Voiding Cystography Practices and Preferences of North American Pediatric Urologists

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Purpose: Little consensus exists regarding the choice of a specific modality of voiding cystography in the evaluation and management of vesicoureteral reflux. We hypothesized that choices of pediatric urologists are based on technical factors of the studies themselves, as well as institutional factors unique to their hospital(s). Therefore, we surveyed pediatric urologists to determine their current practices and preferences of modalities of voiding cystography.

Materials and Methods: We mailed an anonymous survey of 40 questions to all fellows of the American Academy of Pediatrics Section on Urology.

Results: Surveys were returned from 186 of 301 fellows (62%). Of the respondents 57% were in academic, 30% in private and 13% in mixed practices. Given a choice of fluoroscopic voiding cystourethrography, radionuclide cystography and voiding ultrasonography, fluoroscopic voiding cystourethrography was preferred by 98% and 96% of respondents for initial evaluation of urinary tract infection in males and females, respectively, 96% for assessment of prenatal hydronephrosis, 54% for follow-up of vesicoureteral reflux, 59% for screening siblings, and 63% and 66%, respectively, after open and endoscopic correction of vesicoureteral reflux. Voiding ultrasonography was preferred by less than 10% of respondents in all groups, and radionuclide cystography was preferred by the remainder. Voiding images of the urethra, child-friendliness of staff, sensitivity and accuracy were factors most important in choosing a test. Of the respondents 83% reported full-time access to pediatric radiologists at their primary hospital, although a minority had full-time access to pediatric radiologists at additional institutions. Sedation was used in some or most cases by 29%, rarely by 56% and never by 15% of respondents.

Conclusions: Pediatric urologists prefer fluoroscopic voiding cystography in all situations to evaluate vesicoureteral reflux but the proportion varies by indication. Diagnostic and patient issues are of greater concern than radiation dose. Variability in access to pediatric radiologists and ability to obtain the desired study may also alter ordering practices.

Key Words: radiology, urography, urologic diseases, vesicoureteral reflux

Abbreviations and Acronyms

AAP = American Academy of Pediatrics
AUA = American Urological Association
fVCUG = fluoroscopic voiding cystourethrography
RNC = radionuclide cystography
RUS = renal ultrasonography
UTI = urinary tract infection
VCG = voiding cystography
VUR = vesicoureteral reflux
VUS = voiding ultrasonography

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tivity for vesicoureteral reflux but spatial resolution and grading of reflux are limited. Voiding ultrasonography and magnetic resonance cystography have recently been described and avoid radiation altogether, although both remain experimental. All of these tests have the downside of requiring urethral catheterization.

Despite the large body of literature addressing VUR, there is no consensus regarding which imaging modality should be used. Furthermore, outside the setting of febrile UTI in the age group noted no guidelines exist for indications for VCG. Therefore, we polled pediatric urologists across North America for a better understanding of current practices and preferences regarding VCG, and the factors influencing these choices.

PATIENTS AND METHODS

Survey
A 5-page survey was mailed once in the spring of 2007 to all 301 fellows of the AAP Section on Urology (the largest organization of pediatric urologists in North America), along with an anonymous prepaid return envelope. All fellows practice in the United States or Canada. The survey contained 40 multiple-choice or open response questions regarding preferences of VCG modality for various indications, factors determining these preferences, respondent demographics and knowledge of technical aspects of VCUG. In the section regarding modality preference we attempted to ask only what study was preferred when the respondent chose to order such a study, and not whether they thought the study was indicated in all such scenarios (with the introductory instructions, “If you have determined that cystography is appropriate to evaluate for VUR, what is your preferred modality?”). Cost of studies was not included in the list of choices determining preferences. All study activities were approved by our local institutional review board.

Statistical Analysis
Chi-square tests were used for all statistical analyses. Statistical significance was defined by a p value of less than 0.05.

RESULTS

Of 301 fellows 186 (62%) responded to the survey. Among the respondents 57% were in academic, 30% in private and 13% in mixed practices. Of the respondents 2% were younger than 35 years, 32% were 35 to 44 years, 40% were 45 to 54 years, 20% were 55 to 64 years and 6% were 65 years old or older.

Omitted Questions

For single answer questions responses with 2 or more answers were omitted. Answers in which the respondent obviously confused VUS with RUS (not a focus of this study) were omitted. Such confusion was evident from handwritten comments in the margins on these surveys.

Not every respondent answered every question, so the total responses for individual questions were not equal. The fewest number of valid responses to any question was 169 (91%) of all surveys returned. All percentages were determined from the total number of valid responses for each question unless otherwise noted.

Preferred Modality for Evaluation of VUR

fVCUG was the preferred modality in all scenarios but the degree of preference varied by scenario (table 1). It was the overwhelming choice of more than 95% of respondents for initial studies after a first UTI in males and females, and after birth in newborns with a history of prenatal hydronephrosis.

Although less preferred than fVCUG in any situation, RNC was desired more in followup studies or in sibling screening (29% to 44%) than as an initial study (1% to 3%). VUS was preferred by 4 respondents (2% of total) for followup studies. Two of these respondents had also chosen VUS as their preferred modality for initial evaluation in males and females.

Respondents were queried with an open response question regarding the interval of followup VCG for patients being observed with VUR. Mean preferred followup was 15 months, with a median and mode of 12 months. When reported as a range the most commonly cited interval was 12 to 18 months.

<table>
<thead>
<tr>
<th>Table 1. Preferred modality of VCG in various clinical situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>First febrile UTI:</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>178 (98)</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>Followup for VUR</td>
</tr>
<tr>
<td>Sibling screening</td>
</tr>
<tr>
<td>Postnatal evaluation of prenatal hydronephrosis</td>
</tr>
<tr>
<td>Followup after open correction of VUR</td>
</tr>
<tr>
<td>Followup after endoscopic correction of VUR</td>
</tr>
</tbody>
</table>

Percentages for each study are number of respondents ordering study excluding those not ordering a study.
Regarding postoperative imaging, questions were segregated for open vs endoscopic correction of VUR. Nine respondents (5%) did not perform endoscopic correction of VUR. Of those performing endoscopic correction 18 (10%) did not routinely order followup VCG. A statistically significantly greater percentage of respondents, 98 of 178 (55%), did not routinely order a followup study after open correction of VUR (p <0.0001). Mean followups after open and endoscopic correction were 3.7 and 3.1 months, respectively, with a mode of 3 months in both instances.

Factors Influencing Modality Choice
Imaging of urethra, accuracy of grading and sensitivity of test were the most important factors influencing ordering practices, considered “very” or “somewhat” important by greater than 97% of respondents (table 2). Child-friendliness of staff and radiation exposure were of secondary importance, deemed “very” or “somewhat” important by more than 85% of respondents. Patient age and availability of modalities were less important. In a separate question specifically regarding radiation exposure 4 respondents (2%) indicated it was the main factor influencing the preference, 129 (70%) indicated it was a consideration along with other factors and 51 (28%) indicated it was not a factor.

Availability of Voiding Urosonography
Only 27 respondents (16%) indicated that VUS was available in their community. Of those respondents with access to VUS 12 (44%) preferred VUS in at least 1 of the aforementioned instances, while 15 (56%) did not prefer VUS in any instance. Of the 143 respondents who reported no access to VUS 11 (8%) still stated VUS was the preferred study at least once.

Study Performance
A total of 178 pediatric urologists (98%) had access to their preferred study at their primary hospital. One respondent noted the preferred study was unavailable, while 2 noted the preferred study was available but performance was unsatisfactory. One respondent did not routinely order the preferred study, although available, due to lack of child-friendliness of staff. All respondents who could not receive their preferred study indicated they preferred RNC in at least 1 situation. When asked who performed urethral catheterization 5 respondents (3%) indicated the urologist, 38 (20%) the radiologist, 105 (56%) the radiology technologist and 50 (27%) a registered nurse, while 7 (4%) did not know.

Sedation Usage
Use of sedation to reduce anxiety was addressed by a question regarding requests for sedation in patients beyond infancy. A total of 28 respondents (15%) reported never using sedation, 104 (56%) used sedation rarely and 54 (29%) used sedation in some or most cases. Of the latter group the average estimated frequency of sedation usage was 42% of studies (range 5% to 95%).

Of those using sedation midazolam and chlorhydrate were used by 110 (79%) and 26 respondents (19%), respectively. Some respondents selected multiple agents. Responses of “other” included anesthesia choice (5), nitrous oxide (5), diphenhydramine (3), propofol (2), diazepam (2), nitrous oxide and sevofturane (1), and radiology choice (1).

Hospital Type and Practice Characteristics
Of the respondents 107 (59%) worked primarily at a freestanding pediatric hospital and 75 (41%) worked primarily at a pediatric center within a larger hospital. Of those at freestanding pediatric hospitals 68 (63%) were in academic practice and 22 (21%) were in private practice. In contrast, of those who worked at a pediatric center within a larger hospital 32 (43%) were in academic and 32 (43%) were in private practice. This difference was statistically significant (p = 0.0011).

Number of Hospitals at Which VCG Was Ordered
A total of 48 respondents (41%) ordered voiding studies at a single hospital, while 32 (27%) ordered studies at 2 hospitals, 26 (22%) ordered studies at 3 hospitals and 12 (10%) ordered studies at more than 3 hospitals. Of those ordering studies at 1 hospital 34 (72%) were in academic practice and 10 (21%) were in private practice. Among those ordering studies at more than 1 hospital 31 (56%) were in academic and 24 (44%) were in private practice. This difference was statistically significant (p = 0.032).

Access to Pediatric Radiologists
Fellowship trained pediatric radiologists were available full time at the primary hospital for 95 (81%), part time for 14 (11%) and unavailable for 9 respondents (8%). At the secondary hospital full-time access to pediatric radiologists was available for 28 respondents (41%), part-time access for 19 (27%) and no access for 22 (32%). Finally for additional hospitals full-time access to pediatric radiologists

### Table 2. Test, patient and hospital specific factors in modality preference

<table>
<thead>
<tr>
<th>Test Feature</th>
<th>% Very Important</th>
<th>% Somewhat Important</th>
<th>% Not Important</th>
<th>% Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging of urethra</td>
<td>80</td>
<td>19</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Accuracy of grading</td>
<td>64</td>
<td>36</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sensitivity of test</td>
<td>61</td>
<td>36</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Child-friendliness of staff</td>
<td>63</td>
<td>23</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Radiation dose</td>
<td>35</td>
<td>51</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Pt age</td>
<td>22</td>
<td>37</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>Availability of modalities</td>
<td>34</td>
<td>33</td>
<td>32</td>
<td>1</td>
</tr>
</tbody>
</table>
was available for 17 respondents (38%), part-time access for 5 (11%) and no access for 23 (51%).

DISCUSSION
The use of VCG remains controversial due to the lack of consensus regarding indications and the variety of imaging modalities available. For that reason we conducted the first known study to examine the practices and preferences of practitioners ordering VCGs. The goal of this study was not to define indications for VCG, but to determine the current preferences of pediatric urologists. We were pleased with the response rate of 62% to our survey, compared to average physician response rates to mailed surveys of 54%.11

Current AAP guidelines for febrile UTIs in patients 2 months to 2 years old recommend RUS and either IVUCG or RNC as early as possible to rule out VUR and other congenital urological anomalies.1 AUA guidelines suggest early diagnosis of VUR followed by early treatment with antibiotic prophylaxis or surgical correction to prevent acquired reflux nephropathy.12 However, neither AAP nor AUA guidelines suggest a specific modality of VCG in the diagnosis or followup of patients with VUR.

We found that fVCUG was almost universally preferred by pediatric urologists for the initial evaluation following febrile UTIs in both sexes. fVCUG is more sensitive in diagnosing VUR than RUS alone but may not be better than RNC.13,14 However, fVCUG provides greater anatomical detail of the ureters in the presence of VUR and, thus, provides greater accuracy in grading VUR. In fact, the International Reflux Grading system on which prognosis and treatment options are based is defined using fVCUG.5,15 Other ureteral anomalies including ureteral duplication may be better detected with fVCUG. Finally fVCUG provides more accurate anatomical definition of the lower urinary tract and can better detect other congenital abnormalities such as ureteroceles, diverticula and posterior urethral valves. fVCUG was slightly more preferred in initial evaluation of males compared to females (not statistically significant), which could reflect a greater desire to image the urethra in males.

Anatomical abnormalities and grading are less important after the initial diagnosis of VUR, so there is little advantage of fVCUG over RNC in followup studies.14 Our survey population of pediatric urologists appeared to acknowledge this fact, as 44% preferred RNC for followup of VUR compared to 2% to 4% in initial studies. AUA guidelines state that VCG need not be performed more than once annually for followup of VUR, although no preferred interval is specified.12 Most respondents preferred followup of 12 months, although some indicated longer periods.

Asymptomatic siblings of index cases of VUR have an increased prevalence of VUR, although the screening of siblings for VUR is controversial.16 Our survey showed that 21% of respondents did not routinely use VCG to screen siblings. The majority of respondents who did screen preferred fVCUG but RNC was preferred by a significant minority (29%). Several respondents noted using RUS for screening despite it not being a listed choice. Although RUS cannot diagnose VUR, an abnormal RUS may prompt VCG.17

The role of VCG in the postnatal evaluation of prenatal hydronephrosis is also controversial. The majority of fVCUGs performed to evaluate prenatal hydronephrosis are normal, prompting some to advocate the use of RUS only.18 In our study 11% of respondents followed this strategy. However, postnatal RUS findings correlate poorly with the presence of VUR, making a strong argument for VCG in postnatal assessment of prenatal hydronephrosis.19 Most of our respondents followed this latter strategy, and among these fVCUG was nearly universally preferred by a similar proportion for initial evaluation of febrile UTI. This result could be explained by our findings that imaging of the urethra and accuracy of VUR grading were the most important factors driving the choice of VCG modality.

VUR can be surgically managed by ureteral reimplantation/advancement or endoscopic injection.20 Ureteral reimplantation/advancement has a success rate approaching 99%.21–23 Thus, many advocate skipping postoperative VCG to confirm the absence of VUR. Accordingly only 80 of 178 respondents (45%) in our survey routinely obtain VCG following open antireflux surgery. The success of endoscopic correction of VUR, while good, does not match that of open surgery. A recent meta-analysis reviewing endoscopic treatment of VUR revealed success rates of 51% to 79% depending on the grade.24 Despite these variable success rates, 10% of respondents did not routinely order followup imaging after endoscopic correction. For those who desired postoperative VCG the distribution of preferred studies was similar between open and endoscopic procedures with RNC preferred by nearly a third.

Conventional continuous fluoroscopy delivers up to a 100-fold greater radiation dose compared to RNC, which delivers a dose of approximately 0.004 rem.25,26 Modern techniques such as variable rate pulsed fluoroscopy, reduced fluoroscopic time, aggressive coning down to limit exposed anatomy, limited spot images and increased use of the last image captured feature to archive images can reduce the dose delivered during fVCUG 8 to 10 times compared to conventional studies without sacrificing
resolution so that the dose is only 1 order of magnitude greater than RNC. \(^{27-29}\) However, radiation dose to the more radiosensitive gonads is still substantially higher with VCUG. \(^{30}\)

Our survey demonstrated that 35% of pediatric urologists considered the radiation dose of VCG “very important” and 51% considered it “somewhat important” in their choice of voiding study. In contrast, in a similar survey of 204 pediatric radiologists the radiation dose was “very” (54%) or “somewhat” (43%) important when choosing a modality of VCG (Maxfield, Wiener and Frush, unpublished data). To urologists, child-friendliness of the staff was at least as important as radiation dose in choosing a modality. Thus, radiologists and urologists have different priorities when choosing imaging studies, which may explain the differences in their reasons for choosing a VCG modality.

Sedation can be used during VCG to minimize potential psychological trauma related to urethral catheterization, and has been shown not to influence results. \(^{31}\) Conscious sedation is preferred, allowing the patient to void spontaneously. Only 15% of respondents never used sedation, and nearly twice that many used sedation in some or most cases. The remainder of respondents used sedation rarely. A greater proportion of physicians who never or rarely use sedation worked at a freestanding pediatric hospital, although this trend was not statistically significant. This finding suggests the child-friendliness of a freestanding pediatric hospital may lead to a reduced need for sedation.

Newer technologies, namely VUS and magnetic resonance cystography, have been described that obviate the need for radiation in VCG. \(^{5-7}\) However, experience with these modalities is limited. Of the 16% of respondents reporting access to VUS more than half did not prefer this study in any presented clinical situation. Of respondents who did not have access to VUS 8% still preferred this study in at least 1 situation, suggesting confusion between VUS and RUS. Although VUS is rarely used in the United States, European studies have revealed promising sensitivity and accuracy in grading VUR compared to VCUG. \(^{32}\) Magnetic resonance cystography provides simultaneous evaluation of VUR and renal scarring but the practicality of this modality remains unknown, and must address concerns of cost and sedative requirements.

As with any survey study, ours was limited by the questions asked. Despite attempts to limit bias in the questions, the wording of the questions could have favored certain responses or prevented the respondents from accurately providing their preferences and current practices. Additional factors influencing preferences and practices, most notably cost, were not evaluated.

**CONCLUSIONS**

fVCUG is the preferred method of VCG for pediatric urologists in all common clinical scenarios, although the degree of preference varies with indication. Child-friendliness and study access also have roles in ordering preferences, while radiation dose is less of a concern to pediatric urologists than to pediatric radiologists. Hopefully these findings can help pediatric urologists and radiologists work together to manage VUR optimally while minimizing associated radiation exposure and anxiety.

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EDITORIAL COMMENTS

Everyone who has answered questionnaires posing clinical scenarios knows the provided choices do not always reflect his or her preferences. Furthermore, opinions may change with time or be influenced by factors not mentioned in the survey. Nevertheless, these data offer a snapshot of cystography practices by pediatric urologists in 2007, shortly before the recent onslaught of randomized studies challenging prevailing beliefs on the importance of reflux detection and management. Regardless of future developments, voiding cistourethrography likely will remain the imaging of choice when a decision is made for cystography. However, these survey results prompt reflection on other current practices. For example given reduced radiation from RNC, should it be the preferred cystogram for routine followup studies? Similarly realizing the known aversion of mothers and children to cystography, should sedation be considered more often by the 71% of respondents who answered they never or rarely order it? Finally should these usually elective tests be referred to facilities with the greatest expertise and “child-friendliness” regionally available?

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Situations in which more than 1 imaging modality might be used to address a given clinical question are common. Although clinical criteria are often available, other factors frequently influence physician behavior in choosing between competing modalities. Ellison et al demonstrated this to be true of the choice between fVCUG and RNC among pediatric urologists. The strong preference for fVCUG appears to be driven by pragmatic and local factors, despite widely accepted clinical criteria for preferring RNC in some situations. Availability of the 2 modalities per se does not appear to be an issue. Most respondents have access to and prefer the services of pediatric radiologists, whom they perceive as more “child-friendly.” It is interesting that sedation is used somewhat more often at nonpediatric sites. Pediatric radiologists and technologists may be more prone to engage the services of “child life” specialists, who are increasingly available at pediatric hospitals.1

The dosimetry of fVCUG and RNC is complex. Certainly the magnitude of radiation exposure from fVCUG has been reduced dramatically by advances in fluoroscopy technology and technique (reference 27 in article). It is clear that pediatric urologists understand the importance of radiation dose reduction in children (as evidenced by the ALARA—as low as reasonably achievable—principle). However, the nonavailability of dedicated pediatric nuclear medicine services at some institutions appears to be more important for many practitioners than concern with
reducing radiation dose alone in preferring fVCUG over RNC.

Financial considerations can also influence the choice of modality. Although RNC is generally less expensive to perform, the charges for the 2 examinations can differ greatly between institutions. As a result, 1 examination (usually RNC) may be significantly less affordable for families.

As a pediatric radiology department chair, I also have to be concerned with issues of resource utilization. Nuclear medicine is not an overburdened area in most pediatric radiology departments. On the other hand, fluoroscopy is frequently much busier. Dividing the case load between the 2 areas of the department based on clinically accepted criteria might promote better clinical care and customer service, while at the same time allowing us to study more children.

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REFERENCE