Impact of Diuretic Half-Time (T½) on The Sensitivity of kidney Obstruction or Non-obstruction Diagnosis

H.I.Abdelkader[1], H.M.Gad[2], Sahar.Mansour[3], Asmaa.H.ELgndy[4]

Abstract— Diuresis renography is widely accepted as a useful test for investigating the dilatation in urinary tract, discriminating between obstructed and non-bstructed systems and evaluating the kidney function .The test achieve popularity because of its simplicity and noninvasiveness. The aim of this study is to assess the optimum timing of furosemide injection in diuretic renog raphy to get the most accurate diagnosis. One hundred patients with suspected urinary ob struction underwent F+10min diuretic renography protocol. Forty of them gave no response to diuresis and diagnosed as obstructed kidneys, twenty patients showed delayed excretion but improved in response to diuresis and diagnosed as non-obstructed kidneys. The remaining forty patients showed equivocal response to diuresis. The sensitivity of diagnosis of obstructed and non-obstructed kidneys is 60%. The remaning forty patients with equivocal response to diuresis underwent F-15 min diuretic renography with thirty one patients were proved to be obstructed and the other nine were non-obstructed. Overall, Obstruction was found in 71 patients out of 100 patients with mean ± SD T½ values 31.39 min ± 10min. The mean kidney split function was 43.7 %± 2.6%. Twenty nine patients out of 100 patients were non-obstructed with mean ± SD T½ values 9.76 min ±3.31 min and their mean kidney split func tion was 45.59%± 3.34%. This leads to increasing the sensitivity of diagnosis of obstructed and non-obstructed kidneys from 60% to 100 %. Regarding to the forty patients with equivocal response to diuresis at F+10min; thirty one patients were proved to be obstructed by F-15min study with mean ± SD T½ values 29.77min±8min which was16.63 min±2.28 by F+10min (p=.000), however the other nine patients were proved to be non-obstructed with mean ± SD T½ values 12.89 min±3.22 min in F-15 min study and it was 24.89±10.8 min in F+10 min (p=.01). A p value less than .05 was considered significant. In conclusion the optimum timing of diuretic injection is F-15 min prior to renography study for equivocal cases.F-15min renal scintigraphy can be considered as the most sensitive method for diagnosing urinary obstruction and non-obstruction so, it can be taken as a gold standard method in this matter.

Index Terms— diuresis renography, equivocal, kidney obstruction, furosemide.

1 INTRODUCTION

Diuresis renography is widely accepted as a useful test for investigating the dilatation in urinary tract, discriminating between obstructed and non-bstructed systems and evaluating the kidney function [1].The test achieve popularity because of its simplicity and noninvasiveness [2], [3].The principle of nuclear medicine studies based on observing the distribution of a pharmaceutical administered to the patient that are swallowed, inhaled, or injected into the body, where they accumulate in the organ or tissue of interest. By incorporating a radionuclide into the pharmaceutical, measurements can be made of the distribution of this radiopharmaceutical by noting the amount of radioactivity present. This is accomplished by recording the emissions from the radioactivity, with external radiation detectors (gamma camera) placed in the front of the patients [4].

Kidney obstruction can occur at any point in the urinary tract starting from the calyces of the kidney to the external urethral meatus. Such obstruction may be acute, sub acute or chronic; unilateral or bilateral; and total or subtotal. Renal radionuclide studies have several useful applications in the management of patients with acute or chronic urinary tract obstruction [5].

The use of diuretic renography to differentiate equivocal obstruction of the upper urinary tract can aid in evaluating the patient with hydronephrosis described by O'Reilly [6] et al. Those investigators proposed that the appearance of the diuretic response curve can identify the absence or presence of obstruction. Koff et al described diuretic scintirenography using 99mTC- DTPA [7].

Diuresis renography based on three items. First, the degree of hydration should be optimal: this can be achieved by oral hydration in most patients (500 ml water or juice) [8].

Secondly, frusemide injection time varies between groups. The traditional method requires the administration of a diuretic (frusemide) at 20 min after radiopharmaceutical injection and this is the standard renogram [9].

But sometimes this may lead to a number of equivocal responses, an alternative was proposed in which furosemide is injected 15 min before injection of the radiopharmaceutical (F-15) protocol [10]. The furosemide dose is 40 mg in adults 0.5 mg/kg in children and 1 mg/kg in infants [11].

The diuretic timing injection is a crucial part of this study.

Third, the role of the bladder void should be considered. The bladder should be emptied before the beginning of the study. Jones et al (1990) [12] noted that any increase in pelvic

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pressure during bladder filling causing a reduced drainage of the pelvicaliceal system, which can cause false positive results[8] .

Diuretic response is characterized by the drainage half time or T1/2, which is the number of minutes following diuretic injection to eliminate half of the radio activity from a region of interest just proximal to eliminate half the radioactivity [13],[14]. A clearance T1/2 less than 10 minutes mean that there is no obstruction; a clearance T1/2 greater than 20 minutes mean that there is a significant obstruction; and a clearance T1/2 between 10 and 19 minutes means an indeterminate or equivocal cases [11].

2 SUBJECT AND METHOD

2.1 subject

One hundred patients were seen during 2014-2016 in the urology and neprology centre at Mansoura University with suspected urinary obstruction. They underwent F+10min diuretic renography protocol. Forty of them gave no response to diuresis and diagnosed as obstructed kidneys, twenty showed delayed excretion but improved in response to diuresis and diagnosed as non-obstructed kidneys. The remaining forty patients showed equivocal response to diuresis underwent F-15 min diuretic renography .All cases initial assessed by standard gamma camera renography.
The results of applying F-15 protocol were divided into 2 groups;
Group 1(Obstructed group; 31 Kidneys)
Group 2(Non-obstructed group; 9 Kidneys)

2.2 Scintigraphic procedure

All patients should drink 500 mL of water 15 to 30 minutes before tracer injection, and then the bladder should be emptied before the start of the study. All studies were done on a BRIGHT VIEW (PHLIPS) gamma camera with a low-energy all-purpose collimator attached to a PHLIPS computer monitor. The study was done in the supine position. Kidneys, bladder, and ureters were in the field of view. The radiopharmaceutical was Tc-99m DTPA. Tc-99m DTPA dosage was 2–3 mCi. The dose of furosemide was 0.5 mg/kg body weight. F+10 and F-15 diuretic renography were performed as follows:

F + 10 Diuretic Renography protocol

The study start with the injection of Tc-99m DTPA then followed by given furosemide after 10 minutes. After the diuretic was administered the renogram was continued until 10 min. Thus, the total time of acquisition was 20 minutes.

F - 15 Diuretic Renography protocol

The patient should be in a good state of hydration, ensure that there is no clinical reasons make diuresis not be induced, and then the patient empties his/her bladder. Insert a butterfly needle into a suitable vein Inject frusemide at a dose 0.5 mg/kg body weight. Wait 15 min before starting the next step. Inject the Tc-99m DTPA as for a routine renogram .Continue the renogram until 20 min after the radiopharmaceutical injection . Thus, the total time of acquisition was 35 minutes.
Drainage curves in renal scans were recorded and classified in 4 patterns in F + 10 Diuresis Renography and in 3 patterns for F - 15 Diuresis Renography.
The result of drainage half time or T1/2 and split function in the two protocols were recorded and compared by the paired t test using the SPSS software (Statistical package for the social sciences, version 20). A p value less than .05 was considered significant.

3 Results

One hundred patients were examined in our study, forty patients had mean T½ value more than 20min and diagnosed as obstructed kidneys and the other twenty had mean T½ value less than 10min and diagnosed as non-obstructed kidneys. The remaining forty patients had mean T½ value between 10min to 19min with indeterminate diagnosis (equivocal results) in the F+10 (pattern IIb, fig.1), followed up with with F-15 diuresis renography after one month. Diuretic renal scans were done by F-15 protocols showed the following results:
Nine patients showed nonobstructive response (pattern I, fig.1) and thirty one patients showed complete obstruction or obstructive response (pattern II, fig. 1).
One hundred patients by F+10 min protocol showed that forty were obstructed and twenty were non-obstructed with sensitivity 60%. The overall results indicated that obstruction was found in 71 patients out of 100 patients with mean ± SD T½ values 31.39 min ± 10min and the mean kidney split function was 43.7 %± 2.6%. Twenty nine patients out of 100 patients were non-obstructed with mean ± SD T½ values 9.76 min ±3.31 min and their mean kidney split function was 45.59%± 3.34%. This means that applying F-15 protocol to the equivocal group resulted from F+10 protocol leads to increasing the sensitivity of diagnosis of obstructed and non-obstructed kidneys from 60% to 100 %. Comparing the results of F+10min protocol with F-15 min protocol for the forty patients with equivocal response; thirty one patients were proved to be obstructed by F-15min study with mean ± SD T½ values 29.77min±8min which was16.63 min±2.28 by F+10min(p=.000) which illustrated in Fig. 2 , the other nine patients were proved to be non-obstructed with mean ± SD T½ values 12.89 min±3.22 min in F-15 min protocol which was 24.89±10.8 min in F+10 min (p=.01) which illustrated in Fig .3 .
A p value less than .05 was considered significant

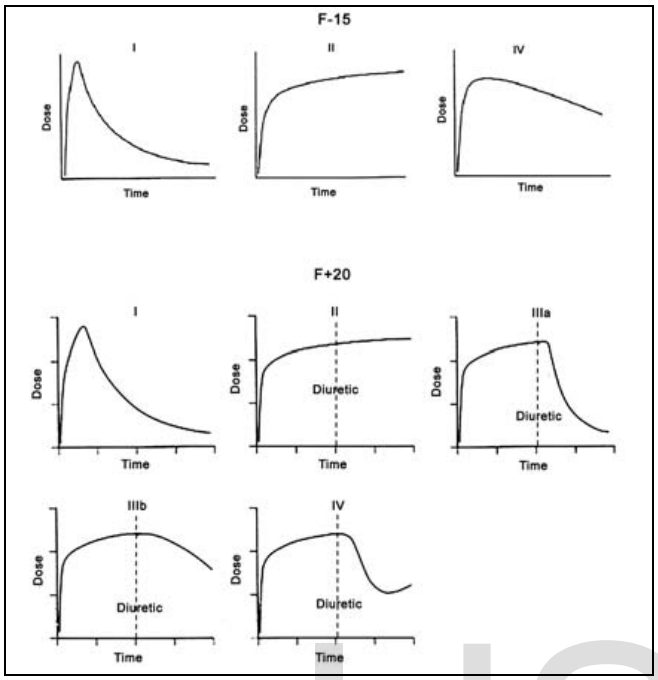


Fig1. Top, F-15 diuresis renography. I, nonobstructive; II, obstructive; and III, equivocal [14]. Bottom, F+20 diuresis renography. I, normal; II, obstructive; IIIa, nonobstructive dilatation; IIIb, equivocal; and IV, delayed decompensation [16] [6], [15].

4 Discussion

Furosemide is used to eliminate salt and water from the body and push the urine through the kidney until reach to the bladder. In the kidneys, salt (composed of sodium and chloride), water, and other small molecules normally are filtered out of the blood and into the tubules of the kidney. The filtered fluid ultimately becomes urine. Most of these molecules that are filtered out of the blood reabsorbed into the blood before the filtered fluid becomes urine and is eliminated from the body. Furosemide works by blocking the absorption of sodium, chloride, and water from the filtered fluid in the kidney tubules, causing an increase in the output of urine (diuresis) [17].

In F-15 renography, the kidney takes enough time to deal with the furosemide to reach the maximum effect. This help in differentiating between kidney obstruction and non-obstruction.

Four patterns of washout curves were identified during the standard diuresis renograms as described by O'Reilly et al[6]. ,i.e un obstructed (normal) (type I) showing plummeted drainage curve before diuretic administration , obstructed (Type 11) showing lack of washout in spite of diuretic administration , hypotonic (dilated non-obstructed) (Type IIIa showing a collapsing curve by diuretic administration) and equivocal (Type IIIb)in which the curve does not ascend as in obstructive pattern , but does not desend, either as illustrated in Fig.1, the delayed double-peak (Homsys's) response indicates intermittent obstruction [18].
In F-15 renography only 3 types of elimination curves were identified, namely unobstructed, obstructed and equivocal fig.1 [19].

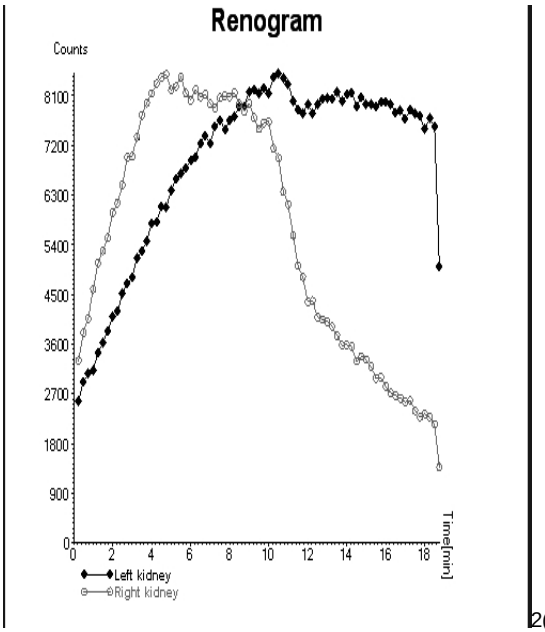
In a study by English and colleagues on 37 hydronephrotic kidneys using the two protocols of F+20 which recommended as the initial technique of choice [7].and F-15, it was shown that 77% of the cases with equivocal patterns and 13% of those with a non-obstructive pattern in the F+20 protocol were all diagnosed obstructive in the F-15[10].

Foda and coworkers studied on 88 children with hydronephrotic kidneys and found that equivocal results is reduced by the F-15 protocol after F+20 protocol[21].In these studies F-15 is the method of choice when the diagnosis is equivocal in the standard F+20 renography .

Sfakiankis et al [22].were the first to propose another diuretic protocol; early injection of furosemide following the radiotracer (F+3) [23].

In this study, diuresis renography was performed using F-15 and F+10 instead of F+20 in patients with equivocal diagnosis, and the results of drainage half time or T1/2 on forty patients were compared.

Of 40 patients, 31 with equivocal patterens in the F+10 protocol had an obstructive pattern in the F-15 with half time or T1/2 equal 16.63 min and 29.77 min respectively (p=.000) which mean there is an increase in T1/2 when the diagnosis is obstructed pattern t1/2 >20 so, there is a significant change in the value of T1/2 after F-15min protocol. But in the nine patients with equivocal pattern in the F+10 protocol , the value of T1/2 become lower after F-15 as the diagnosis was non obstructed with T1/2 equal 12.89 min.



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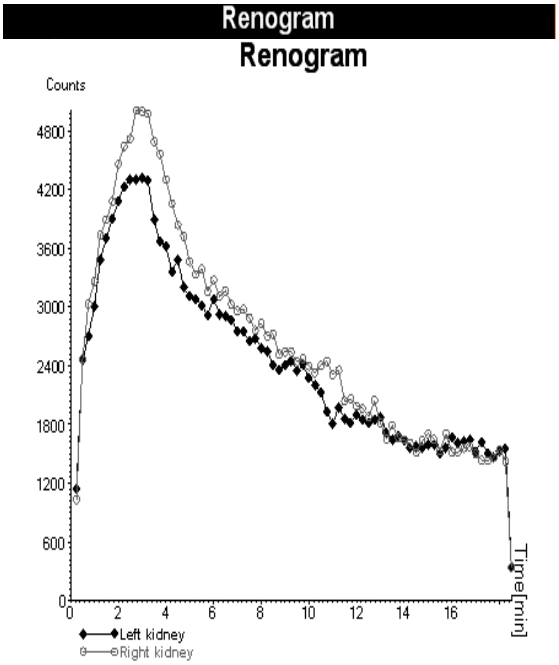

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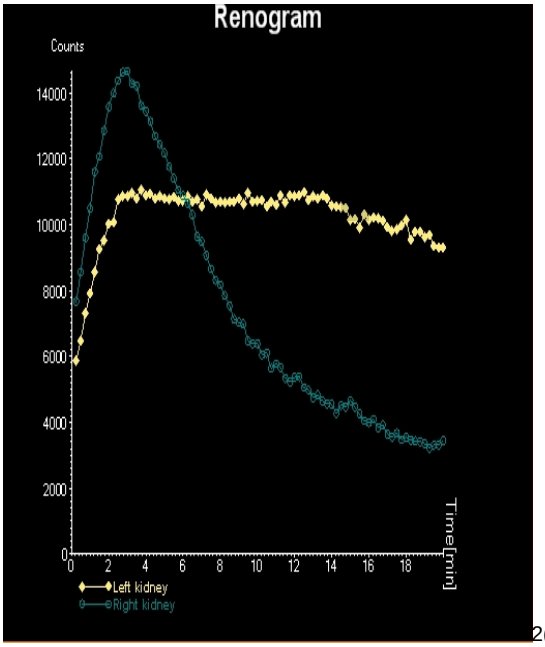

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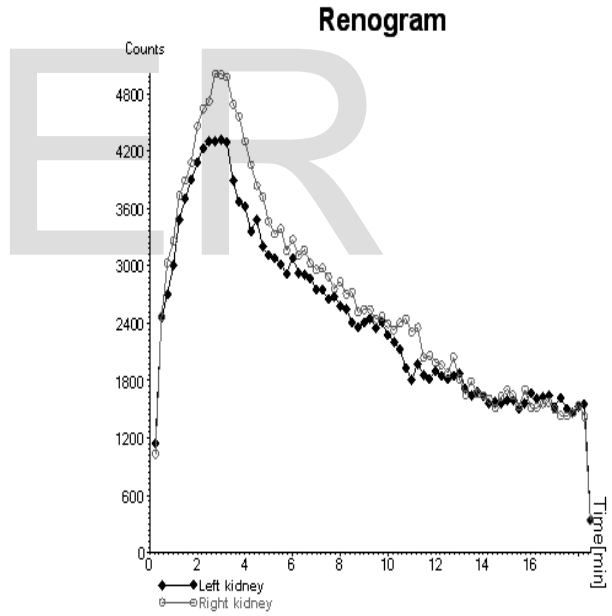

3(d)

Fig.2 Diuresis renal scan in a patient. First pics A, Equivocal result in F+10. Second pic B, Apparent obstruction in F-15.

Fig.3 Diuresis renal scan in a patient.First pic C, Equivocal result in F+10. Second pic D, Apparent Non-obstruction in F-15.

5 CONCLUSION

F-15 renography is the most sensitive method for urinary obstruction diagnosis in suspected obstruction kidneys. So, it can be taken as a gold standard method in this matter. The results of the current study indicated the advantage of using the diuresis renography T½ value to differentiate between obstruction from non obstruction by compare the results wit the standerd values of T½.

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