# RENAL FUNCTIONAL RESERVE AND RENAL HEMODYNAMICS IN HYPERTENSIVE PATIENTS

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## OBJECTIVES

The renal functional reserve (RFR) is the ability of the kidneys to increase renal plasma flow and glomerular filtration rate (GFR) in response to protein intake. It is a measure of functional and anatomic integrity of nephrons. It is not known what relation between RFR and kidney Doppler parameters. We aimed to study the relation between the RFR and renal hemodynamic parameters in hypertensive patients with and without nephropathy who had normal kidney function.

## METHODS

Twenty-four hypertensive subjects with nephropathy (HTN-n, n=10) and hypertension without nephropathy (HTN, n=14) were included in the study. Control group included 11 healthy subjects. Baseline GFR (GFR1) and GFR after intake of egg protein 1 mg/kg of body weight were determined (GFR2). RFR was calculated by the following formula: (GFR2-GFR1)/GFR1x100%. Doppler ultrasound was performed. Arterial blood pressure (BP), body mass index (BMI), and estimated GFR were also recorded. Results were considered as significant if $p \leq 0.05$.

## RESULTS

HTN and HTN-n groups had impaired levels of RFR compared with controls (p<0,05), significantly decreased value of flow velocity parameters (Vmax, Vmin) and increased RRI compared with controls. There was significant negative correlation of RFR with blood pressure levels (sBP, r=-0,435, p=0,009; dBP, r=-0,504, p=0,002), RRI (r=-0.456, p=0,008), microalbuminuria (MAU, r=-0,366, p=0,031) and positive correlation with Vmax and Vmin (r=0,556, p=0,001 and r=0.643, respectively, p<0,001). Linear regression showed that RRI and MAU were independent predictors decreased RFR.

**Table 1.** Baseline characteristics and intergroup comparison in control and hypertension groups

|  | Control, n=11 | HTN, n=14 | HTN-n, n=10 | P value* |
|---|---|---|---|---|
| **Gender**, male:female | 5:6 | 11:3 | 6:4 | 0.240 |
| **Age**, years | 32,4±10,4 | 37,8±6,4 | 32,5±9,08 | 0.107 |
| **BMI**, kg/m2 | 22,9±3,77 | 27,8±3,64 [a] | 23,15±3,75 [b] | 0.004 |
| **Creatinine**, µmol/l | 69,5±8,84 | 81,6±18,9 | 81,1±16,8 | 0.152 |
| **GFR**, ml/min/1,73m2 | 111,3±14,7 | 93,4±29,4 [a] | 99,6±17,3 | 0.113 |
| **MAU**, mg/24h | 11,2±7,7 | 17,5±10,9 | 813,0±424,4 [a,b] | <0.001 |
| **RFR**, % | 11,3 (24,6) | 5,0 (8,08) [a] | 1,05 (9,83) [a] | <0.001 |
| RFR > 5% | 11 (100%) | 5 (35,7%) | 3 (30%) | - |
| RFR ≤ 5% | - | 5 (35,7%) | 2 (20%) | - |
| RFR ≤ 0% | - | 4 (28,6%) | 5 (50%) | - |
| **HTN vintage**, months | - | 8,71±7,17 | 39,5±37,3 [b] | - |
| **sBP**, mmHg | 118,2±7,51 | 157,1±9,74 [a] | 141,0±17,1 [a,b] | <0.001 |
| **dBP**, mmHg | 73,6±5,05 | 97,1±3,77 [a] | 86,0±13,2 [a,b] | <0.001 |
| **Vmax**, mm/sec | 73,0±15,5 | 49,6±9,32 [a] | 56,3±8,18 [a] | <0.001 |
| **Vmin**, mm/sec | 33,2±5,8 | 20,6±6,2 [a] | 22,8±3,21 [a] | <0.001 |
| **SD** | 2,19±0,28 | 2,61±0,75 | 2,49±0,24 [a] | 0.147 |
| **RRI** | 0,54±0,06 | 0,60±0,10 | 0,61±0,04 [a] | 0.072 |
| **PI** | 1,13±0,31 | 1,13±0,46 | 1,07±0,12 | 0.543 |

The data presented as mean±SD or median (IQR) as appropriate. The note: *Kruskal–Wallis test and Chi-square test. Between group differences defined by Mann-Whitney:
[a] Compared with control group (p≤0.05).
[b] Compared with HTN group (p≤0.05).
**BMI** – body mass index, **GFR** – glomerular filtration rate, **MAU** – microalbuminuria, **RFR** – renal functional reserve (given as Median (IQR)), **HTN** – hypertension, **sBP** – systolic blood pressure, **dBP** – diastolic blood pressure, **Vmax** – systolic peak velocity, **Vmin** – end-diastolic velocity, **SD** – systolo-diastolic parity, **RRI** – renal resistive index, **PI** – pulses index.

**Table 2.** Linear regression analysis to determine independent associates of renal functional reserve (RFR, n=35).

| Model | B | S.E. | β | t | P value | 95%CI for B |
|---|---|---|---|---|---|---|
| **Constant[a]** | 32,52 | 25,33 |  | 1,284 | 0,210 | -19,36 – 84,41 |
| AGE | -0,067 | 0,252 | -0,051 | -0,264 | 0,793 | -0,582 – 0,449 |
| GFR | 0,137 | 0,127 | 0,205 | 1,084 | 0,288 | -0,122 – 0,397 |
| MAU | -0,008 | 0,004 | -0,302 | -1,907 | 0,067 | -0,017 – 0,001 |
| RRI | -58,51 | 23,21 | -0,393 | -2,521 | 0,018 | -106,1 – 10,96 |
| **Constant[a]** | 44,92 | 13,48 |  | 3,331 | 0,002 | 17,38 – 72,46 |
| MAU | -0,008 | 0,004 | -0,304 | -1,951 | 0,060 | -,017 – 0,001 |
| RRI | -59,38 | 23,18 | -0,399 | -2,562 | 0,016 | -106,7 – 12,04 |

Dependent variable – RFR. Constant[a]: R=0,594, R2=0,353, F=10,0, P=0,013 (linear regression with "enter" model).
Constant[b]: R=0,545, R2=0,297, F=10,1, P=0,005 (the 3rd step of the linear regression with "backward removal" model).
**GFR** – glomerular filtration rate, **MAU** – microalbuminuria, **RFR** – renal functional reserve, **RRI** – renal resistive index.



**Figure 1.** Distribution of RFR in study groups [Medium, maximum and minimum].
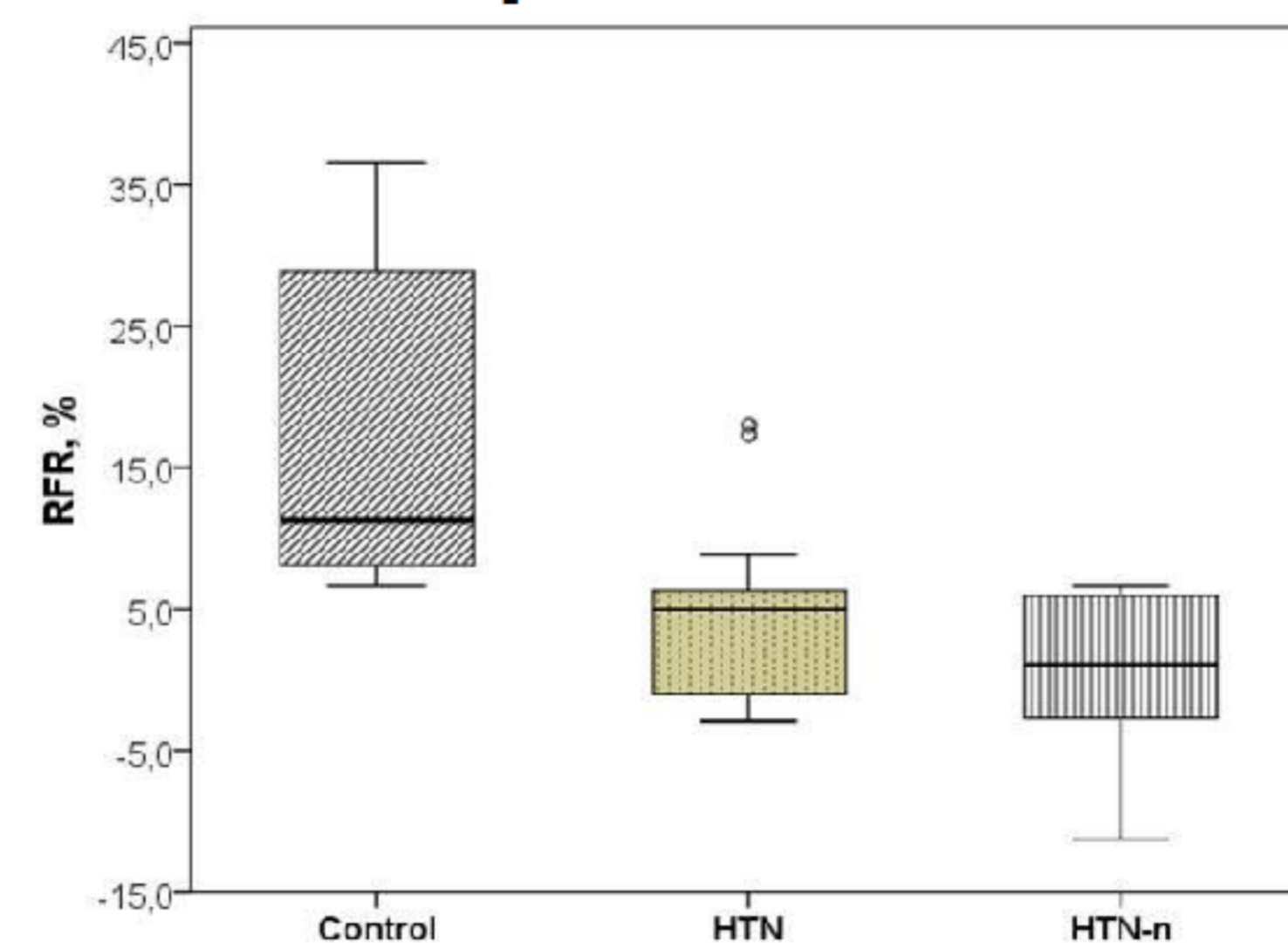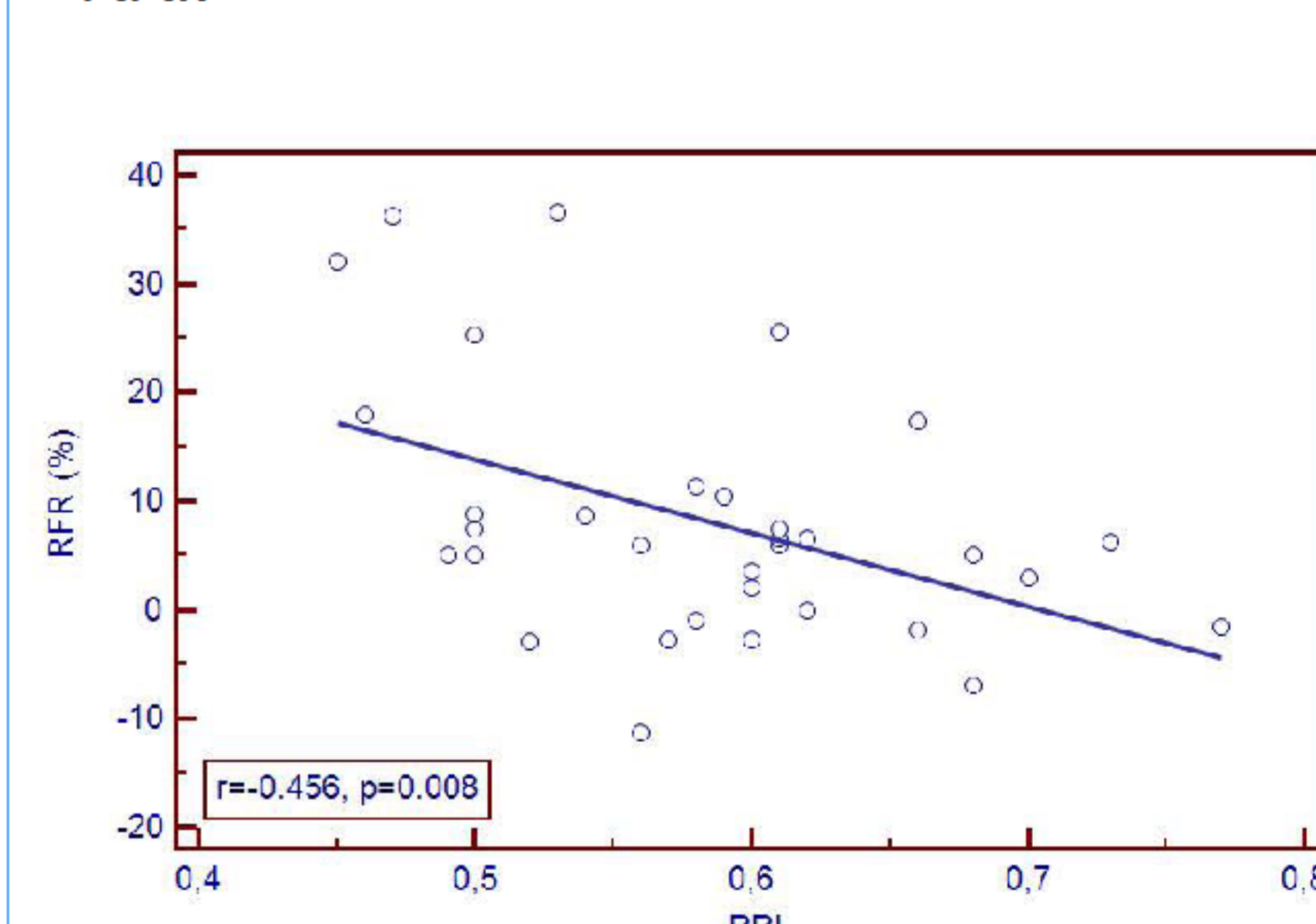


**Figure 2.** Correlation between RFR and RRI.

r=-0,456, p=0,008

## CONCLUSIONS

RFR is lower in hypertensive patients despite near-normal level of kidney function and is related to particular level of blood pressure. RRI and MAU were independent predictors of decreased RFR.

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