ORIGINAL ARTICLE

DIAGNOSTIC ACCURACY OF HIGH RESOLUTION COLOR DOPPLER ULTRASOUND (CDUS) IN DETECTION OF PERIGRAFT COLLECTIONS IN SYMPTOMATIC PATIENTS WITHIN 3 MONTHS OF RENAL TRANSPLANT

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PJR October - December 2015; 25(4): 142-148

ABSTRACT

OBJECTIVE: To determine the diagnostic accuracy of high resolution color doppler ultrasound (CDUS) in detection of perigraft collections in symptomatic patients within 3 months of renal transplant. **SUBJECTS AND METHODS:** Total 173 patients of either gender with age 18 to 50 years,fulfilled inclusion criteria were registered in this study at the Department of Radiology Sindh Institute of Urology and Transplantation (SIUT), Karachi. CDUS was performed on Toshiba Aplio™ 500 and GE Voluson™ 730 PRO using 3.75 MHz convex probe abdominally, serial longitudinal and transverse images were taken and assessed. It was followed by aspiration/drainage of the perigraft fluid collection. **RESULTS:** In this study, there were 100 male and 73 female patients. The overall mean age was 36.72 ± 8.94 years with range 32(18 - 50) years. The overall mean duration after transplantation was 48.21 ± 16.28 days with range 67(21 - 88) days. Among total 173 study subjects, perigraft fluid collection was detected through CDUS in 100 patients, perigraft fluid collection drainage was found in 93 patients. Our results showed that 84 patients were true positive and 64 patients were true negative. Sensitivity, Specificity, PPV, NPV and accuracy were 90.3%, 80.0%, 84.0%, 87.7%, and 85.5% respectively. **CONCLUSION:** Imaging has a critical role in the evaluation of complications after renal transplantation. US and CDUS can facilitate prompt and accurate diagnosis of perigraft fluid collections.
Keywords: ColorDoppler Ultrasound; Perigraft Fluid Collection; Renal Transplantation.

Introduction

Renal transplant is the choice of patients with end stage renal failure that promotes their quality of life and diminishes morbidity.[1] Renal transplantation was first performed successfully in the early 1950s. Renal transplantation confers long term survival than does either hemodialysis or continuous ambulatory peritoneal dialysis.[2] Successful renal transplant, therefore, provides the best hope for most patients with end stage renal disease (ESRD). Renal transplantation is basically the cheapest option, only about 5% of all patients with ESRD end up having a transplant. There are approximately 12 major centers in Pakistan, doing an estimated 400 transplants every year, respectively.[3] Paid donation comprises 50% of all transplants in Pakistan.[4]

However, advances in medical therapy, immunosuppressive therapy and refinements in surgical technique have improved the quality of life of the transplant

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Submitted 21 May 2015, Accepted 8 June 2015

patient. After renal transplantation, postoperative complications occur in approximately 12% - 20% of patients. Despite, continuous progress in surgical technique, vascular complication continue to account for about 3 - 15% of the cases of graft dysfunction, as well as nonvascular complications that can arise postoperatively.[2]

Vascular complications include transplant renal artery stenosis, arteriovenous fistulas or intrarenal pseudoaneurysms following renal transplant biopsy, extrarenal pseudoaneurysms, and graft thrombosis.[2] An incidence of 1.7% renal artery thrombosis, 1.4% renal vein thrombosis, 1.7% renal artery stenosis, 1.4% arterial rupture due to fungal arteritis, 0.7% spontaneous graft ruptures and 12% lymphoceles were observed. Urological complications account for 10-15% of postoperative complications. It is well established that urinary complications are associated with significant morbidity following the kidney transplant operation.[5]

Perigraft fluid collections are quite common, occurring in approximately 50% of renal transplant patients. Of these collections, 15% - 20% become clinically significant. Compression of the transplant vascular structures or the ureter can result in transplant dysfunction. Fluid collections occurring in the early postoperative period include urinomas, hematomas, and abscesses. Lymphoceles, which are the most common fluid collections, usually occur weeks to months after transplantation. US usually depicts perigraft fluid collections, but the findings are frequently nonspecific. US guided fluid aspiration is essential for the diagnosis. CT is also useful for assessing the anatomic relationship of the fluid collection with adjacent structures and can also demonstrate a route for needle guidance and catheter drainage, even when US has failed to do so.[6-8]

Ultrasound and creatinine measurement are routine investigations of kidney function after transplantation and for detection of any complications. Ultrasound imaging is the main imaging method to detect any changes in shape of the transplanted kidney. This is a very safe method and without ionization and intravenous contrast to assess structure of the transplanted kidney compared with other methods.[9]

Peritransplant fluid collections include urinomas, hematomas, lymphoceles, and abscesses. Their size should be documented at baseline US examination because any increase in size may warrant intervention. Growing collections may be indicative of urine leaks, abscesses, or vascular injury. Urinomas and hematomas are most likely to develop immediately after transplantation, whereas lymphoceles generally occur 4 to 8 weeks after the surgical procedure. The ultrasonographic characteristics of peritransplant fluid collections, however, are entirely nonspecific, and ultimately, diagnosis may be made only with percutaneous aspiration.[10]

A delay in treating any of these complications may lead to the loss of renal graft function or even to the patient's death. Interventional radiologists can play a pivotal role in the prompt diagnosis and percutaneous treatment of postoperative complications by performing endovascular treatment, percutaneous urinary intervention, and abscess or fluid drainage. These minimally invasive procedures can either obviate open surgery or stabilize the patient's condition prior to open surgical reintervention.[11]

The purpose of this study is to standardize CDUS for detection of post operative complications of renal transplant. Although there are many renal transplants done annually but there is very limited data is available in Pakistan to detect the accuracy of this radiological method in correct detection of such complications. It is a known fact, that different geographic populations have different results and this study will provide the local evidence. If ultrasound found to be accurate in assessing these patients then study will recommend to use the US for follow up of all post renal transplant and to avoid morbidity.

Material and Methods

Patients of either gender between 18 to 70 years having done renal transplant at SIUT within last 3 months and willing to participate included in this study. CDUS was performed on Toshiba Aplio 50 and GE Voluson 730 PROv using 3.75 MHz convex probe abdominally, serial longitudinal and transverse images were taken and assessed by a senior radiologist (having minimum 5 year's experience in relevant field). It was followed by aspiration/drainage of the perigraft fluid collection. Informed consent was taken from all the patients after explaining the study's

purpose, procedure, and risk-benefit ratio and approval of the ethical committee was given. History was taken in each case.

Patients with complete or partial graft rejection confirmed on CT scan and/or serum creatinine or patients with abnormal biochemical labs (deranged PT and INR) or chronic liver disease patients having history of ascites and cystic collections, such as adnexal cysts in females were excluded from this study.

The statistical analysis was done using SPSS windows package version 22.0. Descriptive analysis was conducted, that is, frequencies and percentages for categorical variableslike gender, mean, and standard deviation for the continuousvariables like age. Frequency was calculated in terms ofpresence or absence collections. *P* value of equal to or less than 0.05 was considered significant. Sensitivity, specificity, and negative and positive predictive values were determined by taking fluid analysis as reference standard.

Result

Total 173 patients of either sex with age between 18 to 50 years who referred to radiology department of SIUT, Karachi from transplant OPD and fulfilled rest of the inclusion criteria, were included in the study to determine the diagnostic accuracy of CDUS.

There were 100 (57.80%) male and 73 (42.19%) female patient in the study.The overall mean age was 36.72 ± 8.94 years with range 32 (18-50) years. The distribution of age is presented in (Fig. 1). The age is further stratified in two groups, 83 (48.0%) patients of = 36 years, 90 (52.0%) patients of >36 years. The overall mean duration after transplantation was 48.21 ± 16.28 days with range 67(21 - 88) days. The distribution of duration of transplantation is presented in (Fig. 2). 57.8 % patient shows perigraft fluid and 42.2% patients show no perigraft fluid. Perigraft fluid was aspirated in 93 (53.8%) patients out of 173.

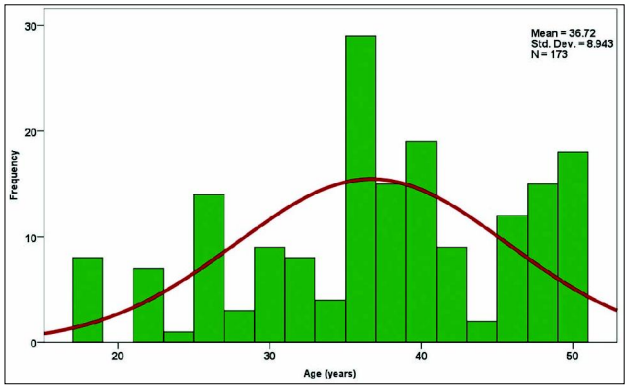

Figure 1: Histogram presenting frequency distribution of age.

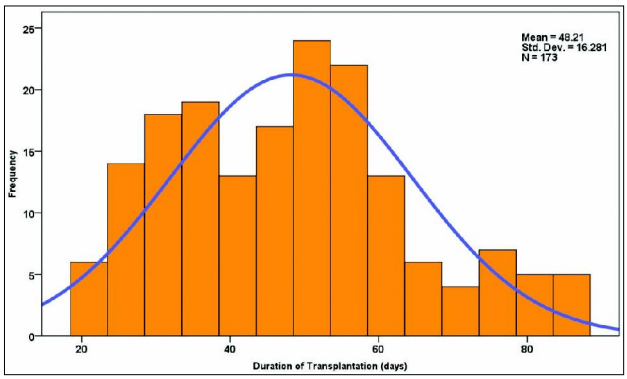

Figure 2: Histogram presenting frequency distribution of duration of transplantation (days)

Descriptive statistics of age according to gender and age groups is presented in (Tab. 1).

The duration of transplantation is further stratified in two groups, 74 (42.8%) patients of ≤ 45 days and 99 (57.2%) patients of > 45 days. Descriptive statistics of duration of transplantation according to gender and perigraft fluid collection detection is presented in (Tab. 2).

Sensitivity, specificity, predictive values and diagnostic accuracy of perigraft fluid collection detection taking perigraft fluid collection drainage as reference standard is calculated. Overall results shows 84 (48.6%) patients were true positive and 64 (37.0%) patients were true negative. 16 (9.2%) were false positive and 9 (5.2%) were false negative. Sensitivity, Specificity, PPV, NPV and accuracy were 90.3%, 80.0%, 84.0%, 87.7%, and 85.5% respectively. These results are also presented in (Tab. 3).

The stratification according to gender, age, and duration after transplantation was done and sensitivity, specificity, and diagnostic accuracy was also calculated post stratification. Post stratification association of outcome with age, gender, and duration after transplantation was calculated using chi square test considered $P \leq 0.05$ as significant. The results are presented in (Tab. 4), (Tab. 5), (Tab. 6), (Tab. 7), (Tab. 8), and (Tab. 9).

	Gender		Age Groups	
	Male (n=100)	**Female** (n=73)	**≤ 36 years** (n=83)	**> 36 years** (n=90)
Mean	36.51	37.01	29.19	43.67
SD	9.37	8.36	5.83	4.64
95% CI	34.65 To 38.37	35.06 To 38.97	27.92 To 30.47	42.69 To 44.64
Median (IQR)	35.0 (15)	37.0 (10)	30.0 (10)	44.0 (8)
Range	32	32	17	13
Minimum	18	18	18	37
Maximum	50	50	35	50

Table 1: Descriptive statistics of age (years) according to gender and age groups

	Gender		Perigraft Fliud Collection Detection	
	Male (n=100)	**Female** (n=73)	**Yes** (n=100)	**No** (n=73)
Mean	47.31	49.44	46.84	50.08
SD	15.21	17.67	15.32	17.44
95% CI	44.29 To 50.33	45.32 To 53.56	43.80 To 49.88	46.01 To 54.15
Median (IQR)	46.0 (20)	50.0 (25)	47.0 (20)	50.0 (26)
Range	63	67	63	67
Minimum	22	21	22	21
Maximum	85	88	85	88

Table 2: Descriptive Statistics of Duration after Transplantation (days) According to Gender and Perigraft Fluid Collection Detection

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=93)	**No** (n=80)	**Total**	
Yes (n=100)	84	16	**100**	**0.000***
No (n=71)	9	64	**73**	
Total	**93**	**80**	**173**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
90.3%	**80.0%**	**84.0%**	**87.7%**	**85.5%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 3: Diagnostic Accuracy of Perigraft Fluid Collection Detection to Perigraft Fluid Collection Drainage

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=61)	**No** (n=39)	**Total**	
Yes (n=62)	55	7	**62**	**0.000***
No (n=38)	6	32	**38**	
Total	**61**	**39**	**100**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
90.2%	**82.1%**	**88.7%**	**84.2%**	**87.0%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 4: Diagnostic Accuracy of Perigraft Fluid Collection Detection ToPerigraft Fluid Collection Drainage According to MALE GENDER

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=32)	**No** (n=41)	**Total**	
Yes (n=38)	29	9	**38**	**0.000***
No (n=35)	3	32	**35**	
Total	**32**	**41**	**73**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
90.6%	**78.0%**	**76.3%**	**91.4%**	**83.5%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 5: Diagnostic Accuracy of Perigraft Fluid Collection Detection to Perigraft Fluid Collection Drainage According to FEMALE GENDER

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	Yes (n=34)	No (n=49)	**Total**	
Yes (n=39)	30	9	**39**	**0.000***
No (n=44)	4	40	**44**	
Total	**34**	**49**	**83**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
88.2%	**81.6%**	**76.9%**	**90.9%**	**84.3%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 6: Diagnostic Accuracy of Perigraft Fluid Collection Detection to Perigraft Fluid Collection Drainage According to AGE ≤ 36 days

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=59)	**No** (n=31)	Total	
Yes (n=61)	54	7	61	**0.000***
No (n=29)	5	24	29	
Total	**59**	**31**	**90**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
91.5%	**77.4%**	**88.5%**	**82.8%**	**86.6%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 7: Diagnostic Accuracy of Perigraft Fluid Collection Detection to Perigraft Fluid Collection Drainage According to AGE >36 days

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=42)	**No** (n=32)	**Total**	
Yes (n=46)	37	9	**46**	**0.000***
No (n=28)	5	23	**28**	
Total	**42**	**32**	**74**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
88.1%	**71.9%**	**80.4%**	**82.1%**	**81.1%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 8: Diagnostic Accuracy of Perigraft Fluid Collection Detection to Perigraft Fluid Collection Drainage According To DURATION OF TRANSPLANTATION ≤ 45 days

	Perigraft Fluid Collection Drainage			*P*-Value
Perigraft Fluid Collection Detection	**Yes** (n=51)	**No** (n=48)	**Total**	
Yes (n=54)	47	7	**54**	**0.000***
No (n=45)	4	41	**45**	
Total	**51**	**48**	**99**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
92.2%	**85.4%**	**87.0%**	**91.1%**	**88.8%**

Chi Square test was applied to check association.
P-value ≤ 0.05 considered as significant.

* Highly significant at 0.01 levels

Table 9: Diagnostic Accuracy of Perigraft Fluid Collection Detection ToPerigraft Fluid Collection Drainage According To DURATION OF TRANSPLANTATION > 45 days

Discussion

Renal transplants are the most frequent visceral transplant, and because of the absence of nephrotoxicity and radiation, ultrasound is widely used to monitor grafts and assess for complications. Complications can be categorised as vascular, parenchymal, ureteric and perinephric collections, with many occurring at predictable times post transplant. Awareness of these pathologies and their features is vital for all radiologists to enable early intervention and prolong graft survival.[12]

For the follow-up of renal transplant recipients creatinine is the main parameter for the detection of changes in renal function. In addition to clinical signs and hematological and serological parameters CDUS is considered valuable for monitoring the vascularization and nonvascular resistance of the graft vessels. Therefore, it is performed routinely after transplantation, especially in cases of a significant increase in creatinine as well as during the annual assessment of transplant recipients. Nevertheless, some authors doubt the usefulness of isolated determinations of renal blood flow velocity indices in evaluating acute renal allograft dysfunction.[13]

The rate of complications following percutaneous biopsy of transplanted kidney is about 5-8%. Perinephric hematomas constitute 25-30% of all such complications. The features on CDUS include low resistance, high velocity arterial flow within the feeding artery and high velocity arterialized venous flow in the associated draining vein.[9]

Postoperative lymphoceles are caused by lymphatic leakage from the allograft bed or from the allograft itself, with a reported prevalence of 0.6%-18%. Renal transplant patients are an infected hematoma, which is usually suspected on the basis of clinical and laboratory findings, can be successfully treated with percutaneous drainage using 12-14-F drains and periodic irrigation with saline solution to prevent drain clogging. Hematomas that form in the immediate postoperative period and then enlarge can result from disruption of a vascular suture line, vessel injuries in the graft bed, or spontaneous graft rupture.[13]

Peritransplant collections diagnosed as hematoma, seroma, or abscess are typically addressed with traditional interventional radiology procedures utilizing aspiration and drainage on a case-by-case basis.

Urinomas are more complex, requiring a coordinated approach with operative repair and/or percutaneous drainage. Lymphoceles can be managed with catheter drainage and subsequent sclerosis.[1,14]

Results of a study showed that Doppler ultrasound was considered for detection of complications in the early phase after kidney transplantation, it could be used as a predictor of long-term kidney function. USis a convenient noninvasive way to check transplanted kidneys in case of short and long-term complications. In the acute stage, these complications include acute rejection, obstruction of urinary tract accompanied with hydronephrosis, acute tubular necrosis, and renal artery and vein thrombosis for which gray scale and color Doppler sonography are diagnostic methods Doppler images can help in diagnosis of kidney dysfunction on the first day postsurgery. Balbooacoet al.[15] argued that there was a significant association between serum creatinine level and Doppler indexes in early phase after renal transplantation. The association between recipients' age and Doppler indexes has been proved by other studies.[14,15,16]

In our study 100 male and 73 females patients of mean age 37 years were examined. Most of the patients were more than 36 years of age. The mean duration of transplantation was 48 days and most of the patients had transplant more than 45 days. CDUS detected fluid collection in 100 patients. The results showed that 84 patients were true positive, correctly diagnosed and 64 patients were true negative, correctly diagnosed. Sensitivity, Specificity, PPV, NPV and accuracy were 90.3%, 80.0%, 84.0%, 87.7%, and 85.5% respectively. There were highly significant association of fluid detection was observed with gender, age and duration of transplantation.

Study Limitations

The study was conducted on a small scale and at urban environment therefore, the findings might not be generalized to larger populations. Other limitations of our study were the number of patients and course of follow up, it seems that evaluation of more cases in longer time will have better result.

Conclusion

Transplantation is currently one of the accepted treatments of irreversible kidney disease. Improvements in surgical techniques and more sophisticated, potent immunosuppressive drugs have resulted in remarkable advances in survival of patients and renal grafts. Nevertheless, substantial complications occur in both the immediate postoperative period and later. Imaging has a critical role in the evaluation of these complications, and interventional radiologic techniques are often successfully applied to their treatment. US can accurately depict and characterize many of the potential complications of renal transplantation. Familiarity with the clinical setting and the appearance of potential renal transplant complications as depicted with the most commonly used modality, CDUS, can facilitate prompt, accurate diagnosis and treatment.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests inrelation to this work.

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