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RESEARCH ARTICLE

Time-Course Effects on Kidney Function in Patients Undergoing Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy is one of the most common elective surgical procedures and is a minimally invasive technique used to treat gallbladder diseases. **Objectives:** This study aimed to evaluate the time-course effects of laparoscopic cholecystectomy on urine output and kidney function. **Methods:** Using a quasi-experimental design, 21 patients scheduled for laparoscopic cholecystectomy at Ali Ibn Abi Taleb Hospital in Zahedan (Iran) were selected. Blood samples for renal function tests were collected at three time points, and kidney function was assessed at four intervals. Data were analyzed using repeated-measures tests before and after the intervention. **Results:** The findings indicate that laparoscopic cholecystectomy did not affect urine output or kidney function in the studied patients. **Conclusions:** Although variations in BUN levels were observed during surgery, creatinine levels remained unchanged. Therefore, laparoscopic cholecystectomy appears to be a safe surgical procedure with respect to renal function. The duration of surgery did not influence renal function tests, kidney function, or urine output.

KEYWORDS: Laparoscopic Cholecystectomy, Laparoscopy, Time, kidney function.

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INTRODUCTION

The occurrence of gallstones has increased significantly. In the United States alone, about one million new cases are diagnosed each year [1]. This disease imposes an important therapeutic and economic burden on healthcare systems, even in Western countries, where 10–20% of people in European and American populations suffer from gallstones [2,3] and often present to emergency departments with acute abdominal pain [4]. In most cases, gallstone symptoms are mild or absent. However, about 25–50% of patients eventually develop complications that make cholecystectomy necessary [5]. Laparoscopic cholecystectomy is the most common surgical method used for this purpose.

Laparoscopic cholecystectomy is one of the most frequently performed abdominal surgeries and is considered the standard treatment for gallstones and cholecystitis [6]. It is a minimally invasive technique [7] designed to reduce the potential damage caused by gallbladder disease [8]. Compared with open surgery, laparoscopic cholecystectomy provides better hemostasis [9]. Thanks to its advantages—including smaller incisions, less postoperative pain, shorter hospital stays, faster recovery, earlier resumption of oral intake, and quicker return to normal activities—it has become the preferred

treatment option for most patients with gallbladder disease [10,11].

According to current evidence, approximately 0.04% of patients undergoing laparoscopic cholecystectomy develop complications [12], such as bile duct injury, acute biliary obstruction, extrahepatic bile duct rupture, gallstone spillage into the abdominal cavity, and subsequent abscess formation.

Laparoscopic surgery may also cause intraoperative physiological disturbances. Insufflation of gas into the peritoneum can lead to hemodynamic changes, including reduced cardiac output, increased systemic vascular resistance, elevated blood pressure, heart rate variability, and decreased respiratory capacity [13].

Furthermore, laparoscopic procedures may induce systemic alterations such as acid–base disturbances, changes in pulmonary and cardiovascular function, and hemodynamic fluctuations. Some studies attribute postoperative changes in liver function to impaired portal venous flow, decreased venous return, or altered intracranial pressure [14]. Reduced hepatic blood flow may not only lead to liver dysfunction but also affect the production of hepatocyte-derived proteins, including coagulation factors (PT, PTT, and INR) [15]. Several studies have reported changes in PT and PTT after

laparoscopic cholecystectomy [15,16], although evidence regarding INR remains inconclusive [16].

Laparoscopy-induced acute kidney injury (AKI) is linked to hormonal-mediated renal vasoconstriction and increased intra-abdominal pressure, which may cause hypoxemia and tubular injury. Although rare, a few cases of laparoscopy-induced AKI have been reported in young patients without previous renal disease. Surgeons should therefore consider this complication in the differential diagnosis of postoperative AKI [17].

Older patients, who are more likely to have pre-existing renal dysfunction, carry a higher risk of renal complications during laparoscopic surgery. These considerations also apply to laparoscopic procedures performed on living kidney donors. The effects of laparoscopy on renal hemodynamics—and their potential implications for postoperative kidney function—are clinically relevant [18].

METHODS

Research Design

This study was conducted using a quasi-experimental before-and-after design and a convenience sampling method for participant recruitment.

Study Population and Participants

The study population consisted of patients scheduled for laparoscopic cholecystectomy—regardless of indication—at Ali Ibn Abi Taleb Hospital in Zahedan.

A total of 21 patients were enrolled.

Inclusion and Exclusion Criteria

The inclusion criteria, based on previous studies, were: symptomatic gallstones confirmed by ultrasonography; age between 18 and 75 years; a maximum body mass index (BMI) of 40; normal baseline BUN and creatinine levels; and willingness to undergo surgery [13].

Exclusion criteria included intolerance to general anesthesia, irreversible coagulation disorders, metastatic lesions, and conversion from laparoscopic to open surgery during the procedure [19]. Patients who met any exclusion criteria were removed from the study.

Experimental Design

Before surgery, a venous catheter was inserted, and anesthesia was induced using propofol (2–3 mg/kg) and fentanyl (0.5 µg/kg) during the first 5 minutes, followed by maintenance with 200–250 µg/min of propofol. Orotracheal intubation was then performed.

Patients received Ringer's solution at 20 cc/kg. Surgery was performed using a four-port technique:

- a 10-mm umbilical port inserted first after CO₂ insufflation,
- a 10-mm xiphoid port,
- a 5-mm mid-clavicular port at the Murphy point, and
- a 5-mm mid-clavicular port near the umbilicus.

Intra-abdominal pressure was maintained at a maximum of 15 mmHg using carbon dioxide. Continuous cardiac monitoring and capnography were performed throughout the procedure.

Blood samples were collected at three time points:

Time point 1: before surgery

Time point 2: 30 minutes after CO₂ insufflation

Time point 3: 30 minutes after removal of the last port

Samples were analyzed for BUN and creatinine and transported to the laboratory under a cold chain for further evaluation [14].

The study followed standard anesthesia protocols according to the American Society of Anesthesiologists. No sex-based selection was applied. No preoperative prophylaxis was used, and there were no indications for

intraoperative administration of low-molecular-weight heparin (LMWH) or antibiotics.

Surgical Time Course

The surgical time course was measured at four points:

Time 1: induction of anesthesia

Time 2: start of CO₂ insufflation

Time 3: CO₂ evacuation

Time 4: patient extubation

Urine output was measured at all four time points.

Statistical Analysis

Data were analyzed using SPSS version 22. Repeated-measures tests and Bonferroni post-hoc analyses were performed, using a before-and-after comparison method.

Timing of Kidney Function Assessment

The relationships between Time 1 and Times 2, 3, and 4 were evaluated.

The mean duration between Time 1 and Time 4 was 98 minutes, and between Time 2 and Time 3 was 81 minutes. These intervals were compared against renal function test results and kidney function measurements.

RESULTS

Before examining the research hypotheses, the Kolmogorov–Smirnov test was used to assess the normality of the data. All variables showed a normal distribution, as the significance values were greater than 0.05. In addition, the assumption of equal variances was evaluated using Levene's test, which showed non-significant results for all variables. Therefore, the assumption of homogeneity of variances was met.

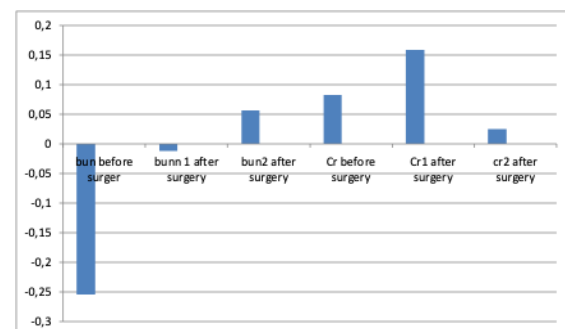


Figure 1: Time-Changes of BUN and Cr on SD ($p<0.01$)

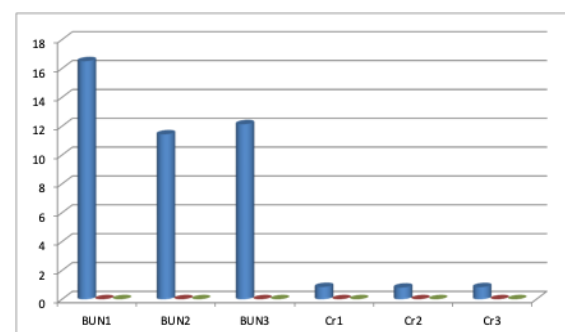


Figure 2: Changes of BUN and Cr on Mean ($p<0.01$)

Figures 1 and 2 show that BUN levels change during laparoscopic surgery, and this change is statistically significant. They also show some variation in creatinine levels, but this change is not significant.

Figure 3 indicates that there is no correlation between the total duration of surgery and renal function test results.

Figure 4 shows no correlation between the duration of surgery and BUN levels.

Figure 5 shows no correlation between the duration of surgery and creatinine levels.

The relationships among the four measured time points were also evaluated. The mean interval between Time 1 and Time 4 was 98 minutes, and the mean interval between Time 2 and Time 3 was 81 minutes. The overall timing between Time 1, Time 2, Time 3, and Time 4 was compared with coagulation test results (Figure 6).

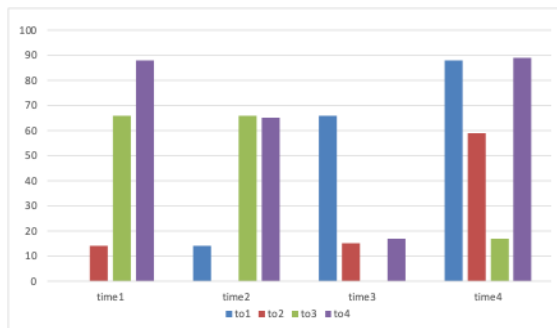


Figure3: Changes of time on Mean (minutes)

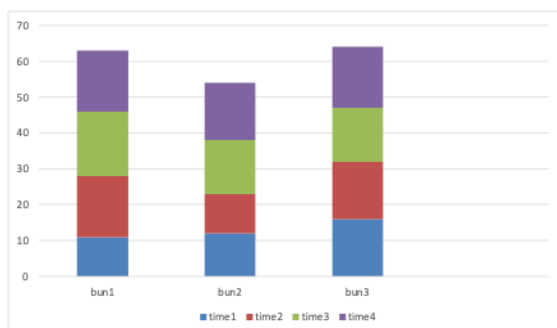


Figure 4 : Changes BUN in time on Mean (minutes) ($p < 0.01$)

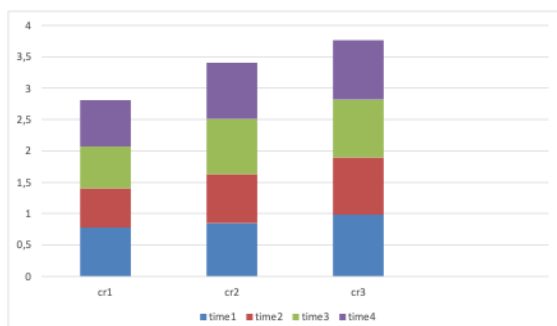


Figure 5 : Changes Cr in time on Mean (minutes) ($p < 0.01$)

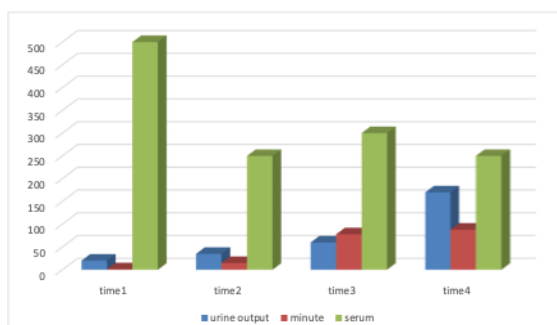


Figure 6 : Changes in urine output in certain times and relation with infusion serums (Mean) ($p < 0.01$)

The time and duration of surgery do not affect renal function tests, urine output, kidney function tests, or overall kidney function.

DISCUSSION

This study shows that laparoscopic cholecystectomy affected only BUN levels, with no significant changes

observed in creatinine. BUN variations may occur due to factors such as low-protein diet or dehydration before or during surgery.

Pneumoperitoneum during laparoscopy can cause transient oliguria, decreased glomerular filtration rate, and reduced renal blood flow. The presence of oliguria together with elevated serum creatinine may indicate acute kidney injury (AKI). Serum cystatin C has been proposed as a newer marker for detecting renal injury. Some studies have compared estimated glomerular filtration rates calculated from cystatin C with those estimated from serum creatinine in patients with normal renal function undergoing laparoscopic surgery [20].

Aside from the effects of pneumoperitoneum on portal vein flow, liver function, and related inflammatory responses, several intervening factors—including age, BMI, surgery duration, and surgical stress—may influence BUN levels. Patients with risk factors such as advanced age, obesity, or prolonged surgical wait times may have increased coagulation activation. These patients form a high-risk group susceptible to the development of deep vein thrombosis after surgery, creating the need for thromboprophylaxis. Laparoscopic surgery can activate coagulation pathways, increase β -thromboglobulin (β -TG), and alter coagulation test results.

This study had several limitations. First, we were unable to assess pancreatic and other abdominal organ function intraoperatively due to high costs. Second, postoperative organ function could not be evaluated to determine later changes. Third, all participants were female patients admitted to a single public hospital, limiting generalizability.

Although rare, laparoscopy-induced AKI may occur due to hormonal stimulation causing renal vasoconstriction and increased intra-abdominal pressure, leading to hypoxemia and tubular injury. Only a few cases of laparoscopy-induced AKI have been reported in young patients without prior renal disease. Surgeons should consider this complication in the differential diagnosis of postoperative AKI [19].

Older patients, who are more likely to have pre-existing renal dysfunction, are at increased risk of renal complications during laparoscopic surgery. The same considerations apply to laparoscopic procedures in living kidney donors. The effects of laparoscopy on renal hemodynamics and potential consequences for kidney function should be recognized by nephrologists [18]. Previous studies have also shown that laparoscopic cholecystectomy does not significantly affect coagulation or liver function tests [21]. Similarly, the duration of surgery does not appear to influence renal function tests. Current evidence suggests that laparoscopic cholecystectomy is a safe and effective procedure, although further research is needed [22].

Opioid-free anesthesia, as part of multimodal analgesia, is a safe anesthetic approach that avoids opioid-related adverse effects in patients undergoing elective laparoscopic cholecystectomy [23]. Residents' operative time improves as surgical experience increases, especially when adjusted for the seniority of the supervising assistant [24]. However, the mean hospital stay may be slightly longer in patients operated on by residents [25].

Laparoscopic cholecystectomy performed with resident participation is safe, even during the early years of training. There is an additional cost of approximately 10% when first-year residents participate, but the difference is not significant for second-year residents [26]. Resident involvement in laparoscopic cholecystectomy, even in complex cases, does not negatively affect postoperative

outcomes. Resident participation is considered ethical, safe, and reliable when performed under proper supervision within an accredited training program.

Additional procedures performed during laparoscopic cholecystectomy may increase morbidity risk [27]. In selected patients, senior residents can safely perform laparoscopic cholecystectomy under supervision [28]. Notably, resident and attending surgeons differ in the level of detail included in consent forms, with residents documenting more complications. This suggests that experience alone does not determine consent completeness; structured education regarding the purpose of consent may reduce variability [29]. Surgeons' demographics, personal experiences, and specialties also influence their teaching styles and the consent-related training residents receive [30].

Laparoscopic cholecystectomy is safe in children. Although most complications are minor, about one fifth require some form of intervention, mostly due to bleeding or biliary complications. No mortality has been reported in pediatric laparoscopic cholecystectomy [31]. Because cholelithiasis in children can lead to serious complications, delaying surgery is not recommended; laparoscopic cholecystectomy is safe in this population with low complication rates [32]. Variations in coagulation parameters during laparoscopy remain an active area of study [33].

Urinary retention is a rare complication after elective cholecystectomy. Supportive measures are often effective, and patients should be encouraged to void before catheter insertion [34]. Elective laparoscopic cholecystectomy without urinary catheterization is feasible in most patients and may reduce perioperative urinary complications [35]. Short-term bladder catheterization has been shown to accelerate recovery of spontaneous voiding and reduce urinary retention, particularly in elderly patients [36,37]. Transient bladder catheterization, based on the concept of

“qi ascending and descending movement,” may also reduce postoperative autonomic dysfunction, promote gastrointestinal recovery, and reduce anesthetic requirements [38,39].

Oliguria is infrequently recognized as a complication of laparoscopic surgery [40]. In experimental studies, animals with normal preoperative renal function did not develop AKI associated with a stable pneumoperitoneum [41].

CONCLUSION

Oliguria is infrequently viewed as a complication of laparoscopic surgery. Under the experimental conditions of this study, animals with normal preoperative renal function did not develop any form of acute kidney injury associated with a stable surgical pneumoperitoneum. Based on our findings, we believe that laparoscopic cholecystectomy is safe with respect to renal function tests, kidney function, and urine output in patients undergoing this procedure.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the [Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals of the International Committee of Medical Journal Editors](#). Indeed, all the authors have actively participated in the redaction and revision of the manuscript and provided approval for this final revised version.

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