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ULTRASOUND AND COLOR DOPPLER EVALUATION OF RENAL TRANSPLANT DYSFUNCTION

Radiology

Dr Ankit Mathur Command Hospital (EC), Kolkata

Dr Manoj Gopinath* Command Hospital (EC), Kolkata *Corresponding Author

ABSTRACT

Renal transplantation has revolutionized treatment of end stage renal disease with improved quality of life of patients. Despite technological advances, transplants are prone to numerous complications. Ultrasound is uniquely placed as an imaging modality in such situations since it is not associated with nephrotoxic contrast usage or with ionizing radiation. It quickly helps to identify treatable complications and also to decide further management or plan a biopsy. This study was a prospective study where 30 consecutive patients who underwent renal transplant were followed up with ultrasound and associated complications were analysed. Acute rejection was noted to be the commonest early complication (33%) and renal artery stenosis and chronic rejection (13%) were the commonest late complications. Ultrasound and Color Doppler were found to be useful in detection of vascular and urological complications but were noted to be of limited value in assessing parenchymal complications causing graft dysfunction.

KEYWORDS

Renal transplant, Graft dysfunction, Ultrasound

Introduction:

Transplantation has revolutionized treatment of end stage renal disease by proving more cost effective than hemodialysis, with a lower morbidity and improved quality of life. (1). Ultrasound is the principal imaging technique used in the evaluation of the transplant kidney and has the advantage of safely imaging the graft and its perfusion without the need for nephrotoxic contrast or ionizing radiation. Despite high graft and patient survival figures, a variety of parenchymal, vascular and urologic complications can threaten the transplant in the postoperative period. The goal of ultrasonographic (USG) and colour Doppler evaluation of the failing renal graft is to identify a treatable complication, to decide requirement of immediate intervention and to decide if a renal biopsy is required for diagnosis. This study was undertaken to assess the role of grey scale USG and colour Doppler in evaluation of renal graft dysfunction and to elucidate the characteristics of the graft kidney in thirty consecutive patients of renal transplant.

Materials and Methods:

The study was conducted at a tertiary care hospital with 30 renal transplant patients. All patients underwent clinical evaluation as well as biochemical and radiological examination in the post transplant period. They were evaluated on gray scale and color Doppler as a protocol on the 5th, 14th and 30thpost operative day. They were also evaluated as and when clinical suspicion of graft dysfunction was raised.

The patients were scanned on GE Logiq 500 MD Color Doppler system using 3.5 MHz convex probe and 7.5 MHz linear probe. Scans were done with the patient in supine position. The transplant kidney, the region around the transplant as well as the bladder were included in the study. The following gray scale parameters were assessed: renal size and parenchyma, cortical echogenicity, cortico-medullary differentiation, size and appearance of medullary pyramids, pelvicalyceal system and presence of any collection. On color Doppler the main renal artery and the anastomosis were examined. The distribution of arterial flow throughout the transplant and also flow within the renal vein were assessed. The following indices of the arterial flow were measured: Resistive Index (RI), Pulsatility Index (PI), Peak systolic velocity (PSV), Acceleration time (AT), Acceleration Index (AI).

After exclusion of vascular and urological causes of graft dysfunction, all the patients with deteriorating function were subjected to biopsy and the histopathological characteristics were correlated with USG and Doppler characteristics.

Results:

A total of 30 renal transplant recipients were included in this study. Most number of patients, 12 (40%) were in the 30-39 years age group. There were 18 male and 12 female patients. 15 patients (50%) presented with a rise in serum creatinine and 8 patients (27%) with oliguria. 2 patients (6%) presented with tenderness and swelling over transplanted kidney. 5 patients (17%) presented as uncontrolled hypertension.

Acute rejection was seen in 10 cases (33%). Three cases of cyclosporine toxicity (10%) and one case of ATN (3%) were encountered. There were four patients who developed chronic rejection (13%). Transplant renal artery stenosis was detected in 4 cases (13%). One case each of renal artery thrombosis (3%) and renal vein thrombosis (3%) were encountered. Peritransplant fluid collections were seen in 13 patients (40%). 3 patients (10%) developed post biopsy arterio-venous fistulas.

SONOGRAPHIC AND COLOR DOPPLER CHARACTERISTICS OF PARENCHYMAL COMPLICATIONS

Out of the 10 patients of acute graft rejection 7 (70%) presented within a week of the transplantation, 2 (20%) within a month and 1 patient presented later (1%). The only case of ATN in our study presented on the 2nd day post transplantation. One case of cyclosporine toxicity presented within a month of surgery and the remaining two presented later. Out of the 10 patients of acute rejection, 7 patients (70%) revealed an increase in the size of the transplant kidney. Increased cortical echogenicity was observed in 5 patients (50%). Prominent medullary pyramids were noted in 3 patients (30%). Impaired cortico-medullary differentiation was seen in 2 patients (20%). 3 patients out of 4 with chronic graft rejection exhibited some increase in the cortical echogenicity with 2 patients showing prominent medullary pyramids.1 patient had RI value between 7 and 8 with the remaining showing RI values <0.7.

On color Doppler, increased impedance was seen in the form of raised RI values (>0.7) in 8 patients (80%) with acute rejection. One patient with acute rejection had RI of more than 0.9. 2 patients had RI < 0.7. The patient with acute tubular necrosis had a RI of 0.88. 2 out of 3 patients with cyclosporine toxicity and 1 out of 4 patients with chronic rejection had RI of more than 0.7.

On follow up scans after treatment, 3 patients of acute rejection showed normal morphological features on gray scale. The others showed persistence of sonographic features either in the form of allograft enlargement or increased cortical echogenicity. The RI and PI values returned to normal in all the cases.

The sensitivity and specificity of Color Doppler flow imaging with a high threshold value of RI (>0.9) in diagnosis of Acute rejection was found to be 10% and 100% respectively.

SONOGRAPHIC AND COLOR DOPPLER CHARACTERISTICS OF VASCULAR COMPLICATIONS

Out of 5 patients who presented with hypertension and were clinically

suspected to have transplant renal artery stenosis, 4 patients showed positive color Doppler findings. No gray scale changes were noted in any of the cases. Table 1.

Table 1. Color Doppler flow imaging characteristics in Transplant Renal Artery stenosis

Doppler Features	No of patients
Renal artery Peak systolic velocities > 200cm/s	5
Focal turbulence/ aliasing	4
Renal + Intrarenal AT > 0.1 sec	4

On the basis of these findings a diagnosis of transplant renal artery stenosis was entertained in 5 patients. On angiography 4 out of 5 patients were confirmed to have significant renal artery stenosis. The sensitivity and specificity of color Doppler to detect transplant renal artery stenosis was found to be 100% and 96.1%.

One patient who presented within first post transplant week with anuria was detected to have transplant renal artery thrombosis. Gray scale findings in this patient were normal. There was lack of arterial flow in both the transplant artery and intrarenal vessels on both color flow and spectral Doppler analysis. (Figure 1) The diagnosis was confirmed by DSA. Inspite of prompt intervention the graft could not be salvaged.

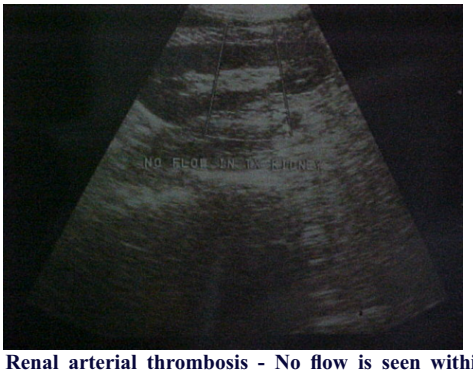

Fig 1: Renal arterial thrombosis - No flow is seen within the transplant kidney on color Doppler

One patient who presented with tenderness and swelling over transplanted kidney on the 5th postoperative day was found to have enlarged, hypoechoic transplant kidney on USG. On color Doppler flow imaging there was absence of venous flow with reversed diastolic flow within the intrarenal arterial system and transplant renal artery. The diagnosis of renal vein thrombosis was considered which was confirmed on DSA. Graft nephrectomy had to be performed in this case.

SONOGRAPHIC AND COLOR DOPPLER CHARACTERISTICS OF UROLOGICAL COMPLICATIONS

13 patients (43%) had peritransplant fluid collections. However only 5 patients had significant collections to result in graft dysfunction. Out of these 4 (31%) were lymphoceles. (Figure 2) Only one appeared within a month of transplantation. All the lymphoceles were located posteroinferomedial to the transplant. 2 patients (15%) had hematomas. Both of them were crescentic in shape and were located in the region around the kidney.

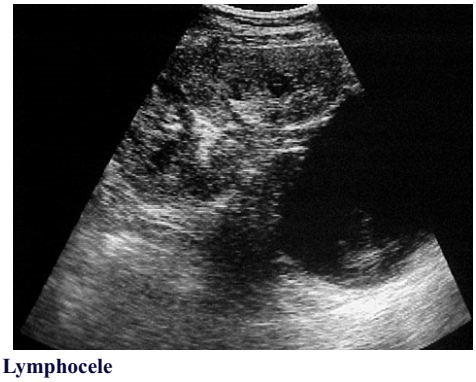

Fig 2: Lymphocele

7 patients (54%) had small post op collections without any graft dysfunction. All of them showed regression on follow up scans. Their location was variable and they appeared cystic in appearance. The sensitivity of ultrasound in detecting urological complications was found to be 100%.

SONOGRAPHIC AND COLOR DOPPLER CHARACTERISTICS OF POST BIOPSY

A-V FISTULAS

Three patients who underwent biopsy for graft dysfunction were subsequently detected to have arteriovenous fistula. Gray scale sonography did not reveal the fistula. However on Color Doppler flow imaging all patients had focal color aliasing, low resistance high velocity flow in feeding artery and arterialized flow in draining vein. On follow up scans 2 of the fistulas regressed spontaneously while one persisted; however it did not cause any graft dysfunction to prompt intervention.

Discussion:

Parenchymal complications

Acute rejection: The most common gray scale change noted in our study was increase in the size of the transplant, which was noted in 7 cases. The other findings were increase in cortical echogenicity, prominent medullary pyramids and impaired cortico-medullary differentiation. Allograft enlargement has been described as fairly specific for acute rejection (2). Our study tried to assess the utility of resistive indices of blood flow measured by Doppler sonography to detect acute rejection. Using a high threshold RI i.e. > 0.9 the sensitivity and specificity of our study was 10% and 100% respectively. This is in concordance with various reports published by other authors (3, 4). There were two cases of acute rejection with RI < 0.7. Likewise, several studies have shown significant number of patients with acute rejection having normal RI values. (5, 6).

Acute tubular necrosis: There was only one case of acute tubular necrosis in our study. There were no gray scale changes noted in this case. The RI and PI values were 0.88 and 1.9. Sonographic findings have been reported to be normal in most cases of ATN (7). However in cases of severe ATN the kidneys may be enlarged with poor cortico-medullary differentiation (8). The RI and PI values were raised in our study. These values have not been found to be specific to differentiate between acute rejection and acute tubular necrosis (5, 6).

Cyclosporine toxicity: There were no changes either on gray scale or on color Doppler sonography in the case of cyclosporine toxicity encountered in our study. This is in consonance with previous studies where no significant sonographic changes were noted with cyclosporine toxicity. (4)

Vascular Complications

Transplant renal artery stenosis: All the patients in this study had peak systolic velocities greater than 200cm/s. Focal turbulence and aliasing was commonly seen. The AT was increased in the post stenotic segment of the main renal artery. Our results approximates to that described by De Morais et al (9). They documented a sensitivity and specificity of 90% and 87.5% for detection of renal artery stenosis when a cutoff value of Peak systolic velocities was taken as 200cm/sec. Our study had one false positive case. This can be explained by the fact that the tortuosity of the renal artery caused by an end-to-side anastomosis can cause high systolic velocities in the renal artery.

Transplant renal artery thrombosis:. There was one case of renal artery thrombosis in our study. Color Doppler flow imaging did not reveal any detectable flow within the main renal artery beyond the site of occlusion as well as in the intrarenal arteries. No venous flow was detected as well. Our study correlates well with the studies by Taylor et al (10) who had detected 11 cases of Transplant Renal Artery thrombosis out of 88 renal transplant recipients

Transplant renal vein thrombosis: Only one case of renal vein thrombosis was detected in our study. The gray scale findings noted were enlargement of the graft with hypoechoic parenchyma. This is in concordance with the gray scale findings described by Rosenfield et al (11). On color Doppler imaging no flow was detected in the transplant vein and there was reversal of diastolic flow in the spectral traces of the main renal artery, segmental and interlobar arteries.

Urological complications

Peritransplant collections: Most were insignificant collections, which appeared immediately in postoperative period and did not cause

any graft dysfunction. Most regressed spontaneously on follow up scans.. This is in concordance with the findings of Silver et al (12) who had described 28 small post transplant collections in their study of 51 transplant recipients. These were considered clinically insignificant and represent either seromas or hematomas. The most common significant peritransplant collection in our study was lymphocele. This was similar to findings of Patricia Morley et al (13).

The sensitivity of detection of significant fluid collections causing graft dysfunction by ultrasound was found to be 100%. This is in consonance with the findings of Silver et al (12) who reported sensitivity of 100% in detection of peritransplant collections.

Post biopsy complications

Arteriovenous fistulas: Duplex Doppler interrogation of the feeding artery showed a high velocity, low resistance waveform and the draining vein had pulsatile arterialized flow. Our findings approximates that of Middleton et al (14) who had observed arterialization of the venous waveform from the draining vein in all their 8 cases of arteriovenous fistulas.

Conclusion:

Gray scale sonography and color Doppler are non invasive, simple and cost effective screening modalities for renal transplant evaluation. Our study suggests usefulness of gray scale ultrasound and Doppler sonography in detection of vascular and urological causes of graft dysfunction. However it is of limited value in assessing parenchymal complications causing graft dysfunction.

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