

F+0 diuretic protocol is superior to F-15 and F+20 for nuclear renogram in children

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ABSTRACT

Introduction: We compare the outcomes of three different diuretic protocols for renograms in children with hydronephrosis.

Materials and Methods: Between August 2011 and July 2013, 148 diuretic renograms were performed to evaluate unilateral grade 3–4 hydronephrosis (reflux, posterior urethral valves, post-pyeloplasty status excluded). Patients were allotted into three groups based on the timing of diuretic administration: Diuretic given 15 min before (F-15), at the same time as (F + 0) and 20 min after (F + 20) radionuclide administration. Dynamic images and renogram curves were inspected to identify in each group (1) number of equivocal curves and (2) number of interrupted studies due to patient movement/discomfort/voiding. Statistical significance was determined by the Fisher exact test.

Results: There was no significant difference in age/sex distribution between groups F-15 ($n = 35$), F + 0 ($n = 38$) and F + 20 ($n = 75$). The number of equivocal curves was significantly less in F + 0 (2/38) and F-15 (3/35) compared with F + 20 (20/75). The number of interrupted studies was significantly less in F + 0 (2/38) compared with F-15 (9/35) and F + 20 (18/75).

Conclusion: The F + 0 and F-15 protocols are superior to the F + 20 protocol in reducing the number of equivocal curves, while the F + 0 protocol is superior to the other two in reducing interruptions due to patient movement or voiding. F + 0 is the diuretic protocol of choice for renogram in children.

Key words: Diuretic protocol, hydronephrosis, nuclear renogram

INTRODUCTION

Diuretic renography is an essential investigation for the evaluation of hydronephrosis in children. The fundamental principle of diuretic renography is that increased urine flow produced by the diuretic will result in prompt washout of activity in a dilated non-obstructed system. In cases of obstruction, washout after diuretic remains slow and there will be prolonged retention of radiopharmaceutical proximal to the obstruction.^[1-6] The onset of action of frusemide is within the first few minutes, while

the maximal effect occurs around 15 min after intravenous administration.^[7,8]

Several protocols for diuretic renography have been described based on variation in timing of diuretic administration relative to radiopharmaceutical. The conventional F + 20 protocol involves diuretic injection at 20 min after the radiopharmaceutical. Subsequent studies reported that this protocol produced equivocal results in at least 15% of cases, while the F-15 protocol in which the diuretic is given 15 min beforehand could reduce the number of equivocal results.^[9-11] The F + 0 protocol, where diuretic is administered at the same time as the radiotracer, is more popular, particularly in children.^[12-14] The aim of the current study is to compare the three different diuretic protocols – F-15, F + 0 and F + 20 – in children with hydronephrosis in terms of (1) number of equivocal curves and (2) number of interrupted studies.

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MATERIALS AND METHODS

All infants and children presenting with unilateral grade 3–4 hydronephrosis and suspected uretero–pelvic junction obstruction were included (prospective un-blinded non-randomized study) in the study. All patients underwent voiding cysto urethrogram [VCUG], and those with

vesico-ureteric reflux were excluded from the study. In addition, those with bilateral hydronephrosis, posterior urethral valves and post-pyeloplasty status were excluded. Diuretic renogram was performed using a standard low-energy high-resolution collimator (GE Millennium MG Dual Head Gamma Camera, USA). Serial images were obtained after intravenous administration of ^{99m}Tc-MAG3. Hydration was maintained by adequate oral fluid intake and the bladder was not routinely catheterized during the study. Oral sedation (Midazolam at the appropriate dose) was administered in all patients 45 min before the procedure to reduce patient movement from apprehension. Whenever the sedation was found to be inadequate, the procedure was rescheduled and only when the child was adequately sedated was the procedure started.

Patients were consecutively assigned to three groups based on the timing of diuretic administration: Frusemide (1 mg/kg/dose) given 15 min before (F-15), at the same time as (F + 0), and 20 min after (F + 20) radionuclide administration. Dynamic images and renogram curves were inspected by the nuclear medicine consultant to identify in each group the (1) number of equivocal curves and (2) number of interrupted studies, due to patient movement/discomfort/voiding, which warrant a repeat study at another date. All the renograms were reported by the same nuclear medicine consultant who was blinded to the patient allotment and final analysis of data. In all cases, careful analysis of drainage half-time, output efficiency and normalized residual activity on post-void study was performed before reporting on patterns: Drainage, obstructed or equivocal.

Whenever the involved renal unit had poor function, the patient was excluded from the study, as the drainage pattern could be misleading in such cases. Statistical significance was determined by the Fisher exact test. Institutional ethical clearance and informed consent was obtained in all cases.

RESULTS

A total of 148 nuclear renograms were performed between August 2011 and July 2013, with F-15 ($n = 35$), F + 0 ($n = 38$) and F + 20 ($n = 75$). There was no significant difference in age distribution between the groups. The number of equivocal curves was significantly less in F + 0 (2/38) and F-15 (3/35) compared with F + 20 (20/75) [Figure 1]. Figure 2 represents a typical equivocal curve in a F + 20 renogram and drainage in the F-15 renogram in the same patient. All equivocal studies in the F + 20 group (20/75) were repeated with the F + 0 or F-15 protocol. Of these, five remained true equivocal (two in F + 0; three in F-15; under follow-up for repeat renograms); 13 were drained and while two were obstructed.

The number of interrupted studies was significantly less in F + 0 (2/38) compared with F-15 (9/35)

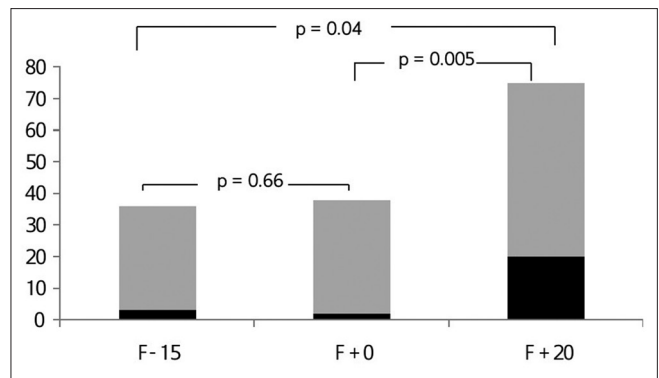


Figure 1: The number of equivocal curves (represented in black) is significantly less in F + 0 (2/38) and F-15 (3/35) compared with F + 20 (20/75)

and F + 20 (18/75) [Figure 3]. The cause of interruptions/movement was as follows: F - 15 group (waking up due to voiding – seven, not known – two); F + 0 group (not known – two); F + 20 group (waking up during frusemide injection due to discomfort or noise – 15; not known – three). Figure 4 shows static image of nuclear renogram highlighting how patient movement could interrupt the study as the region of interest moves out and the drainage curve gets distorted.

DISCUSSION

Diuretic renography is routinely used for the evaluation of kidney function and dilatation of the upper urinary tract in children.^[1,2] The distinction between mechanical obstruction and non-obstructive dilation is critical to patient management. A thorough understanding of the physiological basis and the pitfalls of the technique is required for this and a well-tempered renogram goes a long way in achieving this in children.^[3-6]

Conventionally, F + 20 diuretic renography is followed; however, it requires careful supervision and a longer period of imaging. The F - 15 protocol has been designed such that the timing of radiopharmaceutical administration coincides with the maximal diuretic effect of frusemide. This modification has been shown to significantly reduce the equivocal response rate without significant effect on the assessment of split kidney function.^[7-9]

F + 0 is a protocol that was first proposed by Sfakianakis *et al.*^[10] Studies comparing the F + 0 protocol with other protocols are limited. Turkolmez *et al.*, suggested that the F + 0 method is preferred when equivocal results are obtained by an F + 20 study or as a single test when there is only one opportunity to confirm or exclude the presence of obstruction.^[11] Several studies have reported the successful use of the F + 0 protocol in children with good accuracy.^[12-14]

Our findings reveal that both F - 15 and F + 0 protocols were useful in the reduction of equivocal results as compared with

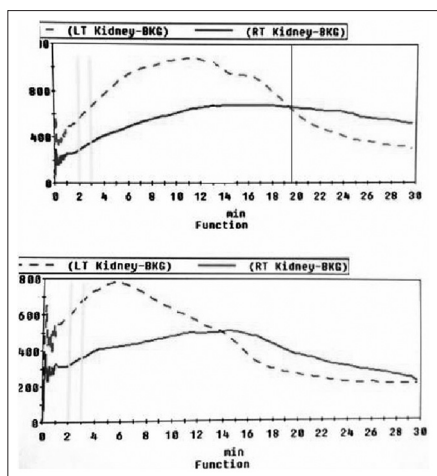


Figure 2: Two different protocols in the same patient with dotted lines representing normal drainage in the left kidney and solid line representing right kidney with hydronephrosis. The top image is a typical equivocal curve in the F + 20 study while the bottom image represents drainage in the F-15 study in the same patient

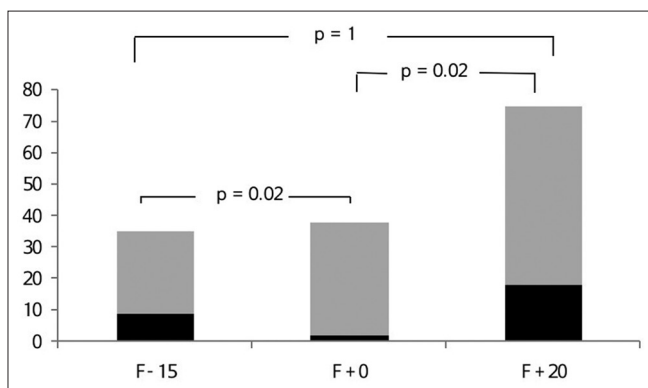


Figure 3: The number of interruptions (represented in black) was significantly less in F+0 (2/38) compared with F-15 (9/35) and F+20 (18/75)

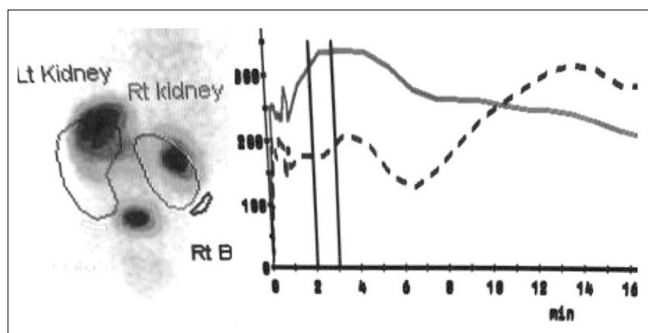


Figure 4: Static image of nuclear renogram highlighting how patient movement could interrupt the study, as the region of interest moves out and the drainage curve gets distorted

the F + 20 protocol. However, interruptions due to voiding were particularly higher in F-15, with patient discomfort/movement due to injection (frusemide), while acquisition was higher in the F + 20 study. These interruptions were far less in the F + 0 group as compared with the F - 15 and F + 20 groups. Liu *et al.* have reported that a shorter period between diuretic administration and completion of

study probably reduces the bladder distension and voiding disruptions in the F + 0 group.^[12] As an institution policy, we used only oral sedation and we did not catheterize the patients. All our patients had undergone prior VCUG to exclude reflux, and parents often dislike the idea of a second study with a catheter. Prior catheterization as suggested for well-tempered renogram^[4-6] is likely to result in less voiding-related interruptions and, with IV sedation, the other factors causing interruption could also be reduced.

Although ours is a non-randomized study, our findings correlate with earlier studies on the F + 0 protocol in reducing the number of equivocal curves and interruptions in studies. F + 0 is likely to be the diuretic protocol of choice for nuclear renogram in children, and further larger studies are warranted to support or negate these findings.

CONCLUSION

The F + 0 and F-15 protocols are superior to the F + 20 protocol in reducing the number of equivocal curves, while the F + 0 protocol is superior to the other two in reducing interruptions due to patient movement or voiding. F + 0 is the diuretic protocol of choice for renogram in children.

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