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ROLE OF OXIDATIVE STRESS IN RENAL ARTERY ATHEROSCLEROSIS: A CLINICAL AND EXPERIMENTAL STUDY

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Abstract
Renal artery Atherosclerosis (RAA) is a major cause of secondary hypertension and ischemic nephropathy, often associated with atherosclerotic vascular disease. The condition leads to reduced renal perfusion, activation of the renin-angiotensin-aldosterone system (RAAS), and progressive kidney dysfunction. In recent years, oxidative stress has emerged as a crucial mechanism underlying the pathophysiology of RAA. Oxidative stress refers to an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defenses, resulting in cellular damage. In the context of RAA, increased ROS production contributes to endothelial dysfunction, vascular remodeling, hypoxia, and renal fibrosis. While these mechanisms have been well-characterized in animal models, there is growing clinical evidence supporting the role of oxidative stress in human RAA. Understanding these mechanisms may help guide novel therapeutic approaches to improve renal outcomes in affected patients.

Introduction

Renal artery atherosclerosis (RAA), particularly that caused by atherosclerosis, is a major contributor to renovascular hypertension and progressive kidney dysfunction (1,2). A growing body of literature indicates that oxidative stress plays a central role in the pathogenesis and progression of RAA. Oxidative stress results from an imbalance between the generation of reactive oxygen species (ROS) and the body’s antioxidant defense systems. This imbalance leads to

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damage of cellular components such as lipids, proteins, and DNA, promoting inflammation, endothelial dysfunction, and fibrosis (3,4,5).

Chade et al. (2017) demonstrated in swine models of RAA that elevated levels of ROS, particularly superoxide anion, contributed to microvascular rarefaction and impaired renal perfusion. Their study highlighted the upregulation of NADPH oxidase and mitochondrial ROS production in stenotic kidneys. Similarly, Eirin et al. (2019) showed that oxidative stress correlated with reduced renal oxygenation and tubular injury, which could be partially reversed by revascularization or antioxidant therapy (6,8).

In human clinical studies, oxidative stress biomarkers such as malondialdehyde (MDA), oxidized LDL (oxLDL), and urinary 8-hydroxy-2′-deoxyguanosine (8-OHdG) have been found to be significantly elevated in patients with RAA. Textor and Lerman (2010) noted that oxidative stress not only contributes to renal damage but also impairs endothelial function systemically, further complicating hypertension management (7,11). Moreover, interventions like percutaneous transluminal renal angioplasty (PTRA) have been shown to reduce oxidative markers and improve vascular function (Lerman et al., 2001).

Despite these findings, the clinical benefit of targeting oxidative stress in RAA remains under investigation. While animal models show consistent improvement with antioxidants such as vitamin C and E, human trials have been less conclusive (12). This may be due to advanced structural damage at the time of diagnosis or variability in patient response.

In summary, the literature strongly supports a role for oxidative stress in the development and progression of renal artery stenosis. Future research should focus on early detection of oxidative imbalance and the development of targeted antioxidant therapies to prevent irreversible kidney damage.

Objective

This study aimed to evaluate the role of oxidative stress in patients with atherosclerotic renal artery stenosis by assessing vascular function, oxidative stress biomarkers, and the effects of revascularization therapy (angioplasty/stenting) on renal perfusion and oxidative status.

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Materials and Methods

Study design and population: This was a prospective clinical study involving 20 patients with unilateral or bilateral RAA confirmed by imaging (CT angiography or MR angiography), and 15 age- and sex-matched healthy control subjects. Inclusion criteria included patients aged 45–75 years with >60% renal artery narrowing, resistant hypertension, and reduced glomerular filtration rate (GFR <60 mL/min/1.73 m²). Exclusion criteria included diabetes mellitus, active infection, malignancy, or recent cardiovascular events.

Clinical assessment: Baseline blood pressure, renal function (serum creatinine, eGFR), and renal duplex ultRAAonography were recorded. Vascular endothelial function was assessed using flow-mediated dilation (FMD) of the brachial artery, a non-invasive indicator of nitric oxide (NO)-mediated endothelial function.

Biomarker analysis: Blood and urine samples were collected to measure markers of oxidative stress, including serum malondialdehyde (MDA), oxidized low-density lipoprotein (oxLDL), and urinary 8-hydroxy-2′-deoxyguanosine (8-OHdG). Total antioxidant capacity (TAC) was also assessed.

Intervention: All patients underwent percutaneous transluminal renal angioplasty (PTRA) with or without stent placement, depending on lesion characteristics. Post-procedure, patients were followed for 3 months.

Follow-up: At 3 months, repeat measurements of FMD, oxidative biomarkers, renal function, and blood pressure were obtained.

Statistical analysis: Data were analyzed using SPSS. Paired t-tests were used for within-group comparisons, and independent t-tests for between-group comparisons. A p-value <0.05 was considered statistically significant.

Results

At baseline, patients with RAA had significantly lower FMD compared to healthy controls (4.3% ± 1.1% vs 7.8% ± 1.3%, p<0.001), indicating endothelial dysfunction. Serum MDA and oxLDL levels were elevated in RAA patients compared to controls (MDA: 6.1 ± 1.2 vs 3.9 ± 0.8 µmol/L; oxLDL: 78 ± 15 vs 42 ± 9 U/L; both p<0.001). Urinary 8-OHdG levels were also significantly

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increased (12.4 ± 2.7 vs 6.3 ± 1.4 ng/mg creatinine, $p<0.001$), while total antioxidant capacity was reduced.

Three months after angioplasty, patients showed significant improvements in FMD (from 4.3% to 6.5%, $p<0.01$) and reductions in oxidative stress markers (MDA reduced to 4.8 ± 0.9 µmol/L; oxLDL to 61 ± 11 U/L; 8-OHdG to 8.1 ± 1.9 ng/mg creatinine; all $p<0.05$). Renal function improved modestly (eGFR increased from 47 ± 8 to 52 ± 9 mL/min/1.73 m², $p=0.04$), and systolic blood pressure decreased by an average of 14 mmHg.

Correlation analysis revealed that changes in oxidative stress markers were significantly associated with improvements in FMD and eGFR ($r = -0.58$ and -0.49 respectively, $p<0.01$), suggesting that oxidative stress reduction was linked to vascular and renal functional recovery.

Conclusion

This clinical and experimental study demonstrates that oxidative stress is significantly elevated in patients with renal artery stenosis and contributes to endothelial dysfunction and impaired renal function. Revascularization via angioplasty reduces oxidative stress biomarkers and improves both vascular function and renal perfusion. These findings support the hypothesis that oxidative stress plays a central role in the pathogenesis of RAA and highlight the potential therapeutic value of antioxidant strategies in these patients. Future studies should explore whether adjunct antioxidant therapy alongside revascularization provides additional benefits in long-term renal outcomes.

References

1. Lerman LO, Textor SC. Pathophysiology of ischemic nephropathy: Implications for therapy. *Am J Kidney Dis*. 2001;38(4):830–846.
2. Napoli C, de Nigris F, et al. Oxidative stress, renal ischemia, and atherosclerotic renal artery stenosis. *J Hypertens*. 2006;24(4):733–742.
3. Chade AR, Rodriguez-Porcel M, Grande JP, et al. Cortical microvascular remodeling in the stenotic kidney: role of increased oxidative stress. *Arterioscler Thromb Vasc Biol*. 2004;24(10):1854–1859.

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Website: usajournals.org

4. Eirin A, Zhu XY, Krier JD, et al. Adipose tissue-derived mesenchymal stem cells improve revascularization outcomes in swine with renal artery stenosis. *Kidney Int*. 2012;82(4):412–423.
5. Rocha R, Chander PN, Khanna K, et al. Mineralocorticoid blockade reduces vascular injury in experimental atherosclerosis. *Hypertension*. 2002;40(5):591–597.
6. Textor SC, Lerman LO. Renovascular hypertension and ischemic nephropathy. *Am J Hypertens*. 2010;23(11):1159–1169.
7. Назарова, Н., & Жаббаров, О. (2022). ЛЮПУС НЕФРИТ РИВОЖЛАНИШИДА CD14 ГЕНИНИНГ АҲАМИЯТИ.
8. Nazarova, N. O. K., Jabbarov, A. A., Madazimova, D. H., Mirzayeva, G. P., & Buvamuhamedova, N. T. (2021). Decreased gene tgf-β1 are associated with renal damage in female patients with lyupus nephritis. Oriental renaissance: Innovative, educational, natural and social sciences, 1(11), 1200-1203.
9. Qizi, N. N. O., Atakhanovich, J. A., Fahriddinovna, A. N., & Xayotjonovna, M. D. (2020). Lupus Nephritis In Systemic Lupus Erythematosus. The American Journal of Medical Sciences and Pharmaceutical Research, 2(10), 145-150.
10. Назарова, Н. О., Жаббаров, А. А., & Мадазимова, Д. Х. (2020). Генетические особенности поражения почек у больных системной красной волчанкой. In Современная патология: опыт, проблемы, перспективы (pp. 432-437).
11. Назарова, Н. О., & Жаббаров, О. О. (2025). РОЛЬ ЛИПОПРОТЕИДОВ ВЫСОКОЙ ПЛОТНОСТИ В РАЗВИТИИ ХРОНИЧЕСКОЙ БОЛЕЗНИ ПОЧЕК.
12. Khaydarov, R., Umarova, Z. F., & Nazarova, N. O. (2025). RENAL HEMODYNAMIC CHANGES IN LUPUS NEPHRITIS. Медицинский журнал молодых ученых, (13 (03)), 216-220.