were compared using the Chi-square test, Fisher's exact test, and two sample *t*-tests when appropriate. For all tests, p values < 0.05 were considered statistically significant. All statistical analyses were conducted using IBM ® SPSS® Statistics version 27.0.0.0 for MacOS® (IBM Corp, Armonk, NY, USA).

Results

A total of 616 patients met the inclusion criteria during the study period. Of these, 9 were excluded due to only requiring nurse's assessment and 17 patients were excluded due to having voluntarily abandoned the ER before seeing a doctor. Thus, 590 patients remained in the study of which 322 (55%) patients presented to the ER before the algorithm was put in use (Group 1) and 268 (45%) patients were managed according to the new algorithm (Group 2). Demographics are presented in Table 1. Median age was similar between the two groups (16 (10–24) years vs 16 (10–22) years, in group 1 and 2, respectively ($p = 0.37$)), as was duration of symptoms (4 (2–10) hours in group 1 vs 4 (2–10) hours in group 2 ($p = 0.98$)).

Results are presented in Table 2. DUS was performed in 0/322 (0%) patients in the group 1 as compared to 65/268 patients (24.2%) in group 2 ($p < 0.001$) but there was no significant difference between the groups in time from presentation at the ER to surgical treatment (128 (91–213) min vs 152 (88–262) min in group 1 and group 2, respectively ($p = 0.59$).

Group 1 patients were significantly more likely to undergo SE when compared to group 2 (36/322 (11.2%) vs 17/268 (6.3%), $p = 0.041$). In total 9/322 patients (2.8%) in group 1 and 9/268 patients (3.4%) in group 2 were diagnosed as having TT ($p = 0.69$). The new algorithm resulted in a significant reduction of NSE with 27 negative explorations in group 1 (TT not confirmed in 27/36 SE (75%)) compared to 8 in group 2 (TT not confirmed in 8/17 SE (45%)) ($p < 0.01$). Overall, 2/322 (0.6%) patients in group 1 underwent orchidectomy upon SE because of unsalvageable ischemia compared to 1/268 (0.4%) patient in group 2 ($p = 1.00$). There were 2/322 (0.6%) missed TTs in patients presenting before the introduction of the new algorithm and 0/268 (0%) after the algorithm was introduced ($p = 0.50$). One of the patients with missed TT presented to the ER with unilateral scrotal pain for 48 h, his condition was misdiagnosed as orchi-epididymitis. He returned to the ER 72 h later and was correctly diagnosed as having TT. The other missed TT presented to the ER with unilateral scrotal pain with a duration of approximately 6 h. He had a palpable scrotal mass and was referred to US the next day. The US showed testicular infarction due to TT. The two patients with missed TT in group 1 were the same patients that underwent orchidectomy in group 1 while the patient who underwent orchidectomy in group 2 was a patient who presented to the ER with a symptom-duration of 72 h.

In group 2, 7 out of the 17 patients (41%) who underwent SE also underwent DUS and out of the 7 patients who underwent both DUS and SE, 5 had TT. In all, 39/322 patients (12.1%) in group 1 were admitted to the hospital compared to 22/268 patients (8.2%) in group 2 ($p = 0.12$).

Discussion

In this study, we demonstrated that in patients presenting with scrotal pain an algorithm using DUS assessment was associated with a significant reduction of NSE without increased rate of missed TT.

It has been reported that one out of every 500 Swedish males will be diagnosed with TT before the age of 25 [9]. Despite TT being relatively frequent and well-studied, accurately diagnosing the condition remains a great challenge. The dramatical consequences of delayed or missed diagnosis may render treating physicians more inclined towards definitely ruling out the diagnosis by means of SE. Boman *et al* have previously reported that negative explorations occur at a frequency of 91% (TT found in 9 patients out of 170 those who underwent SE) [9], while others have reported a rate of 26%–30% [6,7].

The use of DUS has been a subject of debate for a long time [19]. Some argue that, in the event of an actual TT, DUS will inevitably prolong the period before a necessary SE can be executed thereby increasing the risk of testicular loss. Thus, performing an immediate SE on wide indications may be regarded as the safest approach to suspected TT. Furthermore, resources for performing DUS in the acute setting of a suspected TT may vary significantly between different hospitals and also between daytime and nighttime [20], thereby making a general recommendation of DUS inappropriate. In contrast, others have argued that performing SE with high rates of negative findings is a waste of valuable health care resources and ethically doubtful as it exposes healthy patients to the risk of unnecessary postoperative

Table 1. Baseline data on patients (age 1–30 years) presenting to the emergency room with scrotal pain.

	All patients ($N = 590$)	Group 1 Before new memorandum ($n = 322$)	Group 2 After new memorandum ($n = 268$)	Missing values
Age (years)	16 (10–23)	16 (10–24)	16 (10–22)	0
Symptom duration (hours)	4 (2–10)	4 (2–10)	4 (2–10)	406 (68.8)

Data are presented as median (IQR) or n (%) when appropriate.

Table 2. Results of the study population presented by group.

	All patients ($N = 590$)	Group 1 Before new memorandum ($n = 322$)	Group 2 After new memorandum ($n = 268$)	p
Testicular torsion	18 (3.1)	9 (2.8)	9 (3.4)	0.69
Missed testicular torsion	2 (0.3)	2 (0.6)	0 (0)	0.50
Surgical exploration	53 (9.0)	36 (11.2)	17 (6.3)	0.04
Negative surgical exploration	35 (5.9)	27 (8.4)	8 (3.0)	<0.01
Doppler ultrasound exam	65 (11.0)	0 (0)	65 (24.2)	<0.01
Ultrasound exam	105 (17.8)	69 (21.4)	36 (13.4)	<0.01
Hospitalization	61 (10.3)	39 (12.1)	22 (8.2)	0.12
Handling time[a] (minutes)	131(93–235)	128 (91–213)	152 (88–262)	0.59
Orchidectomy[b]	3 (0.5)	2 (0.6)	1 (0.4)	1.0

Data are presented as n (%) or median (IQR) when appropriate. Chi-square test, Fisher's exact test, and two sample t-tests have been used when appropriate. For all tests, p values < 0.05 are considered statistically significant.
[a]Time from presentation at the emergency room until arrival at operating theatre for patients undergoing surgery.
[b]Unsalvageable ischemia detected upon surgical exploration leading to orchidectomy.

complications [9] as well as risk of anesthesiologic complications.

On the 1st of June 2019, we launched a new diagnostic algorithm for assessment of scrotal pain at the ER at Helsingborg hospital. The patients that presented to the ER after the introduction of the new algorithm underwent significantly fewer NSE compared to patients presenting to the ER during the year before the launch. There were no DUS performed in group 1 but 65 in group 2, giving that 3.4 DUS were required to save one SE. It seems like our algorithm spares young patients the unnecessary experience of surgery under general anesthesia, hospitalization and risk of postoperative complications.

As it may be feared that DUS would delay SE for TT we recorded the time from presentation at the ER until arrival at the operating theatre for the patients undergoing SE. However, we found no significant delay of SE in the group that underwent DUS prior to surgical exploration but our results show that the median time between clinical assessment and SE was 24 min longer in the group 2. According to Mellick *et al* [4] the difference in testicle salvage rate after 6 vs 12 h of symptom duration is reduces from 96% to 82%. Considering these data, one can argue that a delay of 24 min before surgical treatment is by far exceeded by the reduced rates of NSE. After introducing the new algorithm, hospitalization rates were 8,2% compared 12.1% prior to its introduction, however the difference was not significant ($p = 0.12$). The hospitalizations that were not due to postoperative care for TT were mostly constituted by severe cases of epididymo-orchitis in need of intravenous antibiotics.

Due to the diagnostic difficulties associated with acute scrotal pain, handling these cases at the ER can be quite challenging. The algorithm presented is easy to understand and use and is therefore suitable for doctors of different specialties and with different levels of urological experience.

First, this study was limited by its retrospective design and by being single-center study with a limited number of patients undergoing SE and being diagnosed with TT. Therefore, it may be under-powered to detect for example a difference in delay of SE. Second, the information campaign that was launched at our hospital just before adopting the new memorandum may have had a positive impact on the overall care for the patients presenting to the ER with scrotal pain. Also, our clinical algorithm allows for the use of an established scoring system like TWIST [12] to determine the risk for TT, but it also allows for the physician at the ER to assess the risk of TT without the help of the scoring system. This may lead to inconsistency in the management of scrotal pain, but we regard it as a safety precaution to rather include than exclude patients from the high-risk-group in the algorithm. On the other hand, this study was strengthened by complete review and follow-up of all patients presenting to the ER with scrotal pain during the study period, complete adherence to the algorithm after its introduction and the completeness of our data. In addition, all surgical reports were reviewed by two independent urologists ensuring the validity of our data.

Conclusion

This study showed that doppler ultrasound assessment of patients at intermediate clinical risk of testicular torsion significantly reduced the frequency of negative surgical explorations without increased rate of missed testicular torsion. We therefore believe that we can safely recommend the use of doppler ultrasound in patients with intermediate risk of testicular torsion.

Disclosure statement

The authors report no conflicts of interest

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