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Bulletin of the National Research Centre (2023) 47:161
https://doi.org/10.1186/s42269-023-01134-6

Bulletin of the National Research Centre

RESEARCH

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Diagnosis of testicular torsion with preserved blood flow detected by color Doppler ultrasonography

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Abstract

Background To diagnose testicular torsion promptly and accurately when diagnosis of testicular torsion is difficult by color Doppler ultrasonography owing to testicular blood flow, we assess the helpfulness of physical findings to aid diagnosis of testicular torsion in cases with preserved testicular blood flow.

Methods We retrospectively collected data of 45 patients below 18 years of age with suspected diagnosis of testicular torsion and underwent surgery. The clinical data of testicular torsion with normal testicular blood flow were compared to testicular torsion with normal testicular blood flow or no-testicular torsion for accurate diagnosis of testicular torsion.

Results Testicular torsion was diagnosed in 34 of the 45 patients, and normal testicular blood flow was detected in six of the 34 patients. In testicular torsion with normal flow, duration of symptoms was significantly shorter, and the degree of torsion was significantly more mild than decreased blood flow. All testicular torsion with normal testicular flow had abnormal testicular findings. Duration of symptoms in patients with testicular torsion with normal flow was also significantly shorter than non-testicular torsion.

Conclusions If testicular blood flow is detected, the presence of abnormal testicular findings and short duration of symptom are highly suspicious for testicular torsion.

Keywords Testicular torsion, Ultrasonography, Testicular blood flow

Background

Testicular torsion is a surgical emergency in which treatment should not be delayed because it can lead to testicular ischemia and atrophy (Mohamed et al. 2023; Chanchlani and Acharya 2023). Immediate diagnosis of testicular torsion has therefore been associated with an increase in the rates of testicular salvage. Appropriate diagnosis of testicular torsion is predominantly based on findings of ultrasonography (US). Color Doppler ultrasonography (CDUS) is useful to diagnose testicular torsion by the findings of absent or decreased testicular blood flow (Hazeltine et al. 2017; Waldert et al. 2010). However, such accurate diagnosis is difficult when blood flow is preserved in the testis, as shown by CDUS (Zvizdic et al. 2021; Nakayama et al. 2020). Clinical history and multiple physical findings may be helpful in such cases for the diagnosis of testicular torsion. Furthermore, testicular torsion with preserved blood flow must be distinguished from other conditions such as epididymitis and torsion of the appendix.

In this study, we compared patients with normal testicular blood flow by CDUS with patients with decreased blood flow. Additionally, we evaluated the difference between patients with normal testicular blood flow and

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other conditions with non-testicular torsion. We aimed to assess the usefulness of physical findings for diagnosis of testicular torsion in cases with preserved testicular blood flow detected by CDUS.

Methods

We retrospectively collected data of 45 patients below the age of 18 who had suspected diagnosis of testicular torsion and underwent surgery at Wakayama Medical University between May 2009 and December 2020. Neonatal patients were eliminated from this study because of different clinical states. Patients with intermittent testicular torsion were also eliminated. All patients underwent physical examination and CDUS by experienced urologists using a color Doppler linear probe (7.5 MHz). Diagnosis of scrotal and testicular abnormal findings by physical examination was compared with the contralateral normal testis. Testicular abnormal position was defined as transverse testicular position or high-riding testis. Diagnosis of the testicular blood flow using CDUS was performed by at least two urologists, and the testicular blood flow of affected testis was carefully compared with the contralateral normal testis. Indication for surgery was decided by inability to rule out testicular torsion. If the intraoperative color of the testis continued to suggest poor blood flow after detorsion or incision of tunica albuginea, orchidectomy was performed. A contralateral orchidopexy was performed for all patients with testicular torsion.

These patients diagnosed as testicular torsion were divided into two groups based on testicular blood flow according to CDUS. The first group had normal testicular blood flow at the same level as the contralateral testis. The second group had the absence of blood flow or decreased blood flow compared with the contralateral normal testis. Additionally, we compared findings of testicular torsion with normal testicular blood and non-testicular torsion. Clinical data, including patient characteristics, duration of symptoms until surgery, physical findings, US findings, intraoperative findings, and type of surgery, were reviewed retrospectively. Data of the two groups were compared to assess the accuracy of diagnosis of testicular torsion. This study was conducted with approval from the Wakayama Medical University Institutional Review Board (approval number 3568) and in accordance with the Declaration of Helsinki.

Statistical analysis was performed using JMP Pro 14 (SAS Institute Inc., Cary, NC, USA). Wilcoxon signed rank test was used to compare continuous variables between the two groups, and the chi-square test and Fisher's exact test were used for categorical variables. P values < 0.05 were considered significant.

Results

Testicular torsion was diagnosed in 34 of the 45 patients (76%), and other condition with non-testicular torsion was diagnosed in 11 (24%). In these 11 patients with non-testicular torsion, nine patients had torsion of the appendix and two patients had epididymo-orchitis. The median age at surgery was 13 years (range, 10–15 years). Presented symptom was sudden-onset scrotal pain in all patients. Patient characteristics are shown in Table 1. Testicular abnormal position and the absence of cremasteric reflex testicular swelling in physical findings of patients with testicular torsion were significantly more common than in patients with non-testicular torsion. Heterogeneous echogenicity in US findings of patients with testicular torsion was significantly more common than in patients with non-testicular torsion. Decreased testicular blood flow by CDUS was not found in patients with non-testicular torsion.

Testicular torsion was diagnosed in six of the 34 patients (18%) with normal testicular blood flow by CDUS, and in 28 (82%) with decreased testicular blood flow. Patient characteristics and operative findings are shown in Table 2. Scrotal and testicular swelling in physical findings of the group with decreased blood flow were significantly more common than in the group with normal blood flow, but there was no significant difference between the two groups in other physical or US findings. Duration of symptoms until surgery in the group with decreased flow was significantly longer than in the group with normal flow. Furthermore, degree of torsion in group with decreased blood flow was significantly more severe than in the group with normal testicular blood flow. Although orchidopexy was performed for all patients in the group with normal testicular blood flow, there was no significant difference between the two groups in surgical treatment.

Patient characteristics and findings of testicular torsion with normal testicular blood flow are shown in Table 3. The median duration of symptom until surgery was five hours (range, 4–10 years). Although there are no abnormal scrotal findings in this group, all patients had abnormal testicular findings. Testicular tenderness was the most frequent of these abnormal physical findings and occurred in five patients. The absence of cremasteric reflex was found in three patients. Only one patient had abnormal US findings, including whirlpool sign and heterogeneous echogenicity. Degree of torsion in all patients was 180°.

Patient characteristics of testicular torsion with normal blood flow and non-testicular torsion are shown in Table 4. Scrotal swelling and erythema were found in some patients with non-testicular torsion, whereas there were no patients with these findings in testicular torsion

Table 1 Patients characteristics

	Testicular torsion ($n=34$)	Non-testicular torsion ($n=11$)	*P* value
Age, median years (IQR)	14 (10–15)	11 (10–14)	0.127
Laterality			0.645
Right, *n* (%)	9 (26)	6 (55)	
Left, *n* (%)	25 (74)	5 (45)	
Physical findings			
Scrotal swelling, *n* (%)	21 (62)	5 (45)	0.485
Scrotal erythema, *n* (%)	9 (26)	2 (18)	0.705
Testicular swelling, *n* (%)	23 (68)	5 (45)	0.285
Testicular tenderness, *n* (%)	31 (91)	8 (73)	0.146
Testicular abnormal position, *n* (%)	22 (65)	2 (18)	0.013
Absence of cremasteric reflex, *n* (%)	20 (58)	2 (18)	0.035
US findings			
Whirlpool sign, *n* (%)	10 (29)	1 (9)	0.246
Heterogeneous echogenicity, *n* (%)	16 (47)	0 (0)	0.004
Decreased testicular blood flow, *n* (%)	28 (82)	0 (0)	< 0.001
Enlarged epididymis, *n* (%)	7 (21)	5 (45)	0.131
Duration of symptom, median hr (IQR)	10 (5–37)	12 (7–24)	0.625

IQR Interquartile range, *US* Ultrasonography

Table 2 Patients characteristics and operative findings of testicular torsion

	Normal flow ($n=6$)	Decreased flow ($n=28$)	*P* value
Age, median years (IQR)	13 (10–14)	14 (9–15)	0.964
Laterality			0.645
Right, *n* (%)	2 (33)	7 (25)	
Left, *n* (%)	4 (66)	21 (75)	
Physical findings			
Scrotal swelling, *n* (%)	0 (0)	21 (75)	0.001
Scrotal erythema, *n* (%)	0 (0)	9 (32)	0.162
Testicular swelling, *n* (%)	1 (17)	22 (79)	0.008
Testicular tenderness, *n* (%)	5 (83)	26 (93)	0.453
Testicular abnormal position, *n* (%)	3 (50)	19 (68)	0.641
Absence of cremasteric reflex, *n* (%)	3 (50)	17 (61)	0.672
US findings			
Whirlpool sign, *n* (%)	1 (17)	9 (32)	0.645
Heterogeneous echogenicity, *n* (%)	1 (17)	15 (54)	0.180
Enlarged epididymis, *n*(%)	2 (33)	5 (45)	0.580
Duration of symptom, median hr (IQR)	5 (4–9)	13 (7–51)	0.042
Degree of torsion, median (IQR)	180 (180–180)	180 (180–360)	0.043
Bell clapper deformity	4 (67)	19 (68)	1.000
Surgical treatment			0.162
Orchidopexy, *n* (%)	6 (100)	19 (68)	
Orchiectomy, *n* (%)	0 (0)	9 (32)	

IQR Interquartile range, *US* Ultrasonography

Table 3 Patients characteristics and operative findings of testicular torsion with normal testicular blood flow

Case	Age	Laterality	Physical findings	US findings	Duration of symptom	Degree of torsion
1	13 yr	Left	Testicular tenderness Absence of cremasteric reflex	Whirlpool sign Heterogeneous echogenicity	6 h	180
2	11 yr	Left	Testicular swelling	–	5 h	180
3	17 yr	Right	Testicular tenderness Testicular abnormal position	–	10 h	180
4	14 yr	Left	Testicular tenderness Testicular abnormal position	–	4 h	180
5	14 yr	Left	Testicular tenderness Testicular abnormal position Absence of cremasteric reflex	–	5 h	180
6	10 yr	Right	Testicular tenderness Absence of cremasteric reflex	–	9 h	180

US Ultrasonography

Table 4 Patients characteristics with normal testicular blood flow

	Testicular torsion ($n=6$)	Non-testicular torsion ($n=11$)	*P* value
Age, median years (IQR)	13 (10–14)	11 (10–14)	0.220
Laterality			0.620
Right, *n* (%)	2 (33)	6 (55)	
Left, *n* (%)	4 (67)	5 (45)	
Physical findings			
Scrotal swelling, *n* (%)	0 (0)	5 (45)	0.102
Scrotal erythema, *n* (%)	0 (0)	2 (18)	0.515
Testicular swelling, *n* (%)	1 (17)	5 (45)	0.333
Testicular tenderness, *n* (%)	5 (83)	8 (73)	1.000
Testicular abnormal position, *n* (%)	3 (50)	2 (18)	0.281
Absence of cremasteric reflex, *n* (%)	3 (50)	2 (18)	0.280
US findings			
Whirlpool sign, *n* (%)	1 (17)	1 (9)	0.650
Heterogeneous echogenicity, *n* (%)	1 (17)	0 (0)	0.353
Enlarged epididymis, *n* (%)	2 (33)	5 (45)	1.000
Duration of symptom, median hr (IQR)	5 (4–9)	12 (7–24)	0.044

IQR Interquartile range, *US* Ultrasonography

with normal blood flow, though these differences were not statistically significant. Duration of symptoms until surgery in patients with non-testicular torsion was significantly longer than in testicular torsion with normal flow.

Discussion

Among various diseases that cause acute scrotum, testicular torsion must be promptly diagnosed and treated with surgery. Delayed diagnosis and treatment for testicular torsion can result in testicular ischemia and necrosis (Mohamed et al. 2023; Chanchlani and Acharya 2023). CDUS is the most useful examination for diagnosing of testicular torsion when decrease or absence of testicular blood flow is detected on CDUS. Hazeltine et al. reported that the sensitivity of testicular blood flow by CDUS is 88.9–100%, and the specificity is 97–98.8% (Hazeltine et al. 2017). However, testicular blood flow is known to be preserved on CDUS in some cases of testicular torsion (Zvizdic et al. 2021; Nakayama et al. 2020; Bandarkar and Blask 2018).

In this study, testicular blood flow was detected by CDUS in six of the 34 patients with testicular torsion.

Testicular vascularity can be preserved in cases of partial or incomplete torsion, such as the spermatic cord twists less than 360° and/or for a short duration (Zvizdic et al. 2021; Nakayama et al. 2020; Lim et al. 2022). If the degree of spermatic cord torsion is less than 360°, venous outflow is obstructed when but arterial flow is preserved. If the degree of spermatic cord torsion is 360° or greater, arterial flow is disturbed, which could lead to testicular ischemia (Zvizdic et al. 2021; Nakayama et al. 2020). Several abnormal findings are subsequently detected in testis with time. Abnormal findings of testicular torsion, including decrease or absence of testicular blood flow, therefore depend on gradual blood flow impairment and duration. Degree of torsion was 180° in all cases with preserved testicular blood flow by CDUS, and in this study, duration of symptoms until surgery was shorter than that in cases with decreased blood flow.

Other than testicular blood flow, the importance and usefulness of US findings for diagnosis of testicular torsion have been noted, including whirlpool sign and heterogeneous parenchymal echogenicity (Bandarkar and Blask 2018; Lim et al. 2022; Abbas et al. 2018). However, whirlpool sign depends on the degree and thickness of the twisting of the spermatic cord, and heterogeneous parenchymal echogenicity reflects a longer period of torsion and ischemia (Bandarkar and Blask 2018; Lim et al. 2022). These findings may not, therefore, be detected in cases with lesser degree or shorter period of torsion. In this study, these US findings were detected in only one patient with preserved testicular blood flow by CDUS.

Various predictive physical findings in relation to diagnosing testicular torsion have been reported (Abbas et al. 2018; Sharp et al. 2013; Wang and Mo 2019; Barbosa et al. 2013). Although the presence of scrotal swelling or scrotal erythema is clinically valuable findings of testicular torsion, these findings reflect the degree of inflammation and may present over time (Sharp et al. 2013; Wang and Mo 2019). Our results suggest that there were abnormal scrotal findings in cases with decreased testicular blood flow with greater degree or longer period of torsion. Abnormal testicular findings are sufficiently reliable to diagnose testicular torsion, such as the testicular swelling, testicular tenderness, abnormal testicular position and the absence of cremasteric reflex (Abbas et al. 2018; Sharp et al. 2013; Wang and Mo 2019; Barbosa et al. 2013). Comparison of affected and unaffected testis can lead to greater accuracy in physical examination of acute scrotum. This study suggests that testicular torsion should not be ruled out if patients with scrotal pain have at least one finding of testicular abnormality. In addition, our data indicate that shorter duration, lesser degree of torsion, and preserved testicular blood flow by CDUS may be predictors of successful testicular salvage in patients with testicular torsion.

Several diseases can cause acute scrotal pain such as a testicular torsion, epididymitis, and torsion of the appendix. Testicular torsion can be predicted by the clinical features including pain less than 24 h, abnormal cremasteric reflex, and/or high position of the testis (Bandarkar and Blask 2018). However, it may be difficult to differentiate between testicular torsion with preserved blood flow and another condition by physical examination. Actually, some patients without testicular torsion had the absence of cremasteric reflex or testicular abnormal position in this study. On the other hand, all testicular torsion with testicular blood flow had no abnormal scrotal findings including scrotal swelling and erythema. The presence of these scrotal findings depends on degree of inflammation and is found later in the presentation (Bandarkar and Blask 2018; Sharp et al. 2013). Therefore, these abnormal scrotal findings are appeared in either torsion of the appendix or epididymo-orchitis rather than testicular torsion with testicular blood flow. Moreover, symptoms and clinical findings of patients without testicular torsion may be milder and longer than testicular torsion with testicular blood flow (Laher et al. 2020). Our data and previous reports indicate that a short duration of symptoms and normal scrotal findings may be predictors of testicular torsion with preserved testicular blood flow in patients with acute scrotal pain.

This study has several limitations. It was a single institutional retrospective study, and the sample size was relatively small. In addition, there were no patients with symptoms other than scrotal pain, so we cannot suggest that clinical information such as degree and duration of several symptoms may be useful in diagnosis of testicular torsion. Secondly, several urologists performed CDUS in this study, which affect the results depending on their experience and skills. However, in practice, most patients with testicular torsion visit only with an emergency, and differences in CDUS findings according to differing urologists are unavoidable. Despite these limitations, extensive data of patients with normal testicular blood flow by CDUS have not been previously reported, so physical findings of the patients presented in this study are thought to be helpful for diagnosis of testicular torsion with normal testicular blood flow by CDUS. However, because of the small number of testicular torsion cases with preserved blood flow in this study, it is uncertain whether unnecessary surgery for conditions other than testicular torsion can be avoided. Therefore, future studies with larger sample size are necessary for accurate diagnosis of testicular torsion with normal testicular blood flow by CDUS.

Conclusions

The presence of testicular blood flow by CDUS does not exclude testicular torsion. Such cases represent lesser-degree testicular torsion or of a short duration. If testicular blood flow is detected by CDUS, the presence of abnormal testicular findings by physical examination, including testicular swelling, testicular tenderness, abnormal testicular position and the absence of cremasteric reflex, is highly suspicious of testicular torsion. Moreover, a short duration of symptoms and normal scrotal findings may be useful for diagnosis of testicular torsion with normal testicular blood flow. When testicular blood flow is preserved by CDUS, testicular torsion should not be rule out based on CDUS finding, but should be diagnosed with duration of symptom and findings in the testis and scrotum.

Abbreviations

US Ultrasonography
CDUS Color Doppler ultrasonography

Acknowledgements

We acknowledge proofreading and editing by Benjamin Phillis at the Clinical Study Support Center at Wakayama Medical University.

Author contributions

KK performed project development, data management, data analysis, and manuscript writing. YU performed data collection and data analysis. SY performed data collection and data management. YK performed project development and manuscript editing. IH performed project development, data management, and manuscript editing.

Funding

There was no funding of this study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The protocol for this study has been approved by the ethics committee of Wakayama Medical University, approval number 3568. Informed consent was obtained through an opt-out process due to the retrospective nature of this study. Opt-out informed consent protocol was used for use of participant data for research purposes which is permitted by national guidelines.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 6 September 2023 Accepted: 18 October 2023
Published online: 06 November 2023

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