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Brief report

Technetium-99m-dimercaptosuccinic acid renal scintigraphy in children over 5 years*

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Abstract. We retrospectively evaluated the frequency of renal scintigraphic abnormalities in children over 5 years admitted with a first symptomatic urinary tract infection (UTI). Among 261 children investigated, we found only 23 over 5 years having had technetium-99m-dimercaptosuccinic acid scintigraphy during the acute phase of a first UTI. Obvious scintigraphic abnormalities were detected in 14 children (15 kidneys): 12 kidneys showed focal cortical defects and 3 were small and deformed. Ultrasound was normal in 7 of the 15 kidneys with abnormal scintigraphy and in all the kidneys with normal scintigraphy. Among the 12 kidneys with focal cortical lesions, 8 kidneys returned to normal or improved considerably 2–12 months after initial work-up. In conclusion, in children over 5 years admitted with a first symptomatic UTI, the frequency of scintigraphic abnormalities is high and a strategy based only on ultrasound data would miss about 50% of the abnormal kidneys.

Key words: Dimercaptosuccinic acid – Urinary tract infection – Acute pyelonephritis – Diagnostic strategy

Introduction

Acute pyelonephritis (APN) is usually diagnosed on the basis of clinical and biological signs and a positive urine culture. At present there is no "gold standard" test for diagnosis. Although technetium-99m-dimercaptosuccinic acid (Tc-99m DMSA) scintigraphy is considered the most-sensitive technique for the identification of the renal parenchymal change in APN as well as in the detection of scarring [1–9], there is no general agreement when this should be performed. Strategies differ throughout the world [10–13]. It has been suggested that children over 5 years of age with a first documented urinary tract infection (UTI) are unlikely to develop new renal lesions [14], and therefore do not require scintigraphic investigations in the face of normal ultrasonography (US) [12, 15]. The aim of this study was to evaluate retrospectively the frequency of scintigraphic abnormalities in children over 5 years with a first documented symptomatic UTI.

Patients and methods

Study design. In our department, all children presenting with a clinical and biological picture of APN [16] undergo, within 3 days of admission, an "acute" DMSA scintigraphy. A "late" scintigraphy is performed, usually 6 months after the acute episode. This strategy was occasionally used before 1990 and was used systematically thereafter.

Between January 1991 and December 1992, 261 patients with present or past symptomatic UTI underwent DMSA scintigraphy. Among these, 91 over 5 years were identified. The medical records of these children were closely examined by two pediatricians and consensus decisions were taken. Cases with insufficient criteria for symptomatic UTI, those with incomplete data (such as unclear history, acute DMSA or US missing), a history of previous UTI, or the presence of gross urinary tract malformations (such as major pelviureteric junction obstruction, urethral valves, horseshoe kidney, etc.) were excluded. We did not exclude patients with vesicoureteral reflux.

We found only 23 patients, aged between 5 and 13 years (mean 8 years 11 months) who were investigated because of a first documented UTI. In all, both DMSA scintigraphy and renal US were performed during the acute phase of infection (within 3 days of admission). In those with abnormal initial DMSA scintigraphy, a control, generally performed 6 months after the initial work-up, was available. The data of these 23 patients are analyzed in the present study.

Imaging techniques. US and scintigraphic examinations were systematically and independently interpreted by well-trained pediatric radiologists and nuclear medicine physicians and the criteria used for the interpretation of the images did not change during the period of the investigation. In the present study, only results from the reports of the attending physicians were used, with no retrospective changes.

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US was performed on a Toshiba Sonolayer SSH-140 A/G by a pediatric radiologist. The criteria for renal abnormality were: focal or general parenchymal hyper- or hypoechogenicity, loss of corticomedullary differentiation, thickened pelvic wall, irregular outlining of the kidney, parenchymal reduction, and increase of renal size.

The scintigraphic images were obtained with a gamma camera equipped with a high-resolution collimator 2–4 h after an intravenous injection of Tc-99m DMSA, according to the recommendations of the European Paediatric Nuclear Medicine Task Group [17]. The acquisition time was 5 min for each image. One posterior and two oblique views were obtained often with zoom magnification. The criteria for renal abnormality were those used in the departments familiar with cortical scintigraphy in children: single or multiple hypoactive areas, small or deformed kidneys.

Results

Acute phase of infection

Among the 23 patients over 5 years with a first documented UTI, 14 (61%) had abnormal DMSA scintigraphy. Unilateral abnormalities were seen in 13 children, bilateral abnormalities in 1. Among the 15 abnormal kidneys, 12 showed focal cortical defects and 3 were small and deformed. Among the 15 kidneys with abnormal DMSA scintigraphy, 7 were normal and 8 were abnormal on US. All 7 kidneys with normal US showed focal abnormalities on DMSA scintigraphy. The 8 kidneys with abnormal US were also abnormal on DMSA scintigraphy (5 kidneys with focal lesions, 3 small deformed kidneys).

Scintigraphic follow-up

Among the 12 kidneys (11 patients) with focal cortical lesions, 8 kidneys (7 patients) returned to normal or improved considerably 2 months to 1 year after the initial scintigraphy. Two kidneys (2 patients) remained unchanged after 1 year and no control was available for 2 kidneys (2 patients). The 3 small deformed kidneys (3 patients) remained unchanged on control scintigraphy. The 13 normal kidneys on the contralateral side of an abnormal kidney remained normal on the control examination.

Discussion

Tc-99m-DMSA scintigraphy is considered a highly sensitive technique for the detection of APN as well as sequelae [1–9]. Several experimental studies have validated the technique for both indications [7, 18]. However, at present no consensus has been reached concerning the use of this technique in the diagnostic strategy [10–13]. Is DMSA scintigraphy indicated during the acute phase of a first UTI? Should it be restricted to the later detection of permanent lesions?

In a survey on vesico-renal reflux conducted in 1988, Smyth et al. [13] reported that 42% of the consultant pediatricians had no rigid policy for managing UTI in children. Should boys be managed differently from girls? Is strategy dependent on the patient's age? Smyth et al. [13] found 24 different schemes in their survey on the evaluation of UTI. Other investigators share the same experience [11, 15].

It has been suggested [12, 15] that the strategy for the use of DMSA scintigraphy should depend on age: "it should not be performed in children over 5 years with a first proven UTI and normal ultrasound." We decided therefore to investigate retrospectively the frequency of acute DMSA lesions in patients over 5 years. The limitations of a retrospective study are well known and a selection bias is always possible. However, when the medical records were reviewed, the results of imaging were not taken into account in the selection, and, by rejecting cases with an insufficient number of criteria for APN, we only increased the probability of dealing with upper UTI.

In the present series of 261 children with UTI, only 23 with a first UTI were over 5 years (9%). Such a small number was expected, since it is well known that about 80% of first UTIs occur at less than 2 years of age. This small number has probably led some authors to conclude erroneously that the strategy for the use of DMSA scintigraphy should be different after 5 years of age. In this study, scintigraphic abnormalities were nevertheless encountered in 61% of children over 5 years of age with a first UTI. This is at least comparable to that found in a general population of children with first UTI [4, 7, 19–21]. Smellie et al. [14] have previously shown that children over 5 years are unlikely to develop new lesions. However, these children were all on long-term prophylaxis and the risk for developing new lesions was therefore low. This cannot be extended, as suggested by Gordon [12], to children presenting after 5 years of age with a first UTI, since these children (whether or not they had reflux) are not on prophylaxis at the time of their first infection.

A similar incidence of scintigraphic abnormalities in children over 5 years of age was recently described by Benador et al. [5]. However, these authors found 80% scars on repeat scintigraphy, and these lesions may already have been present long before the acute infection. In our series, 53% of the abnormal kidneys became normal or almost normal on control scintigraphy, thus demonstrating that the initial abnormality on DMSA scintigraphy was indeed the expression of an acute lesion occurring after the age of 5 years, and was neither the sequelae of a previous infection nor the recurrence of an acute lesion on a scarred kidney. Finally, it is interesting to note that US was normal in almost half of the kidneys with scintigraphic abnormalities, while no positive US examinations were found in patients with normal DMSA scans.

On the basis of these data, there is no reason to propose that the strategy for the detection of renal lesions, in patients admitted to hospital with UTI, should be different in children over 5 years. In these children, a strategy based exclusively on US would miss a significant proportion of abnormal kidneys.

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Literature abstract

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Control of pulsatile and tonic parathyroid hormone secretion by ionized calcium

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To investigate the effect of changes in ionized calcium on instantaneous PTH secretion, we examined seven young healthy volunteers by 1-min blood sampling under conditions of normo-, hypo-, and hypercalcemia. After a baseline period of 75 min, ambient ionized calcium was either increased or decreased by 0.2 mmol/L for 105 min by clamped infusion of calcium gluconate or sodium citrate. The characteristics of PTH secretion were analyzed by a deconvolution technique, accounting for subject-specific plasma PTH disappearance half-life, as measured during the first 15 min of calcium infusion (range, 2.04–2.93 min). The process regularity of pulsatile PTH secretion was evaluated by an approximate entropy statistic.

Under baseline conditions, 32% of total PTH secretion was released in a pulsatile fashion, with a burst frequency of 6.9 ± 0.8 h^{-1} and a PTH mass per burst of 2.6 ± 0.9 pmol/L. The remaining 68% of total secretion was attributed to tonic hormone release.

During the initial 30 min of induced hypocalcemia, pulsatile secretion increased by 1140%, whereas tonic secretion did not change. The preferential increase in pulsatile PTH secretion was mediated by a combined rise in burst frequency and mass released per burst. During subsequent steady state hypocalcemia, the tonic secretion rate increased (255% of baseline), whereas burst frequency and burst mass decreased (to 103% and 189% of the baseline values), restoring the baseline ratio of tonic to pulsatile PTH secretion. The regularity of PTH release increased during steady state hypocalcemia.

During hypercalcemia, tonic secretion, burst mass, and burst frequency decreased by 75%, 82%, and 32%, respectively, and remained constant throughout the clamp period.

We conclude that acute hypocalcemia elicits an immediate pulsatile and a delayed tonic secretory response of the parathyroid gland with increased regularity of PTH release. Acute hypercalcemia suppresses both the pulsatile and the tonic component of PTH secretion.