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Multimodality Radiological Diagnosis of Post Renal Transplantation Complications

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Abstract

Background: Renal transplantation is the most effective treatment option in patients with end-stage renal disease. Studies have shown that the 5-year survival after renal transplantation is 70%, as compared to 30% survival in patients receiving dialysis.For precise planning, early detection of problems, and workflow effectiveness, it is essential to adopt the proper diagnostic technique in preoperative analysis and also in postoperative follow-up procedure.

Aim of Study: To detect the of renal transplant complications by MRI and/or renal scintigraphy compared to renal biopsy in a selected cases.

Patients and Methods: This study involved 90 renal transplant patients. There were 63 (70%) male patients and 27 (30%) female patients. They varied in age from 24 to 45 years (mean age 34.5 years). These 90 patients were subdivided into three groups as patients of medical complication (30 patients), patients of surgical complications (30 patients) and Control group of thirty recipient patients. Gray scale Ultrasonography and color Doppler Sonography Applied routinely on all examined transplant recipients. These subjects have been assessed via MRI using 3 Tesla MRI scanner, (Philips, Ingenia).

Radio-isotope diuretic renogram by Philips Gamma Camera using Tc99-DTPA radioactive tracer. Performed routinely after 2 weeks from transplantation to all cases as basal study.

Results: Study included 90 transplant recipients. That were subdivided into three groups, Group of medical complication Their ages ranged from 20-41 years mean (30.67±9.95) & group of surgical complication; their ages ranged from 23-44 mean (33.90±10.88) and the control group includes 30 transplant recipients normal subjects, their ages ranged from 23-43 years mean (33.47±9.67). Males represented 76.7% and females represented 7% of patients with medical complications. Males represented 73.3% and females represented 26.7% of patients with surgical complications. Males represented 60% and females represented 40% of patients with normal transplanted kidney functions.

There is statistically significant lower mean ADC among medical complications than control groups (1.71 versus 2.02, respectively) without statistically significant difference between control, surgical complications (p=0.153) and between medical & surgical complications (p=0.172).

There is statistically significance as higher mean GFR isotope among cases with surgical complications than cases with medical complications (72.28 & 59.82, p=0.01). Perfusion phase illustrates statistically significant difference between studied groups; with higher frequency of reduced perfusion among cases with medical than cases with surgical complications.

Conclusion: There was a significant decrease in the graft ADC map in cases with medical complication (ATN and Acute rejection) than control group.

Estimated GFRVia using Tc99-DTPA radioactive tracer renal scintigraphy showed statistical significant low at case of medical complication in comparison to control group & group of surgical complications.

Renal scintigraphy and DWI MRI provide noninvasive methods for detection of renal allograft dysfunction.

Key Words: *Renal transplantation – Renal Scintigraphy – Apparent diffusion coefficient – GFR.*

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Introduction

RENAL transplantation is the most effective treatment option in patients with end-stage renal disease. Studies have shown that the 5-year survival after renal transplantation is 70%, as compared to 30% survival in patients receiving dialysis [1].

The first successful kidney transplant was done in the early 1950s, and since then, it has been the preferred course of therapy for the majority of patients with end-stage renal illness. Renal transplantation offers superior quality of life and longer-term survival compared to hemodialysis or continuous ambulatory peritoneal dialysis [2].

For precise planning, early detection of problems, and workflow effectiveness, it is essential to adopt the proper diagnostic technique in preoperative analysis and also in postoperative follow-up procedure [2,3].

The most important role of diagnostic radiological methods is to identify multiple complications in the post-transplant period [1].

Surgical complications of renal transplantation include peri-nephric collections in the form of urinomas, lymphoceles and hematomas and Vascular complications such as renal artery stenosis, renal vein thrombosis, renal vein stenosis, renal artery thrombosis, internal arteriovenous fistulas and pseudo aneurysms, external arteriovenous fistulas. Collecting system abnormalities include urinary tract obstruction, also considered surgical complications. However acute tubular necrosis, rejection, drug induced nephrotoxicity are considered medical complications [4].

Percutaneous biopsy is a vital diagnostic tool for transplant patients with impaired renal function. While fine-needle biopsies are less prevalent, core needle biopsies are still used at some institutes [5].

Magnetic Resonance Image (MRI) is an excellent modality for renal imaging. When compared to US or CT, MRI is a desirable modality due to its greater contrast resolution, multi-planar capability, absence of operator reliance, and no need for intravenous iodinated CM. Additionally, it has been demonstrated that the general capability of MRI for improved characterization of abnormalities found using US or CT has a significant impact on the clinical treatment of post-transplant problems [6].

By applying fast MRI sequences together with paramagnetic contrast agents, with regard to cross-sectional and vascular information, MRI has several benefits without the hazards of ionizing radiation, iodinated contrast, or arterial catheterization [7].

There are several sequences available in magnetic resonance imaging that may be used to gather information on anatomy, function, flow, and lesion characterization. The renal allograft's pelvic position reduces breathing-related motion artefacts, especially if the torso coil is tightly fastened around the pelvis to prevent abdominal wall motion [8].

Renal scintigraphy studies are valuable for providing an assessment of transplant perfusion. 99m TC-DTPA or 99m TC-MAG3 are used because of their excellent imaging characteristics. After injection, images are acquired every second for 60 seconds. As the bolus descends the iliac arteries, a well-perfused kidney is quickly visible, with peak renal activity happening 4 to 6 seconds after peak distal aortic vision. Perfusion may be evaluated qualitatively by viewing serial 2-second analog images acquired on X-ray film [9].

Patients and Methods

Patients:

This observational cohort study involving 90 renal transplant patients, Between January 2020 and January 2022, they were referred by the nephrology and urology departments and assessed at Mansoura Urology and Nephrology Center's Radiology Department. There were 63 (70%) male patients and 27 (30%) female patients. They varied in age from 24 to 45 years (mean age 34.5 years). These 90 patients were divided into three groups as patients of medical complication (30 patients), patients of surgical complications (30 patients) and control group of thirty patients.

The study was approved by ethical committee of Faculty of Medicine Mansoura University (Institutional Research Board).

Patients were informed with the aim of study and consents were signed.

Inclusion criteria:

Any case suspected with renal transplant complication as follow:

1- Reduced urine output.
2- Rising serum creatinine after basal decline after transplantation.

Exclusion criteria:

1- Patients who refuse the study.
2- Contraindications for radioisotope renography such as pregnant females.
3- Contraindications for MRI such as patients with cardiac pacemaker, patients with cochlear implants, patients with artificial prosthesis.
4- Claustrophobic patients.
5- Patient with high serum creatinine that is not fit for Gadolinium I.V injection.

All patients were subjected to clinical history taking.

Methods:

Gray scale Ultrasonography and color Doppler Sonography Applied routinely on all examined transplant patients using B-mode ultrasonography with a 5MHZ multi-frequency curvi-linear array probe. These subjects have been assessed via MRI using 3 Tesla MRI scanner, (as follow; Thirty transplant patients have been assessed shortly after surgery (within the first two weeks) due to fast graft function impairment, i.e. increasing serum creatinine and decreased urine output. After two weeks, thirty patients were assessed (Routine Basal

MR examinations) as a control group and Thirty patients were assessed postoperatively (during the first two weeks) because of collection or obstruction observed by US.

MRI Technique including Sagittal and coronal localizers. Axial and sagittal SE T1WI, Axial and Coronal fast spin echo T2WI. Post-contrast axial and coronal gradient images.

Radio-isotope diuretic renogram by using Tc99-DTPA radioactive tracer. Performed routinely after 2 weeks from transplantation to all cases as basal study. Performed for 30 cases before two weeks (elevated S Cr. shortly after transplantation and when obstruction is suspected). All examined patients should be well hydrated.

US guided biopsy was done as a gold standard technique to confirm diagnosis of patients with medical complications.

Results

Patients ages ranged from 20-41 years mean (30.67±9.95) & group of surgical complication; their ages ranged from 23-44 mean (33.90±10.88). and the control group includes 30 transplant patients with normal serum creatinine, their ages ranged from 23-43 years mean (33.47±9.67). Males represented 76.7% and females represented 7% of patients with medical complications. Males represented 73.3% and females represented 26.7% of patients with surgical complications. Males represented 60% and females represented 40% of patients with normal transplanted kidney functions.

Table (1) illustrates statistically significant difference between cases with medical and surgical complications as regard conventional technique with higher abnormal findings among cases with medical complications than cases with surgical complications. No statistically significant difference is detected between groups with complications as regard MRI & MRU findings.

Table (2) shows statistically significant higher mean GFR isotope among cases with surgical complications than cases with medical complications (72.28 & 59.82, p=0.0 1). Perfusion phase illustrates statistically significant difference between studied groups; with higher frequency of reduced perfusion among cases with medical than cases with surgical complications (43.3%, 13.3%), all control group have normal perfusion phase. Tracer Uptake illustrates statistically significant difference between studied groups; with higher frequency of reduced tracer uptake among cases with medical than cases with surgical complications (41.4%, 13.8%), all control group have good tracer uptake. Excretory phase illustrates statistically significant difference between studied groups; 20.7% of cases with surgical complications show leakage, 6.9% delayed excretory phase versus 3.3% of cases with medical complications have delayed and leakage in excretory phase.

Table (3) demonstrates that MR have accuracy 91.7% in detecting renal complications as compared to biopsy findings and isotope have 89.7% accuracy in detecting renal complications.

Table (1): Comparison of MRI findings between studied groups.

Magnetic Resonance Imaging	Medical complications n=30 (%)	Surgical complications n=30 (%)	Test of significance
Conventional:			
Negative finding	9 (30)	2 (6.7)	p=0.018*
Collections	15 (50)	25 (83.3)	
Infarction	6 (20)	3 (10)	
MRA:			
Negative finding	29 (96.7)	26 (86.7)	p=0.475
Renal artery stenosis	1 (3.3)	2 (6.7)	
Graft vein thrombosis	0	1 (3.3)	
Perfusion defects	0	1 (3.3)	
MRU:			
Negative finding	26 (86.7)	24 (80)	p=0.09
Urinary leakage	0	4 (13.3)	
Mild HN	4 (13.3)	2 (6.7)	

Control group shows normal findings.
FET: Fischer exact test.
$\chi 2$:Chi-Square test.
*Statistically significant.

Table (2): Comparison of isotope findings between studied groups.

Isotope	Control n=30	Medical complications n=30	Surgical complications n=30	Test of significance	Paired comparison
GFR isotope	68.16±6.33	59.82±14.77	72.28±27.11	F=3.65 p=0.03*	p_1=0.08 p_2=0.383 p_3=0.01*
T1/2 isotope / min	22.58±8.11	27.05±14.01	21.81±11.53	F=1.82 p=0.168	p_1=0.135 p_2=0.797 p_3=0.081
Perfusion phase:					
Normal	30 (100)	16 (53.3)	24 (80.0)	MC	p_1<0.001 *
Poor perfusion	0	1 (3.3)	2 (6.7)	p<0.001*	p_2<0.001*
Reduced perfusion	0	13 (43.3)	4 (13.3)		p_3=0.035*
Tracer Uptake:					
Normal	0	15 (51.7)	25 (86.2)	MC	p_1<0.001 *
Reduced	0	12 (41.4)	4 (13.8)	p<0.001*	p_2<0.001*
Good	30 (100)	1 (3.4)	0		p_3=0.037*
Equivocal	0	1 (3.4)	0		
Excretory phase:					
Normal & non obstructed	30 (100)	17 (56.7)	18 (60)	MC	p_1<0.001 *
Partially obstructed	0	2 (6.7)	0	p<0.001*	p_2<0.001*
Good	0	9 (30.0)	3 (10.3)		p_3=0.078
Delayed	0	1 (3.3)	2 (6.9)		
Leakage	0	1 (3.3)	6 (20.7)		

MC: Monte Carlo test.
F : One Way ANOVA test.
p_1 : Difference between control group and cases with medical complications.
p_2 : Difference between control group and cases with surgical complications.
p_3 : Difference between cases with medical and surgical complications.

Table (3): Validity of imaging in relation to studied biopsy and histopathology results.

for complications	Sensitivity%	Specificity%	PPV%	NPV%	Accuracy%
MR	100.0	66.7	90.0	100.0	91.7
Isotope	75.0	92.0	100.0	95.8	89.7

PPV: Positive predictive value. NPV: Negative predictive value.

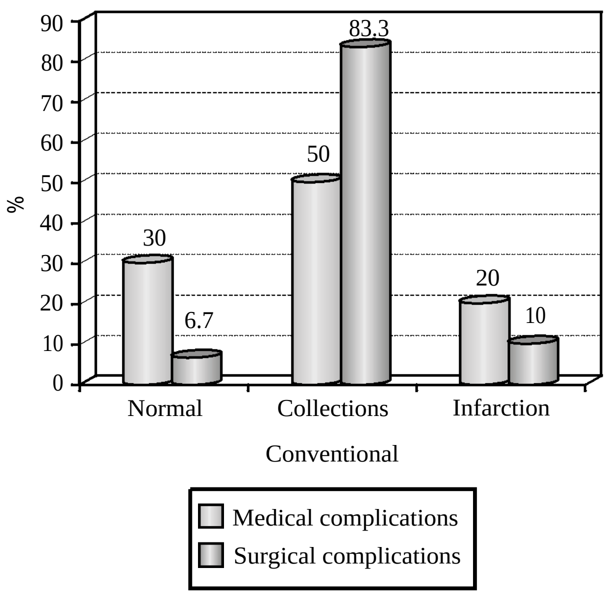


Fig. (1): Conventional MRI findings among studied groups.

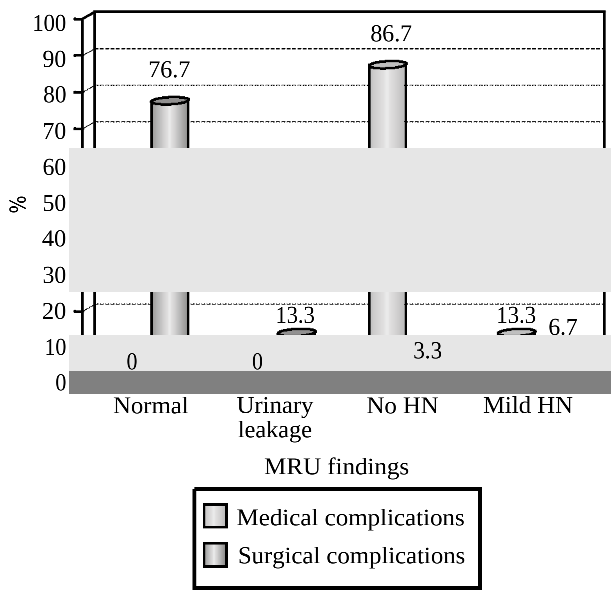


Fig. (2): MRU findings among studied groups.

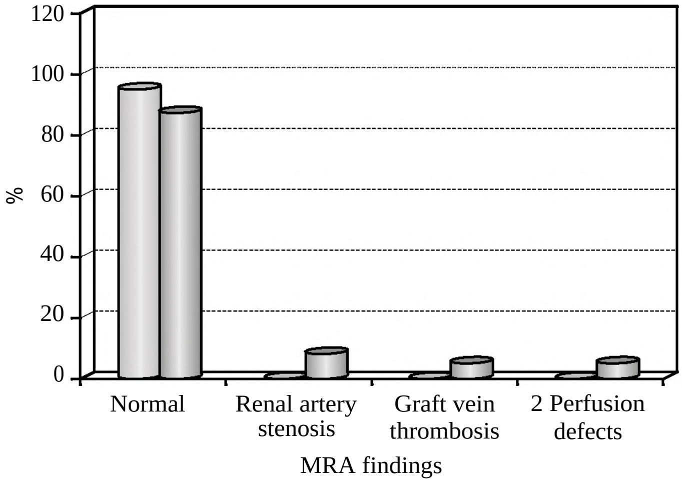


Fig. (3): MRA findings among studied groups.

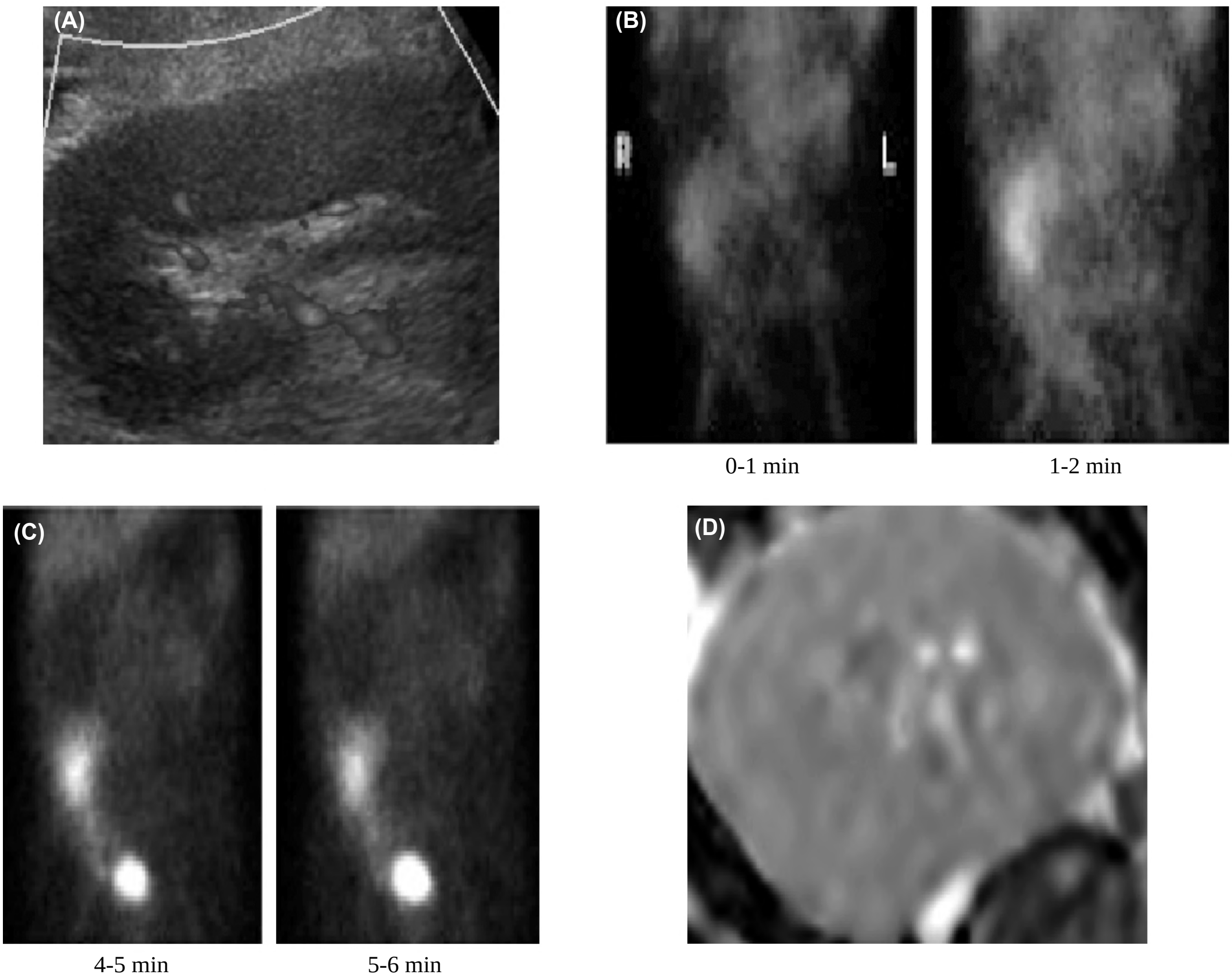
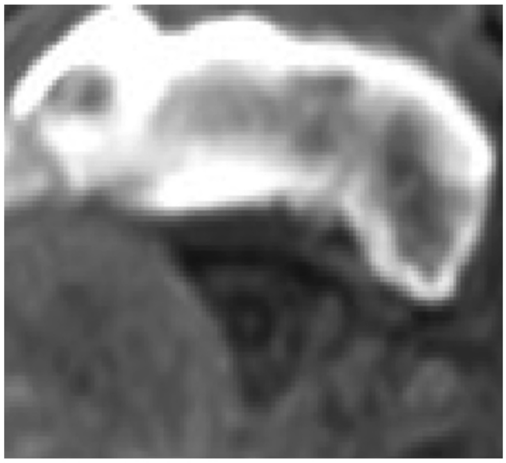
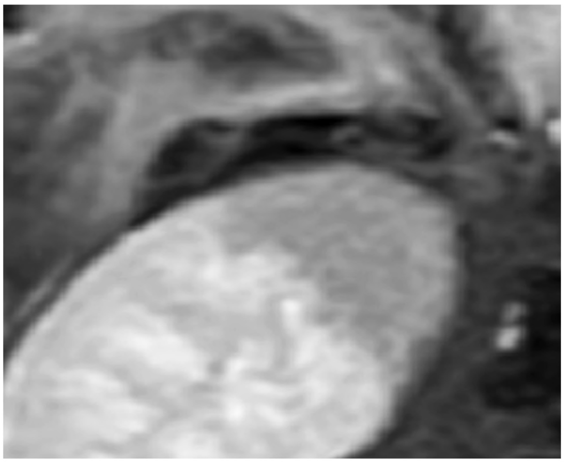
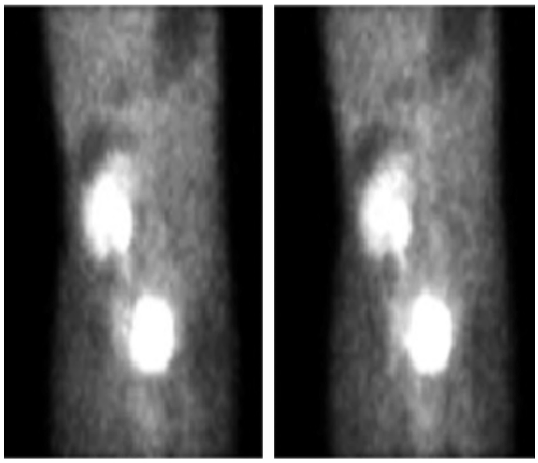


Fig. (4): A 43-year-old male patient presented with rising serum creatinine and relatively reduced urine output. That was diagnosed as Acute Rejection by imaging; and confirmed by graft biopsy. (A): Routine US and Doppler was done revealed reduced intra-parenchymal perfusion. (B): Diuretic renography (perfusion phase) shows reduced renal perfusion in comparison to aorta and iliac vessels. (C): Diuretic renogram (parenchymal uptake) shows reasonable uptake of the renal parenchyma. (D): ADC axial image shows relatively diffuse low ADC map.


(A)


(B)


(C)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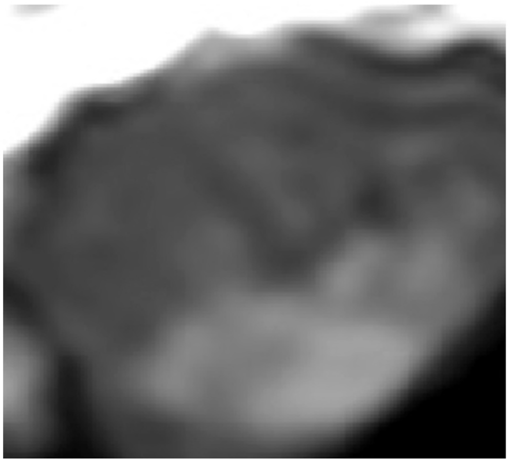
(D)


(E)

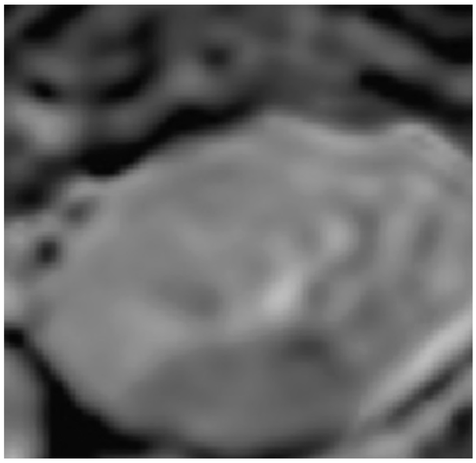

(F)

Fig. (5): A 35-year-old female patient presented with swelling at right iliac fossa related to the graft. Routine US showed well defined heterogonous peri- graft fluid collection. That diagnosed as perinephric hematoma by MRI (high SI at T 1 WI), with upper polar infarct by (post contrast MRI, and Renogram), as incidental finding. The case underwent PCD fixation with aspiration of blood. (A): Grey scale US shows perinephric collection. (B): Axial T 1 -W fast SE MR image shows the pronounced perinephric collection with heterogeneous high SI compared with renal parenchyma. (C): Post contrast T 1 WI corticomedullary phase shows marginal enhancement of the collection with hypo-perfused upper polar region that reported as cortical infarction. Which in turn seen restricted at DWI (E) and low ADC map (F). (D): Diuretic renography shows perinephric photogenic area related to upper pole that reported as a collection associated with upper hypo perfused area.

Discussion

The aim of this study was to detect early renal allograft complication by MRI and/or renal scintigraphy compared to final histopathological diagnosis.

Our study was conducted on 90 patients, which in turn subdivided into three groups of medical, surgical complications and control groups.

The most significant and most frequent complications are acute rejection, acute tubular necrosis, renal artery stenosis, perinephric fluid collections, urinary obstruction.

ADC detects AR more efficiently than lab measurements alone [10]. Both the cortex and the medulla has showed a considerable reduction in ADC values during rejection, which increased once again following recovery. The degree of rejection and the ADC reduction exhibited a positive relation. Another study found that reduction of ADC values for both AR and ATN, however ATN's pattern was classified as a typical mosaic similar to tiger skin [11].

Apparent diffusion coefficient (ADC) in this study had cut off value sensitivity and specificity to detect ATN was 1.935 x 10^–3mm^2/S, 70% and 65.7% respectively. And to detect acute rejection was 60%, 65.5% respectively.

Yazici et al., [11] discovered that RI was inferior than scintigraphy that done within two days after transplantation when it came to predicting long-term graft function [11].

Aktas A [10] found that while a renogram performed at discharge could predict late (more than 6 months) graft loss, one conducted 1 to 2 days after transplantation could predict primary graft dysfunction, prolonged time to graft function, low hospital discharge chromium EDTA clearance, and low 1- and 5-year graft survival [10].

Renal artery stenosis mimics the scintigraphic rejection finding in appearance. If baseline data are available for comparison, ACE inhibitor renography can help with the diagnosis.

Scintigraphy can be used with furosemide in cases of urinary obstruction, much like it is in native kidneys. The presence of radioactivity in an unusual site can be used to diagnose urinary leakage. Renal clearance tests are routinely carried out at various institutions, particularly in Europe, to assess renal function. In the United States, they are less regularly carried out [12].

In our study we found that renal scintigraphy regarding assessing graft perfusion sensitivity, specificity, PPV, NPP and overall accuracy was 75%, 92%, 100%, 95.8%, 89.7 respectively. And isotopic uptake sensitivity, specificity, PPV, NPP and overall accuracy was 50%, 92%, 50%, 92%, 86.2% respectively. That differ from Yazici et al., [11] results from sensitivity was 39.5% and specificity 93.7%.

In our study renal scintigraphy could differentiate between AR and ATN with sensitivity 73.3% for GFR and 63.3% for T1/2. Specificity 63.3% for GFR.

We had 100% sensitivity, specificity, overall accuracy and positive predictive value for MRI in detection of surgical complication at post transplantation 100%, 50%, 93.1% and 92.6% for graft surgical complication respectively.

Only one case with graft vein thrombosis was radiographically detected in our study by MRA as a filling defect of renal vein and edematous graft at conventional MRI, with renal scintigraphy this case showed very poor function and GFR about 6.7ml/min. such case underwent surgical thrombectomy.

Regarding the peri-graft fluid collections, hematoma is frequent in the first few days following surgery. The small haematoma is often disappears spontaneously, however larger ones may cause pressure symptoms, displace the transplanted kidney, cause hydronephrosis, or burst intraperitoneally and cause shock. Such circumstances allow for the performance of diagnostic aspiration with or without percutaneous drainage [9].

In the first one or two weeks following surgery, urinoma is often discovered between the transplanted kidney and the bladder. It happens as a result of urine extravasating continuously or gradually from the ureter, renal pelvis, or uretero-vesical anastomosis [14].

Lymphocele can emerge either early or late after surgery. If large, it increases in size over time, leading to hydronephrosis and the need for drainage. Abscess development could occur spontaneously or as a result of an infection superimposed on a peri-transplant fluid collection. Percutaneous drainage should be conducted using either surgical or sonographically guided needle aspiration [15].

In our study; MRI detected 7 patients of 9 with peri-graft hematomas (77.7%), 7 patients of 10 with urinomas (70%), 10 patients of 14 with lymphoceles (71.4%) and 6 cases with abscesses formation (100%). The remaining one patient with peri-transplant hematoma was diagnosed as lymphocele; this was due to central liquefaction of the haematoma and greater SI than that of urine in the urinary bladder.

The sensitivity, specificity, overall accuracy, positive predictive value and negative predictive value for MRI in detection of peri-graft hematoma were 85.7%, 98.9%, 99.4%, 75% and 99.4%, for urinoma, they were 83.3%, 100%, 99.4%, 100% and 99.4% while for lymphocele, they were 80%, 98.8%, 98.9%, 80% and 98.8%.

MRA was able to show RAS in two cases and exclude areas of infarction inside the renal parenchyma, which are evident as areas of heterogeneous T 1 and T2 signal and as focused areas of nonenhancement on the post contrast images. MRA was also able to show areas of stenosis in the major renal artery. Making use of 3D gadolinium-enhanced MRA to diagnose transplant RAS, Ismael et al., **[12]** had an accuracy of 88.5%, a specificity of 80%, and a sensitivity of 93.7%. In addition, it was possible to see medullary and cortical necrosis. There have been described of post-transplant patients with cyclosporine toxicity, rejection, and ATN losing corticomedullary differentiation.

Despite the limited use of MRI methods in the diagnosis of complications following kidney transplantation, evidence of their usefulness is rising. The advantages of MRI include the non-invasive method, the ability to obtain data promptly, and the ability to monitor renal anatomy and function with a single test that can be multi-parametric. Approach **[13]**.

The disadvantages include the relatively high cost, the time-consuming data processing, and, most critically, the lack of standard approaches and validation. The majority of existing experience is with anatomical MRI methods for detecting vascular and urological problems, and these approaches have already been utilized in clinical settings. The use of functional MRI to identify nephrological problems such as AR, ATN, and post-transplant infection is still in its early phases. **[14]**.

In our study; renal scintigraphy detected 6 cases (100%) with tracer extravasation denoting urinary leakage (urinoma), and 1 patient with ureteric stricture, however renogram was found of no role in detection of peri-graft hematoma or lymphocele.

Conclusion:

MRI offers multiple advantages in the assessment of renal transplants; it provides cross sectional and vascular information without the risk of ionizing radiation, iodinated contrast or arterial catheterization.

The objective of this work was to evaluate the role of MRI in assessment of kidney transplants as regards; renal function, parenchymal morphology, vascular anatomy, the capability of MRI to diagnose and differentiate various post-transplant medical and surgical complications. This study was carried out on 90 renal transplant recipients in Urology and Nephrology Centre, Mansoura University.

The Results of MRI and renal scintigraphy were compared with histopathological findings, interventional techniques and operative findings whenever performed.

The sensitivity, specificity, overall accuracy, positive predictive value and negative predictive value for MRI in detection of peri-graft hematoma were 85.7%, 98.9%, 99.4%, 75% and 99.4%, for urinoma, they were 83.3%, 100%, 99.4%, 100% and 99.4% while for lymphocele, they were 80%, 98.8%, 98.9%, 80% and 98.8%.

Renal scintigraphy regarding assessing graft perfusion sensitivity, specificity, PPV, NPP and overall accuracy was 75%, 92%, 100%, 95.8%, 89.7% respectively. And isotopic uptake sensitivity, specificity, PPV, NPP and overall accuracy was 50%, 92%, 50%, 92%.

Only one case with graft vein thrombosis was radiographically detected in our study by MRA as a filling defect of renal vein and edematous graft at conventional MRI, with renal scintigraphy this case showed very poor function and GFR about 6.7ml/min. such case underwent surgical thrombectomy.

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التشخيص الإشعاعى متعدد الوسائط لمضاعفات ما بعد زراعة الكلى

زرع الكلى هو الاختيار الأكثر فعالية فى علاج المرضى الذين يعانون من الفشل الكلوى المزمن. وقد أظهرت الدراسات أن البقاء على قيد الحياة لمدة ٥ سنوات بعد زراعة الكلى ما يقارب ٧٠٪، مقارنة بالمرضى الذين يتلقون غسيل الكلى حيث أن فترة بقائهم على قيد الحياة لمدة ٥ سنوات لا تتعدى ٣٠٪.

استخدام الوسائل التشخيصية المناسبة قبل وبعد الجراحة وكذلك فى متابعة المرضى يعتبر أمر مهم للإعداد الدقيق والتشخيص المبكر للمضاعفات. أهم دور للطرق الإشعاعية التشخيصية هو تحديد المضاعفات المختلفة فى فترة ما بعد الزرع.

وتشمل مضاعفات زرع الكى مجموعات شبه الكلوية فى شكل تجمعات بولية بالغشاء البريتونى، تجمعات دموية. تناقص التروية الكلوية فى شكل نخر أنبوبى حاد، الرفض، السمية الكلوية للعقاقير، المضاعفات الوعائية، تضيق الشريان الكلوى، تخثر الوريد الكلوى، تضيق الوريد الكلوى، تخثر لاشريان الكلوى، نواسير الشرايين الكلوية، الشرايين الداخلية الوريدية تشوهات مثل انسداد المسالك البولية.

تعد الخزعة الكلوية أداة تشخيصية قيمة فى تشخيص تقلص وظائف الكلى. على الرغم من أن خزعات الإبرة الأساسية أكثر شيوعاً، فإن بعض المراكز تستخدم أيضاً خزعات الإبرة الدقيقة. عند استخدام الموجات الفوق صوتية لتوجيه الإبرة نحو القشرة الكلوية، يمكن الحصول على عينات تحتوى على الكبيبات المتعددة، وبالتالى تحسين العائد التشخيصى لكل ممر إبرة.

يعد الرنين المغناطيسى (MRI) هى طريقة مناسبة للتصوير الكلوى. حيث أنه طريقة أكثر دقة عند مقارنته بالموجات الفوق صوتية أو الأشعة المقطعية بسبب دقة التباين الفائقة، والقدرة متعددة المستويات وعدم الحاجة إلى الصبغة المعالجة باليود فى الوريد. أيضاً، التصوير بالرنين المغناطيسى لديها لقدرة العامة لزيادة توضيف المضاعفات المكتشفة بالموجات الفوق صوتية أو الأشعة المقطعية.

الهدف من العمل : إكتشاف مضاعفات زرع الكلى والتصوير بواسطة الرنين المغناطيسى والنظائر المشعة.

أساليب البحث : شملت هذه الدراسة المستقبلية للسيطرة على الحالات ٩٠ حالة زرع الكلى مع مضاعفات تم تشخيصها بواسطة إعادة تصوير النظائر المشعة و/أو التصوير بالرنين المغناطيسى، حيث تم تحويل المرضى من قسم أمراض الكلى أو العيادات الخارجية فى مركز المسالك البولية وأمراض الكلى جامعة المنصورة إلى قسم الأشعة فى مركز أمراض المسالك البولية وأمراض الكلى المنصورة الجامعة، مصر.

ومن هذه الدراسة تم إستخلاص ما يلى :

- أن الرنين المغناطيسى له دور مهم فى تشخيص وتفرقة مختلف المضاعفات الطبية التى تلى عملية زراعة الكلى.
- إستخدام الرنين المغناطيسى الوظيفى فى تشخيص المضاعفات الطبية فى الفترة الأولى من زرع الكلى كطريقة واعدة و مبشرة فى تشخيص التسرب البولى بدون التعرض الإشعاعى أو إستخدام صبغة يودية. يقتصر إستخدام الرنين المغناطيسى الإستاتيكى على الحالات ذات التمدد فى الكئوس الكلوية وحوض الكلى مع وجود قصور فى الوظائف الإخراجية الحاد ليست محددة. تم العثور على دراسات تدفق النويدات المشعة لتكون مفيدة، لأن الرفض يرتبط بشكل مميز بانخفاض تدفق الدم الكلوى (التروية)، فى حين يرتبط ATN عادة بتدفق كلوى طبيعى أو منخفض بشكل طفيف. ومع ذلك، قد يؤدى ATN الشديد، وأمراض الكلى المتنى الأخرى، والتخثر الشريانى والوريدى، وإنسداد المسالك البولية إلى انخفاض التدفق وتقليل إفراز النويدات المشعة. مع ATN ، تظهر دراسة النويدات المشعة عادة نضحاً طبيعياً أو منخفضاً بشكل طفيف، وتركيز منخفض للمقتفى، ووقت عبور طويل، وتراكم مستمر للنظير.