The stenosis of transplant renal artery diagnosed with contrast-enhanced ultrasound (CE-US) - preliminary report

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Authors: P. Grzelak, I. Kurnatowska, L. Stefanczyk; #odz/PL
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Purpose

Surgical complications in the immediate post-transplant period occur in 5-10% of patients after the kidney transplant, most of them may affect parenchymal perfusion. One of the most serious postoperative complications are the renal artery (transplant renal artery stenosis - TRAS). Critical TRAS defined as the stenosis greater than 70% has usually non-specific clinical manifestation. A lower degree of stenosis (50-69%) are usually asymptomatic and therefore cause serious diagnostic difficulties. Fig.1 Clinical manifestations of TRAS include difficulties to achieve adequate blood pressure control, impairment of the excretory, endocrine and homeostatic function of the transplanted kidney and thereby may lead to the development of ischemic nephropathy. These changes are not specific for ischemic nephropathy, hence the search for new diagnostic methods that allow for diagnosing the cause of graft dysfunction in quick and reliable manner.

Currently, the primary imaging examination used in diagnosing of TRAS is standard ultrasound B presentation, extended with color Doppler assessment of the flow spectrum (US-CD/PD/US-PW). It is usually possible to assess the degree of stenosis on the basis of spectral flow in the vessels of the graft. However, this method has many limitations and cannot prove that TRAS is responsible for early graft dysfunction. Administration of the contrast agent enables direct visualization, recording and quantification of blood flow to the kidney.

The aim of this study was to analyse the changes of parenchymal CE perfusion in the kidney graft to detect TRAS in early post transplant course.
Fig. 1: CTA, transplant renal artery stenosis (TRAS); the renal artery stenosis of about 12 mm from the anastomosis.

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Methods and Materials

This study is based on the analysis of CE-US examinations performed in 10 patients after kidney transplantation, all patients were diagnosed with TRAS in the postoperative period (mean age: 40 SD 11.1, range: 19-65). The cases of TRAS are derived from the observation of 120 consecutive patients who underwent the CE-US after renal transplantation (mean age: 46 SD 12.5, range: 19-65). The diagnosis of TRAS was made 1-14 days after transplantation on the basis of standardized test B + US-CD/PD/PW. Immediately after the B + US-CD/PD/PW had been performed CE-US examination. It was carried out after intravenous administration of SonoVue Diagnostics (Bracco Int.) in dose of 2.4 mL per examination (Milan, Italy). The diagnosis of TRAS was confirmed in all cases by MRA, magnetic resonance angiography (Siemens Avanto, Phase contrast angiography, Gadovist) or CTA, computed tomography angiography (GE Light-Speed, minutes of contrast, 400 lomeron). All kidneys for transplantation were from deceived donors. All patients received standard triple immunosuppressive therapy, no antibody induction therapy was used.

Ultrasound studies were performed using GE Vivid 7, with a convex probe (type 3.5C). The CE-US examination protocol included recording of 30 second long dynamic cine loop in the long axis of the kidney visualising the inflow of CE to the KTX. The data was analyzed quantitatively on a workstation (EchoPack, software Q-analyze, GE) with the time intensity curves (TIC). The rate of the CE inflow was evaluated in the cortex (time t1) and renal pyramids (time t2). For statistical analysis assumed rise time TIC curve to reach its maximum. The results of patients with TRAS was compared to the results of 110 transplant patients from our database of CE-US studies without TRAS or other critical complications in postoperative period.

All results are expressed as mean ± SD. Statistical significance was defined at p<0.05. The normality of data distribution was checked by Shapiro-Wilk test, and non-normally distributed data were logarithmically transformed before analysis. Between-group comparisons were performed using t-test for repeated measurements or the Wilcoxon sign rank test for normally and non-normally distributed data, respectively. The Pearson or Spearman correlation coefficient was used to assess relations between the variables.

All subjects gave their written informed consent for the participation in the study and the study protocol was approved by the Bioethics Committee of the Medical University of Lodz, Poland.
Results

Based on the B + US-CD/PD/PW examination TRAS of different degree was diagnosed in 10 (8.3%) consecutive patients after kidney transplantation. The diagnosis of TRAS was confirmed in all cases by reference methods (MRA and CTA). Fig.2,3

In all patients who were diagnosed with postoperative TRAS delayed secretory function (DGF) occurred and those individuals required dialysis for an average of 11 ± 6.7 days after transplantation. In the patients without stenosis CE inflow time to cortex (time t1) ranged from 0.8 to 2.6 seconds (mean 1.48 sec.), and pyramids (time t2) from 0.9 to 3.7 seconds (mean 2.15 sec.). Fig.4 Time of CE inflow to the graft parenchyma was significantly longer. For cortex it ranged from 2.5 to 4.35 seconds (mean 3.32 sec.) for the pyramids 4.0-8.2 seconds (mean 6.11 sec.) Fig.5. By analysing the time of CE inflow into selected areas of the parenchyma significant difference were noted between patients with undisturbed CE saturation and patients with decreased inflow due to TRAS (mean time for cortex was 1.48 ± 3.7 vs 3.32 ± 3.8 s, p <0.19 and for pyramids 2.15 ± 3.9 vs 6.11 ± 3.8 s, p <0.2). We also analyzed a correlation between TRAS severity assessed on the basis of CTA / MRA and the rate of CE inflow (t1 and t2) into selected areas of the parenchyma. The correlation was statistically significant and tight (R=0.97 for t1 and 0.9 for t2; p<0.001).

After 6 month from kidney transplant patients with a history of TRAS had significantly higher serum creatinine level than recipients with a normal renal artery blood flow (1.78 mg/dL vs 1.51 mg/dl, p<0.02). Estimated GFR was also decreased 35.7 ml/min vs 46.4 ml/min, respectively (p<0.05).
**Fig. 2:** CTA, transplant renal artery stenosis (TRAS); the assess the degree of stenosis (82%).

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**Fig. 3:** CTA, transplant renal artery stenosis (TRAS); the renal artery stenosis of about 12 mm from the anastomosis.

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Fig. 4: CE-US. Normal perfusion in the transplanted kidney parenchyma.

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Fig. 5: CE-US study. The transplant renal artery stenosis (TRAS).

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Conclusion

CE-US allows for quick and non-invasive assessment of perenchymal kidney graft perfusion. It enables to confirm diagnosis of TRAS in the early postoperative period.


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