

Diuresis Renography for Differentiation of Upper Urinary Tract Dilatation From Obstruction F+20 and F-15 Methods

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Introduction: The aim of this study was to evaluate diuresis renography with an intravenous injection of furosemide 20 minutes after administering the radiopharmaceutical (F+20 protocol) or 15 minutes before (F-15 protocol) in patients with upper urinary tract dilatation.

Materials and Methods: Twenty-one patients with pyelocaliceal system dilatation, but not ureteral dilatation, on ultrasonography were evaluated. The patients underwent diuresis renography using the F+20 and F-15 protocols. Renal scan findings and kidney split function were recorded. Then, the patients underwent surgical or conservative treatment according to their clinical conditions and imaging results. Follow-up was done 3 and 6 months postoperatively by physical examination, intravenous urography, and diuresis renography.

Results: Eleven patients (52.4%) had complete obstruction in both protocols of renography, and 5 (23.8%) had an equivocal result in the F+20 and an obstructive pattern in the F-15. These patients underwent surgical operation. In 3 patients (14.3%), both protocols demonstrated a normal urinary tract. In 2 patients (9.5%), a nonobstructive response in the F+20 and an equivocal result in the F-15 were seen. One of them underwent surgical operation because of impaired kidney function during the follow-up and 1 was treated conservatively. Overall, obstruction was found in 16 out of 21 patients (76.2%) by the F-15 protocol, while it was found in 11 (52.4%) by the F+20 protocol ($P = .01$). The mean kidney split function was $55.15\% \pm 7.82\%$ and $54.81\% \pm 6.87\%$ in F+20 and F-15 protocols, respectively ($P = .45$).

Conclusion: Using the F-15 protocol may reduce the equivocal results of the F+20 for diuresis renography.

Keywords: diuresis renography, upper urinary tract, diuretics, pyelocaliceal system obstruction

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INTRODUCTION

Diuresis renography was first used by O'Reilly in 1978 and then by other urologists and radiologists as the method of choice for evaluation of the upper urinary tract.^(1,2) This diagnostic tool can differentiate obstruction in the pyelocaliceal system from dilatation without obstruction.⁽³⁾ The protocols used for this purpose include F+20, F-15, F+0, and combined F-15 and F+20

that are named according to the time of diuretic administration in relation to radiopharmaceutical injection.⁽⁴⁾ However, none of these protocols is recognized as a standard method for the time of diuretic administration during renography.⁽⁵⁾ Some centers use the F-15 technique if the obstruction is suspected and some routinely use the F+20.^(6,7)

In both protocols, the preferred radiopharmaceuticals are technetium

Tc 99m L,L-ethylenedicysteine (^{99m}Tc-EC) or ^{99m}Tc-mercaptoacetyltriglycine (^{99m}Tc-MAG3).⁽⁸⁾ The F+20 protocol leads to 15% to 17% equivocal results and therefore, the alternative method of the F-15 has been recommended to reduce this rate to 3%.^(7,9-11) The use of the F-15 method results in a longer study period and bladder overdistension that may cause problems in the kidney drainage and misinterpretation of the results.⁽⁵⁾ In a comparative study, we performed diuresis renography using the two protocols of F+20 and F-15 in patients with upper urinary tract dilatation.

MATERIALS AND METHODS

Patients

Between March 2004 and December 2005, we studied patients with pyelocaliceal system dilatation, but without ureteral dilatation, on ultrasonography. After physical examination and history taking, imaging and laboratory tests including serum creatinine level, urinalysis, and intravenous urography (IVU) or retrograde pyelography were done. Patients without obstructive signs or obstruction due to urinary calculi were excluded. We enrolled 21 patients with pyelocaliceal dilatation on ultrasonography, delayed excretion, pyelocaliceal dilatation, nonvisualized ureter, and caliceal clubbing on IVU, and absence of contrast medium drainage from the pyelocaliceal system after the catheter removal on retrograde pyelography. All patients provided informed consent and the study was approved by the ethics committee of Mashhad University of Medical Sciences, Mashhad, Iran.

Procedure

Diuresis renography was done to evaluate the kidney function and obstruction using the two protocols of F+20 and F-15 with an interval of 24 to 48 hours. First, the F+20 protocol was performed. The patient was recommended to drink 500 milliliter of water before the procedure. Then, ^{99m}Tc-EC was injected intravenously and 20 minutes thereafter, furosemide (0.5 mg/kg for adults and 1 mg/kg for children) was administered. The patient was then evaluated by Siemens gamma camera (Siemens AG, Erlangen, Germany). About 24 to 48 hours after the first procedure, renography was repeated using the F-15 protocol. In this protocol, furosemide was administered 15 minutes before the injection of

^{99m}Tc-EC. In both protocols, bladder drainage was performed to prevent from false positive results.

Drainage curves in renal scans were recorded and classified in 4 patterns for the F+20 protocol and in 3 for the F-15 protocol (Figure 1).^(1,11,12) According to the diagnoses made, conservative treatment or surgical operation was carried out for each patient. The patients were followed up by physical examination and IVU or diuresis renography, 3 and 6 months after the treatment. The final diagnoses were made based on the clinical course, intraoperative findings, and follow-up findings, and the primary renography results were evaluated accordingly.

Statistical Analyses

For comparison of the renal scans, marginal homogeneity test was used and the results of kidney split function in the two protocols were compared by the paired *t* test. The statistical analyses were done using the SPSS software (Statistical Package for the Social Sciences, version 9.0, SPSS Inc, Chicago, Ill, USA). A *P* value less than .05 was considered significant.

RESULTS

A total of 15 men and 6 women were enrolled in the study. The mean age of the patients was 25.0 ± 16.3 years. The chief complaints of the patients were flank pain in 17, hematuria in 2, and urinary tract infection in 2. The pyelocaliceal system dilatation was on the right and left sides in 6 and 15 patients, respectively. Ultrasonography also demonstrated a reduction in the cortex thickness (severe reduction in 2 patients). In 19 patients, the IVU was performed and revealed a delay in excretion and dilatation in the pyelocaliceal system and nonvisualized ureter. In patients with high levels of serum creatinine, retrograde pyelography was performed and showed ureteropelvic junction obstruction (UPJO). Diuretic renal scans yielded by the F+20 and F-15 protocols showed the following results:

Eleven patients (52.4%) showed complete obstruction or obstructive response (pattern II) in both protocols. Five patients (23.8%) had an equivocal result (pattern IIIb) in the F+20, while in the F-15, they had the obstructive pattern II (Figure 2). Patients of these two groups underwent surgical operation and the diagnosis was UPJO. Intravenous urography or diuresis

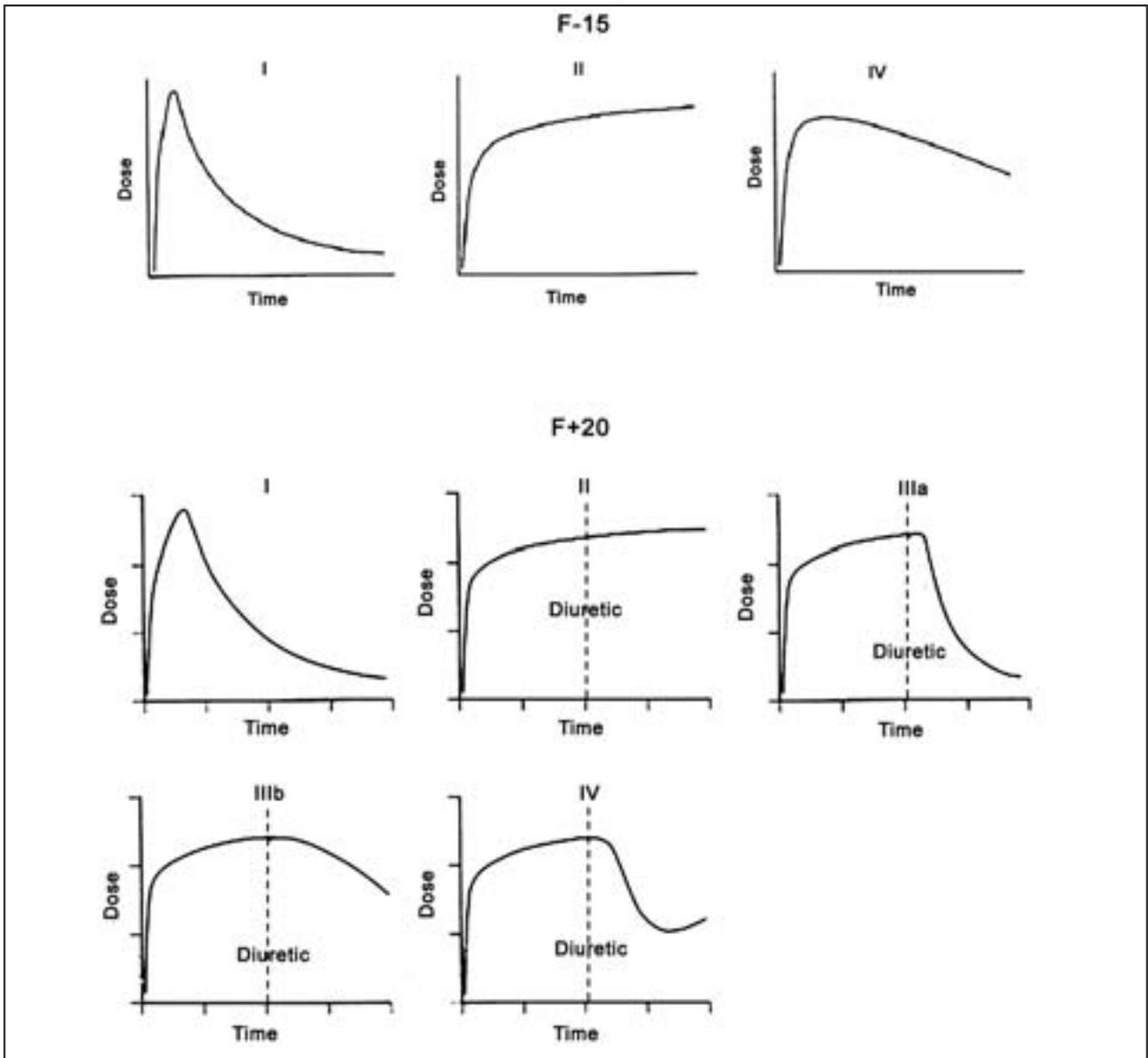


Figure 1. Top, F-15 diuresis renography. I, nonobstructive; II, obstructive; and III, equivocal.⁽¹²⁾ Bottom, F+20 diuresis renography. I, normal; II, obstructive; IIIa, nonobstructive dilatation; IIIb, equivocal; and IV, delayed decompensation.^(1,11)

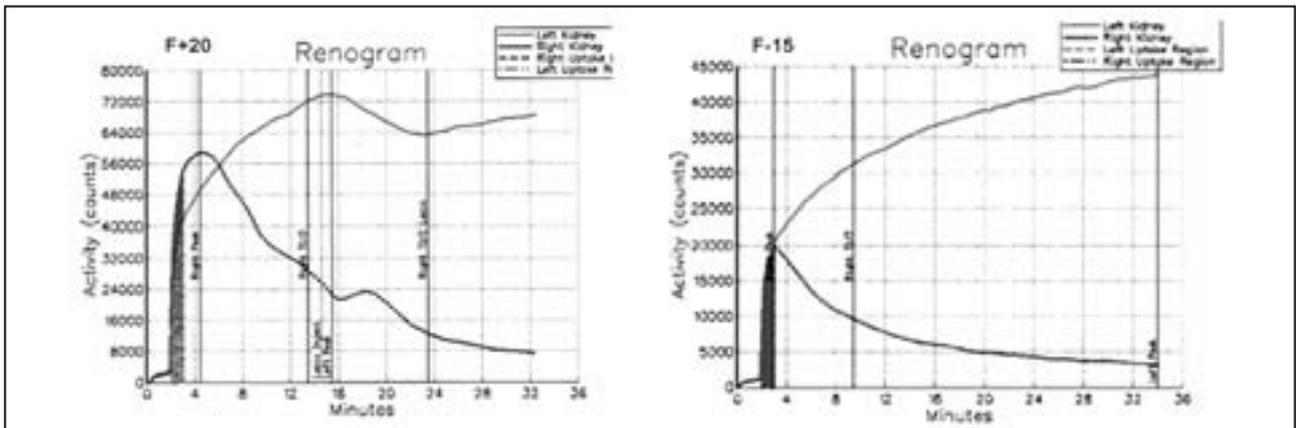


Figure 2. Diuresis renal scan in a 15-year-old patient. Left, Equivocal result in F+20. Right, Apparent obstruction in F-15.

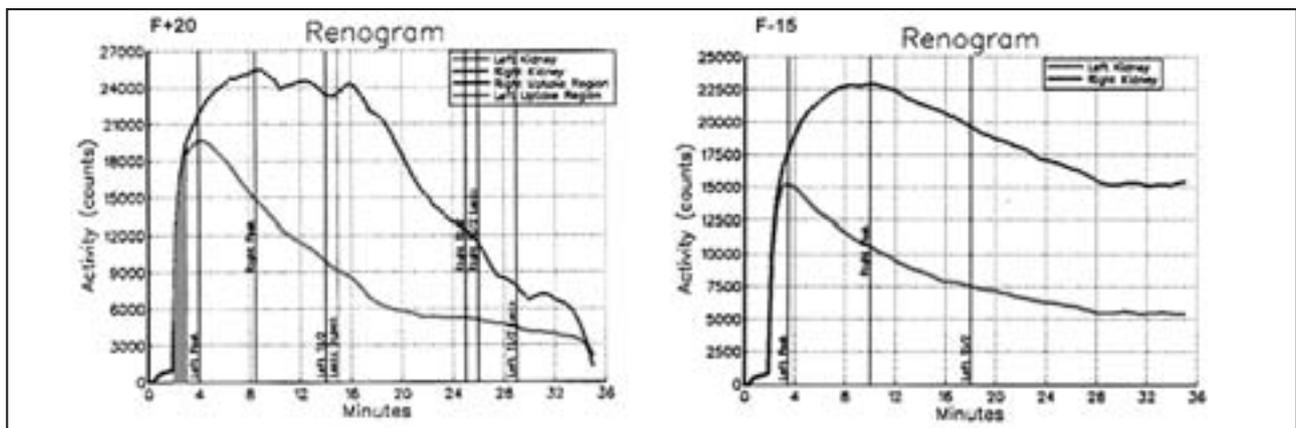


Figure 3. Diuresis renal scan in a 56-year-old patient. Left, Nonobstructive hydronephrosis in F+20. Right, Equivocal result in F-15.

renography was performed 3 months postoperatively that showed improvement of the obstruction in all of the 16 patients.

In 3 patients (14.3%), both protocols demonstrated an intact urinary tract (pattern I). In 2 patients (9.5%), a nonobstructive response (pattern IIIa) in the F+20 and an equivocal result (pattern III) in the F-15 were seen (Figure 3). The patients in the latter group were followed up with diuresis renography 3 and 6 months postoperatively. One patient underwent surgical operation, because of impairment in kidney function and 1 was treated conservatively.

Overall, obstruction was found in 16 out of 21 patients (76.2%) by the F-15 protocol, while it was found in 11 (52.4%) by the F+20 protocol ($P = .01$). The mean kidney function (split function) was $55.15\% \pm 7.82\%$ and $54.81\% \pm 6.87\%$ in the F+20 and F-15 protocols, respectively. Since the results of the both kidney function tests had normal distribution (Kolmogorov-Smirnov test), the paired t test was used for their comparison that showed a nonsignificant difference ($P = .45$).

DISCUSSION

Diuresis renography is a noninvasive imaging tool for the evaluation of kidney function and urinary drainage.⁽²⁾ The main objective of this method is differentiation of obstructive from nonobstructive dilatation.⁽³⁾ Primary investigations suggested the F+20 as the standard protocol; however, no gold standard exists. Four classic types of response have been determined for the F+20 protocol (Figure 1) including: I, normal response showing plummeted drainage curve before diuretic administration; II,

obstructive response showing lack of washout in spite of diuretic administration; IIIa, nonobstructive response or dilatation without obstruction with a collapsing curve by diuretic administration; IIIb, partial obstruction or massively dilated system in which the curve does not ascend as in obstructive pattern, but does not descend, either; and IV, delayed decompensation in which the primary washout is acceptable, but the curve flattens and even ascends.^(1,11) In pattern IV, the flow rate reaches a level that cannot evacuate the urine, resulting in decompensation and more dilatation.⁽⁴⁾

When patterns IIIb or IV are seen in the F+20 renal scan, usually renography with F-15 protocol is recommended.^(4,6) If hydration is fair and the single-kidney glomerular filtration rate (GFR) is greater than 16 mL/min, F-15 may reduce the equivocal results to 3% and when the single-kidney GFR is less than 16 mL/min, the response to the diuretic is suboptimal and more invasive diagnostic methods such as pressure flow study are warranted.⁽⁴⁾ In the F-15 protocol, the most effective response to the diuretic is when the radiopharmaceutical is introduced into the pyelocaliceal system.^(6,7) Three forms of responses have been defined in the F-15 protocol (Figure 1) that include: I, no obstruction; II, obstruction; and III, equivocal.^(4,12) In a study by English and colleagues on 37 hydronephrotic kidneys using the two protocols of F+20 and F-15, it was shown that 77% of the cases with equivocal patterns and 13% of those with a nonobstructive pattern in the F+20 protocol were obstructive in the F-15.⁽¹²⁾ Foda and coworkers studied on 88 children with hydronephrotic kidneys and found that equivocal results in the F+20 significantly reduced by the F-15 protocol.⁽¹³⁾ These

studies suggest that F-15 is the method of choice when the diagnosis is equivocal in the F+20 protocol.

In our study, diuresis renography was performed using these two protocols in patients with upper urinary tract dilatation, and we compared the results with the clinical and surgical findings and follow-up results. Of 21 patients, 11 (52.4%) showed obstructive pattern in both protocols. Five patients (23.8%) with equivocal patterns in the F+20 protocol had an obstructive pattern in the F-15. Of these 5 patients, 4 had intermittent flank pain and pain after drinking water. They underwent pyeloplasty due to UPJO. The patients' symptoms relieved after the surgery and obstruction was improved. Two patients had nonobstructive response or dilatation without obstruction in the F+20 who showed an equivocal pattern in the F-15. They both underwent renography 6 months later. One patient was operated due to impairment of kidney function and 1 underwent conservative treatment. Obstruction was diagnosed in 52.4% and 76.2% of the patients by the F+20 and F-15 protocols, respectively. In our patients, the split function of the kidneys did not change with the protocol, which is in accordance with the findings of Upsdell and associates.⁽¹⁴⁾

CONCLUSION

Diuresis renography is a noninvasive method for evaluation of the kidney function and dilatation of the upper urinary tract. The F+20 protocol is the routine method of diuretic injection and when the findings are equivocal, the F-15 is recommended. However, to reduce the costs and patients' dissatisfaction, using the F-15 protocol might be recommendable as the first step for patients with upper urinary tract dilatation, especially those with flank pain after drinking liquids. However, further studies with evaluation of the positive and negative points of each method are warranted.

CONFLICT OF INTEREST

None declared.

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