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RESEARCH ARTICLE

Evaluation of Plasma Homocysteine as a Biomarker for Acute Renal Injury Following Extracorporeal Shock Wave Lithotripsy (ESWL) in Patients with Renal Stone Disease

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ABSTRACT

Extracorporeal shock wave lithotripsy (ESWL) is a non-invasive procedure used to fragment renal stones, yet it may cause renal injury. This study aims to evaluate plasma homocysteine levels as a potential marker of acute renal injury in patients undergoing ESWL for renal stone disease. A total of 100 patients with renal calculi underwent ESWL and were assessed for plasma homocysteine levels pre- and post-procedure. Results indicated a significant rise in plasma homocysteine levels post-ESWL, suggesting its association with acute renal injury. Furthermore, patients with larger stones and higher energy settings demonstrated greater increases in homocysteine. These findings indicate that plasma homocysteine may serve as a useful biomarker for renal injury following ESWL, aiding in the early detection and management of renal damage. Further research is necessary to confirm these results and to establish plasma homocysteine as a routine marker in clinical practice.

Keywords: Plasma homocysteine, acute renal injury, extracorporeal shock wave lithotripsy, renal stones, biomarker.

INTRODUCTION:

Extracorporeal shock wave lithotripsy (ESWL) is a widely used, non-invasive procedure for the treatment of renal calculi, which involves the use of shock waves to fragment stones so that they can pass through the urinary tract (1). Although it is a relatively safe procedure, various studies have reported renal complications, including acute renal injury (ARI), hematuria, and transient impairment of renal function, due to the mechanical forces involved in ESWL (2, 3).

Renal injury during ESWL can result from direct trauma to the renal parenchyma, microvascular damage, and the generation of free radicals, leading to inflammation and tissue injury (4). Detecting early renal injury post-ESWL is crucial for minimizing long-term complications such as chronic kidney disease (CKD) (5). However, the lack of specific markers for ARI has limited the ability to diagnose and manage such injuries effectively. Plasma homocysteine, a sulfur-containing amino acid, has been proposed as a potential biomarker for renal injury (6).

Homocysteine levels are known to increase in various pathological conditions, including cardiovascular disease, oxidative stress, and renal impairment (7). Elevated homocysteine levels have been associated with endothelial dysfunction, impaired renal hemodynamics, and renal tubular damage (8). Moreover, studies have suggested a correlation between hyperhomocysteinemia and acute kidney injury (AKI), where homocysteine acts as a mediator of oxidative stress and inflammation (9). Given this background, we hypothesized that plasma homocysteine may be a sensitive marker for detecting acute renal injury following ESWL.

In this study, we aim to evaluate the role of plasma homocysteine as a marker of ARI in patients undergoing ESWL for renal stone disease. By assessing the changes in homocysteine levels pre- and post-ESWL, we aim to establish whether homocysteine can serve as an early indicator of renal injury and help guide the clinical management of patients undergoing this procedure.

Aim and Objectives:

Aim:

To assess plasma homocysteine levels as a potential marker of acute renal injury in patients undergoing ESWL for renal stone disease.

Objectives:

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1. To evaluate the changes in plasma homocysteine levels before and after ESWL in patients with renal calculi.
2. To determine the correlation between plasma homocysteine levels and the severity of renal injury following ESWL, based on stone size and energy settings used.

Materials and Methods:

This prospective study was conducted at a tertiary care hospital, where 100 patients with renal calculi undergoing ESWL were enrolled. Ethical approval was obtained, and informed consent was acquired from all participants.

Inclusion Criteria:

1. Patients aged 18–65 years with confirmed renal stone disease (stone size 5–20 mm) undergoing ESWL.
2. Normal baseline renal function (serum creatinine within normal limits).
3. No history of prior renal surgery or significant cardiovascular disease.

Exclusion Criteria:

1. Patients with known hyperhomocysteinemia or on medications affecting homocysteine levels.
2. Patients with chronic kidney disease (CKD) or pre-existing renal dysfunction.
3. Those undergoing ESWL for multiple stones or complex stones requiring multiple sessions.

Plasma homocysteine levels were measured in all patients 24 hours prior to ESWL and 48 hours post-procedure using an enzyme-linked immunosorbent assay (ELISA). The ESWL was performed using a standard lithotripter with a maximum of 3000 shocks and energy settings ranging from 14–18 kV, depending on stone size and patient tolerance. Post-ESWL renal injury was assessed using plasma homocysteine levels, serum creatinine, and ultrasound for detecting renal hematomas.

Statistical analysis was performed using SPSS software, and a p-value <0.05 was considered statistically significant.

Results:

Table 1: Plasma Homocysteine Levels Pre- and Post-ESWL

Parameter	Pre-ESWL (Mean ± SD)	Post-ESWL (Mean ± SD)	p-value
Plasma Homocysteine (µmol/L)	10.5 ± 2.5	15.8 ± 4.1	0.001
Serum Creatinine (mg/dL)	0.9 ± 0.1	1.2 ± 0.2	0.02

Table 2: Correlation of Stone Size and Energy Settings with Homocysteine Levels Post-ESWL

Stone Size (mm)	Energy Setting (kV)	Homocysteine Increase (%)	p-value
5–10	14	30%	0.01
11–15	16	40%	0.001
16–20	18	55%	0.001

Description:

There was a significant increase in plasma homocysteine levels post-ESWL (mean increase from 10.5 µmol/L to 15.8 µmol/L, p=0.001). The rise in homocysteine levels was greater in patients with larger stones (16–20 mm) and those who required higher energy settings (18 kV) during the procedure.

Discussion:

This study demonstrates a significant increase in plasma homocysteine levels following ESWL, suggesting its potential role as a marker for acute renal injury. The elevation in homocysteine was particularly pronounced in patients with larger stones and those exposed to higher energy levels during the procedure, indicating a direct correlation between the severity of renal injury and these factors. Similar findings have been reported in studies investigating the relationship between hyperhomocysteinemia and renal injury in other clinical contexts (10).

The mechanical forces exerted by shock waves during ESWL can cause endothelial damage and microvascular injury within the renal parenchyma, leading to increased homocysteine production (11). Homocysteine has been implicated in promoting oxidative stress, endothelial dysfunction, and

inflammation, all of which contribute to renal injury (12). The results of this study align with previous research linking elevated homocysteine levels with kidney injury and suggest that monitoring homocysteine could provide an early indicator of ESWL-induced renal damage (13).

The clinical significance of these findings lies in the potential application of homocysteine as a biomarker for renal injury in ESWL patients. Currently, serum creatinine and imaging techniques such as ultrasound are commonly used to assess renal function post-ESWL; however, these methods may not detect early or subtle renal damage (14). The use of homocysteine as a marker could allow for earlier detection and intervention, reducing the risk of long-term renal impairment.

While the findings are promising, this study is limited by its relatively small sample size and short follow-up period. Future studies with larger cohorts and longer-term follow-up are needed to validate the use of plasma homocysteine as a routine marker for renal injury in ESWL patients. Additionally, the impact of patient-specific factors such as genetics and pre-existing conditions on homocysteine levels warrants further investigation.

Conclusion:

This study highlights the potential of plasma homocysteine as a marker for acute renal injury in patients undergoing ESWL for renal stone disease. The significant increase in homocysteine levels post-ESWL, particularly in patients with larger stones and higher energy settings, suggests that homocysteine could serve as an early indicator of renal injury. Monitoring homocysteine levels may improve the detection and management of ESWL-related renal complications, ultimately leading to better patient outcomes. Further research is needed to establish homocysteine as a standard biomarker for renal injury in clinical practice.

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