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# Predictive value of resistive index in graft survival after kidney transplant

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## Summary

*Introduction: The intrarenal resistance index (RI) is a calculated parameter for the assessment of the status of the graft during the follow-up ultrasound of the transplanted kidney. Currently it is still unclear the predictive value of RI, also in function of the time.*
*Materials and Methods: We retrospectively investigated the correlation between the RI and the graft survival (GS) and the overall survival (OS) after transplantation. We evaluated 268 patients transplanted between 2003 and 2011, the mean follow-up was 73 months (12-136). The RI was evaluated at 8 days, 6 months, 1 year and 3 years. The ROC analysis was used to calculate the predictive value of RI and the Kaplan Mayer curves was used to evaluated the OS and PS.*
*Results: The ROC analysis, correlated to the GS, identified a value of RI equal to 0.75 as a cut-off. All patients was stratified according to the RI at 8 days (RI ≤ 0,75: 212 vs RI > 0.75: 56), at 6 months (RI ≤ 0.75: 237 vs RI > 0.75: 31), at 1 year (RI ≤ 0.75: 229 vs RI > 0.75: 39) and at 3 years (RI ≤ 0.75: 224 vs RI > 0.75: 44). The RI showed statistically significant differences between the two groups in favor of those who had an RI ≤ 0.75 only at 8 days and at 6 moths (p = 0.0078 and p = 0.02 to 8 days to 6 months) on the GS. On the contrary, we observed that the RI estimated at 1 year and 3 years has not correlated with the GS. The same RI cut-off was correlate with PS after transplantation. We observed that there are no correlations between the RI and OS.*
*Conclusions: The RI proved to be a good prognostic factor on survival organ when it was evaluated in the first months of follow-up after transplantation. This parameter does not appear, however, correlate with OS of the transplanted subject.*

KEY WORDS: *Kidney transplant; Doppler sonography; Resistive index; Graft survival; Patient survival.*

## INTRODUCTION

*Kidney transplantation* (KTx) is the optimal method of treatment in patients with end-stage kidney disease since the 1960s, and it has good outcomes in terms of morbidity, mortality and quality of life (1, 2). In many renal-transplantation centers, measurement of the *intrarenal resistive index* (RI) by means of Doppler ultrasonography is routinely used to evaluate renal allografts (3, 4). The RI is derived from the pulsatile flow-velocity waveform. The RI Pourcelot is a semiquantitative parameter, it is calculated on the curve speed/time as the ratio (SD)/S, where S is the peak systolic velocity and D the peak diastolic velocity (5). Previous cross-sectional study linked an increased intrarenal resistive index after kidney transplantation with an increased risk of graft loss or recipient death (6).
The role of RI on the *Graft Survival* (GS) and *overall survival* (OS) is still controversial, the RI appears to be related to the GS and OS; but his real role in the follow-up the patient is still not clear. According to some recent studies the RI, routinely measured at predefined time points after transplantation, reflects characteristics of the recipient but not those of the graft (7-8).
The purpose of this study was to analyze the impact of RI value on graft survival in relationship to the time of the Doppler.

## MATERIAL AND METHODS

We retrospectively investigated the correlation between the RI and the GS and the OS after transplantation. We evaluated 268 patients transplanted between 2003 and 2011, the mean follow-up was 73 months (12-136). The RI was evaluated at 8 days, 6 months, 1 year and 3 years. The ROC analysis was used to calculate the predictive value of RI and the Kaplan Mayer curves was used to evaluated the OS and PS.
The RI were measured by duplex ultrasound, the Doppler spectra were obtained from the segmental arteries at three different location and the values were obtained from the mean of the three different location.
The RI were measured at 8 days, 6 months, 1 year and 3 years after kidney transplantation.
The donor variables collected from the database were: age, *body mass index* (BMI), serum creatinine levels, clearance at the time of death and biopsy by the Remuzzi-Karpinsky score. Recipient variables were: age, BMI, time on dialysis, cold ischemia time, delayed renal function incidence, hospitalization, incidence of acute graft rejection, GS and OS.
The ROC analysis, correlated to the GS, was used to

**Table 1.** *Diagnostic findings of cases series.*

| | Groups RI at 8 days | | | Groups RI at 6 months | | |
|---|---|---|---|---|---|---|
| **Donors** | **RI ≤ 0,75** | **RI > 0.75** | **P** | **RI ≤ 0,75** | **RI > 0.75** | **P** |
| Means age | 44,7 ± 17,1 (13-77) | 49,8 ± 15 (17-72) | NS | 44,9 ± 16,9 (13-77) | 55,7 ± 13,4 (25-75) | 0,001 |
| Karpinsky score | 1,38 ± 1,47 (0-6) | 2,1 ± 1,5 (0-5) | 0,009 | 1,62 ± 1,58 (0-6) | 2,15 ± 1,3 (0-4) | NS |
| Mean cold ischemia | 14,8 ± 5,2 (7-32) | 15,8 ± 4,1 (8-24) | NS | 15,1 ± 4,9 (7-31) | 19,1 ± 6,1 (12-32) | 0,004 |
| **Recipients** | | | | | | |
| Mean age (years) | 43,5 ± 10,6 (14-65) | 49,5 ± 9,1 (25-62) | < 0,001 | 44,8 ± 10,2 (14-64) | 53,2 ± 7,5 (36-65) | < 0,001 |
| Mean BMI (Kg/m$^2$) | 23,7 ± 4,5 (17,3-37) | 22,53 ± 3,9 (16,1-31,6) | NS | 23,4 ± 4,2 (17,3-37,2) | 22,9 ± 4,5 (16,1-35) | NS |
| Mean time of dyalisis | 67,4 ± 54,8 (3-264) | 101,5 ± 68,9 (3,4-339,6) | < 0,001 | 72,2 ± 55,9 (3-267) | 82,8 ± 70,7 (11-339) | NS |
| sCr (mg/dl) at moment of RI | 1,77 ± 0,70 (0,7 - 4,0) | 2,5 ± 1,17 (0,9-5,7) | < 0,001 | 1,60 ± 0,50 (0,8-3,5) | 1,78 ± 0,52 (0,9-3) | NS |

identify the RI cut-off, the GS and OS were calculated by Kaplan Mayer analyses. The lang-rank test was used to compare survival curves; p < 0,05 was considered statistically significant. Statistical analyses were performed by MedCalc software.

**RESULTS**

In our transplant center, 268 kidney transplant from cadaveric donors were performed. Mean follow-up time of 73 months (CI 12-136). Table 1 shows the main characteristics of donor and recipients according to RI groups.
The ROC analyze was used to identify the RI cut-off. We correlated the value of RI at 8 days, 6 months, 1 year and 3 years after kidney transplantation correlated to the GS. The area under the curve (AUC = 0,647) was better when the RI was calculated at 8 days.
The cut-off identified was 0,75 with better relationship between sensitivity and specificity (Sensitivity: 49%, Specificity: 82%, p = 0,0014) (Figure 1).
This value was used as cut-off; thus all patients was stratified according to the RI at 8 days (RI ≤ 0,75: 212 vs RI > 0.75: 56), at 6 months (RI ≤ 0,75: 237

**Figure 2.**
*The Kaplan-Mayer estimates graft survival correlated to RI at 8 days (p = 0.0078).*
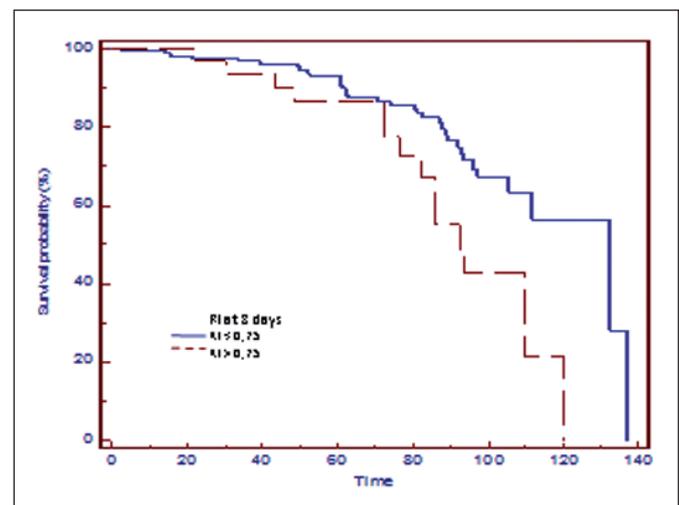


**Figure 3.**
*The Kaplan-Mayer estimates graft survival correlated to RI at 6 months (p = 0.02).*
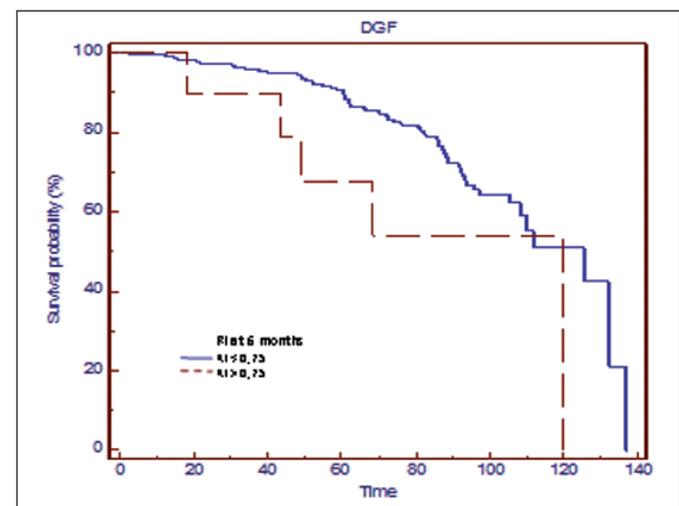


**Figure 1.**
*The ROC analyze identified as cut-off 0,75 with better relationship between the sensitivity and specificity (AUC = 0,647).*
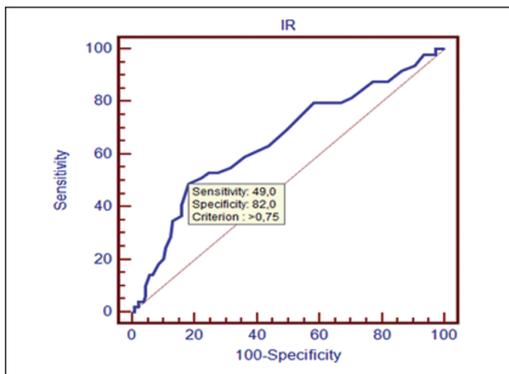
vs RI > 0.75: 31), at 1 year (RI ≤ 0,75: 229 vs RI > 0.75: 39) and at 3 years (RI ≤ 0,75: 224 vs RI > 0.75: 44). Kaplan-Maier estimates of cumulative GS we significantly worse in patients who had an RI > 0.75, in correlation to the RI calculated at 8 days (Figure 2) and 6 moths (Figure 3) (p = 0.0078 and p = 0.02 to 8 days and to 6 months). When the population was stratified in correlation to RI calculation at 1 years and at 3 years, its values is not correlated to the GS.

When we evaluated the OS in relationship to the RI, we did not find any relationship.

## DISCUSSION

After kidney transplantation, several complications may occur. For many years, research has been focused on non-invasive diagnostic techniques, that would be reliably predict the outcome of transplantation and graft function. Doppler ultrasonography is a useful tool for early evaluation of the kidney vasculature and function (9). According to previous studies, clinical parameters associated with increased RI were older donor and recipient age and vascular compliance (10-13).

*Kolonko et al.* concluded that the high RI values measured in the very early post-transplant period predict worse kidney graft function and increased risk of all-cause graft loss, and he said the RI is not completely independent from the adverse influence of *delayed graft function* (DGF) on the premature graft loss (14). Other author concluded the same (7). *Naesens et al.* confirmed that the RI, routinely measured at predefined time points after transplantation, reflects characteristics of the recipient but not those of the graft (8).

We estimated that the RI has an importance when it is calculated in the early months after the transplantation. We identified a value of 0,75 as cut-off. The importance of RI is within 6 months, but it is correlated only with the GS but not with the OS.

## CONCLUSIONS

The RI proved to be a good prognostic factor on survival organ when it was evaluated in the early months of follow-up after transplantation. This parameter does not appear, however, correlate with OS of the transplanted subject.

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