The Role of Perioperative Parameters on Predicting Acute Kidney Injury During Laparoscopic Abdominal Surgery

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Abstract

Objective: To assess role of intra-operative parameters in order to predict acute kidney injury (AKI) following laparoscopic abdominal & pelvic surgery.

Material & Methods: This single centred cohort study was conducted at surgical floor, Fatima Memorial hospital, Lahore between May 2020 to May 2022.80 patients underwent laparoscopic abdominal or pelvic surgery. Blood samples were taken for serum creatinine estimation before surgery, 8 hours, 24 hours and 72 hours after surgery. Urine output was measured 8 hours, 24 hours and 72 hours after surgery. Similarly, operation time, insufflation time and blood loss pre-operatively were also calculated.

Results: Of the 80 patients, 23 (28.7%) developed AKI. The mean age, blood pressure, BMI, glomerular filtration rate and type of surgical procedure was identical in both AKI &non-AKI groups. Operation time, inflation time and blood loss were significantly higher in AKI group than non-AKI group ($p<0.001$).

Conclusion: AKI is a transient but common condition that can arise after any laparoscopic abdominal surgery. Operation time, inflation time and blood loss can predict AKI perioperatively.

Key words: Laparoscopic abdominal surgery, Pneumoperitoneum, Acute kidney injury

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Introduction

Since the advent of laparoscopy, abdominal surgery has been revolutionized. Its merits include smaller incision size, lesser pain postoperatively, early ambulation with faster recovery and return to routine activities and work.[1] For successful and effective laparoscopy, creation of pneumoperitoneum is first and vital step as better visualization and movement of laparoscopic instruments peroperatively is not possible without it. The commonly used gas to insufflate peritoneal cavity is carbon dioxide (Co_2). Certain physiological variations have been reported while creating pneumoperitoneum, namely the renal functions.[1] Many authors have shown conflicting reports while trying to establish relationship between CO_2 induced pneumoperitoneum and renal functional changes in animal models. Chiu and colleagues used well hydrated pigs and reported a 60% reduction in blood flow to kidney after 2 hours of CO_2 insufflation which returned to normal after desufflation.[2] Kirsch and associates showed in pigs that at a pressure of 15mmHg of pneumoperitoneum, Inferior vena cava (IVC) blood flow decreases and resultantly decreasing urine output and increasing serum creatinine.[3] On the contrary, Ali and Yavuz with associates showed that renal perfusion is preserved even after a pneumoperitoneum greater than 15mmHg.[4,5] According to Kidney Disease Improving Global Outcomes (KIDGO) criteria, AKI is defined as increase in serum creatinine ≥ 0.3mg/dl within 48 hours or urine volume < 0.5ml/kg/hour for 6 hours.[6] Data in this context is Pakistan is almost nil. No human study is available in Pakistani set up to validate these findings for laparoscopic abdominal surgery.

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Material & Methods

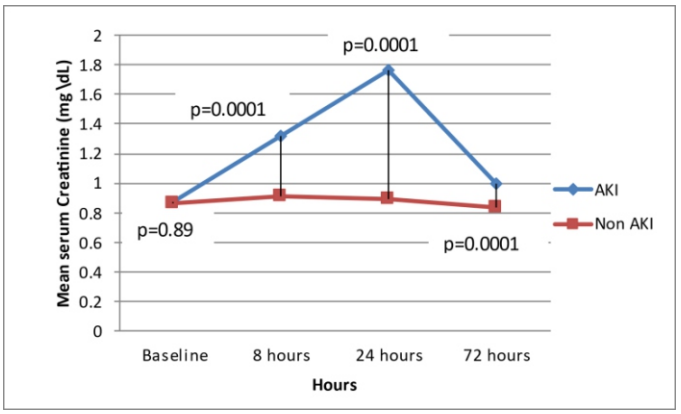
After approval from IRB, this single centred cohort study was conducted at Surgical floor, Fatima Memorial hospital, Lahore between May 2020 to May 2022. Sample size was 80. All patients above 18 years of age, with ASA status between I to III, who underwent laparoscopic abdominopelvic surgery for ≥ 2 hours were included in the study, as this time period was long enough to affect kidney physiology. Patients with pre-existing chronic kidney disease and those on NSAID therapy were excluded from the study as they could affect post-operative renal physiology. After taking informed consent, all patients underwent laparoscopic abdominal or pelvic surgery. Same anaesthetic agent with standard dose was used in all patients. Pneumoperitoneum was kept at 15 mmHg as a standard in all cases. Standard treatment was offered to all the patients post-operatively including IV fluids, IV antibiotics and analgesia. Blood samples were taken for serum creatinine estimation before surgery, 8 hours,24 hours and 72 hours after surgery. Urine output was measured 8 hours, 24 hours and 72 hours after surgery. Similarly, operation time, insufflation time and blood loss peroperatively were also calculated. All the data was recorded in structured proforma. AKI was assessed by following KIDGO criteria. Statistical analysis was performed on SPSS version 21. Descriptive statistics were computed and described as mean ± SD. Categorical variables were stated using frequency distribution. Paired samples were subjected to t test. P value of less than 0.05 was taken as significant.

Results

A total of 80 patients were included in the study who underwent laparoscopic abdominal surgery. Out of these, AKI was found in twenty-three patients postoperatively. All the patients showed both rising serum creatinine levels and falling urine output measurements postoperatively. No statistical difference was found between AKI and non-AKI groups with regards to demographic and clinical parameters of the patient as shown in table 1. The serum creatinine and urine output both started to be affected 8 hours after surgery. The serum creatinine reached its peak 24 hours after surgery. However, it started to decline and return to normal after 72 hours. Similarly, urine output declined to a minimum 24 hours after surgery but returned to normal after 72 hours of surgery. These results are shown in Fig 1 & 2. Certain intraoperative parameters were calculated and measured retrospectively and then compared in both groups to denote any one of them in diagnosing and predicting AKI postoperatively. Our results are summarised in table 2.

Table 1: *Patient demographic and clinical characteristics*

Characteristics	AKI group (N=23)	Non-AKI group (N=57)	P value
Age (in years)	43.65± 6.56	41.98± 8.77	0.413
Gender (M: F)	4: 19	16:41	0.401
BMI (kg/m²)	29.61± 6.87	28.26± 5.96	0.365
Preoperative serum creatinine (mg/dL)	0.87± 0.20	0.86± 0.21	0.891
eGFR (ml/min/m²)	87.89± 21.86	93.43± 22.09	0.312
Pulse rate (beats/min)	80.87± 7.47	76.19± 7.45	0.481
Systolic blood pressure (mmHg)	128.17± 10.03	125.28±11.85	0.306
Diastolic blood pressure (mmHg)	75.65± 7.39	76.00± 9.42	0.875
ASA status			
I	8	35	0.301
II	9	17	
III	6	5	
Type of operation			
Abdominal	11	32	0.747
pelvic	9	20	
Abdominal-pelvic	3	5	



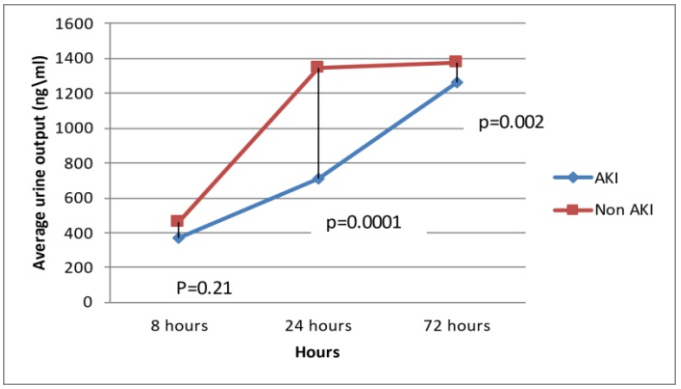


Figure 1. *Postoperative creatinine levels comparison at different time intervals*

Table 2: *Role of operativeparameters in predicting AKI*

Variable	AKI group	Non-AKI group	P value
Operation time(minutes)	191.52± 51.86	132.63±17.27	0.0001
Insufflation time(minutes)	165.22± 37.67	116.93±16.55	0.0001
Blood loss (ml)	158.04± 52.86	106.32±38.82	0.0001
Length of stay (days)	6.65± 2.12	3.05± 1.00	0.0001

Figure 2. *Postoperative urine output comparison at different time intervals*

Discussion

In recent years, laparoscopic surgery has gained popularity due to not only less operative stress response and improved clinical outcomes like length of stay in hospital, operation time, haemorrhage and analgesia requirement post-operatively, as compared to open surgical procedures.[7] Traditionally, 15mmHg was considered to be the standard intra-abdominal pressure[8]. Such pressure may disrupt biochemical and mechanical balance. The systems most affected by the raised intra-abdominal pressure are cardiovascular, pulmonary and renal systems. This fact has been proved by several published studies.[9,10] In healthy individuals, stress on these systems is well tolerated as they have good cardiopulmonary reserves. However, in an elderly or moribund patient with compromised reserve, role of laparoscopy becomes restricted. Since standardization of laparoscopy had been done, problem arises regarding the optimum pneumoperitoneum pressure maintenance. International guide lines recommend the use of "the lowest intra-abdominal pressure allowing adequate exposure of the operative field rather than a routine pressure"[11]. Recent studies show that during laparoscopic abdominal operations, better visualization and surgical manipulation is achieved by maintaining an intra-abdominal pressure of 15mmHg or more but it has the potential to compromise renal perfusion.[12]

Incidence of AKI in our study is 28.7% which is much higher than data published earlier as Sharma et al. and Abdullah et al. reported this incidence in bariatric procedures in the range of 2.3-2.9%.[13,14] It must be taken into consideration that they did not include urine output measurements in their study but we strictly followed KIDGO criteria which allowed us broader AKI detection. These previous studies also denote that patients having different types of laparoscopic abdominal surgery affect incidence of AKI. However, our results contradict this finding as our findings are also concurred by Srisawat et al. who found that different types of laparoscopic abdominal surgical procedures have no association with AKI[15]. Our study showed that operation time, CO_2 inflation time and blood loss has strong association with AKI (Table 2). It must be noted that intra-abdominal pressure was kept at a standard of 15mmHg in all these cases in both AKI and non-AKI groups. This fact correlates with previous study in pigs showing that intra-abdominal pressure higher than 20mmHg is associated with renal hypofuntioning.[16] In spite of the fact that an intra-abdominal pressure of 15 mmHg has less effect on AKI, it is strongly recommended for surgeons and anaesthesiologists to prevent prolonged CO_2 inflation by limiting its inflation time, thereby reducing risk of AKI in peri-operative period. Operation time was found to be significant in our study (p=0.0001). Shuto et al. contradict our report stating no association between operation time and AKI[16]. However, other authors concurred with our findings that an operation time of more than 210 minutes might increase of AKI from 0.8-4.4%[15]. We also found that peri-operative blood loss is also a significant indicator of AKI (p=0.0001). This finding is supported by Liu et al. who reported a strong independent relationship between peri-operative bleeding and AKI in patients undergoing cardiac bypass surgery[17]. They also reported blood transfusion to be a contributory factor in development of AKI and suggested to minimize its use to avoid AKI post-operatively. None of our patients needed blood transfusion, so this aspect of association between blood transfusion and development of AKI after laparoscopic abdominal surgery still remains to be unclear.

Conclusion

AKI is a transient but common condition that can arise after any laparoscopic abdominal surgery. Operation time, inflation time and blood loss can predict AKI perioperatively. Further studies with large randomized controlled trial using novel biomarkers for kidney injury is required to validate these findings.

Conflict of interest *None*

Funding source *None*

References

1. Srisawat N, Kongwibulwut M, Laoveeravat P, Lumplertgul N, Chatkaew P, Saeyub P, Latthaprecha K, Peerapornratana S, Tiranathanagul K, Eiam-Ong S, Tungsanga K. The role of intraoperative parameters on predicting laparoscopic abdominal surgery associated acute kidney injury. BMC nephrology. 2018 Dec;19(1):1-8.

2. Tanabalan C, Raman A, Mumtaz F. Robot-assisted partial nephrectomy: How to minimise renal ischaemia. Arab Journal of Urology. 2018 Sep 1;16(3):350-6.
3. Kopitkó C, Medve L, Gondos T, Soliman KM, Fülöp T. Mediators of Regional Kidney Perfusion during Surgical Pneumo-Peritoneum Creation and the Risk of Acute Kidney Injury—A Review of Basic Physiology. Journal of Clinical Medicine. 2022 May 12;11(10): 2728.
4. Tang Y, Li B, Ouyang W, Jiang G, Tang H, Liu X. Intraoperative Hypertension Is Associated with Postoperative Acute Kidney Injury after Laparoscopic Surgery. Journal of Personalized Medicine. 2023 Mar 17;13(3):541.
5. Aksakal D, Hückstädt T, Richter S, Klitscher D, Wowra T, Schier F, Wessel LM, Kubiak R. The effect of intermittent intraabdominal pressure elevations and low cardiac output on the femoral to carotid arterial blood pressure difference in piglets. Surgical endoscopy. 2016 Nov;30:5052-8.
6. JVaAL NL. Did KDIGO guidelines on acute kidney injury improve patient outcome. Intensive Care Med. 2017.
7. Kim JE, Min SK, Ha E, Lee D, Kim YJ, Kwak HJ. Effects of deep neuromuscular block with low pressure pneumoperitoneum on respiratory mechanics and biotrauma in a deep Trendelenburg position. Sci Rep 2021; 11(1): 1935.
8. Ortenzi M, Montori G, Sartori A, Balla A, Botteri E, Piatto G, Gallo G, Vigna S, Guerrieri M, Williams S, Podda M. Low-pressure versus standard-pressure pneumoperitoneum in laparoscopic cholecystectomy: a systematic review and meta-analysis of randomized controlled trials. Surgical Endoscopy. 2022 Oct; 36 (10): 7092-113.
9. Essber H, Cohen B, Artis AS, Leung SM, Maheshwari K, Khan MZ, Sessler DI, Turan A, Ruetzler K. Renal injury after open versus laparoscopic non-cardiac surgery: a retrospective cohort analysis. Brazilian Journal of Anesthesiology (English Edition). 2021 Jan 1;71(1): 50-7.
10. Aruparayil N, Bolton W, Mishra A, Bains L, Gnanaraj J, King R, Ensor T, King N, Jayne D, Shinkins B. Clinical effectiveness of gasless laparoscopic surgery for abdominal conditions: systematic review and meta-analysis. Surgical endoscopy. 2021 Dec; 35(12): 6427-37.
11. Sobocki J, Pędziwiatr M, Bigda J, Hołówko W, Major P, Mitura K, Myśliwiec P, Nowosad M, Obcowska-Hamerska A, Orłowski M, Proczko-Stepaniak M. The Association of Polish Surgeons (APS) clinical guidelines for the use of laparoscopy in the management of abdominal emergencies. Part I. Videosurgery and Other Miniinvasive Techniques. 2023;18(1).
12. Csaba K, Rosivall L, Medve L, Gondos T, Soliman KM, Szabo Z, et al. Pneumoperitoneum and acute kidney injury- an integrative clinical concept review. ASAIO J. 2023; 69(2): 54-65.
13. Copur S, Berkkan M, Hasbal NB, Basile C, Kanbay M. Abdominal compartment syndrome: An often overlooked cause of acute kidney injury. Journal of nephrology. 2022 Jul;35(6):1595-603.
14. Abdullah HR, Tan TP, Vaez M, Deb C, Farag N, Jackson TD, Wong DT. Predictors of perioperative acute kidney injury in obese patients undergoing laparoscopic bariatric surgery: A single centre retrospective cohort study. Obes Surg. 2016; 26: 1493-9.
15. Srisawat N, Kong wibulwut M, Laoveeravat P et al. The role of intraoperative parameters on predicting laparoscopic abdominal surgery associated acute kidney injury. BMC Nephrol. 2018;19: 1081-4.
16. Scott J, Singh A, Valverde A. Pneumoperitoneum in veterinary laparoscopy: a review. Veterinary Sciences. 2020 May 12;7(2):64.
17. Liu W, Xi Z, Gu C, Dong R, AlHelal J, Yan Z. Impact of major bleeding on the risk of acute kidney injury in patients undergoing off-pump coronary artery bypass grafting. J Thorac Dis. 2018;10(6): 3381-89.

Authors Contribution

JKL, STB: Conceptualization of Project
SM: Data Collection
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MZ, MS: Statistical Analysis
MZ, FH Drafting, Revision
FH: Writing of Manuscript