Comparative Study Between Two Radionuclide Techniques in Measurement of Glomerular Filtration Rate

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خلاصة

تم قياس معدل ترشيح الكلى لخمسين مريضا بوحدة الطب النووي بمركز علاج الأورام والطب النووي (نمرك) وقد تم القياس باستخدام مادة التكنشيوم 99م د.ت.ب.أ وكانت الجرعة المعطاة لكل مريض 111 ـ 118 ميجا بيكريل وتم تجميع المعلومات على الكمبيوتر كل 15 ثانية مع حساب نسبة التقاط الكلى. وبعد 72 ساعة تم اعطاء جرعة 3,7 ميجا بيكريل من الكروميوم ـ 51 اي. دي. ت. أ. 79,61 ± 22,4 ملليتر/ دقيقة.
بالمقارنة بـ 84,34 ± 26,3 ملليتر ـ دقيقة. وباستخدام طريقة التصوير الذري المباشر كان كل من الكروميوم 51 أي. دي. ت.أ. والتكنشيوم 99م د.ت.ب.أ على علاقة ايجابية بتنقية الكرياتين (ر = 0,87 و 0,91) وقد تم استخدام معادلة اختزال معدلة لتصليح نتائج التكنشيوم 99م في معدل ترشيح الكلى (تكنشيوم 99م د.ت.ب.أ x 0,81 + 11 ± ملليتر/ دقيقة).

Abstract

Fifty patients were referred to nuclear medicine department in NEMROCK center for measurement of glomerular filtration rate (GFR). The group included 34 males and 16 females with a mean age of 38.3 ± 10.7 years. Estimation of GFR was done using 111-185mBq of ^{99m}Tc-DTPA with data collected on 128 x 128 matrix on IDAC computer every 15 seconds with calculation of renal uptake and GFR applying Gates method). 72 hours later, a dose 3.7 mBq of ^{51}Cr-EDTA with 2 blood samples taken at 120, 240 minutes with estimation of plasma clearance using Russel et al., method (1985). The mean clearance of ^{51}Cr-EDTA was 79.61±22.4 ml/min compared to 84.34±26.3 ml/min. using direct scintigraphic method with positive correlation using regression analysis

(r= 0.96). Also, both ^{51}Cr-EDTA and in vivo ^{99m}Tc-DTPA were positively correlated with creatinine clearance (r= 0.87 and 0.91 respectively). A modified regression formulas was used for correction of the results of ^{99m}Tc-DTPA values GFR(^{99m}Tc-DTPA) X = 0.81 ± 6.4ml/min.

Introduction :

A variety of techniques have been proposed for the routine measurement of GFR following a single injection of labeled chelate. Measurement can be made using in vitro Cromium-51 EDTA (1,2) or in vivo renal uptake using a scintillation camera (3,4).

In the current study, comparison between scintigraphic in vivo technique using ^{99m}Tc-DTPA uptake versus the two plasma simple in vitro technique using ^{51}Cr-EDTA to evaluate the accuracy for glomerular filtration rate (GFR) estimation was applied.

Material and Methods:

The study included 50 patients referred for determination of GFR in the period October 1991 to october 1992. The group is formed of 34 males and 16 males with their mean age ± SD (38.3+10.68 years).

The creatinine clearance ranged 17-125 ml.min. In vivo GFR measurement was done using 111-185 MBq (3-5 mCi) of ^{99m}Tc-DTPA for estimation of fractional renal accumulation. Dynamic data was collected on 128 x 128 matrix using IDAC computer connected to Sopha camera every 15 seconds for 20 minutes. A preinjection and postinjection count of syringe for one minute which was placed at 30 cm from the center of collimator. A composite image was the study and processed using 10% Calculation of renal uptake and GFR was created at the end of background subtraction. done applying Gates method (1982).

In vitro GFR measurment was performed by injection of 3.7 MBq (100 uCi) of ^{51}Cr-EDTA followed by taking two blood samples from contralateral arm at 120, 240 minutes. A preinjection and postinjection count of syringe was done. The blood samples were centrifuged at 1500 g and plasma samples were counted in scintillation detector with a relative counting error of 1.0%. Plasma clearance was determined using technique of Russel et al., (1985).

Comparison between in vitro and in vivo estimation of GFR was done using linear regression analysis.

Results :

The mean value for clearance using the final slope of in vitro ^{51}Cr-EDTA was 79.61+22.35 ml/min compared to 84.34 +26.32 ml/min. using in vivo scintigraphic technique with ^{99m}Tc-DTPA. There was excellent positive correlation between both methods using regression analysis (r=0.96) (Fig.I). Also, ^{51}Cr-EDTA clearance was significantly positively correlated with creatinine clearance (r= 0.91) (Fig.2). Similarly, ^{99m}Tc-DTPA in vivo GFR measurement was positively correlated with creatinine clearance (r=0.87) (Fig.3). However, ^{51}Cr.EDTA clearance method had higher sensitivity (l00%) and accuracy (96.5%) compared to 87%, 87.8% in ^{99m}Tc-DTPA in vivo measurement. We postulated that modification of the value of GFR estimated by in vivo scintigraphic technique using regression analysis of GFR measured in vitro by ^{51}Cr-EDTA may increase the accuracy of this test (modified GFR=ll+(GFRX0.81) + 6.4 S.E. The value of GFR using the above modification was significantly correlated with creatinine clearance (Fig.4). However, the mean modified GFR was significantly higher than creatinine clearance with a mean difference of 3.75%. whereas, the initial mean GFR using In vivo ^{99m}Tc-DTPA measurement showed a higher mean difference of 11% compared to creatinine clearance (Table 1). Thus, creatinine clearance is better matched with modified GFR with a wider scale of confidence.

Table (1) : Mean Values of GER by The in Vitro (^{51}Cr-EDTA) and in Vivo (^{99m}Tc-DTPA) Techniques and Creatinine Clearance

GER	MEAN ml. min.$^{-1}$	S.D	Paired value	DF	P
^{51}Cr-EDTA	79.61	22.35			
			2.69	49	<0.01
CREATININE CLEARANCE	75.86	22.83			
			4.62	49	<0.01
^{99m}Tc-DTPA	84.34	26.32			

Discussion:

For routine clinical use, it may be an advantage to employ technique which reduce patient and laboratory time. Several investigators showed that in vivo measurement of GFR using ^{99m}Tc DTPA satisfies this requirements, being single radionuclide injection which is performed within short time with low radiation dose and no need for repeated blood samples (3,4).

In this study, in vivo measurement of GFR was done applying Gates technique (1982) for measurement of kidney uptake for 2-3 minutes postinjection. We found good correlation between GFR measurement using ^{99m}Tc-DTPA and creatinine clearance (r=0.87). A similar significant correlation was reported by 6,3.

The second in vitro method for measurement of GFR using ^{51}Cr-EDTA have the advantages of stability and lack of external clearance which make sit more suitable for measurement of plasma clearance. A high correlation between the two plasma sample method and creatinine clearance was seen in this study (r=0.91). Similar, results was reported by 6 & 7. However, the limitation for using this technique are being relatively expensive and at least 4 hours are needed to perform exponential analysis of the plasma disappearance curve with minimum two blood samples required.

On the contrary, the plasma clearance using ^{51}Cr-EDTA for GFR measurement had high correlation with in vivo scintigraphic method (r=0.96 with S.E.= 6.4). This in agreement with 4 & 8 with their correlation (r = 0.96 with SE 8ml/m., r = 0.99 with SE 9.3 ml/m respectively).

Comparison between the clearance rate using ^{99m}Tc-DTPA and ^{51}Cr-EDTA showed a slight difference of 4.7%. A nearly similar difference of 3.7% was reported by 9, whereas 6,8 reported higher difference of 7.6% between both methods. Such higher difference may be related to the instability or protein binding of ^{99m}Tc-DTPA preparation used.

In view of high degree of sensitivity and accuracy using in vivo ^{99m}Tc-DTPA GFR measurement, we postulated modification formula using regression analysis to increase the precision of the test. The modified GFR mean value was significantly positively correlated with

creatinine clearance. Similar correlation equation have been reported by 10,6 for correction of high systemic result.

References :

[1].Russel,C.D. and Dubovsky, E.V.: Measurement of renal function with radionuclides. J. Nucl. Med., 30:2053-2057.(1989)

[2].Summerville,D.A.; Poher,C.S. and Treves,S.T.: The use of radiopharmaceuticals in the measurement of glomerular filtration rate: a review in: Freeman,L.M. (ed.).Nuclear Medicine Annual, 1990. Raven, New York, p.191-221.(1990)

[3].Gates :Estimation from fractional renal accumulation of ^{99m}Tc-DTPA (stannous). Am. J. Roentgenol., 138:565-570.(1982)

[4].Lee,T.; Constable,A.R.; and Granage,R.W.: A method for GFR determination without blood samples in routine renal scintigraphy with ^{99m}Tc-DTPA. In radionuclides in nephrology, proceedings of the 5th international symposium, London, Academic Press. (1982)

[5].Braren,V. ;Versage, P.N. ;Touya,J .J . ;Brill, A.B .; Goddard, J. ;and Rhamy, R.K.: Radioisotopic determination of GFR. JUBI, 121:145-147.(1979)

[6].Hilson,A.J.W.; Mistry,R.D.; and Mausy,M.N.: ^{99m}Tc-DTPA for the measurement of glomerular filtration rate. Br.J.Radiol., 49:724-26,1976

[7].Chervu,R.L.; Lee,H.B.; Goyal, Q.; and Blaufox, M.D.: Use of ^{99m}Tc-Cu-DTPA complex as the renal function agent. J. Nucl. Med., 18(1):62-66. (1977)

[8].Fleming, J.S; Wilkinson, J; oliver,R.M; Ackery, D.M.; Blacke, G.M.; and Waller, DG: Comparison of radionuclide estimation of glomerular filtration rate using ^{99m}Tc DTPA and ^{51}Cr-EDTA. Eur. J. Nucl. Med., 18:391-396.(1991)

[9].Rehling, M.; Moller, M.I.; Thandrup, B.; Lund,O.; and Trajensen, J.: Simultaneous measurmenet of renal clearance and plasma clearance of ^{99m}Tc-DTPA, ^{51}Cr EDTA and inulin in man. Clin. Sci., 66:613-619. (1984)

[10].Brochner-Morterser,: A simple method for determination of GFR. Scan. J. Clin. Lab. Invest., 30:271-274. (1972)

Figure 1: Correlation between GFR values estimated from direct scintigraphic technique using ^{99m}Tc-TIPA and blood sampling technique using ^{51}Cr-EDTA.

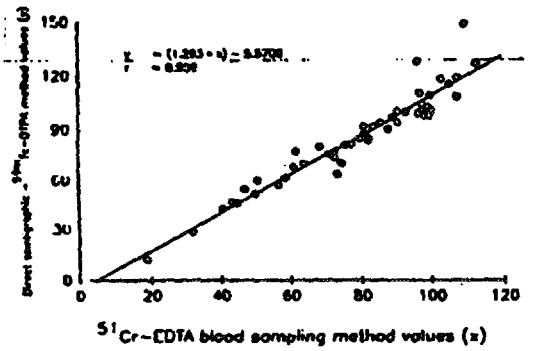

Figure 2: Correlation between GFR value estimated from direct scintigraphic technique using ^{51}Cr-EDTA and creatinine clearance.

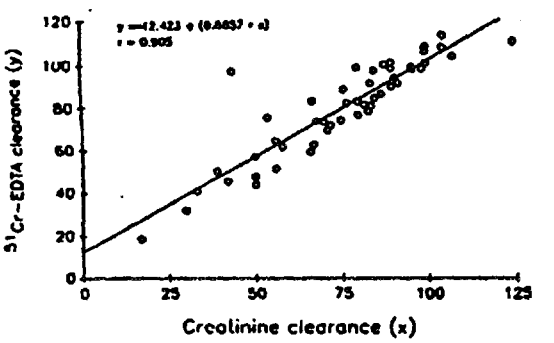

Figure 3: Correlation between GFR values estimated from direct scintigraphic technique using ^{99m}Tc-DTPA and creatinine clearance

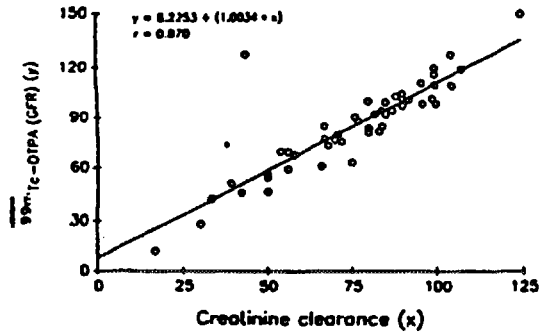

Figure 4: Correlation between the modified GFR and ^{51}Cr-EDTA clearance values.