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Original Research Article

In Patients Undergoing Extracorporeal Shock Wave Lithotripsy for Renal Stone Disease, Plasma Homocysteine Was Measured as a Marker of Acute Renal Injury

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Abstract

Background: Severe kidney damage (AKI) by biomarker release may occur during extracorporeal wave lithotripsy (ESWL), a common treatment used to treat high urinary tract stones. Severe kidney damage has been linked to extracorporeal shockwave lithotripsy (ESWL) due to damage to the arteries and tissues. Because less developed countries do not have real-time glomerular filtration parameters, effective indicators are needed to prevent tubular kidney damage. Shock wave lithotripsy (SWL) for kidney stones is becoming more popular every year, and as a result, post-operative complications such hematuria and acute kidney injury (AKI) are expected to develop. The importance of plasma total homocysteine (tHCy), serum high-sensitivity C reactive protein (hs CRP), and serum creatinine as symptoms of severe kidney damage, as well as their association with kidney dysfunction will be investigated.

Aim: The goal of the study is to compare plasma tHCy to other markers of AKI, such as serum creatinine and serum hs CRP, in patients receiving ESWL for renal stone disease.

Material and method: Plasma tHCy, serum creatinine, and serum hs CRP were measured in 60 patients receiving ESWL for renal stone disease 24 hours before and after the surgery. AKI and non-AKI patients were separated into two groups. Statistical Analysis: Rates, ratios, percentages, and mean standard deviation using SPSS statistical software. Statistical significance was defined as a $P<0.05$ at a 95% confidence range.

Results: AKI grew in 26.25 percent of patients after ESWL. Patients with AKI had significantly higher plasma thHCy levels after ESWL than those who did not have AKI. In people with AKI, moderate levels of creatinine in the blood and mean changes after ESWL were very high. Patients with AKI and those who did not have AKI had similar post-ESWL mean serum hs CRP values. However, following ESWL, which is the only 24-hour kidney transplant, 62.22 percent of patients with AKI experienced a significant increase in blood pressure hs CRP (2≥fold of baseline).

Conclusion: ESWL is a safe and effective method for treating renal stone disease, although it has the potential to produce acute renal damage. Following acute renal damage produced by ESWL, plasma, total homocysteine, and serum hs CRP, as well as serum Creatinine, all rise markedly. As a result, in individuals with renal stone disease, plasma total homocysteine, serum hs CRP, and serum creatinine can be employed as acute renal damage markers after ESWL.

Keywords: Plasma Homocysteine, Acute renal injury, Extracorporeal Shock, Lithotripsy and Renal stone

Introduction

Extracorporeal shockwave lithotripsy (ESWL) is a slow attack that breaks down small stones using a positive pressure of 20-110 Pa and a negative pressure of 5-10 MPa. [1,2] The energy released as a result of this run rises and erodes the stone. [3] The power created by pulses has the potential to cause tissue damage by causing inflammation of the surrounding tissues, despite the fact that ESWL is a non-invasive, safe, and effective treatment. [4] Unsurprisingly, ESWL was connected to acute renal impairment in up to 3.6 percent of people. [5] Shock wave lithotripsy (SWL) is a non-invasive treatment for kidney stones with a diameter of less than 2 cm. [6] According to recent data, SWL therapies are being used more frequently, as the number of kidney stones in the United Kingdom has increased by two-thirds in the last decade. [7]

Renal stone disease is becoming increasingly common, with a lifetime risk of kidney stones ranging from 6% to 12% in the general population of the United States. [8,9] Extracorporeal shock wave lithotripsy (ESWL) has been widely accepted as a first-line treatment for kidney and beyond stones since the early 1980's. It is a quick, painless, and effective non-invasive procedure that can be performed as an anesthetic procedure without anesthesia. The Dornier HM3 lithotripter was the first to be introduced. [10] The effects of ESWL on renal function have been studied extensively. Patients with renal impairment were recently found to have increased plasma homocysteine levels. [11]

Homocysteine is a sulfur-containing amino acid with a reactive sulfhydryl group (SH) that, like most thiols, can be oxidised to disulfide in the presence of oxygen at physiological pH. (RSH). It is produced by demethylating methionine and can be reversibly converted back to methionine or permanently turned to cysteine. These reactions are accelerated by transition metals, Vitamin B6, B12, and folic acid. Homocysteine produces homocysteine thiolactone, a five-component heterocycle, when cycling. Homocysteine-containing peptides often differentiate themselves due to this “self-looping” process, which creates oxidative stress. Homocysteine is excreted from the body through renal and extrarenal systems. Kidney metabolism, like creatinine metabolism, involves urination after glomerular filtration. For many people, high levels of tHcy are associated with atherothrombotic vascular disease and various other diseases, such as Alzheimer's, osteoporosis, deep vein thrombosis, and pulmonary embolism. [12,13] A spike in serum creatinine is also caused by any kidney illness, whether acute or chronic. It's a well-known marker of renal injury that's removed through glomerular filtration. Any injury or inflammatory disease might produce the nonspecific sign hs-CRP. According to RIFLE standards, AKI is defined as a two-fold increase in serum creatinine from baseline after ESWL.

Material and Methods

The current research was conducted in the Department of General Surgery. All of the participants in the study gave their informed consent in both English and the vernacular language.

Selection of Patients

The study comprised sixty patients who were having ESWL for renal stones and met the inclusion criteria. The study comprised patients between the ages of 25 and 60 who were receiving ESWL for the first time as the only therapy option. The study excluded pregnant patients, patients with baseline renal impairment who developed post-ESWL complications such as ureteric obstruction or sepsis that required additional intervention, calculi >2 cm, patients with chronic kidney disease or acute renal failure, and patients with blood coagulation disorders. The Institutional Ethics Committee granted Ethical Clearance prior to the start of the project.

Patients who met the eligibility criteria were informed about the study's goals and consented in writing. The complaints were noted, along with demographic information such as age and gender. The patients were given clinical examinations and their vital signs were recorded. The systemic evaluation has been finished. On a pre-made pro forma, these conclusions were written down. Patients were subjected to the following routine investigations before to ESWL. A complete blood count, mini renal test, liver function test, urine routine, and microscopy, as well as a full blood count, small renal test, liver function test, urine routine, and microscopy, are all conducted. X-ray kidney, ureter, bladder (KUB), ultrasonography (USG) KUB, or plain computed tomography (PCT) KUB were used to determine the location and diameter of the calculi. As per usual hospital procedure, SWL therapy was conducted using a Wolf P3000 lithotripter with triple focus technology and ultrasound/fluoroscopic imaging for localization.

Patients were maintained hydrated before, during, and after ESWL. All of the ESWLs were done with a Siemens modularis lithotripter under local anaesthesia with gel or intravenous sedation (fentanyl/propofol/morphine/ketamine). The procedure was carried out in a supine position. A combination of USG and fluoroscopy was frequently used to target the calculi. The rate of shocks was fixed at 60 per minute. The maximum number of shocks given per sitting was increased to 3000. The overall number of shocks utilised every session was changed to produce acceptable calculus fragmentation. The process was stopped if the maximum shocks delivered surpassed 3000 without proper fragmentation.

The rise in plasma tHCy, serum hs CRP, and serum creatinine levels was seen before and after ESWL, i.e., 24 hours before (baseline value) and 24 hours after ESWL, respectively. We acquired fasting samples. Plasma tHCy was measured using EDTA anticoagulated blood. It was calculated using an automated architect immunoassay analyzer, and levels of 5.9 to 16 mol/L were considered normal.[14] The levels of serum hs CRP were measured using an Automated DADE Dimension RXL Analyzer, and ranges between 0 and 3 mg/dL were considered normal.[15] For the measurements, plain blood was used. The Automated DADE Dimension RXL Analyzer was used to calculate serum creatinine levels. Normal levels were considered to be between 0.5 and 1.4 mg/dL. [16]

Result:-

Table 1: Patients' demographics

Characteristics of the study population	N
Total number of patients	60
Males, n	44
Females, n	16
Age (years), mean±SD	38.44±6.33

Number of calculi n	
1	40
2	18
3	2
Location of calculi, n	
Renal pelvis	33
Upper calyx	10
Middle calyx	9
Lower calyx	8
Calculus size (mm), n	
5-10	6
11-15	30
16-19	24

Table 2. Comparisons between groups according to eGFR

Parameters	**Stages 1-2 (n = 40)**	**Stages 3-5 (n = 20)**
Homocysteine (μM/L)	11.10 ± 2.64	15.54 ± 2.86
Uric acid (mg/dL)	3.08 ± 1.92	3.48 ± 1.88
BUN (mg/dL)	12.79 ± 2.57	26.38 ± 5.98
Cr (mg/dL)	1.09 ± 0.10	1.55 ± 0.19
eGFR (mL/min/1.73 m2	71.18 ± 10.06	40.44 ± 6.76
Glucose (mg/dL)	99.77 ± 11.19	91.42 ± 09.30
AST (IU/mL)	22.37 ± 5.84	23.04 ± 4.10
ALT (IU/mL)	27.40 ± 16.96	22.56 ± 11.98
TC (mg/dL)	187.71 ± 35.11	181.75 ± 25.33
LDL (mg/dL)	109.56 ± 19.05	115.43 ± 17.03
HDL (mg/dL) ± 7.65 0.005	47.02 ± 6.20	32.61 ± 5.45
TG (mg/dL)	197.10 ± 112.75	149.34 ± 55.74
sBP (mmHg)	122.26 ± 15.19	114.21 ± 7.73
dBP (mmHg	70.88 ± 8.64	44.65 ± 5.83
Homocysteine (μM/L)	10.12 ± 2.36	15.35 ± 3.70

Values show moderate deviation. AST, aspartate aminotransferase; ALT, alanine aminotransferase; TC, total cholesterol; LDL, low density lipoprotein; HDL, high density lipoprotein; TG, triglyceride; EGFR, Glomerular filtering rate; AST, aspartate aminotransferase; ALT, alanine aminotransferase; TC, total cholesterol; LDL, low density lip sBP represents systolic blood pressure. "Not important" is defined by the abbreviation NS.

Discussion

ESWL is a common surgery for people who need treatment for upper urinary tract stones. It's a non-invasive procedure that can be performed as an outpatient procedure. [17] Despite its proven safety and efficacy, various studies on the difficulties that can arise after ESWL have been undertaken. [18,19] By rupturing blood arteries in the medulla and cortex, ESWL generates a predictable sequence of immediate renal injury, which is followed by intraparenchymal haemorrhage, oxidative stress, inflammation, and renal hemodynamic impairment. After the acute damage has healed, scarring and the loss of functioning renal tissue may ensue. [20] ESWL can induce tissue damage by causing

inflammation, haemorrhage, and hemodynamic abnormalities, all of which can contribute to acute renal injury, according to reports. [14,15] To diagnose acute renal damage caused by ESWL, real-time GFR should be employed. However, this technology is not available in all parts of the region. [21]

Patients with renal impairment were recently found to have increased plasma homocysteine levels. Renal function has been demonstrated to be the most important driver of plasma tHcy levels in various investigations. [22,23] The researchers wanted to see if there was a link between plasma tHCy levels and ESWL in renal stone patients. Furthermore, any type of renal illness, whether acute or chronic, results in an increase in serum creatinine levels.[24] It's a well-known kidney injury indicator that's secreted via glomerular fitration. Any injury or inflammatory condition can produce the nonspecific marker serum hs CRP.[25,26] This prompted us to compare plasma homocysteine to other markers including serum creatinine and serum hs CRP as a measure of acute renal damage in patients undergoing ESWL for renal stone disease.

In a study done by Demir et al. [12] The researchers wanted to examine if there was a link between tHcy levels and ESWL in kidney stone patients, and if the change in homocysteine levels followed the recovery in renal dysfunction. tHcy levels increased statistically significantly from 9.4 ±1.4 to 18 ±4.8 and 11.2 ±2.1 at 2 days and 3 months, respectively, in their study. At 2 days and 3 months after ESWL, serum creatinine revealed a statistically significant increase compared to baseline. Modi et al. conducted a study that found. [27] The mean hs CRP value increased in all three groups after 48 hours of lithotripsy, i.e., Group A (no antioxidant), Group B (Vitamin E), and Group C (Vitamin C), but then gradually reduced. Mean hs CRP levels were significantly lower in Group B (Vitamin E) and Group C (Vitamin C) on days 2, 7, and 28 after lithotripsy (Student's t test, $P < 0.05$) compared to Group A. (no antioxidant). Although the difference was not statistically significant (Student's t test, $P > 0.05$), the mean hs CRP value in Group C (Vitamin C) was lower than in Group B (Vitamin E). In one study done by Moriyama et al. [28] Fifty patients who underwent cardiac surgery with cardiopulmonary bypass were separated into two groups based on AKI criteria (KDIGO criteria) in terms of postoperative outcomes: AKI group (n = 11) and non AKI group (n = 39). Demir et al. [12] found that after ESWL for renal stones, tHcy levels increased statistically significantly from 9.4 ±1.4–18 ±4.8 and 11.2± 2.1 at 2 days and 3 months, respectively. [29]

Overall, the results of this study imply that plasma tHcy and serum creatinine might be used as indicators of acute renal damage. With the aforementioned explanation serum, hs CRP can be considered a kidney damage marker, however more research is needed. The study had several limitations, including the inability to analyse long-term recovery of these indicators and renal function, as well as a smaller sample size of the study population.

Conclusion:

ESWL is a safe and effective method for treating renal stone disease, although it has the potential to produce acute renal damage. Following acute renal damage produced by ESWL, plasma, total homocysteine, and serum hs-CRP, as well as serum Creatinine, all rise markedly. As a result, in individuals with renal stone disease, plasma total homocysteine, serum hs-CRP, and serum creatinine can be employed as acute renal damage markers after ESWL.

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