



Real-world management of testicular torsion: Level of adherence to the EAU Pediatric Urology guidelines

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Keywords

Testicular torsion; Testicular ischemia; Pediatric urology; Survey; Emergency

Abbreviations

EAU, European Association of Urology; OR, Operation Room; FEBU, Fellow of the European Board of Urology; US, Ultrasound; TWIST, Testicular Workup for Ischemia and Suspected Torsion

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Abstract

Background

Testicular torsion is the most frequent cause of irreversible ischemia to the testis. Despite guidelines being available, challenges remain in both diagnosis and management of the disease.

Objective

This study aims to determine the adherence of urologists and residents in urology to the European Association of Urology (EAU) Pediatric Guideline on Testicular torsion.

Study design

Both Dutch and European urologists, and residents in urology filled in a survey on testicular torsion. Information on demographics, diagnostics, and treatment modalities was retrieved from the questionnaire based on the EAU Guideline on Paediatric Urology.

Results

A total of 303 responders participated, of which 214 (71%) were from The Netherlands. Most (61%) responders treated three or more cases of testicular torsion in 2020. Ultrasound was used by 64%, followed by an attempt of manual detorsion by 38%

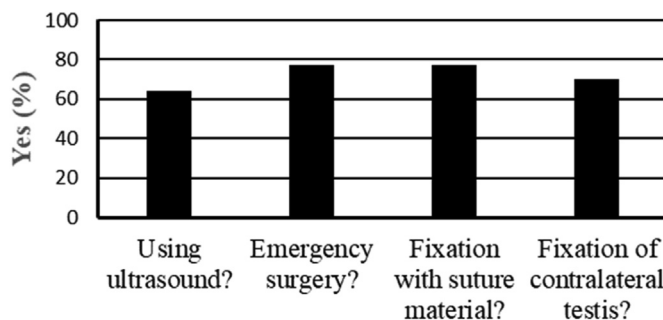
(Summary Fig.). Importantly, 23% preferred not to perform emergency surgery after successful manual detorsion. A Winkelmann procedure was performed by 23%, without fixation of the testis using suture material. A large group of responders (30%) only fixed the contralateral testis by a proven testicular torsion.

Discussion

A feasible adherence to the EAU Guideline on Paediatric Urology in treating testicular torsion was reported using this survey, although not all recommendations are implemented as proposed. The fact that outcomes of the different diagnostic and treatment modalities are lacking might be a limitation in interpreting the results of this survey.

Conclusion

Majority of the responders followed the EAU Guideline on Paediatric Urology in the diagnosis and treatment of testicular torsion. Ultrasound might contribute to diagnosing testicular torsion as long as this does not cause any delay for surgical exploration. Surprisingly, many urologists do not perform a surgical fixation of the testis after detorsion. Since a wide range of techniques and materials is used in case of surgical fixation, the guideline may provide in preferences for a unified policy among urologists.



Summary Figure Percentage of respondents performing ultrasound, emergency surgery, fixation with suture material or fixation of the contralateral testis.

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Introduction

Testicular torsion is a well-known emergency in urological practice. It is commonly diagnosed in paediatric patients with an incidence of 5.9 patients per 100,000 males (age: 1–17 years) [1]. For patients with an age of 18 years or older the incidence is lower, with 1.3 per 100,000 males. Testicular torsion remains the most frequent cause of irreversible testicular ischemia, but that could be prevented when diagnosis and treatment are performed correctly during a narrow window of opportunity.

The European Association of Urology (EAU) Guidelines on Paediatric Urology advises to perform a manual detorsion without anesthesia [2]. A successful detorsion is defined as immediate pain relief and normal findings at clinical examination. According to the guidelines, scrotal ultrasound (US) examination might be helpful, but should never delay the intervention. Hence, testicular torsion needs prompt surgical intervention (<24 h) and a bilateral orchidopexy is required, even after a successful detorsion. For the type of fixation (i.e., one-point, two-point, or three-point fixation) and suture-material the guidelines provide no recommendations. A guideline for diagnosis and treatment of testicular torsion considering adolescents or adults is lacking, however, the Guideline on Paediatric Urology should sustain in this matter.

This study aims to assess the adherence to the EAU guideline on testicular torsion by urologists and residents in urology using a survey. It is hypothesized that due to challenges in diagnosis and management of testicular torsions diagnostic habits and treatment modalities might deviate from the recommendations of the EAU guideline.

Methods

This survey utilized an online, self-administered survey distributed among urologists and residents in urology (hereafter referred to as *responders*) in the Netherlands and 21 other countries (Supplementary Table 1). An email describing the purpose and significance of the survey was sent with a link to 'Survey Planet' in February 2020 and repeated in July 2020. Responders were recruited via the Dutch Urological Association (Nederlandse Vereniging voor Urologie), and European professional networks. The Dutch Urological Association send a link of the questionnaire by email to all members comprising urologists ($n = 410$) and urologists in training ($n = 95$). Residents not in training are no member of this association and they had to receive the questionnaire via urologists or residents in training working in their institution. The professional networks consisted of urologists known to the auteurs as former colleagues, work within the EAU or collaborations between institutes. The questionnaire included 18, mostly closed-ended questions, about demographics (country, number of treatment testicular torsion, age, and type of institution), diagnosis (use of ultrasound), and treatment (manual detorsion, emergency surgery, surgical techniques, and use of materials). The questionnaire was developed *de novo* with the Guideline on Pediatric Urology used as guideline [2]. Pretesting of the questionnaire was done by urologists from the Franciscus Gasthuis & Vlietland Hospital (community training hospital) in Rotterdam. No sensibility testing of the questionnaire was

performed. See all questions in Table 1. Responders were not compensated for participation. The questions were pseudo-anonymous, as participants had the option to fill in their email addresses in case of questions or remarks, although this was not mandatory. The following case was presented as a guideline for the questionnaire: *A 14-year-old boy, otherwise fit and healthy, suddenly developed acute severe pain in the right side of the scrotum 2 h ago, shortly before breakfast. On examination in the emergency room, you find a painful, high and transverse testis on the right side with an absent cremaster reflex. There are no abnormalities on the left side. The patient's last meal was last night. What are your actions?* A comparison between Dutch and European responders was performed as sub-analyses and can be found in the supplementary.

Results

Demographics

A total of 303 responders took the survey, of which 214 (71%) were from The Netherlands. The age of the responders was over 40 years in 59%, 81% were clinically active as urologists and 17% were residents in urology (Table 2). Of the responders, 40% was working in a community training hospital. Most (60%) treated three or more cases of testicular torsions in 2020. Considering the Dutch cohort, 175 of the 214 (79%) were active urologists. Based on the known number of 410 urologists and 95 residents in training in the Netherlands, a response rate of 42% was achieved. As there was no information on characteristics of non-responders, no comparison was possible with the characteristics of the responders.

Diagnosis

Ultrasound was reported to be performed in 64% of the cases, and in 46% of the cases, this was done by a radiologist. In 22%, it was only performed by the responder if the radiologist was not available immediately. Only 3.6% of the responders reported that ultrasound was never indicated for testicular torsion.

Treatment

Manual detorsion was in any case performed by 38% of the responders (97% without anesthesia) versus 37% of the responders who do never attempt a manual detorsion. When a manual detorsion was performed, it was considered to be successful when the pain settled and/or US showed Doppler signals. Considering surgery, 77% of responders regard testicular torsion as an emergency and will perform surgery immediately, even after successful detorsion. Importantly, 23% of the responders prefer not to perform emergency surgery. In this context, 26% will only perform surgery on the first available occasion on the regular planned operating schedule. When surgery is performed, majority perform a medial incision in the raphe of the scrotum (76%). A Winkelmann fixation, fixation of the edges of the opened tunica vaginalis behind the spermatic cord, was performed in 59% of the cases after opening the tunica vaginalis. A soluble braided suture was used for the fixation in 48%, and in 69% of the cases, the testis was fixed with a 2 or 3-point

Table 1 Questions of the survey on diagnosis and management of testicular torsion.**Questions****Do you perform a scrotal ultrasound?**

- A. Yes, always.
- B. Only if I have doubts about the diagnosis.
- C. No, never. Testicular torsion is a clinical diagnosis.

Who performs the scrotal ultrasound?

- A. I perform it myself
- B. I'll always ask the radiologist to perform it.
- C. Depending the immediate availability, I'll ask the radiologist. Otherwise, I'll perform is myself.
- D. Only if I doubt the results of my own ultrasound, I'll ask the radiologist to perform it.
- E. An ultrasound is never indicated in cases like this.

Do you (attempt to) do a manual detorsion?

- A. Yes, with infiltration of funiculus with local anesthetics because it is a painful act.
- B. Yes, but without anesthetics, otherwise you are less able to see if it is still painful.
- C. Only if there is no prompt availability of an operating room.
- D. No, never

When do you consider manual detorsion to be successful?

- A. When the pain is (almost) completely gone.
- B. I check it with ultrasound: if the Doppler signals have significantly improved.
- C. If, after a full 360° detorsion, the right testicle is in the same position as the left side.
- D. I never attempt a manual detorsion

Do you perform emergency surgery?

- A. Yes, always.
- B. Yes, even if the manual detorsion has been successful.
- C. No, preferably not. Only if the manual detorsion has not been successful, or if there is uncertainty about this.

After a successful detorsion in the emergency room, when do you perform surgery (orchidopexy)?

- A. I do not perform manual detorsion and operate immediately.
- B. As soon as possible after detorsion (emergency surgery).
- C. Within 24 h.
- D. Within 72 h.
- E. On the first available occasion in the regular planning.
- F. Only in case of recurrence.

Which incision would you choose?

- A. Medial scrotal incision in the raphe.
- B. Lateral scrotal incision in the skinline (perpendicular to the raphe).
- C. Inguinal incision plus scrotal incision.
- D. Inguinal incision without scrotal incision.

Do you open the tunica vaginalis during the procedure?

- A. Yes, always, and I stich the edges together behind the spermatic cord (Winkelmann technique).
- B. Yes, always, but without the Winkelmann fixation stiches.
- C. No, I usually don't.

Which suture material do you use to fixate the testis?

- A. I do not fixate the testis, just detorsion and Winkelmann technique.
- B. Soluble monofilament.
- C. Insoluble monofilament.
- D. Soluble braided suture.
- E. Insoluble braided suture.

To what structure do you fixate the testis?

- A. Tunica vaginalis (sac surrounding testis).
- B. Tunica dartos (muscular inside lining of the scrotum).
- C. Funiculus/spermatic cord.
- D. I do not fixate the testis after detorsion

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Table 1 (continued)

Questions

How do you fixate the testis?

- A. Suture through the tunica albuginea into the parenchyma (big bite).
- B. Suture as superficial as possible through the tunica albuginea.
- C. Suture preferably through surrounding structures to spare testis parenchyma.
- D. I do not fixate the testis.

How many stitches do you use to fixate a single testis?

- A. I do not fixate the testis after detorsion.
- B. 1-Point fixation.
- C. 2-Point fixation.
- D. 3-Point fixation.

Do you fixate the healthy, contralateral left testicle?

- A. Yes, always.
- B. Only if there was actually a proven torsion on the right side perioperatively.
- C. No, never.

In 2020 I personally treated...?

- A. 0 cases.
- B. 1–2 cases.
- C. 3–5 cases.
- D. 5 or more cases.

What is your age?

- A. Under 30.
- B. 30–39.
- C. 40–49.
- D. 50–59.
- E. 60 and over.

In what kind of institution do you work mainly?

- A. Academic hospital.
- B. Community training hospital.
- C. Community not-training hospital.
- D. Private hospital.

I am...?

- A. Resident in training.
- B. Clinically active urologist.
- C. Retired.
- D. Pediatric urologist.
- E. Clinical andrologist.
- F. Fellow of the European Board of Urology (FEBU).

fixation. Surprisingly, 23% of the responders indicated that they never fix the testes and will only perform detorsion plus the Winkelmann procedure during surgery. Most of the responders will eventually also fixate the contralateral testis, but 30% only perform this when there was indeed a proven torsion of the ipsilateral testis. A comparison between Dutch responders and European responders as a sub-analysis can be found in [Supplementary Table 2](#). The most remarkable differences were found in the timing of surgery and fixation of the testis where European urologists seem more inclined to perform an emergency operation and fixate the testis more often with suture material.

Discussion

In this survey of the real-world management of testicular torsion, we found that the majority of responders follow

the EAU Guideline of Paediatric Urology. Most of the responders stated that an emergency operation for testicular torsion is indicated, even after a successful detorsion. When an orchidopexy is performed, a majority will also fix the contralateral testis, as recommended by the Guideline.

The majority of the responders (64%) use ultrasound for the diagnosis of testicular torsion which is equal to the proportion of 60% of pediatric urologist in Saudi Arabia who filled in a survey on testicular torsion [3]. In the past, testicular torsion was a purely clinical diagnosis based on patient's history and clinical examination. However, with the current widespread availability of high-end ultrasound (US), to our opinion, this could help in the diagnosis of testicular torsion. In 2006, *Gunther* et al. already showed the importance of high-end Doppler ultrasound in diagnosing and differentiating testicular torsion in 61 boys with an acute scrotum [4]. All 15 suspected testicular torsions by

Table 2 Response of the questionnaire considering demographic, diagnostic and treatment characteristics (N = 303).

Characteristics	n (%)
Demographic characteristics	
Role responder	
Urologist	188 (62)
Resident (in training)	51 (17)
Retired	5 (1.7)
Paediatric urologist	5 (1.7)
Clinical andrologist	7 (1.7)
FEBU	47 (15)
Institution	
Academic hospital	78 (26)
Community training hospital	120 (40)
Community not-training hospital	89 (29)
Private hospital	16 (5.3)
Age (years)	
Under 30	11 (3.6)
30–39	112 (37)
40–49	97 (32)
50–59	56 (18)
Over 60	27 (8.9)
Number of testicular torsions treated (last year)?	
0 cases	29 (9.6)
1-2 cases	90 (30)
3-5 cases	130 (42)
5 or more cases	54 (18)
Diagnostic characteristics	
Scrotal ultrasound?	
Yes	196 (64)
Only with doubts	96 (32)
No, never	11 (3.6)
Who performs the scrotal ultrasound?	
Myself	49 (16)
A radiologist	140 (46)
Me, pending availability radiologist	68 (22)
Only with own doubts: radiologist	35 (12)
Ultrasound is never indicated	11 (3.6)
Treatment characteristics	
Manual detorsion?	
Yes, with anesthetics	3 (1.0)
Yes, without anesthetics	108 (37)
Pending availability immediate OR	77 (25)
No, never	115 (37)
Successful manual detorsion?	
When pain is gone	86 (28)
If ultrasound shows Doppler signal(s)	92 (30)
Same position of testes	10 (3.3)
I never attempt manual detorsion	115 (39)
Treatment characteristics	
Emergency surgery?	
Yes, always	164 (54)
Yes, even after successful detorsion	68 (23)
No, preferably not	71 (23)
Timing of surgery?	
No detorsion, immediate OR	115 (38)
OR as soon as possible after detorsion	76 (25)
Within 24 h	15 (5.0)
Within 72 h	12 (4.0)
Only in case of recurrence	5 (1.7)

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Table 2 (continued)

Characteristics	n (%)
First available occasion regular planning	80 (26)
Placement of incision?	
Medial in the raphe	229 (76)
Lateral, perpendicular to raphe	66 (22)
Inguinal plus scrotal	4 (1.3)
Inguinal only	4 (1.3)
Opening tunica vaginalis?	
Yes, with Winkelmann fixation	181 (59)
Yes, but without Winkelmann fixation	108 (36)
No, I usually don't	14 (4.6)
Suture material?	
Just detorsion, no fixation	71 (23)
Soluble monofilament	32 (11)
Insoluble monofilament	42 (14)
Soluble braided suture	146 (48)
Insoluble braided suture	12 (4.0)
Structure for fixation?	
Tunica vaginalis	59 (20)
Tunica dartos	173 (57)
I do not fixate the testis	71 (23)
Type of fixation?	
Big bite through tunica albuginea	28 (9.2)
Superficial bite through tunica albuginea	155 (51)
Suture through surrounding structures	49 (16)
I do not fixate the testis	71 (24)
Number of stitches?	
I do not fixate the testis	71 (24)
1-point fixation	22 (7.3)
2-point fixation	95 (31)
3-point fixation	115 (38)
Fixation of contralateral, healthy testis?	
Yes, always	195 (64)
Only after a proven torsion	89 (30)
No, never	19 (6.3)

FEBU = Fellow of the European Board of Urology; OR = Operation Room

using ultrasound were surgically proven. While all 33 boys with normal Doppler signals were conservatively treated and showed normal perfusion during the following two years of follow-up. Testicular ultrasound performed by a radiologist was recommended since presentation on sonography can be subtle and misleading and arterial flow might be preserved or even increased [5]. However, US should never delay diagnosis and treatment. The 'Testicular Workup for Ischemia and Suspected Torsion (TWIST)'-score, with a positive predictive value of 94% and a negative predictive value of 100%, might help in the decision on waiting for the availability of a radiologist or immediate surgery [6]. By calculating the TWIST-score, patients are classified into low-, intermediate- and high-risk groups. Low-risk patients do not need examination by US and another diagnosis should be devised. For high-risk patients' surgical exploration is indicated without the need for US.

As described by Sessions et al., 20% of patients (11 of 54) showed residual torsion during exploration after reported pain relief following manual detorsion [7]. And in case

salvage surgery is performed 7–12 h after testicular torsion, almost 20% of the testis will be atrophic as shown by a meta-analysis in 1635 boys [8]. After 19–24 h, even more than 50% of the testis will be irreversibly damaged. Therefore, prompt surgical treatment is recommended by the EAU Guideline, although almost a quarter of the responders stated that they prefer not to perform emergency surgery with possible a higher patients' risk of losing a testis. Although not supported by literature, it may be explained by the tendency that a successful detorsion in the ER is considered an adequate treatment and that an official orchiopexy can be performed in the following week during daytime. Hence, the essence of emergency surgery should definitely be brought to the attention of urologists and residents in training, as the chance of saving a testis depends on the timing of surgery. To achieve more awareness of this important step in treating testicular torsion, more education and attention to the guideline is needed. As recommended, surgery includes orchidopexy of the ipsilateral and contralateral testis and/or removal of an

atrophic testis. That bilateral orchidopexy should be performed was already an universal agreement in 2002 following a survey filled in by 33 urologist from the North West region of England on treatment of testicular torsion [9]. This was also confirmed by *Almaramhy* et al., as 95% of the pediatric urologist stated to fixated both testes in case of a proven testicular torsion [3]. However, within the present study, 23% of responders do not fix the testis at all during surgery. The reason for this outcome is not clear since there is no literature supporting this method, although this probably has to do with the assumption that the use of sutures during fixation of the testis might influence fertility. A study by *Arap* et al., however, showed no difference in sperm count or motility after orchidopexy versus healthy patients [10]. For patients with bilateral orchidopexy or orchiectomy and fixation of the ipsilateral testis, a pregnancy rate of more than 90% was described by *Gielchinsky* et al. [11].

Considering the technique and material used for incision and fixation, there are no recommendations in the Guideline resulting in a variation of used techniques and materials in this study. Hence, this has not been changed as compared to the variations already showed by *Pearce* et al. in 2002 in the North West of England [9]. Within this study, most of the responders perform a medial incision of the scrotum and fix with a 2- or 3-point fixation, subsequent to a Winkelmann fixation of the tunica vaginalis. A systematic review in 2020 by *Moore* et al. highlighted the absence of quality data analyzing the effect of different surgical techniques on outcomes, such as re-torsions and fertility [12]. Although, predominantly short-term outcomes were presented (6–31 weeks, up to 15 years), a re-torsion of the contra- and ipsilateral testis was not described, whatever surgical approach was used. By analyzing case reports on re-torsions after fixation, *Sells* et al. described a higher incidence of recurrences when absorbable sutures were used, although this might come from the higher number of cases using this material [13]. Considering fixation of the contralateral side there is also a lack of quality data. However, 78% of pubertal boys diagnosed with testicular torsion appeared to have a 'Bell Clapper deformity' of the contralateral testis; indicating the need for fixation of this testis [14].

Some important differences were observed between the Dutch responders and those from abroad. One-third of the Dutch responders preferred to perform surgery on the first occasion in the regular planned list, whereas European responders preferably performed an emergency operation. As the Dutch guideline advises surgical exploration within 6 h, this might be the explanation for this difference [15]. A Winkelmann fixation was actually performed more often by the Dutch responders compared to their European colleagues. The most remarkable difference, however, concerned fixation of the testis. Of the Dutch responders, 32% do not fix the testes using suture material vs. only 2.4% of the responders abroad ($p < 0.001$). This is even more surprising, as the Dutch guideline on testicular torsion also recommends to fixate the ipsi- and contralateral testis. Age and institution showed not to be associated with the decision to fixate or not to fixate the testes. As performing an emergency operation and fixation of the testes are the two cornerstones of treating testicular torsion, this is an important confirmation that, especially

within the Netherlands, a higher level of consciousness is needed of the available guidelines.

A limitation of the current survey is that the questions are possibly answered in the context of this single clinical case. For every individual clinical case, there are nuances and differences. This might have influenced the answers given by the responders. Another limitation is the fact that for the Dutch invitations, a national database by the Dutch Urology Association was used. For the 'European' responders, this was done by a professional network; mostly urologists actively involved within the EAU. Hence, this might explain why the European responders do follow the EAU guidelines more strictly compared to the Dutch responders. The fact that these networks were used to invite respondents for this survey, might have resulted in a response bias. With the assumption that every urologist or resident in training uses and is aware of the EAU guideline in clinical practice, this survey is based on this guideline. Off course, some residents might not even be aware of this guideline or use a national guideline. We do believe that the impact of this group is small, as the EAU guideline is not unique for treatment of testicular torsion and most national protocols in Europa are based on the EAU guideline. Also, information is lacking on the outcome of the different treatment modalities, used materials and timing of surgery. Another limitation is the distribution of responders, 71% were Dutch. Therefore, a balanced comparison between Dutch and European responders was not possible.

Conclusion

Acute testicular torsion is one of the most dramatic urological emergencies for both the patient and his family. When presented in the emergency room, the majority of the responders of this survey appear to follow the EAU Guideline. Even after a successful manual detorsion, an emergency orchidopexy of both testes is usually performed. Surprisingly, during scrotal exploration, many urologists do not perform a surgical fixation after detorsion. The reason for that remains unclear, but might implicate that more awareness of the guideline is needed. This survey showed a wide range of used surgical techniques. For a unified policy, the guideline may provide preferred techniques and materials, which are currently lacking on this subject. Finally, with the widespread availability of ultrasound, to our opinion, this modality could increasingly contribute in diagnosing testicular torsion.

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Conflicts of interest

None.

Ethical approval

Approval for this study was not required.

References

- [1] Greear GM, Romano MF, Katz MH, Munarriz R, Rague JT. Testicular torsion: epidemiological risk factors for orchiectomy in pediatric and adult patients. *Int J Impot Res* 2021; 33(2):184–90.
- [2] Radmayr C, et al. EAU Guideline on Pediatric Urology presented at the EAU Annual Congress Amsterdam 2022. ISBN 978-94-92671-16-5. European Association of Urology Guidelines Office 2022. <http://uroweb.org/guideline/paediatric-urology/>.
- [3] Almaramhy HH. Surgical practice among pediatric surgeons and pediatric urologists in the Kingdom of Saudi Arabia for the management of suspected testicular torsion. *Saudi Med J* 2018;39(12):1232–7.
- [4] Gunther P, Schenk JP, Wunsch R, Holland-Cunz S, Kessler U, Troger J, et al. Acute testicular torsion in children: the role of sonography in the diagnostic workup. *Eur Radiol* 2006;16(11): 2527–32.
- [5] Bandarkar AN, Blask AR. Testicular torsion with preserved flow: key sonographic features and value-added approach to diagnosis. *Pediatr Radiol* 2018;48(5):735–44.
- [6] Sheth KR, Keays M, Grimsby GM, Granberg CF, Menon VS, DaJusta DG, et al. Diagnosing testicular torsion before urological consultation and imaging: validation of the TWIST score. *J Urol* 2016;195(6):1870–6.
- [7] Sessions AE, Rabinowitz R, Hulbert WC, Goldstein MM, Mevorach RA. Testicular torsion: direction, degree, duration and disinformation. *J Urol* 2003;169(2):663–5.
- [8] Visser AJ, Heyns CF. Testicular function after torsion of the spermatic cord. *BJU Int* 2003;92(3):200–3.
- [9] Pearce I, Islam S, McIntyre IG, O’Flynn KJ. Suspected testicular torsion: a survey of clinical practice in North West England. *J R Soc Med* 2002;95(5):247–9.
- [10] Arap MA, Vicentini FC, Cocuzza M, Hallak J, Athayde K, Lucon AM, et al. Late hormonal levels, semen parameters, and presence of antisperm antibodies in patients treated for testicular torsion. *J Androl* 2007;28(4):528–32.
- [11] Gielchinsky I, Suraqui E, Hidas G, Zuaiteir M, Landau EH, Simon A, et al. Pregnancy rates after testicular torsion. *J Urol* 2016;196(3):852–5.
- [12] Moore SL, Chebbout R, Cumberbatch M, Bondad J, Forster L, Hendry J, et al. Orchidopexy for testicular torsion: a systematic review of surgical technique. *Eur Urol Focus* 2021; 7(6):1493–503.
- [13] Sells H, Moretti KL, Burfield GD. Recurrent torsion after previous testicular fixation. *ANZ J Surg* 2002;72(1):46–8.
- [14] Martin AD, Rushton HG. The prevalence of bell clapper anomaly in the solitary testis in cases of prior perinatal torsion. *J Urol* 2014;191(5 Suppl):1573–7.
- [15] Acute NvU. Urologische Diagnostiek en Therapie; torsio testis. Nederlandse Vereniging voor Urologie; 2015.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpuro.2022.09.020>.