

## Decreased resistive index in renal transplant recipients as a treatable imaging finding: a transplant surgeons' perspective

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### Abstract

**Objectives:** The objective of this study was to evaluate the causes of decreased resistive index with graft dysfunction and to evaluate the outcome of different interventions performed in such cases.

**Materials and Methods:** It is a retrospective analysis which was done at Sindh Institute of Urology and Transplantation, Karachi, Pakistan, between 2005 and 2015. Case notes of all patients who had renal transplantation in this time period were analyzed for demographic data, angiographic findings and serum creatinine values at the time of decreased resistive index. The type of management which was offered was also recorded. Finally, the graft function and post-operative resistive indices were analyzed. Data were entered and analyzed in SPSS version 10.0.

**Results:** A total of 53 patients were included in this study. The majority of these patients (41: 77.4%) were male (Figure 1) with mean age of  $27.4 \pm 9.6$  years. Causes of decreased resistive index included; graft under tension, 34 (64.15%); arterial kinking, 9 (16.98%); arterial stenosis, 8 (15.09%) and fungal arteritis, 2 (3.77%). The majority of the patients were managed by re-exploration and minimizing the tension of graft by placing it in subcutaneous space. Two patients underwent graft nephrectomy because of fungal infection. Mean serum creatinine values in pre- and post-operative periods were  $1.66 \pm 0.78$  mg/dl and  $1.32 \pm 0.79$  mg/dl, respectively.

**Conclusions:** Decreased resistive index on color Doppler imaging in early post-operative period warrants prompt surgical intervention.

**Keywords:** graft dysfunction, graft loss, fungal arteritis, arterial kinking

### Introduction:

Renal transplantation (RT) is currently the gold standard for the treatment of patients suffering from end-stage renal disease (ESRD).<sup>1</sup> Improvement in surgical techniques and the advent of more sophisticated and potent immunosuppressive drugs have resulted in remarkable improvement in short- and medium-term survival of renal allografts and patients. Nevertheless, substantial complications may occur in both peri-operative and immediate post-operative period which may present as graft dysfunction and significant morbidity. Ultrasonography of the renal graft with color doppler imaging (CDI) has a critical role in the evaluation of these compli-

cations.<sup>2</sup> Traditionally, a rise in resistive index (RI) has been used to diagnose acute rejection by non-invasive means. Decreased blood flow in the graft with consequent decrease in resistive index is one of the reasons of oliguria or anuria in the immediate post-transplant period. This can be very well documented with the help of color doppler imaging. Immediate correction of these complications by surgery or angioplasty can salvage the graft functions.<sup>3,4</sup>

The main objective of this study was to evaluate the causes of decreased RI with graft dysfunction and to evaluate the outcome of different interventions performed in such cases.

**Received:**  
2nd January 2018

**Accepted:**  
4th June 2018

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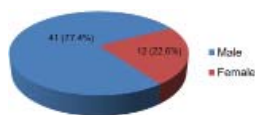


Fig. 1: Gender distribution of cases

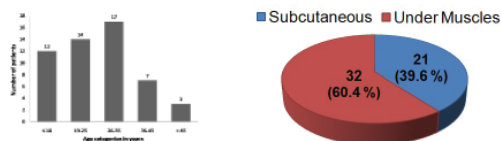


Fig. 2: Distribution of patients according to age group

Fig. 3: Anatomical location of the grafts within the abdominal cavity

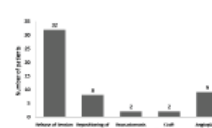


Fig. 4: Various surgical and radiological interventions performed in patients with decreased RI

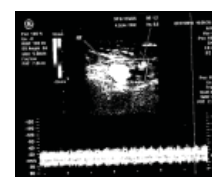


Fig. 5: Color doppler imaging (CDI) finding in a case of fungal arteritis.

Table-1: Various causes of decreased resistive index (RI) and their detection times in 53 renal transplant recipients

Causes of low RI	Number of patients (n=53)	Detection period of low RI (in days)
Graft under tension, n (%)	34 (64.15)	4.97±15.69
Arterial kinking, n (%)	9 (16.98)	32.8±82.14
Arterial stenosis, n (%)	8 (15.09)	140.63±110.21
Fungal arteritis, n (%)	2 (3.77)	45.32±64.6

Table-2: Distribution of resistive indices (RIs) and serum creatinine during pre-operative and post-operative periods in 53 renal transplant patients

Parameters	Pre-operative	Post-operative	p-Value
Resistive Index (RI)			
≤ 0.5, n (%)	53(100)	1(1.9)	< 0.001
> 0.5, n (%)	-	50(94.3)*	
Serum creatinine, mg (Mean±SD)	1.66 ± 0.78	1.32 ± 0.79	0.4

**Material and Methods:**

It is a retrospective analysis which was done at Sindh Institute of Urology and Transplantation (SIUT), Karachi, Pakistan, between 2005 and 2015. Written informed consent was obtained from all patients. The research was conducted in accordance with the ethical standards as laid down in the declaration of Helsinki, as revised in 2008. Case notes of all patients who had renal transplantation in this time period were analyzed for demographic data, angiographic findings and serum creatinine values at the time of decreased RI. The type of management which was offered was also recorded. Any significant per-operative findings were also included in this study. Finally the graft function and post-operative RI were analyzed.

The renal doppler arterial RI is defined as (peak systolic velocity - end diastolic velocity) / peak systolic velocity. An automated ultrasound color Doppler machine (Voluson 730 Pro 7) was used to make all calculations. The high frequency

probe that gives measurable waveforms was used, supplemented by color or power doppler sonography as necessary for vessel localization. Arcuate arteries (at the cortico-medullary junction) or interlobar arteries (adjacent to medullary pyramids) were then insonated using a 2mm to 4mm doppler gate. Waveforms were optimized for measurement using the lowest pulse repetition frequency without aliasing (to maximize waveform size), the highest gain without obscuring background noise, and the lowest wall filter. 3 to 5 reproducible waveforms from each kidney are obtained, and RIs from these waveforms are averaged to arrive at mean RI values for each kidney. Values from 0.6-0.7 were taken as normal. The value of ≤0.5 was taken as low RI for the purpose of this study. The diagnosis of fungal arteritis was made on histo-pathological examination of arterial biopsies and subsequent graft nephrectomy specimens.

Statistical analysis: The data were entered into and analyzed by Statistical Package for Social Sciences (SPSS) version 10.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used. Mean±standard deviation (SD) was used for quantitative variables while qualitative data were given in numbers (percentages). Chi-square test was used for determining the statistical significance of differences between the groups. P value <0.5 was considered as statistically significant.

**Results:**

A total of 53 patients were included in this study. The majority of these patients (41: 77.4%) were male (figure-1) with mean age of 27.4±9.6 years. Majority of patients belonged to <35 years age group, as shown (figure-2). Different causes of decreased RI and their detection periods are shown (table-1). The anatomical position of the

grafts at the time of transplant is shown in (figure-3). The majority of the patients were managed by re-exploration and minimizing the tension of graft by placing it in subcutaneous space (figure-4). Other surgical and radiological interventions for decreased RI are also shown in figure-4. Two patients underwent graft nephrectomy because of fungal infection (figure-4). RI and mean serum creatinine values in pre and post operative periods are shown in Table-2. CDI finding of a patient who had fungal arteritis is shown in (figure-5).

#### **Discussion:**

The mean reference value for normal RI in adults was determined to be  $0.60 \pm 0.10$  with a value of 0.70 as the upper limit of normal.<sup>5</sup> Whenever there is a decrease in urinary output in the immediate post-operative period, it warrants looking for blood flow in the graft by CDI. Low RI on CDI is suggestive of decreased blood flow in the graft, which may be because of the compartment syndrome secondary to overlying muscle tension. Grafts under tension are often seen in pediatric recipients receiving adult kidneys and this condition may also be seen in adults who have limited retro-peritoneal space which results in diffuse renal parenchymal compression and/or kinking of the renal vessels within a tight compartment.<sup>6</sup> In our study, 64% of patients had low RI in early post-operative period because of grafts under tension. All of these patients were successfully managed by exploration and repositioning of the graft to minimize the tension so that blood flow pattern became normal, which is an utter need for the proper functioning of the graft.

Kinking and torsion of the vessels are the main causes of oliguria or anuria.<sup>7</sup> These conditions are promptly diagnosed by decreased RI on CDI. Nine cases in this study showed that arterial kinking was the cause of decreased RI. All of them required surgery for the repositioning of the artery which lead to normal blood flow in the graft and ultimately the graft functions were preserved.

Transplant renal artery stenosis (TRAS) is a

relatively frequent, potentially curable cause of refractory hypertension and graft dysfunction. TRAS accounts for 75% of all post-transplant vascular complications.<sup>8</sup> TRAS may be due to kinking of the renal artery or faulty technique. When renal function is stable and doppler parameter shows peak systolic velocity  $>180$  cm/sec and RI is  $>0.50$ , it excludes hemodynamically significant stenosis.<sup>9</sup> In these clinical scenarios, no specific intervention is required and only pharmacological treatment is usually required to control blood pressure. Angioplasty and stenting are the first choice of therapy for short linear stenosis which should be relatively distal to the anastomotic site.<sup>4</sup> Surgery is indicated for those patients who had undergone failed angioplasty. Surgical technique includes resection and re-anastomosis using saphenous vein as a bypass graft, patch graft or localized endarterectomy with a success rate ranging from 63 to 92 % and recurrence rate of approximately 12%.<sup>10</sup>

Infection is always a problem in transplants. Fungal infections have always presented as dreadful complications. Two cases in our study suffered from fungal arteritis. CDI of these two patients showed decreased RI. Both of them required graft nephrectomy. This has also been described by Badiie and Alborzi.<sup>11</sup> The natural history of fungal arteritis in renal allograft usually culminates in graft nephrectomy and there is not much to be offered to these unfortunate patients.

There are certain limitations in the study. It is a single center-based, retrospective study. Long-term follow-up data is not provided. However, despite these limitations, we believe that this study is a useful addition to the existing scanty literature on this topic.

#### **Conclusion:**

Post-operative CDI is mandatory in early as well as late post-transplant period. If there is a decrease in RI, the surgeon should take a prompt action in terms of exploration especially in early post-transplant period. However, in late post-transplant period, an angiography should be performed and if there is any positive finding, it

should be managed accordingly.

**Conflict of interest:** None

**Funding source:** None

**Role and contribution of authors:**

Dr Rehan Mohsin, collected the data and references and wrote the initial writeup.

Dr Bipin Mahrjan, helped in collecting the references and introduction writing.

Dr Asad Shahzad, helped in data collection and reference collection and also helped in discussion writing

Dr Gauhar Sultan, helped in collecting the references and discussion writing

Dr Muhammed Mubarak, helped in reference collection and discussion writing

Dr Tahir Aziz, helped in references collection and discussion and conclusion writing

Dr Altaf Hashmi, critically review the article and advised changes in discussion writing.

Dr Adeeb Rizvi, critically reviewed the article and made the final changes.

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