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# Point-of-care ultrasonography for the diagnosis of testicular torsion: a practical resident curriculum

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**Background:** Prompt Doppler ultrasonography to aid in diagnosis is often key to managing testicular torsion, but there may be delays in access; a faster, more widely available alternative is point-of-care ultrasonography (POCUS). The purpose of this study was to develop and evaluate a scrotal POCUS curriculum for urology and emergency medicine residents.

**Methods:** Content experts in urology, emergency medicine and diagnostic imaging collaborated in a modified Delphi method to design a practical didactic curriculum for scrotal POCUS for the identification of testicular torsion. Training included 3 online video teaching modules and a 1-hour hands-on teaching session with standardized adult patients. We evaluated participants' competency in scrotal POCUS using a validated scale. We assessed participants' knowledge, comfort and confidence in performing scrotal POCUS before and after the intervention and at 3 months.

**Results:** Twenty-four urology ( $n = 12$ ) and emergency medicine ( $n = 12$ ) residents participated in the curriculum. After hands-on practice, 23 participants (96%) were deemed competent at scrotal POCUS. Pre-post testing showed significant improvement in knowledge (mean score 63% v. 80%,  $p < 0.001$ ), comfort (mean Likert score 0.6 v. 3.6,  $p < 0.001$ ) and confidence (mean Likert score 1.0 v. 2.1,  $p < 0.001$ ) after the intervention. These effects were maintained at the 3-month assessment.

**Conclusion:** The scrotal POCUS curriculum was effective and acceptable to both urology and emergency medicine residents. The findings suggest that scrotal POCUS can be learned effectively through a short hands-on session and didactic instruction.

**Contexte :** Le diagnostic rapide d'une torsion testiculaire à l'aide d'une échographie Doppler est souvent crucial à la prise en charge de ce trouble. Or, comme l'accès à cet examen peut être limité, l'échographie portable constitue une solution de rechange rapide et largement accessible. La présente étude visait la mise au point et l'évaluation d'un programme de formation sur l'échographie portable scrotale destiné aux résidents en urologie et en médecine d'urgence.

**Méthodes :** Des experts en urologie, en médecine d'urgence et en imagerie diagnostique se sont servis d'une méthode Delphi modifiée pour concevoir un programme de formation sur l'échographie portable visant à faciliter le diagnostic de la torsion testiculaire. Ce programme comprenait 3 modules d'apprentissage vidéo en ligne, ainsi qu'une séance pratique d'une heure auprès de patients adultes normalisés. Nous avons évalué les compétences des participants en matière d'échographie portable scrotale au moyen d'une échelle validée. Nous avons également évalué les connaissances, l'aisance et le niveau de confiance des participants à l'égard de cet examen avant et immédiatement après la formation, puis 3 mois plus tard.

**Résultats :** Au total, 24 résidents en urologie ( $n = 12$ ) et en médecine d'urgence ( $n = 12$ ) ont suivi le programme de formation. Après la séance pratique, 23 participants (96%) avaient les compétences nécessaires à la réalisation d'une échographie portable scrotale. La comparaison des résultats obtenus avant et immédiatement après la formation a montré une augmentation significative des connaissances (note moyenne : 63% c. 80%;  $p < 0,001$ ), de l'aisance (moyenne à l'échelle de Likert : 0,6 c. 3,6;  $p < 0,001$ ) et du niveau de confiance (moyenne à l'échelle de Likert : 1,0 c. 2,1;  $p < 0,001$ ) des participants. Les effets de la formation étaient toujours présents 3 mois plus tard.

**Conclusion :** Le programme de formation sur l'échographie portable scrotale s'est avéré efficace et acceptable pour les résidents en urologie et en médecine d'urgence. Les résultats obtenus laissent croire qu'une formation pédagogique et une courte séance d'apprentissage pratique permettent l'enseignement efficace de l'échographie portable scrotale.

**T**esticular torsion is a urologic emergency. It occurs primarily in males aged 10–19 years, with a prevalence of 1 in 4000.<sup>1</sup> Patients classically present with acute-onset scrotal pain, nausea and vomiting. Testicular torsion is a clinical diagnosis, but scrotal Doppler ultrasonography is often used as a diagnostic adjunct. Scrotal Doppler ultrasonography is considered 97% accurate in diagnosis.<sup>2</sup> Management of torsion is prompt scrotal exploration, detorsion and orchiopexy, as testicular viability decreases over time. Testicular salvage rates are upward of 90% if exploration occurs within the first 6 hours of symptom onset. These rates drop precipitously thereafter, to about 60% at 13 hours and 50% by 24 hours.<sup>3</sup>

Prompt Doppler ultrasonography to aid in diagnosis is often key to managing testicular torsion. However, Chan and colleagues<sup>4</sup> found that there was a 48-minute delay in having Doppler ultrasonography performed in patients who presented with testicular torsion to a Canadian academic hospital. In smaller centres, this delay may be even longer because of the need to call the ultrasonography technologist in from home or to transfer patients to larger centres. Overholt and colleagues<sup>5</sup> found that in cases in which the patient required transfer for Doppler ultrasonography, there was a 6-hour delay to treatment. Such delays may lead to delays in definitive management and increased rates of testicular loss.

A safe, faster, inexpensive alternative to formal Doppler ultrasonography is point-of-care ultrasonography (POCUS), which is readily available in most emergency departments. In Ontario, the cost of POCUS performed by an emergency physician falls within the physician's original assessment fee, whereas formal Doppler ultrasonography costs \$47.30 to perform and \$23.80 for a radiologist to interpret the sonograms.<sup>6</sup> Friedman and colleagues<sup>7</sup> reported that POCUS for acute scrotum assessment had a specificity of 99% and agreement of 70% compared to formal Doppler ultrasonography. More important, agreement was 100% for true testicular torsion, and all true-positive cases were identified by POCUS. In addition, on average, diagnosis with POCUS was 73 minutes faster than with formal Doppler ultrasonography. Half of the patients diagnosed with testicular torsion from POCUS examination were taken directly to the operating room without having formal Doppler ultrasonography performed. This study highlights the potential for POCUS to save both time to treatment and cost of investigation. As such, it is important to have a curriculum to teach practitioners the skills required to assess for testicular torsion using POCUS.

In 2015, the International Federation for Emergency Medicine issued a guideline in an attempt to standardize POCUS education.<sup>8</sup> The federation identified 4 key components to training: initial introduction, gaining experience, achieving competency and maintaining skills. Studies

have also shown that small-group learning using case examples and hands-on teaching is most effective for skills acquisition.<sup>9,10</sup> Our multidisciplinary group sought to develop and validate a scrotal POCUS curriculum for urology and emergency medicine residents.

## METHODS

### Setting

Curriculum development, training and resident evaluation were carried out in teaching hospitals at a tertiary care academic hospital. These hospitals are tertiary care centres with accredited Royal College of Physicians and Surgeons of Canada Urology and Emergency Medicine training programs. As this was a quality-improvement initiative, research ethics board approval was not required. The study period was February to May 2019.

### Participants

All residents (postgraduate years 1–5) actively enrolled in residency training in urology or emergency medicine were recruited by email invitation and consented to participate in our study. None had ever used POCUS clinically to assess for testicular torsion.

### Design

We used a modified Delphi method to reach a consensus on curriculum objectives and study design. A group of experts in urology (P.Z.T.W., S.D., H.R.), emergency medicine (G.B.) and diagnostic imaging (F.M.) participated in consolidating the objectives for the POCUS curriculum. They decided on specific knowledge and technical skills required to perform competent scrotal POCUS.

These objectives formed the blueprint for the curriculum, which we used to develop online video teaching modules, knowledge-based tests and practical assessment metrics. We developed 3 video modules, each about 10 minutes in duration, covering information and anatomy related to the scrotum, basics of POCUS, how to generate and interpret images, and specifics of scrotal POCUS techniques, including assessment of torsion. Comfort and confidence were deemed outcome measures to assess whether residents had gained the skills required to perform scrotal POCUS.

All members of the expert group reviewed the video modules and tests to ensure appropriateness, effectiveness and correctness of disseminated information. Multiple rounds of edits and adjustments occurred based on expert feedback until consensus within the group was met.

We selected a pre–post–retention design as a means of assessing the curriculum.

## Intervention

Before the intervention, the participants completed a pre-test consisting of knowledge-based questions including visual recognition questions on testicular torsion and POCUS. Data were collected on level of experience with POCUS as well as initial comfort and confidence with scrotal POCUS. We assessed comfort using a 6-point Likert scale ranging from 0 (extremely uncomfortable) to 5 (very comfortable), and confidence using a 4-point Likert scale ranging from 0 (not confident) to 3 (very confident). We measured the time required to visually recognize testicular torsion as a surrogate marker for improvement in image recognition. The participants then completed questions assessing their ability to identify flow or no flow (torsion or not) on scrotal POCUS images. They were assessed based on their time to decision and accuracy. Details regarding interventions and the outcome measures are displayed in Figure 1.

The residents then watched the 3 teaching video modules, after which they participated in a hands-on teaching session during which experts instructed them on POCUS techniques. Standardized patients were used for hands-on practice of scrotal POCUS. The residents practised for 1 hour and were then evaluated by the experts using the Objective Structured Assessment of Ultrasound Skills (OSAUS) scale, a validated tool for assessment of POCUS competence.<sup>11</sup> The OSAUS scale assesses knowledge of indication for examination, knowledge of ultrasonography equipment, image optimization, systematic examination, image interpretation, documentation of findings and integration of findings into medical decision-making. Each criterion is graded on a scale from 1 (lowest) to 5 (highest). A score of 4 on each criterion of the OSAUS scale was set a priori to indicate competence. A score of 4 meant the resi-

dent was able to operate the equipment with expertise, was competent at image optimization, displayed a systematic approach, correctly interpreted the findings and documented the findings appropriately. For internal validity, the experts also scored each other.

After the hands-on training, participants completed a post-test containing the same knowledge and visual recognition questions as the pretest. Feedback regarding enjoyment and effectiveness of the curriculum, beneficial aspects, improvements and future benefit was obtained via Likert ratings and open-ended questions on the post-test (Appendix 1, available at [canjsurg.ca/019119-a1](http://canjsurg.ca/019119-a1)). Participants were asked whether they would find a refresher course beneficial to assist them in using scrotal POCUS going forward and whether a quick refresher video would be beneficial.

The post-test test was readministered 3 months later to assess knowledge retention, and comfort and confidence performing scrotal POCUS.

## Outcomes

The primary outcome was the effectiveness of the intervention at teaching scrotal POCUS to identify testicular torsion. Secondary outcomes were acceptability of the curriculum and feedback related to curriculum improvement.

## Statistical analysis

We performed statistical analysis using matched pairing to assess for change in comfort, confidence and knowledge. For assessment of image recognition, we compared the mean time to identification of flow or no flow and proportion of images identified correctly before and after the intervention. Feedback was reported descriptively.

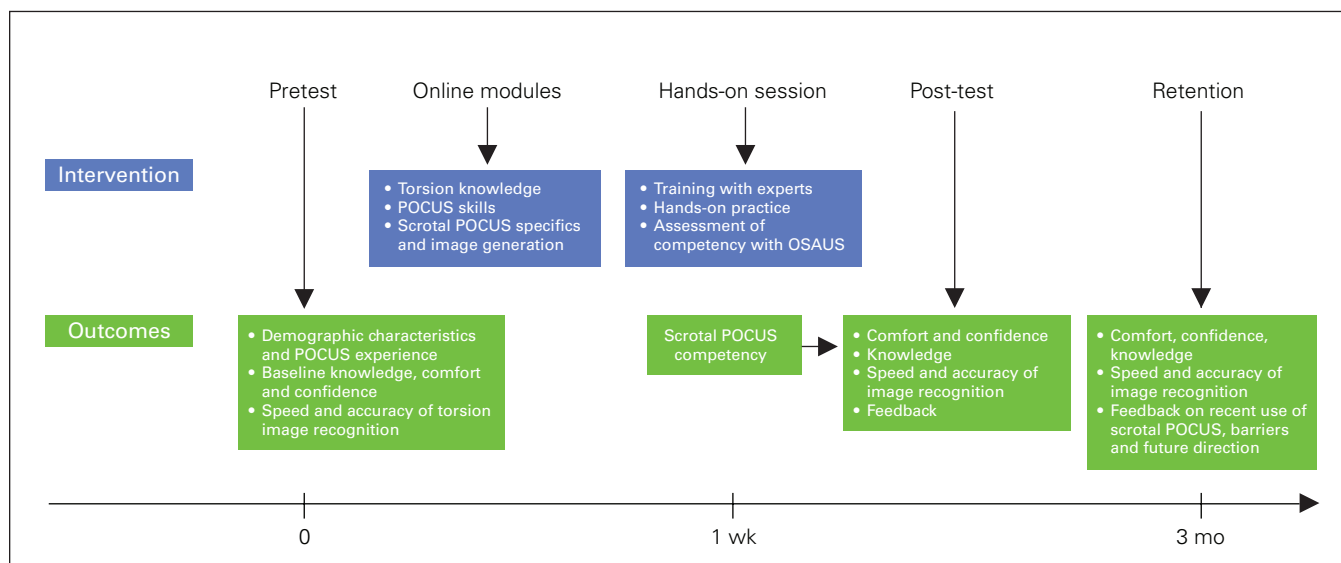


Fig. 1. Study design. OSAUS = Objective Structured Assessment of Ultrasound Skills scale; POCUS = point-of-care ultrasonography.

**Table 1. Comparison of residents' outcomes before and after a scrotal point-of-care ultrasonography curriculum, and before and 3 months after**

Outcome	Mean score <i>n</i> = 24			Mean score <i>n</i> = 15		
	Before intervention	After intervention	<i>p</i> value	Before intervention	3 mo after intervention	<i>p</i> value
Knowledge	63%	80%	< 0.001	63%	75%	0.08
Comfort*	0.6	3.6	< 0.001	0.8	3.2	< 0.001
Confidence†	1.0	2.1	< 0.001	1.2	2.4	0.004

\*Assessed on 6-point Likert scale ranging from 0 (extremely uncomfortable) to 5 (very comfortable).  
†Assessed on 4-point Likert scale ranging from 0 (not confident) to 3 (very confident).

## RESULTS

Twenty-four residents (12 from urology and 12 from emergency medicine) were recruited. None had performed more than 5 scrotal POCUS examinations before the study. Ten residents (42%) had no formal POCUS training, 11 (46%) had minimal exposure, and 3 (12%) had prior formal POCUS training.

After hands-on practice, 23 participants (96%) were deemed competent at scrotal POCUS. All the experts involved in the study met the same criteria of competency when scored with the OSAUS scale.

Pre-post testing showed significant improvement in knowledge after the intervention (mean score 63% v. 80%,  $p < 0.001$ ) (Table 1). Participants were more comfortable (mean Likert score 0.6 v. 3.6,  $p < 0.001$ ) and more confident (mean Likert score 1.0 v. 2.1,  $p < 0.001$ ) using scrotal POCUS to assess for testicular torsion after the intervention.

There were 20 respondents (15 pairs) for comparison of the pretest results to the 3-month results for analysis of retention. The results for knowledge at 3 months were similar to those immediately after the intervention (82% v. 75%,  $p = 0.08$ ) (Table 1). At 3 months, participants remained somewhat comfortable or comfortable with performing scrotal POCUS, and there was no significant difference in their comfort level compared to immediately after the intervention ( $p = 0.4$ ). Eighteen residents (90%) still felt confident in their ability to interpret images, 1 (5%) felt moderately confident, and 1 (5%) did not feel confident.

The feedback regarding the overall curriculum was positive, with a mean Likert score of 3.5 (helpful/very helpful). Nineteen respondents provided feedback on the hands-on session with POCUS experts; almost all found the session to be beneficial (mean Likert score 4.5 [effective/very effective]). Participants also found the video modules to be effective, but slightly less than the hands-on training (mean Likert score 4.0). Five respondents (26%) felt that no improvements to the curriculum were needed, 3 (16%) felt it would be beneficial to have standardized patients with real disorders, and 2 (10%) suggested a smaller trainee group size.

The limitation most commonly cited was the lack of patients with possible torsion for residents to practise scanning going forward. Participants also mentioned concern related to using the ultrasonography machine and having timely access to the machine. Some emergency medicine residents were concerned about staff comfort with scrotal POCUS.

Ten participants (50%) felt that the most difficult part of scrotal POCUS was identifying flow versus no flow, and 9 (45%) felt that using the ultrasonography machine was the most difficult. Participants, on average, felt somewhat confident with their “knobology” skills (ability to use the ultrasonography machine to generate images) (mean Likert score 3.2).

Four participants (20%) felt a refresher course would be helpful, 10 (50%) did not think such a course would be necessary, and 6 (30%) were uncertain. Almost all (19 [95%]) felt a quick refresher video would be beneficial.

The opportunity to use POCUS in appropriate clinical care scenarios since the training was limited: 14 participants (70%) had had no opportunity to use their skills, 4 (20%) had had 1–5 opportunities, and 2 (5%) had used scrotal POCUS 6 times or more.

## DISCUSSION

Point-of-care ultrasonography is inexpensive and has been shown to be a reliable means of diagnosing testicular torsion.<sup>7</sup> This study highlights the success of a curriculum to teach an interdisciplinary group of residents with varying prior experience with POCUS the skills required to perform scrotal POCUS for identification of testicular torsion. Knowledge, confidence, comfort were all improved after the curriculum. Participants also improved their speed of torsion diagnosis when assessing POCUS images. These improvements were retained at 3 months. The hands-on session was effective, rendering 96% of participants competent in the technical skills of scrotal POCUS.

This curriculum was designed in accordance with the structure detailed by the International Federation for Emergency Medicine, which recommends that POCUS

curricula should include 4 stages: introduction, experience acquisition, competency confirmation and skills maintenance.<sup>8</sup> The introduction of our curriculum included the video modules and hands-on training. The use of video modules and hands-on training allowed participants the opportunity to learn how to perform scrotal POCUS and diagnose testicular torsion. Although hands-on practice time was limited, it enabled the participants to increase their comfort and confidence levels, and this was maintained at 3 months. Further experience was acquired through practice with standardized patients. Competency was assessed with the OSAUS scale, and maintenance of skills was encouraged in the form of continued use of POCUS. However, as POCUS performance was limited owing to a restricted number of patients presenting with acute scrotum within the 3-month follow-up period, we plan to develop a video to promote skill maintenance.

Residents felt that too much time was spent on the video modules and not enough time on hands-on training. They also suggested that the ability to scan patients with real disorders would be beneficial. In future iterations of this curriculum, the video portion will be shortened and the hands-on portion will be longer. If possible, standardized patients with different disorders (epididymitis, mass, orchitis) will be used. If this is not possible, a low-fidelity model to simulate various scrotal disorders will be used. To improve the comfort of residents who have had minimal scanning opportunity before assessing a patient with POCUS, we are developing a short review video on the knobology of scrotal POCUS, as well as a brief tutorial on how to perform scrotal POCUS. The video could be saved onto a cell phone and watched before performing scrotal POCUS.

### Limitations

The main limitation of this study is the small sample. A larger sample with more diversity in POCUS experience would help to better assess the curriculum. Another limitation is that only adult standardized patients without testicular torsion were used. In future iterations of the curriculum, standardized patients with different disorders will be used if possible.

### CONCLUSION

The curriculum described was an effective means of teaching residents to perform scrotal POCUS. It was acceptable to both urology and emergency medicine residents. Significant improvements in knowledge of and comfort, confidence and competence in performing scrotal POCUS were observed. In a health care climate of limited resources and often insufficient access to diagnostic

imaging, POCUS can assist physicians in the prompt diagnosis of testicular torsion and potentially improve rates of testicular salvage.

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**Competing interests:** None declared.

**Contributors:** L. Stringer, S. Cocco, E.P. Chan, F. Myslik, G. Brahm, S. Dave and P.Z.T. Wang designed the study. L. Stringer, S. Cocco, A. Jiang, F. Myslik and G. Brahm acquired the data, which L. Stringer, S. Cocco, A. Jiang, F. Myslik, H. Razvi and P.Z.T. Wang analyzed. L. Stringer, S. Cocco and F. Myslik wrote the article, which L. Stringer, S. Cocco, E.P. Chan, F. Myslik, G. Brahm, H. Razvi, S. Dave and P.Z.T. Wang critically revised. All authors gave final approval of the article to be published.

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