Door To Detorsion Time Determines Testicular Survival

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OBJECTIVE To determine the importance of the duration of in-hospital management of patients with testicular torsion for testes survival. The time from onset of symptoms until surgery is a well-known factor determining testicular survival but there is no data regarding the contribution of in-hospital management duration to testicular survival. Unlike the time from onset of symptoms until seeking medical attention, the time from registration to the emergency department (ED) to the time of detorsion—"Door To Detorsion time" (DTD) is dependent on medical providers and should be minimized.

MATERIALS AND METHODS Data was retrieved on all patients who underwent surgery for testicular torsion in 1994-2014 ($N = 219$). We used multivariable logistic regression analysis to examine independent association between DTD time or duration of symptoms to testicular survival.

RESULTS Median DTD time was 135 minutes (range 23-546). Among patients with a viable testis, median DTD time was 107 minutes (range 35-381) compared to 160 minutes (range 23-546) among patients with a nonviable testis ($P < .001$). Logistic regression models showed that both DTD time ($P = .04$) and duration of symptoms ($P < .001$) are independent factors associated with testicular survival.

Adjusted odds ratio was 1.0048 for a nonviable testis for every minute of delayed management in the ED ($P = .04$). Results suggest that every 10 minutes of delay in the ED increases the chance of having a nonviable testis in exploration by 4.8%.

CONCLUSION DTD is an independent factor predicting testicular survival. Institutional efforts should be made to decrease duration of DTD. DTD should be considered as a measure for quality of care. UROLOGY 133: 211–215, 2019. © 2019 Elsevier Inc.

Testicular torsion is a leading cause of testicular loss and can result in fertility and endocrine impairment.[1-2] Abnormal sperm analysis has been found after torsion in over 50% of patients, which correlated with the duration of torsion.[3] Some of these patients have been declared infertile and were unable to conceive a child.[4] Endocrine functions have been also shown to be affected after torsion, with reduced Inhibin B levels, known as a predictor of spermatogenesis efficiency.[5,6] Therefore, the importance of this condition can not be overemphasized and continued research in this field is justified.

Several studies in animal models suggested that the contralateral testis can be affected as well after testicular torsion, possibly due to reflex vasoconstriction and hypoxia[7,8] and immune response after Blood-Testes Barrier breakdown,[9,10] thus worsening fertility prognosis.

Testicular torsion is a urological emergency requiring prompt diagnosis and treatment. Duration of symptoms before seeking medical attention is a known predictor of testicular damage,[11] emphasizing the need for immediate scrotal exploration, detorsion and orchiopexy. Early scrotal exploration in patients presenting with symptoms duration under 6 hours can salvage most testes.[12,13] When symptoms last longer, testes viability rates decline.[14,15]

In the field of cardiology, the term "Door To Balloon" (DTB) was established to describe the time measured from the moment a patient with ST-segment elevation myocardial infarction enters the emergency department (ED), to the time of coronary balloon inflation. Short door to balloon time increases survival and is considered today a core quality of treatment measure by the Joint Commission on Accreditation of Healthcare Organizations Internationally (JCI).[16,17] Much research and hospital effort is invested in the past years aiming to shorten DTB time in order to improve survival of myocardial infraction patients.[18,19]

In contrast to the intense work done in cardiology, little information can be found in the literature regarding duration of hospital management of patients with suspected testicular torsion.

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In this study we offer a new term—"Door To Detorsion time" (DTD)—which is the time measured from the moment a patient suspected with testicular torsion enters the ED, to the time of operative testicular detorsion. While the time from initial symptoms presentation until arrival to medical care is difficult to control, late diagnosis and delay in hospital management are factors that can potentially be minimized by the medical staff.

This study aims to find if DTD is an independent factor predicting testicular survival.

METHODS

After obtaining an IRB approval, data of patients who underwent surgical treatment for testicular torsion, between the years 1994-2014, was retrospectively extracted from computerized medical records.

Demographic and clinical information was obtained. Duration of symptoms before ED registration, exact time of registration to ED, time of ultrasound (US) examination and the time of induction of anesthesia were collected.

The time intervals from registration to the ED to US examination and to induction of anesthesia ("DTD") were calculated.

We elected to use the rates of testis macroscopic nonviability as our primary endpoint. We found this endpoint to be more objective than the rates of orchiectomy performed since the study extended over a prolonged period of time with multiple surgeons with varied thresholds for orchiectomy. Testis nonviability was defined when the surgical notes recorded that the testis was found to be nonviable in exploration (reported as black, necrotic, or nonviable) and did not recover after detorsion.

Statistical analysis was performed using SPSS statistics software, version 24. Univariate analysis for categorical variables was performed by the chi-square test, and the nonparametric Mann-Whitney-*U* test was used for continuous variables. Multivariate logistic regression models were used to simultaneously test association of statistically significant variables to the dependent variable—viability of testis. Kaplan-Meier survival plots were used to display testicular survival. All tests were 2 tailed and a *P* value of .05 or less was considered statistically significant.

RESULTS

Overall, 231 patients were operated for testicular torsion in the years 1994-2014. Of those, 12 (5%) patients had insufficient documented data and were excluded from the study. Mean patients' age was 15.3 years (SD 7.70); the youngest operated patient was 4 months old and the oldest 47 years old. A nonviable testis was found in 112 cases (51.1%).

Duration of Prehospital Symptoms

Duration of symptoms before hospital arrival varied greatly. The shortest time found was 1 hour and the longest 10 days, with a median time of 6 hours (Table 1).

Among patients in which a nonviable testis was found, the median duration of symptoms was 24 hours (range 1-240). In the group of patients with viable testes, median duration was 3 hours (range 1-72, $P < .001$).

We viewed duration of symptoms in 6 hours interval timeframes and its influence on testicular survival (Fig. 1). Out of all patients, 111 patients (50.7%) presented to the ED with symptoms lasting less than 6 hours. Of these patients, in 25 (22.5%) a nonviable testis was found in exploration. When presented after more than 24 hours most but not all testes were nonviable (91.7%).

Adjusted odds ratio, as computed by logistic regression, was used to estimate the damage caused by delayed arrival to the ED (Table 2). Odds ratio for having a nonviable testis was 1.083 for every hour of delay ($P < .001$), that is, every hour of delayed arrival to the ED increases the odds of a nonviable testis by 8.3%.

Survival analysis was used to present the survival curve of testes with delayed presentation to the ED. A steep decline in testicular viability is seen in the curve as time of symptoms was longer, and especially when symptoms lasted more than 24 hours (Fig. 2).

Door to Detorsion Time

Median "DTD time", was 135 minutes. Shortest DTD time shown was 23 minutes and the longest 546 minutes. Median DTD was 160 minutes (range 23-546) in patients with a nonviable testis compared with a median of 107 minutes (range 35-381) in patients with a viable testis ($P < .001$).

Adjusted odds ratio, was used to estimate testicular damage caused by delayed management in the ED. Odds ratio was 1.0048 for a nonviable testis for every minute of delay ($P = .04$). Results suggest that every 10 minutes of delay in the ED increases the chance of having a nonviable testis in exploration by 4.8% (Table 2).

Survival analysis was used to present the survival curve of testes with delayed ED management. A steep decline in testicular viability can be seen in the curve the longer the management was, and especially when it was longer than 60 minutes (Fig. 2).

Ultrasound

US examination was performed in 86.9% of cases. Median ED to US interval was found to be 45.3 minutes (range 9-436). The median interval time was 43 minutes (range 9-221) among patients with viable testis compared with patients who had a nonviable testis with 47 minutes (range 9-436). There was no statistical significance ($P = .158$).

Table 1. Parameters affecting testicular outcome—univariate analysis

	Viable Testis	Nonviable Testis	*P* Value
Cases (%)	107 (49%)	112 (51%)	
Age in years Mean, (SD)	16 (5.4)	14 (9.3)	$P = .04$
Duration of symptoms in hours Median, (range)	3 (1-72)	24 (1-240)	$P < .001$
Door to detorsion in minutes Median, (range)	107 (35-381)	160 (23-546)	$P < .001$

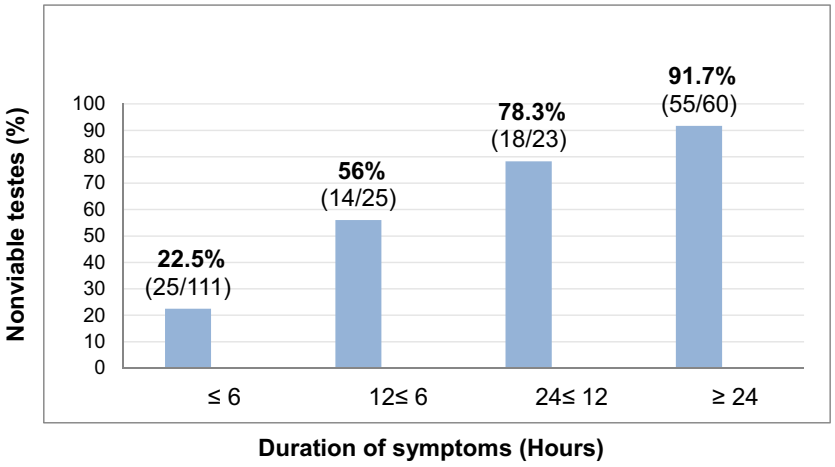

Figure 1. Association between duration of symptoms and viability of testes categorized into timeframes. In brackets are number of nonviable testes found in exploration out of all explorations done among patients presented with symptoms duration matching each timeframe ($N = 219$). (Color version available online.)

Table 2. Factors predictive of nonviable testis in multivariate logistic regression

	P Value	Adjusted OR	95% CI
Age at torsion	$P = .15$	0.966	0.92-1.01
Duration of symptoms	$P < .001$	1.083	1.05-1.12
DTD	$P = .04$	1.0048	1.00-1.01

DTD, Door To Detorsion.

DISCUSSION

The time period between emergence of symptoms to definitive treatment can be divided to 2 parts. The time from beginning of symptoms to ED registration and the time from registration to testicular detorsion. While the first part is not directly influenced by the medical staff, the latter is under our control and is subject to improvement. The treatment is a team work effort including the triage nurses, urologists, radiologists, operating room (OR) staff, and anesthesiologists. The quality of care should focus on education and emphasize the importance of shortening the DTD time.

Our study is the first to show that in-hospital management (DTD) is an independent factor influencing testicular survival. In this study, median DTD was 135 minutes, and was roughly an hour shorter among patients with viable testes found in surgery.

One would think that patients presenting to the ED with long duration of symptoms will have longer DTD time for the reason that hospital staff will assume that the testis is already nonviable and would not rush to surgery.

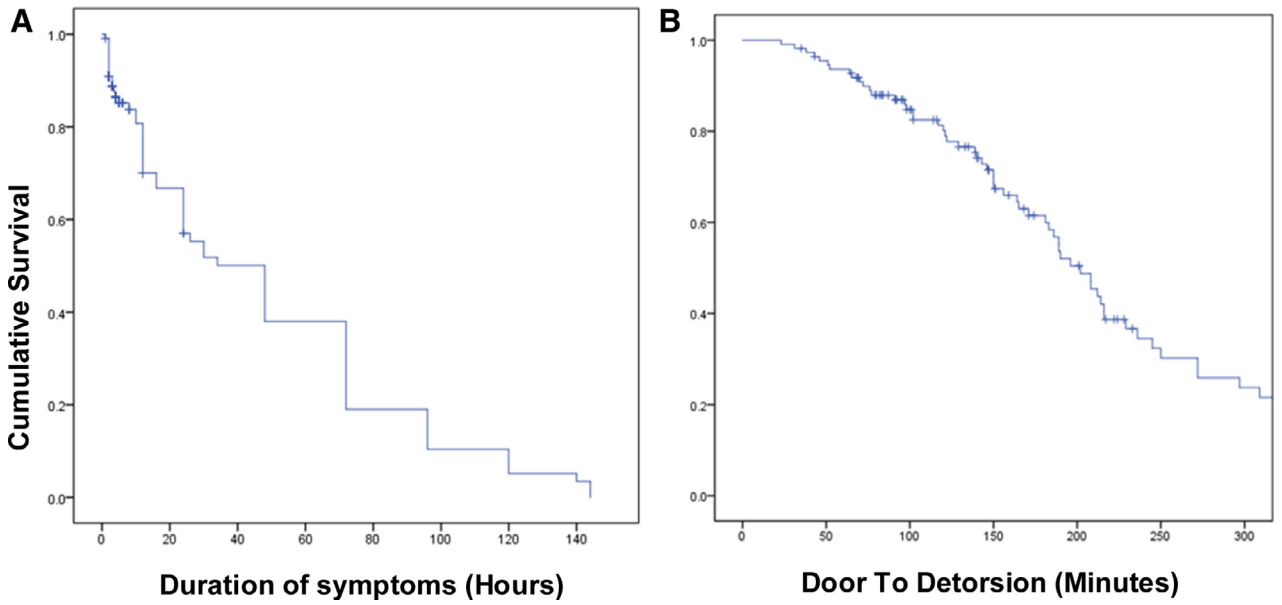

Figure 2. Survival analysis: Testicular viability influenced by duration of symptoms [**A**] and Door To Detorsion time [**B**]. (Color version available online.)

However, logistic regression models in this study found that DTD time independently influence testicular survival. These results demonstrate the significance of accurate diagnosis and quick treatment, and urge us to reduce DTD. Possible explanation to our findings, that DTD time is as crucial as duration of symptoms to testicular survival, might be nonlinear speed of testicular deterioration after torsion making the last periods before detorsion the more critical than the initial time for testicular survival.

We found that in our institute most patients suspected to have testicular torsion undergo ultrasonography to assess testicular blood flow. The time found until the performance of this imaging modality in our institute is quite reasonable but the examination has potential to cause delay in treatment. This fast and cheap imaging modality contributes greatly in establishing diagnosis and decision of surgery but should be omitted if high index of clinical suspicion exists.

Afsarlar et al aimed to shorten the time in the ED of patients with testicular torsion by implementing a checklist to identify high-risk patients. In their study,[20] they gathered registration, US examination and operation times, and calculated the intervals. Mean ED to OR time (DTD time) in that study was 198 minutes (SD 76), an hour longer than the time found in our study. After meeting with department leaders of the ED, radiology, and OR departments and using the checklist, they managed to reduce US to OR interval time by an hour. This information strengthens the idea that improving awareness of this emergency among medical staff can shorten management time in the hospital.

Current literature agrees that late arrival to a hospital can result in testicular loss and decreased fertility.[1,2] Six hours is believed to be the upper cutoff in which treatment should be initiated by, prompting several studies to recommend that effort should be put in increasing public awareness of the condition, in order to shorten arrival time to the hospital[21-23]. This was not the case in our study, with almost a quarter of patients presented with an ischemic unviable testis within this time frame.

US News and World Report are known for their "America's Best hospitals" ranking list released annually. One of the quality measures used for hospital ranking for pediatric urology is the time from hospital registration of patients with testicular torsion until operation. ED to OR time shorter than 4 hours among 90% of patients grants the hospital full scores.

Our study undermines this number. Figure 2 shows testicular viability rate of approximately 30% by that time. We believe that 4 hours of management is too long and we recommend US News and World Report to consider reducing this number.

Our study has few limitations. First is its retrospective nature that relied on patients' self-reporting on the duration of pain which may be exposed to a recall bias. Second, this study viewed cases over 20 years thus including many surgeons that performed the operations and might have had different thresholds for when to conduct orchiectomy. Some surgeons chose to preserve the testis even if seemed unviable with the hope of preserving some of its function, while other conducted orchiectomy with every sign of nonviability. Choosing our endpoint of macroscopic viability as stated in the surgical reports and not the type of surgery conducted overcomes this confounder and is a more reliable endpoint then orchiectomy. We still tried to find a more definitive endpoint such as postoperative US documentation of testicular atrophy. Unfortunately, due to low rate of patients' compliance to postoperative US examinations, lack of satisfactory documentation in the ones that were examined and the retrospective nature of this study we were left unable to use this logical endpoint for this study.

It is clear though, that in any future prospective study conducted, testicular atrophy or viability must be evaluated and determined by a postoperation US examination.

We believe that a well-organized, comprehensive educational campaign conducted in hospitals might reduce management time and diminish rates of nonviable testes. Further prospective internation study is needed in order to point at specific hinders in management, but it is already clear that a global change in the perception of this condition and establishment of a quick, efficient, routine route of management is a way to improve present unsatisfactory results. We also recommend that DTD time should be considered as a core quality of care measure in ED and hospitals.

CONCLUSION

Testicular salvage after torsion depends on 2 main factors—quick seeking of medical attention and fast and efficient in-hospital management. In this study we introduce the term—"DTD time"—which is the time from the moment a patient with suspected testicular torsion is registered in the ED, to the time of detorsion. We found DTD to be an important and independent factor affecting testicular survival, regardless of the prehospital delay.

References

1. Bennett S, Nicholson MS, Little TM. Torsion of the testis: why is the prognosis so poor? *Br Med J (Clin Res Ed)*. 1987;294:824.
2. Romeo C, Impellizzeri P, Arrigo T, et al. Late hormonal function after testicular torsion. *J Pediatr Surg*. 2010;45:411–413.
3. Bartsch G, Frank S, Marberger H, et al. Testicular torsion: late results with special regard to fertility and endocrine function. *J Urol*. 1980;124:375–378.
4. Thomas WE, Cooper MJ, Crane GA, et al. Testicular exocrine malfunction after torsion. *Lancet*. 1984;2:1357–1360.
5. Taskinen S, Taskinen M, Rintala R. Testicular torsion: orchiectomy or orchiopexy? *J Pediatr Urol*. 2008;4:210–213.
6. Anawalt BD, Bebb RA, Matsumoto AM, et al. Serum inhibin B levels reflect Sertoli cell function in normal men and men with testicular dysfunction. *J Clin Endocrinol Metab*. 1996;81:3341–3345.
7. Tanyel FC, Büyükpamukçu N, Hiçsönmez A. Contralateral testicular blood flow during unilateral testicular torsion. *Br J Urol*. 1989;63:522–524.
8. Kolettis PN, Stowe NT, Inman SR, et al. Acute spermatic cord torsion alters the microcirculation of the contralateral testis. *J Urol*. 1996;155:350–354.

9. Nagler HM, White RD. The effect of testicular torsion on the contralateral testis. *J Urol*. 1982;128:1343–1348.
10. Visser AJ, Heyns CF. Testicular function after torsion of the spermatic cord. *BJU Int*. 2003;92:200–203.
11. Cuckow PM, Frank JD. Torsion of the testis. *BJU Int*. 2000;86:349–353.
12. Anderson JB, Williamson RC. Testicular torsion in Bristol: a 25-year review. *Br J Surg*. 1988;75:988–992.
13. Ringdahl E, Teague L. Testicular torsion. *Am Fam Physician*. 2006;74:1739–1743.
14. Lewis AG, Bukowski TP, Jarvis PD, et al. Evaluation of acute scrotum in the emergency department. *J Pediatr Surg*. 1995;30:277–281; discussion 281-272.
15. Dunne PJ, O'Loughlin BS. Testicular torsion: time is the enemy. *Aust N Z J Surg*. 2000;70:441–442.
16. McNamara RL, Wang Y, Herrin J, et al. Effect of door-to-balloon time on mortality in patients with ST-segment elevation myocardial infarction. *J Am Coll Cardiol*. 2006;47:2180–2186.
17. Cannon CP, Gibson CM, Lambrew CT, et al. Relationship of symptom-onset-to-balloon time and door-to-balloon time with mortality in patients undergoing angioplasty for acute myocardial infarction. *JAMA*. 2000;283:2941–2947.
18. Krumholz HM, Bradley EH, Nallamothu BK, et al. A campaign to improve the timeliness of primary percutaneous coronary intervention: Door-to-Balloon: an Alliance for Quality. *JACC Cardiovasc Interv*. 2008;1:97–104.
19. Bradley EH, Herrin J, Wang Y, et al. Strategies for reducing the door-to-balloon time in acute myocardial infarction. *N Engl J Med*. 2006;355:2308–2320.
20. Afsarlar CE, Ryan SL, Donel E, et al. Standardized process to improve patient flow from the Emergency Room to the Operating Room for pediatric patients with testicular torsion. *J Pediatr Urol*. 2016;12:233.e231-234.
21. Rampaul MS, Hosking SW. Testicular torsion: most delay occurs outside hospital. *Ann R Coll Surg Engl*. 1998;80:169–172.
22. Nasrallah P, Nair G, Congeni J, et al. Testicular health awareness in pubertal males. *J Urol*. 2000;164(3 Pt 2):1115–1117.
23. Jones DJ, Macreadie D, Morgans BT. Testicular torsion in the armed services: twelve year review of 179 cases. *Br J Surg*. 1986;73:624–626.