

VOIDING CYSTOURETHROGRAPHY USING THE SUPRAPUBIC VERSUS TRANSURETHRAL ROUTE IN INFANTS AND CHILDREN: RESULTS OF A PROSPECTIVE PAIN SCALE ORIENTED STUDY

JOSEF OSWALD, MARCUS RICCABONA, LUKAS LUSUARDI, HANNO ULMER, GEORG BARTSCH
AND CHRISTIAN RADMAYR

From the Department of Urology and Institute of Biostatistics, University of Innsbruck, Innsbruck and Department of Pediatric Urology, Linz, Austria

ABSTRACT

Purpose: We determined the advantages and disadvantages of different types of contrast medium injection into the bladder for imaging children during evaluation for urinary tract infection in regard to child behavior and distress during urethral catheterization or suprapubic puncture.

Materials and Methods: From December 2000 to September 2001 we prospectively compared transurethral catheter and suprapubic voiding cystourethrography in children with a history of urinary tract infection. A total of 65 children with a mean age of 33.8 months were entered into the study, of whom 32 underwent transurethral catheterization and 33 underwent suprapubic puncture with topical anesthesia. Each child was evaluated, particularly in regard to discomfort and pain using an objective pain score that measures stress and pain during a medical procedure.

Results: Objective pain score recording showed a mean pain score plus or minus SD of 4.25 ± 1.3 in the transurethral catheterization and 3.03 ± 1.21 in the suprapubic puncture groups. Correlation studies of age in the 2 groups also showed a significant impact of age on the objective pain score. In the transurethral group the score increased with age ($p < 0.001$), whereas in the suprapubic group it decreased with age ($p < 0.001$).

Conclusions: The current study shows that the suprapubic puncture technique with topical anesthesia was well tolerated and associated with a low pain score independent of patient age. Transurethral catheterization was also tolerated but it was associated with a low pain score only in the younger age group. Thus, we recommend that voiding cystourethrography in children older than 24 months should be done via the suprapubic route.

KEY WORDS: bladder, urethra, diagnostic imaging, pain, catheterization

Vesicoureteral reflux, which has been identified as a risk factor for febrile urinary tract infection, is present in 18% to 40% of children evaluated for an initial urinary tract infection.¹ Infants and young children with urinary tract infection and fever are at highest risk for renal damage due to recurrent urinary tract infections. Current guidelines of the American Academy of Pediatrics on detecting vesicoureteral reflux after an initial urinary tract infection in febrile infants and children 2 months to 2 years old recommend voiding cystourethrography as the standard diagnostic method.² Voiding cystourethrography is also commonly performed in children with prenatally diagnosed hydronephrosis and voiding abnormalities. The procedure should analyze bladder capacity, contour, emptying capability, reflux presence and grade, and the appearance of the bladder neck and urethra.

Clinical experience indicates that urethral catheterization is often perceived by the child and parents as an invasive and painful procedure. Health care professionals are challenged to help the child and parents through the procedure in an effective manner and with minimal distress.³ Alternatively the suprapubic route for injecting contrast medium during voiding cystourethrography in children is time tested.^{4,5} Particularly in regard to establishing less painful diagnostic procedures in pediatric urology we performed a prospective study comparing suprapubic puncture versus transurethral catheterization. Since more than 200 suprapubic voiding cystourethrograms yearly are performed at our department of urology, we are familiar with this technique. In addition to

the fact that contrast medium may be safely and easily placed into the bladder via the suprapubic route, this technique is also ideal for studying vesicoureteral reflux, neurogenic bladder, urethral stricture and posterior urethral valves.

Infants and children with urinary tract infection are of particular concern because the risk of renal damage is greatest in this age group. Since the diagnosis is frequently challenging and the clinical presentation tends to be nonspecific, a strategy that minimizes false-negative and false-positive results should be used. Urine obtained by suprapubic aspiration is least likely to be contaminated and it may be collected at the same examination. This technique has been considered the gold standard for urine sampling to detect significant bacteriuria in children.⁶

MATERIALS AND METHODS

A total of 40 girls and 25 boys with a mean age of 33.8 months (range 1 to 84) were entered into the study and available for evaluation. Patients were assigned in random fashion to the 2 groups using medical record numbers created by 2 computer generated lists. The table lists patient characteristics. There were no significant differences in age and sex in the 2 groups.

To decrease distress behavior associated with voiding cystourethrography we taught parents some weeks before the investigation how to provide the child with a candid explanation of the diagnostic procedure. As a result of appropriate

Accepted for publication July 19, 2002.

	Patient characteristics		p Value
	Technique		
	Transurethral	Suprapubic	
No. pts.	32	33	
Age (mos.):			0.52 (Mann-Whitney U test)
Mean \pm SD	29.4 \pm 22.77	32.88 \pm 23.44	
Median	21.5	32	
Range	2–84	1–86	
No. boys/girls	12/20	13/20	1 (Fisher's exact test)

preparation, all parents agreed to study enrollment and no child was excluded from analysis. After informed consent was obtained fluoroscopy was done and voiding cystourethrography was performed in standard fashion. When the flow of meglumine iodipamide contrast medium stopped and complete bladder filling was presumed, steep oblique images of the bladder centered on the ureterovesical junction were obtained. Images were also obtained during voiding as well as in the post-void phase for a final assessment of reflux, enabling the detection of the most common pathological conditions with low radiation exposure.⁷ The whole urethra was imaged. The cycle of fluoroscopic cystography was repeated in the 2 groups if vesicoureteral reflux was not observed during bladder filling and voiding cycle 1, and/or if predicted bladder capacity was not attained. The study was repeated to avoid underestimating the presence or degree of reflux.⁸

Transurethral technique. Transurethral bladder catheterization was done according to a standard aseptic procedure.⁹ After manual labial separation in girls and prepuce retraction in boys, and after accurate meatal cleaning using 10% povidone-iodine solution the bladder was catheterized with an 8Fr latex-free feeding tube lubricated with sterile water-soluble surgical lubricating jelly containing the local anesthesia lignocaine hydrochloride. A catheter was advanced into the bladder and taped along the lower abdomen in boys or to the inner thigh in girls. We routinely recommend antibiotic prophylaxis in children who undergo voiding cystourethrography via the transurethral technique to prevent infection secondary to bladder catheterization.¹⁰

Suprapubic technique. In all children a eutectic mixture of local anesthetic cream containing lidocaine and prilocaine was applied to the pubis 1 hour before starting the procedure. Preliminary abdominal ultrasound was done to ensure adequate bladder filling, allowing safe bladder puncture. Suprapubic voiding cystourethrography was performed by sterile bladder puncture in the midline 1 to 2 cm. above the symphysis pubis using an 18 to 21 gauge needle. The needle was angled 10 to 15 degrees cranial to avoid puncturing the trigone. The needle was attached to a 20 cm. tube connected to a stopcock, enabling separate urine aspiration and contrast medium infusion. After puncture the bladder was filled with contrast medium until the child started to void. The needle remained in place for a second cycle of bladder filling when no reflux was visualized. This maneuver prevented false-negative results possibly caused by insufficient contrast material due to intermixture with urine.

Pain assessment. A number of tools for evaluating pain in children have been developed and are currently in use throughout the United States and Europe.¹¹ Objective pain assessment is reliably performed using the objective pain score,¹² which is independent of subjective pain reporting by parents, the child or medical staff. Because it is based on objective criteria, such as tachycardia, measuring pain responses to painful procedures is possible in infants and children. Pain was assessed by the investigator by monitoring blood pressure elevation, crying, movement, agitation and verbal complaints or body language of pain. Each variable contributed 0 to 2 points for a cumulative score of between 0 and 10 (see Appendix). A score of 4 or more when managing

postoperative pain in children normally indicates an analgesic requirement.¹³

Statistical analysis. Data are shown as the mean plus or minus SD, median and range. The 2 groups were compared using the Mann-Whitney U or Fisher exact test as appropriate. Associations of the objective pain score with gender and age were evaluated by calculating Spearman's correlation coefficient with $p < 0.05$ considered statistically significant.

RESULTS

During the 10 months from December 2000 to September 2001 we recruited 32 children into the transurethral group and 33 into the suprapubic group for a total of 40 girls and 25 boys. In approximately 30% of the children without bladder control ultrasound revealed inadequate bladder filling that was unsuitable for safe puncture. Consequently latency until the next bladder filling was accepted. In the meantime parents were asked to provide the children with liquid until bladder filling was confirmed by ultrasound after 30 to 60 minutes. No major complications caused by the 2 techniques were noted. In the transurethral group catheterization was repeated in 3 of 8 girls with a mean age of 18 months due to primary vaginal dislocation of the feeding tube. In that group catheterization was also repeated in 2 boys with severe phimosis. In 3 of the 33 children in the suprapubic group the needle was dislocated during voiding. Because sufficient reflux was noted before needle dislocation in 2 cases, puncture was not repeated. In 1 child in whom no reflux was noted a repeat procedure was mandatory.

There was an overall statistically significant difference in the objective pain score in the transurethral and suprapubic groups (mean 4.25 ± 1.3 , median 4 and range 2 to 7 versus mean 3.03 ± 1.21 , mean 3 and range 1 to 5, $p = 0.001$). In the 40 girls in the transurethral and suprapubic groups the mean and median pain scores were 4.2 ± 1.24 and 4 (range 2 to 7), and 2.7 ± 1.26 and 3 (range 1 to 5), respectively ($p = 0.001$, fig. 1). However, in the 25 boys in the transurethral and suprapubic groups the mean and median scores were 4.33 ± 1.44 and 4 (range 2 to 6), and 3.54 ± 0.97 and 4 (range 2 to 5), which was not statistically significant ($p = 0.186$), probably due to the smaller number of patients. Patient age correlated significantly with the pain assessed for the 2 techniques of instilling contrast medium. In the transurethral group the objective pain score increased with age ($r = 0.593$, $p < 0.001$) whereas in the suprapubic group it decreased with age ($r = -0.686$, $p < 0.001$, fig. 2). This finding was noted in girls and boys.

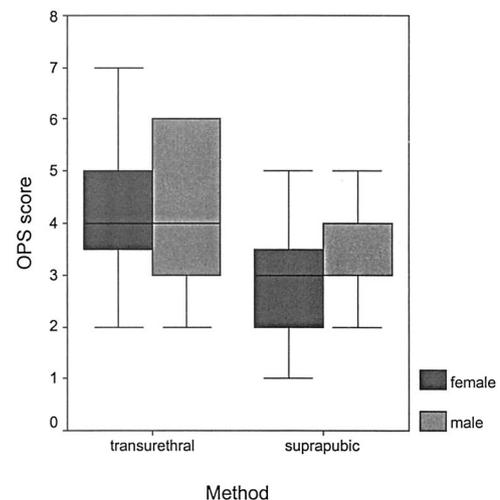


FIG. 1 Objective pain score (OPS) according to gender and method. Horizontal lines indicate median. Boxes indicate IQR. Whiskers indicate range.

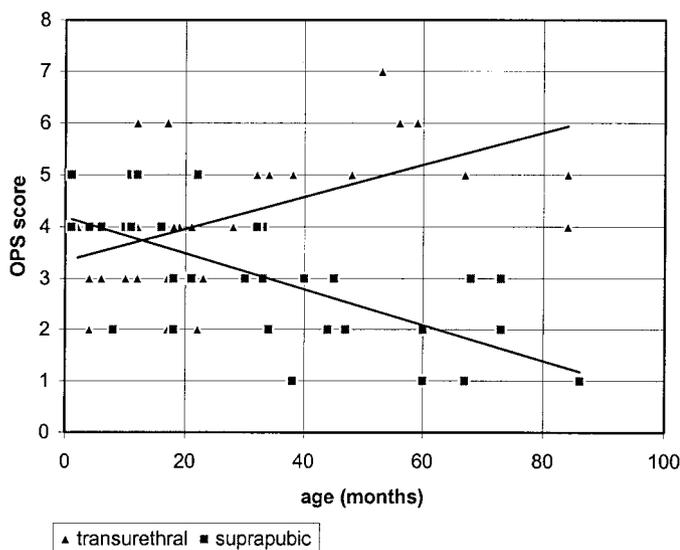


FIG. 2. Objective pain score (OPS) according to age and method

DISCUSSION

Diagnostic techniques and clinical interventions necessarily cause pain and mental strain, which are sometimes avoidable.¹⁴ There has been increased focus on child and adolescent pain, for example acute pain in venepuncture, nonacute pain and psychological factors of pain as well as the importance of stress management.¹⁵ The pain of diagnostic procedures is under treated in children. Children should be respected as an authority according to their perception of pain associated with diagnostic methods. The overall pain experience as well as behavioral responses depend not only on the sensory responses associated with a noxious stimuli, but also on individual factors, such as on child emotional components, previous experience, observational learning and developmental level. In children the inability to understand instructions and describe pain is a problem in pediatric pain assessment,¹⁶ although pain evaluation in children is necessary for evaluating diagnostic procedures in infancy. The memory of children of the features of the voiding cystourethrography experience are striking because this invasive procedure is similar in many respects to incidents of sexual abuse. Children undergoing transurethral catheterization remembered 88% of the component features of the voiding cystourethrography experience at the initial assessment and 83% after 6 weeks.¹⁷ Behavioral and salivary cortisol measures indicated that the children were distressed during the procedure. The relationship of emotion to pain is well recognized in childhood.¹⁸ The developing sense of shame in older children is especially affected by the amount of direct exposure during transurethral catheterization. In addition, the special features of the male urethra in regard to its length and curvature as well as sensibility are incriminating circumstances in older boys. Children feel disgust especially with diagnostic tests in infancy, such as repeat voiding cystourethrograms, whereas mastering these challenging life experiences with minimal distress contributes to the evolving self-concept of a child.¹⁹ To avoid repeat voiding cystourethrograms and, thus, decrease child discomfort pediatric urologists recommend omitting voiding cystourethrography after ureteral reimplantation due to the success rate of up to 98% of standard ureteral reimplantation.²⁰

Post-procedural symptoms in children who undergo voiding cystourethrograms secondary to catheterization include perineal discomfort, dysuria, urinary retention, gross hematuria and intermittent enuresis. Zerlin and Shulkin reported

data on the frequency, nature and duration of symptoms after cystography in 100 successive children who underwent voiding cystourethrography after the administration of iothalamate meglumine.²¹ The 2 control groups included 100 successive children who underwent radionuclide cystography and 28 successive children who underwent diuretic renal scintigraphy and in whom a urethral catheter was placed, respectively. Post-procedural symptoms were reported in 35.1% of those who underwent voiding cystourethrography and in the 2 control groups. Boys complained of symptoms significantly more often than girls ($p \leq 0.0005$). With adequate parent and patient preparation the discomfort and anxiety of voiding cystourethrography can be decreased. Preparation of the child must be tailored to the developmental level of the child.³ However, while our results clearly show that discomfort and anxiety are associated with catheter insertion, there was a statistically significant difference in the mean pain score in the transurethral and suprapubic groups as well as in older children ($p < 0.001$), confirming that age is a predictor of pain in children.²²

Since we know that behavioral reactions and the degree of pain do not always correlate,²³ we think that the significant difference determined by the objective pain score in our study may be the most appropriate expression of sensitivity to painful stimuli in children. These stimuli could be dramatically decreased or avoided using the suprapubic puncture technique combined with topical anesthesia. The lower pain score in older children in the suprapubic puncture group may have been related to the lower sensitivity of anesthetized skin compared with that of the urethra. Furthermore, a safe and essential examination showing the whole male urethra without irritating the sensitive urethral mucosa and artificial interference due to the catheter is only possible via the suprapubic voiding cystourethrography technique. This examination is needed to diagnose congenital urethral anomalies, such as posterior and anterior urethral valves, anterior urethral diverticulum, megalourethra or the male variant of spinning top urethra.²⁴ The diagnosis of congenital posterior lesions causing obstruction in children is challenging. Recently a study showed that infravesical urethral pathology was due more to urethral membranes than urethral valves.²⁵ Therefore, urethral studies in children should be performed without touching this pathological region of interest.

Minor criticisms are related to the mandatory requirement of a full bladder for puncture, especially in children without bladder control. The amount of bladder filling must be controlled on ultrasound by puncture. Bladder trained children can express the urge to void, indicating sufficient bladder volume for puncture. Therefore, especially in younger children without bladder control the suprapubic voiding cystourethrography technique is more time-consuming since it requires time to achieve a full bladder. At the outset several hours are projected for this investigation at our department, so that enough common rooms with child care are available. Inexperienced investigators may dislocate the needle when the child voids, displacing the needle tip out of the bladder. For these reasons the suprapubic voiding cystourethrography technique is not widely accepted. A second cycle of bladder filling is not always possible subsequently. To avoid these problems an intravenous cannula could be used instead of a needle. The drawbacks of this technique include insufficient cannula length, especially in older children. Also, handling requires more time circumstantially, prolonging the study unnecessarily. An alternative to the intravenous cannula that would provide sufficient length could be an epidural catheter passing through an 18-gauge Tuohy needle, which is usually used for intraoperative and postoperative analgesia in infants and children.

CONCLUSIONS

We believe that performing voiding cystourethrography with the suprapubic technique combined with topical anesthesia in children older than 24 months provides the advantage of decreasing pain and discomfort in children during the diagnosis of infravesical and supravvesical abnormalities. Consequently we emphasize the importance of providing a less painful investigation modality in older children using

suprapubic voiding cystourethrography. In the future more attention must be routinely given to the psychological well-being of children undergoing elective diagnostic procedures. More research is required in this area because children have a right to receive high quality medical investigations, including systematic assessment and relief of pain symptoms.

M. Deibl, Institute of Biostatistics, Innsbruck, Austria assisted with statistical studies.

APPENDIX: OBJECTIVE PAIN SCORE

	O	1	2
Facial Expression	Relaxed muscles	Grimace	Tight facial Muscles
Crying	Not Crying	Crying but Easily calmed	Inconsolable
Moving	None	Restless	Thrashing
Agitation	Sleeping	Mild	Hysterical
Increased vital Signs	Heart rate and blood pressure at Baseline	Heart rate and blood pressure < 20%	Heart rate and blood pressure > 20%

REFERENCES

- Dick, P. T. and Feldman, W.: Routine diagnostic imaging for childhood urinary tract infection: a systematic overview. *J Pediatr*, **128**: 15, 1996
- Practice parameter: the diagnosis, treatment, and evaluation of the initial urinary tract infection in febrile infants and young children. American Academy of Pediatrics. Committee on Quality Improvement. Subcommittee on Urinary Tract Infection. *Pediatrics*, **103**: 843, 1999
- Kleiber, C. and McCarthy, A. M.: Parent behavior and child distress during urethral catheterization. *J Soc Pediatr Nurs*, **4**: 95, 1999
- Omogbehin, B. and Willich, E.: Suprapubic micturition cystourethrography in infancy and childhood. *Pediatr Radiol*, **3**: 20, 1975
- Mohammed, S. H.: Suprapubic micturition cystourethrography. *Acta Radiol*, **29**: 165, 1988
- Jodal, U.: The natural history of bacteriuria in childhood. *Infect Dis Clin North Am*, **1**: 713, 1987
- Kleinman, P. K., Diamond, D. A., Karellas, A., Spevak, M. R., Nimkin, K. and Belanger, P.: Tailored low-dose fluoroscopic voiding cystourethrography for the reevaluation of vesicoureteral reflux in girls. *AJR Am J Roentgenol*, **162**: 1151, 1994
- Fernbach, S. K., Feinstein, K. A. and Schmidt, M. B.: Pediatric voiding cystourethrography: a pictorial guide. *Radiographics*, **20**: 155, 2000
- Lohf, J.: *Pediatric Outpatient Procedures*. Philadelphia: J. B. Lippincott Co., pp. 142–152, 1991
- Glynn, B. and Gordon, I. R.: [The risk of infection of the urinary tract as a result of micturating cystourethrography in children.] *Ann Radiol*, **13**: 283, 1970
- McRae, M. E., Rourke, D. A., Imperial-Perez, F. A., Eisenring, C. M. and Ueda, J. N.: Development of a research-based standard for assessment, intervention, and evaluation of pain after neonatal and pediatric cardiac surgery. *Pediatr Nurs*, **23**: 263, 1997
- Broadman, L. M., Rice, L. J. and Hannallah, R. S.: Testing the validity of an objective pain scale for infants and children. *Anesthesiology*, **69**: 770, 1988
- Dalens, B., Ecoffey, C., Joly, A., Giaufre, E., Gustafsson, U., Huledal, G. et al: Pharmacokinetics and analgesic effect of ropivacaine following ilioinguinal/iliohypogastric nerve block in children. *Paediatr Anaesth*, **11**: 415, 2001
- Nagy, S.: Strategies used by burns nurses to cope with the infliction of pain on patients. *J Adv Nurs*, **29**: 1427, 1999
- Smith, M. S., Tyler, D. C., Womack, W. M. and Chen, A. C.: Assessment and management of recurrent pain in adolescence. *Pediatrician*, **16**: 85, 1989
- Byrne, A., Morton, J. and Salmon, P.: Defending against patients' pain: a qualitative analysis of nurses' responses to children's postoperative pain. *J Psychosom Res*, **50**: 69, 2001
- Merritt, K. A., Ornstein, P. A. and Spicker, B.: Children's memory for a salient medical procedure: implications for testimony. *Pediatrics*, **94**: 17, 1994
- McGrath, P. A.: Psychological aspects of pain perception. In: *Pain in Infants, Children and Adolescents*. Edited by N. Schechter, C. Berde and M. Yaster. Baltimore: Williams and Wilkins Co., pp. 39–64, 1993
- Stashinko, E. E. and Goldberger, J.: Test or trauma? The voiding cystourethrogram experience of young children. *Issues Compr Pediatr Nurs*, **21**: 85, 1998
- Barrieras, D., Lapointe, S., Reddy, P. P., Williot, P., McLorie, G. A., Bägli, D. et al: Are postoperative studies justified after extravesical ureteral reimplantation? *J Urol*, **164**: 1064, 2000
- Zerin, J. M. and Shulkin, B. L.: Postprocedural symptoms in children who undergo imaging studies of the urinary tract: is it the contrast material or the catheter? *Radiology*, **182**: 727, 1992
- Palermo, T. M. and Drotar, D.: Prediction of children's postoperative pain: the role of presurgical expectations and anticipatory emotions. *J Pediatr Psychol*, **21**: 683, 1996
- Hester, N. K.: The preoperational child's reaction to immunization. *Nurs Res*, **28**: 250, 1979
- Hoebcke, P. B., Van Laecke, E., Raes, A., Vande Walle, J. and Oosterlinck, W.: Membrano-bulbo-urethral junction stenosis. Posterior urethra obstruction due to extreme caliber disproportion in the male urethra. *Eur Urol*, **32**: 480, 1997
- Imaji, R., Moon, D. A. and Dewan, P. A.: Congenital posterior urethral membrane: variable morphological expression. *J Urol*, **165**: 1240, 2001