Diuretic Renography in Children

TO THE EDITOR: We read with much interest the Procedure Guideline for Diuretic Renography in Children (*1*). Such detailed and comprehensive guidelines are without doubt useful for all involved in the management of hydronephrosis in children. Nevertheless, we would like to comment on some points of this procedure guideline.

INTRAVENOUS HYDRATION BEFORE AND DURING THE TEST

The theoretical basis of this procedure is that a child, despite being encouraged to drink before the test, may be relatively dehydrated and, as a consequence, have a low diuresis at the moment of tracer injection. We think, however, that, in the usual conditions, the administration of intravenous fluids is not necessary. Children on whom the furosemide test is performed are generally ambulatory and have no reason to have severe sodium and water depletion. They are encouraged to drink an additional amount of fluid 1 hr before the test, and this amount is comparable to what is recommended be administered by intravenous line by the guideline authors. If the child refuses any supplementary drink, it is most likely that he or she does not need the additional fluid. Moreover, these physiological conditions are completely changed once the patient receives furosemide. Within a few minutes, there is a rapid rise in urinary flow and, in our personal experience of the last 20 yr, older children often protest with energy being obliged to stay on the table until the end of the acquisition, although they emptied their bladder before the test; young children will have a spontaneous voiding, either during the acquisition period or within the next 15 min.

BLADDER CATHETERIZATION

The principle of bladder catheterization is clear. Any filling of the bladder can result in back pressure and, as a consequence, poor renal emptying and variable lasix slopes, resulting in misinterpretation of the test. How mandatory is this procedure? The authors of the guideline seem to accept that it is not absolutely necessary in older children. Why? It is clear that the furosemide injection can result very rapidly in bladder filling, and there is no reason to think that a full bladder is of less importance in an older child than in an infant.

An alternative solution that is used in several centers in Europe is to let the child void spontaneously and perform postvoiding images. Those children routinely experiencing this procedure know that within a few minutes after voiding, a nondrained kidney can dramatically change into an empty kidney. One can argue that waiting for spontaneous bladder emptying could be time-consuming. In our experience on many hundreds of children, this is not the case. As said before, children who receive a furosemide injection are considerably increasing their urinary flow, and this results very often in a spontaneous micturition during the 15 min after lasix injection. In case bladder activity is still significantly high at the end of the acquisition, it will take generally an additional few minutes to obtain a new micturition with satisfactory bladder emptying. When this is not the case, one can let the child wait in the waiting room, perform an examination on the next patient, then reexamine the child's bladder emptying 30 min later. During this time, older children are invited to walk for a few minutes, whereas infants are placed in an erect position in their mother's arms to add kidney emptying by means of gravity.

Which parameter should then be used for the interpretation of the response to furosemide when adopting this procedure? Those who are in favor of the systematic bladder catheter will pertinently object that any parameter of the lasix curve is not valid: a completely flat curve with a full bladder is meaningless; the progressive bladder filling under lasix can progressively flatten a descending curve; and a change of slope will occur when the bladder is emptying during acquisition. In all these cases, the analysis of the curve is complicated and may result in complete misinterpretation of kidney drainage. There is, however, a solution that is partly suggested by the guideline authors themselves: instead of using the diuretic half-time, one can estimate the percentage of activity remaining in the kidney at the end of the test (*2*). Having obtained an empty bladder after spontaneous micturition, it is easy to acquire 1- or 2-min images and to evaluate quantitatively the amount left in the kidney. This is a very simple procedure, requiring only minimal computer programming. It can of course be applied as well when a bladder catheter has been used.

To which image should this postmicturition image be compared? We traditionally use the initial image of the lasix acquisition, but it is most probable that an early image of the renogram (1 to 2 min after tracer injection) is a better point of comparison.

We agree, however, that in some cases, such as urethral valves or neurogenic bladder, a bladder catheter may be required.

WHICH TECHNIQUES TO CHOOSE

In the absence of adequate standards, it is very difficult to demonstrate that one particular technique is better or worse than another. This is particularly true in the case of the furosemide test, since the definition of obstruction is the subject of multiple debates. Criteria such as progressive deterioration of renal function if the obstruction is not relieved or surgical demonstration of obstruction are not widely accepted (*3*). It is well known, however, that in cases of prenatal detection of asymptomatic hydronephrosis, the number of children who will need surgery is low. We have therefore reviewed all cases having had a furosemide test with ^{99m}Tc-mercaptoacetyltryglycine (MAG3) because of postnatally confirmed prenatal hydronephrosis whether reflux was present or not. We focused on patients who were tested between 3 and 24 mo. We discarded the furosemide tests performed before 3 mo because of the possible immaturity of the kidney. We did not take into account patients with normal renal emptying during renography who did not require a furosemide injection.

The total number of hydronephrotic kidneys was 93, corresponding to 84 patients. All studies occurred without intravenous hydration and bladder catheterization. A 20-min renographic study was followed by lasix administration at a dose of 1 mg/kg body weight and a 15-min acquisition. In all cases, a postmicturition image was available and the only parameter used to assess renal drainage was residual renal activity after micturition, expressed in percentage of activity at the moment of injection of furosemide. We divided the responses into three groups: Type 1: >60% residual activity; this corresponds visually to poor or no emptying of the kidney. Type 2: <30% residual activity; in these cases, there was agreement that good

kidney emptying was obtained (this is not very different from the criteria outlined by the guideline authors, suggesting that good response means a $T_{1/2}$ of <10 min). Type 3: between 30% and 60%; these were considered to be equivocal responses. Analysis of our data showed that in 83 hydronephrotic kidneys (74 patients) we had a Type 2 response. In 9 kidneys (9 patients), we observed a Type 1 response on at least one renographic study and all these patients underwent a pyeloplasty. In 1 kidney (1 patient), a Type 3 response was observed (57% residual activity) and the patient also had surgery.

We conclude that in our series of ^{99m}Tc-MAG3 renographic studies, the percentage of abnormal or equivocal responses to furosemide is low, as expected in this particular population of patients with prenatally detected hydronephrotic kidneys. Oral hydration and absence of bladder catheterization did not result in an abnormal number of poor responses to furosemide.

Bladder catheterization and intravenous hydration are invasive and time-consuming procedures, and they are not easy to apply to ambulatory young patients. We strongly suggest that these procedures not be used routinely, unless the authors of the guideline are able to produce unequivocal arguments for their systematic application.

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REPLY: I appreciate the input of Dr. Piepsz and his colleagues on the topic of intravenous hydration and bladder catheterization in the performance of diuretic renography in children. He strongly suggests "that these procedures not be used routinely" in diuretic renography. The suggestions for hydration and catheterization that appear in the Procedure Guideline for Diuretic Renography in Children published in *Journal of Nuclear Medicine* in October 1997 (*1*) were based partly on the recommendations that appeared in the description of the "well-tempered" diuretic renogram (*2*) as well as the practical wisdom of several pediatric nuclear physicians. The well-tempered diuretic renogram was formulated by a consortium of members of the Society for Fetal Urology and the Pediatric Nuclear Medicine Club of the Society of Nuclear Medicine (SNM). The purpose of the well-tempered diuretic renogram was to diminish the effects of the many variables (renal function, compliance of the collecting system, back pressure from the full bladder, state of hydration, choice of radiopharmaceutical and timing of the diuretic injection) that can complicate and confuse study results. The standardization of methodology in the U.S. permits many different institutions to compare statistics and accumulate significant data to answer many questions about perinatal hydronephrosis.

However, the SNM's clinical procedure guideline is intended to be more flexible than the research procedure that would be used in multicenter trials. Increased flexibility permits the guideline to be adopted by nuclear physicians in private practice and general hospitals, as well as those in tertiary-care children's hospitals. The guideline clearly states that "some laboratories do not use intravenous hydration or catheter drainage of the bladder for the initial evaluation (particularly in older children) so that the kidneys can be evaluated without intervention," so Dr. Piepsz's preference to avoid catheterization and hydration is completely acceptable.

All of the SNM's procedure guidelines are reviewed periodically. We appreciate the comments of Dr. Piepsz and his colleagues and encourage other nuclear medicine professionals to send any comments they have on any guideline to the Guidelines Development and Communications committee (Kevin Donohoe, chairman). All comments will be given careful consideration when the guidelines are revised.

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SPECT Imaging with Technetium-99m-Tetrofosmin for Pulmonary Nodules

TO THE EDITOR: In the article by Kao et al. (*1*), they stated that the diagnostic sensitivity and specificity in previous reports, including ours (*2*), seemed excessively high in contrast to their results. Studies in the previous reports used a similar scanning protocol for dosage and imaging time. Kao et al. reported that one possible explanation might be selection of patients with different P-glycoprotein expression. I agree that patient selection might be one of the causes for the differences in sensitivity and specificity. However, other causes for the differences also should be considered. The differences might arise from a selection of the range in images for reconstruction in data processing. Judging from the figures in their article, Kao et al. selected a relatively large range of images for reconstruction. If there are extremely high-count regions such as the myocardium and the liver in the reconstructed SPECT images, small and low-count lesions will not be visualized at all, or they will be visualized poorly. If possible, the reconstruction of images should be performed by excluding high-count regions to improve sensitivity.

In addition, although the results of Kao et al. showed that there was no difference in the sensitivities in detecting by ^{99m}Tc-tetrofosmin among histological types of lung cancer, our preliminary studies (*3*) demonstrated that the sensitivity of detecting small lung cancers with ^{99m}Tc-tetrofosmin tended to be lower in adenocarcinoma, especially in the bronchioloalveolar type, than in other cancers. It is necessary to compare small lung cancers without necrotic tissue and to compare similar tumor sizes, to examine the difference of ^{99m}Tc-tetrofosmin uptake among various histological types of lung cancer. In the case of a large mass with poor perfusion, the lesion will not be visualized, or it will be only partially visualized.

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