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EDITORIAL

Effects of Ureteral Function on Assessment of Hydronephrosis

The need for assessment of ureteric function in the patient with an obviously dilated ureter has increased particularly with the added spectrum of asymptomatic patients presenting with hydronephrosis and hydroureter on antenatal and perinatal ultrasound. Early detection provides both a potential for prophylaxis against urinary tract infection with subsequent renal parenchymal damage, and prophylaxis against atrophy or developmental delay from pressure effects secondary to obstruction. At present, our knowledge of the natural history of hydronephrosis continues to be de-

finied. Prior surgical interventions were planned on anatomical findings in symptomatic patients with urinary tract infection, pain, hematuria or stone formation with detection methods that were more invasive and gave anatomical rather than physiological or functional information. It is thus important that documentation of renal function, functional effects of obstruction and response to therapy be fully evaluated, particularly in the asymptomatic patient. Correlations will maximize the advantages of early detection and minimize the effects of unwarranted intervention on the developing urinary tract, as well as providing accurate information to the family and the primary caretaker to guide decision making.

Twenty years experience with diuretic renography has allowed defini-

tion of obstructive patterns, renal and bladder function and differential clearance data. Reproducible results depend on meticulous technique, with diagnostic accuracy of diuretic renography depending upon renal function (glomerular filtration rate), as well as the distention characteristics of the pelvis and ureteric function (1). Adequate hydration must be assured and there should be sufficient residual renal function to allow diuretic response to define the distensibility and volume of the collecting system. Urinary bladder volume and drainage can also affect the pattern of response and the ability to interpret drainage of the lower ureter, hence the practice of bladder catheter drainage during study. Standard testing protocols are required with study design and interpretation requiring close collabora-

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tion by a nuclear medicine specialist, urologist and nephrologist for maximal clinical benefit.

Although interpretation of the diuretic renogram may be based solely upon the appearance of the washout curve without consideration of calculated half-times or sequential analog images (2, 3), other workers suggest maximal interpretation requires calculation of half-time for clearance of the isotope from renal parenchyma and the ureter with the bladder under catheter drainage (1). Catheterization eliminates the effect of vesicoureteric reflux on the lower ureter and prevents overlying bladder images, thus allowing better interpretation of upper tract obstruction at the risk of obscuring effect of bladder dynamics on ureteric obstruction. A small number of patients (~5%) will require manual syringe evacuation of the catheterized bladder to accomplish a clear lower urinary tract for study. Continual review of images during the study is necessary to define this group and provide differentiation from those with lower ureteral obstruction such as described by Jamar et al. (4) in the accompanying article.

Although it has been estimated that over 80% of children with dilated ureters can be evaluated with diuretic renogram alone (5), a number of patients require more invasive testing with pressure-perfusion studies (6,7) for final definition of ureteric dynamics and to define obstruction. As conventionally performed diuretic renography predicts obstruction in 87%–90% (5,8,9). Predictions are most accurate when obstruction is at the ureteropelvic junction where 93% sensitivity has been demonstrated (8). Severe hydronephrosis may mask the effect of diuresis on isotope tracer clearance from the renal pelvis making a pressure-perfusion study or restudy after a period of nephrostomy drainage necessary for full evaluation (8). Other situations where inaccurate results are obtained include patients with low-grade ureteropelvic junction obstruction where high flow perfusion may be necessary to demonstrate ob-

struction (5) or in a small subgroup of patients with abnormalities of drainage in the supine position (9). Definition of time-activity curves in both kidney and ureter as used by Jamar et al. (4) increase definition of ureteric function and may reduce the number of invasive pressure-perfusion studies necessary.

Jamar et al. in their accompanying article, discuss the influence of ureteral function on renal washout during diuresis renography in children studied with bladder catheter drainage to prevent effects of bladder distention on washout curve. Sufficient correlation was made with other imaging modalities, voiding study, antegrade or retrograde pyelography where available and their study includes correlation with results of surgical intervention providing a critical clinical study. By allowing a visual check on drainage, discordant results of a technical nature are avoided e.g., inappropriate choice of area of interest, patient motion (particularly in infants), superimposed bladder activity. Their hypothesis is that extra information on ureteric function is gained by performing the study under standard hydration and catheterization. By examining areas of interest over the ureter if visually abnormal ureteric collections are defined a more accurate picture of ureteral function is possible. The washout curves were obtained using regions of interest drawn on 60-min sum frame images. T_{max} , RA_{30} , $KT_{1/2}$ were calculated from the exponential of steepest negative slope of the renogram after furosemide induced diuresis. A ureteric washout index $UT_{1/2}$ was also determined for the ureter when a visual abnormality was present. Examination of both visual images and the curves so generated were used to increase accuracy in prediction of surgically remediable obstruction. The results in their study are consistent with their hypothesis.

Evaluation of ureteric washout was helpful in extending evaluation of ureters with visually abnormal appearance. Jamar et al. suggest a potential for a false-positive study if the area of

interest is confined to the renal washout $KT_{1/2}$, exposing the patient to potentially unnecessary surgery to the upper ureter. In those patients with ureteric dilatation throughout the ureteric length (ureterovesical junction obstruction) $UT_{1/2}$ provides information correlating with later successful surgery suggesting this is an appropriate test when used with their protocol. In this series, Jamar et al. obtained excellent agreement between $KT_{1/2}$ and $UT_{1/2}$ in those ureters with obstruction lower than ureteropelvic site. Conventionally maximal physiological effects on $KT_{1/2}$ are associated with ureteropelvic junction obstruction. Definition of an obstructive pattern in the ureter, $UT_{1/2}$, as opposed to upper tract obstruction correlated well with response to surgery on the lower ureter alone, thus increasing the accuracy of the study.

The results in this study (4) suggest abnormal visualization of the ureter represents a highly sensitive indicator of significant abnormality or dysfunction of the ureter. Corroboration by radiological demonstration of associated morphological anomaly is advised particularly in this early stage of assessing a new technique. A negative scan virtually eliminates obstruction as the cause of a dilated ureter and most consistent with vesicoureteric reflux; an appropriate voiding study can be planned if there is ultrasound evidence of dilatation and negative renography.

Similar studies in other uro-radiology units will be necessary to corroborate the findings in this study. Kass et al. have suggested that using the activity seen over the dilated distal ureter in ureterovesical obstruction was no more reliable than viewing the entire dilated collecting system (1). They did note, however, that if the area of interest examined included the kidney only and not the ureter a false-negative test was possible. A further cause for a false-negative diuretic renogram include the blunted effect (9) of diuresis in severe hydronephrosis, while a false-positive may be seen in those patients where drainage

is impaired in the supine position with excellent response to change in position (9). Correlation with antegrade pyelography and pressure-perfusion studies should be carried out when possible and correlation with response to surgery should be clearly documented. Anatomical and function studies both before and after correction will be necessary to allow the findings of this study to be extended to a wider population. Careful documentation of technique, results and calculations will be extremely important to allow maximal comparison in other units. As in the assessment of all new methods or technology, critical evaluations is necessary.

The relatively noninvasive nature of the study apart from bladder catheterization and its sensitivity and

specificity make this technique a potentially valuable tool for planning the most appropriate surgical correction in patients with hydronephrosis and/or hydroureter. A repeat study, if shown to be a consistent indicator of practical ureteric function, will allow for early correction of ureteric obstruction and noninvasive postoperative assessment of results.

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