

Procalcitonin as Predictor of Bowel Injury in Penetrating Abdominal Injury

Ayad Khani Maikhan, Ali Rodan Shuwelif, Haider Salim Mihson

Department of Surgery, Al-Kindy Teaching Hospital, Baghdad, Iraq

Abstract

Background: Diagnosis of bowel injury may be considered one of the difficulties in penetrating abdominal trauma. **Aim of the Study:** The aim of this study is to estimate the predictive ability of procalcitonin in diagnosing bowel injury in multiply injured patients. **Patient and Methods:** In a cross-sectional study at the Emergency Department of Al-Kindy teaching hospital over 1 year, patients were had penetrating abdominal trauma, and measurement of procalcitonin to all participants to estimate its predictive ability. **Results:** Procalcitonin was found to be a single independent predictor of bowel perforation with sensitivity of 90.3%, specificity of 80.6%, and cutoff point of 4.5 ng/ml. **Conclusion:** Procalcitonin level of more than 4.5 ng/ml in cases of penetrating abdominal injury may be considered an aiding predictor for bowel perforation, thus shifting the treatment toward surgical intervention.

Keywords: Bowel injury, bowel perforation, penetrating abdominal trauma, procalcitonin

INTRODUCTION

Abdominal trauma is one of the most common sources of hypovolemic shock in multiply injured patients. Surgical intervention may be the result for both rapid diagnosis and to treat these patients.^[1] Bowel injury can be a preoperative diagnostic dilemma as 20% of them were missed even by initial abdominal and pelvic computed tomography scans.^[2]

Previous studies investigated the effect of (leukocyte count, C-reactive protein, interleukin, and tumor necrosis factor) as indicators of bowel injury.^[3,4] However, none of them were specific.

Procalcitonin is a 116 amino acids polypeptide prohormone. In normal conditions, a scanty amount of procalcitonin is found in plasma. Under the influence of endotoxins and interleukin and tumor necrosis factors, its rate of production can be increased to thousand times than normal. Other than the thyroid, procalcitonin is produced in many organs, including the liver, pancreas, and intestine, this production is activated in the presence of bacterial infection and downregulated by viral infection.^[5]

Previous studies showed that procalcitonin could be elevated in cases of liver or bowel injury, and its level was not affected in other intra-abdominal injuries.^[2] Investigating this biomarker

could have a role in the prediction of bowel injury in multiply injured patients.

Aim of the study

The aim of this study is to estimate the predictive ability of procalcitonin in diagnosing bowel injury in multiply injured patients.

PATIENTS AND METHODS

A cross-sectional study was conducted at the Emergency Department of Al-Kindy teaching hospital over 1 year (from April 1, 2021, to April 1, 2022). Patients included in the study were all patients suffering from penetrating abdominal injuries presented within 1 h to the hospital and indicated for abdominal surgery, while cases of blunt trauma, trauma to sites other than the abdomen, cases with chronic medical comorbidities, and chronic drug or substance users were excluded from the study.

Address for correspondence: Dr. Ali Rodan Shuwelif,
Al-Kindy Teaching Hospital, Baghdad, Iraq.
E-mail: ali_rawdhan_farttoosi@yahoo.com

Submitted: 16-Sep-2022 Revised: 23-Oct-2022 Accepted: 15-Nov-2022 Published: 02-Jan-2023

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Maikhan AK, Shuwelif AR, Mihson HS. Procalcitonin as predictor of bowel injury in penetrating abdominal injury. *Mustansiriyah Med J* 2022;21:192-5.

Access this article online

Quick Response Code:



Website:
<http://www.mmjonline.org>

DOI:
10.4103/mj.mj_47_22

After the application of the ATLS protocol, the research data were collected. These data include patient age, gender, duration of the referral to the hospital, vital signs, and all cases indicated for laparotomy, and 5 mL of blood drawn for measurement of procalcitonin. Blood was kept in EDTA tube and centrifuged for a quarter of an hour and the serum was separated and frozen to be transferred to a private laboratory for measurement after thawing using an ELISA kit (RayBio® Human Procalcitonin catalog number ELH-PROCALC) and Cobas e 411 immunoassay analyzers (Roche, Germany). After a few minutes, the result could be interpreted as normal if it is <0.05 ng/mL (as a reference range provided by the manufacturer).

After the surgery reporting the operative finding as (bowel injury and other types of injury).

Statistical analysis was done by the Statistical Package for the Social Sciences (SPSS) software (IBM company, Illinois, USA), and data were presented as mean, standard deviation, counts, and percentage. $P < 0.05$ was considered statistically significant. Tests of significance used were Chi-square for categorical data, Student's *t*-test for continuous variables, predictive ability, cutoff point, and the area under the curve calculated using the receiver operator characteristic curve. Sensitivity (SN), specificity (SP), positive predictive value, negative predictive value, accuracy, and relative risk were calculated according to the estimated cutoff point.

RESULTS

Sixty-seven cases suffered from penetrating abdominal trauma were admitted for laparotomy. Thirty-one (46.3%)

cases had bowel injuries, and 36 (53.7%) cases had no bowel injuries.

The two groups were not different in regard to demographical data, type of insult (bullet or stab wound), and associated injuries found in both groups and again no difference in the associated organ injury and bowel injury was found. Higher mean procalcitonin level was found in cases with bowel injury (mean 6.55) than those without such type of injury (mean 1.77). this difference was statically significant, as shown in Table 1.

After the application of binary logistic regression analysis, it was found that procalcitonin level is the single independent predictor for bowel injury as shown in Table 2.

The receiver operating characteristic curve analysis [Figure 1] showed that the above 4.5 ng/ml level of procalcitonin, the SN was 90.3% and SP was 80.6% as explained in Table 3.

DISCUSSION

Around 20% of all war injuries are abdominal, Bowel injury (BI) was common in the majority of those injuries.^[6] In this study, the most common gender involved in penetrating abdominal injury was male, as found by Oosthuizen *et al.*^[7] The mean age of the patients was similar in regard to the bowel injury, these similarities in age and gender enhance the homogeneity of the data collected thus eliminating its effect on the rest of the variables. Twenty-five (37.3%) cases required blood transfusion yet this result was not a predictor of bowel injury, Hanna *et al.*^[8] found that 38% of cases of bullet injuries require blood transfusion and 24% of all penetrating abdominal trauma require blood transfusion. The rate of intensive care unit

Table 1: Distribution of data

Variables	No bowel injury, <i>n</i> (%)	Bowel injury, <i>n</i> (%)	Total, <i>n</i> (%)	<i>P</i>
Gender				
Male	33 (91.7)	29 (93.5)	62 (92.5)	0.770
Female	3 (8.3)	2 (6.5)	5 (7.5)	
Age, mean±SD	27.58±6.26	28.06±7	27.80±6.57	0.362
Recruitment of blood product				
No	21 (58.3)	21 (67.7)	42 (62.7)	0.427
Yes	15 (41.7)	10 (32.3)	25 (37.3)	
ICU admission				
No	29 (80.6)	23 (74.2)	52 (77.6)	0.533
Yes	7 (19.4)	8 (25.8)	15 (22.4)	
Type of trauma				
Bullet injury	28 (77.8)	22 (71.0)	50 (74.6)	0.523
Stab wound	8 (22.2)	9 (29.0)	17 (25.4)	
Associated injuries				
Muscle or omentum	11 (30.6)	14 (45.2)	25 (37.3)	0.317
Liver	14 (38.9)	8 (25.8)	22 (32.8)	
Spleen	3 (8.3)	0	3 (4.5)	
Kidney	2 (5.6)	2 (6.5)	4 (6.0)	
Retroperitoneal	6 (16.7)	7 (22.6)	13 (19.4)	
Procalcitonin, mean±SD	1.77±2.05	6.55±2.2	3.98±3.19	<0.0001

SD: Standard deviation, ICU: Intensive care unit

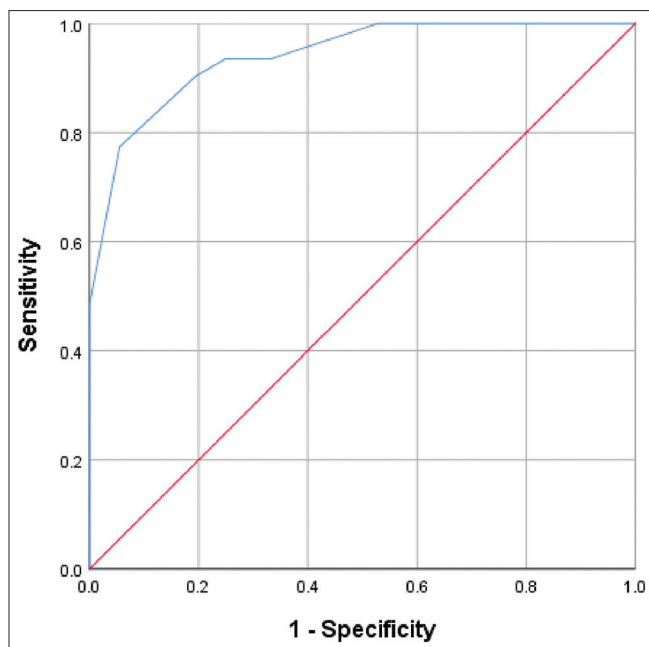


Figure 1: Procalcitonin ROC curve analysis. ROC: Receiver operating characteristic

admission was 22.4% for overnight observation. Fifty (74.6%) cases had bullet injury, and no significant difference was found in regard to bowel injury, whereas Cardi *et al.*^[6] ($n = 953$) found that bullet injury more associated with bowel injury than stab wound, this difference may be attributed to the small sample size in the current study that makes room for type II error. The liver was the most common solid organ involved (32.8%), Jeroukhimov *et al.*^[9] also found that the next to bowel injury is liver injury with rate of 8.4%. The current study showed that procalcitonin level was the single independent predictor for bowel injury with high SN and SP at a cutoff point of 4.5 ng/ml. This high SP could be explained by the role of the intestinal in the production of procalcitonin in the face of inflammation associated with bowel injury, on the other hand, intraperitoneal organs (other than the liver), had no role in the production of procalcitonin (as found in the study conducted by Xu *et al.*^[10]). Cosse *et al.*^[11] found that cutoff point of 2.47 ng/ml was associated with 76.3% SN and 84.2% SP these differences may be attributed to the difference in the study population as in their study they investigated the role of procalcitonin in bowel ischemia, these results highlight the association of procalcitonin with bowel injury (ischemic in addition to perforation). While Feng *et al.*^[12] in their study on cases of perforated appendicitis found that PCT more than 0.46 ng/mL was associated with 93% SN and SP. These differences in the cutoff point may be attributed to the minimal bowel content that spilled in the peritoneal cavity in cases of appendicitis in comparison to penetrating bowel injury, as procalcitonin is marker of the severity of infection as stated by Mahuli *et al.*^[13] who investigated the role of procalcitonin in abdominal sepsis.

Table 2: Binary logistic regression analysis

Variable	B	P
Age	-0.023	0.715
Procalcitonin	181.005	0.001
Gender	2.902	0.395
Blood	0.314	0.669
ICU	-0.681	0.457
Type of trauma	-1.695	0.056
Duration	-0.021	0.470
Associated injuries	-0.472	0.903

ICU: Intensive care unit

Table 3: Predictive ability of procalcitonin

Predictor	Level
Cutoff point (ng/mL)	4.5
AUC (95% CI)	0.941 (0.889-0.993)
SN (%)	90.3
SP (%)	80.6
PPV (%)	80
NPV (%)	90.6
Acc (%)	85
RR (95% CI)	4.64 (2.36-9.12)

CI: Confidence interval, SN: Sensitivity, SP: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, Acc: Accuracy, RR: Relative risk, AUC: Area under the curve

CONCLUSION

A procalcitonin level of more than 4.5 ng/ml in cases of penetrating abdominal injury may be considered an aiding predictor for bowel perforation, thus shifting the treatment toward surgical intervention.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Khan M. Abdominal trauma. In: Khan M, McMonagle M, editors. Trauma: Code Red. 1st ed. Boca Raton, Florida, USA: CRC Press; 2019. p. 189-232.
- Smyth L, Bendinelli C, Lee N, Reeds MG, Loh EJ, Amico F, *et al.* WSES guidelines on blunt and penetrating bowel injury: Diagnosis, investigations, and treatment. World J Emerg Surg 2022;17:13.
- Zingg T, Agri F, Bourgeat M, Yersin B, Romain B, Schmidt S, *et al.* Avoiding delayed diagnosis of significant blunt bowel and mesenteric injuries: Can a scoring tool make the difference? A 7-year retrospective cohort study. Injury 2018;49:33-41.
- Thiele JR, Zeller J, Kiefer J, Braig D, Kreuzaler S, Lenz Y, *et al.* A conformational change in C-reactive protein enhances leukocyte recruitment and reactive oxygen species generation in ischemia/reperfusion injury. Front Immunol 2018;9:675.
- Vijayan AL, Vanimaya RS, Saikant R, Lakshmi S, Kartik R. Procalcitonin: A promising diagnostic marker for sepsis and antibiotic therapy. J Intensive Care. 2017;5:51.
- Cardi M, Ibrahim K, Alizai SW, Mohammad H, Garatti M, Rainone A, *et al.* Injury patterns and causes of death in 953 patients with penetrating abdominal war wounds in a civilian independent non-governmental

- organization hospital in Lashkargah, Afghanistan. *World J Emerg Surg* 2019;14:51.
7. Oosthuizen GV, Kloppe J, Buitendag J, Variawa S, Čačala SR, Kong VY, *et al.* Penetrating colon trauma-the effect of concomitant small bowel injury on outcome. *Injury* 2022;53:1615-9.
 8. Hanna K, Asmar S, Dittillo M, Chehab M, Khurram M, Bible L, *et al.* Readmission with major abdominal complications after penetrating abdominal trauma. *J Surg Res* 2021;257:69-78.
 9. Jeroukhimov I, Wiser I, HersHKovitz Y, Shapira Z, Peleg K, Alfici R, *et al.* Frequency of intra-abdominal organ injury is higher in patients with concomitant stab wounds to other anatomical areas. *BMC Emerg Med* 2018;18:18.
 10. Xu HG, Tian M, Pan SY. Clinical utility of procalcitonin and its association with pathogenic microorganisms. *Crit Rev Clin Lab Sci* 2022;59:93-111.
 11. Cosse C, Sabbagh C, Browet F, Mauvais F, Rebibo L, Zogheib E, *et al.* Serum value of procalcitonin as a marker of intestinal damages: Type, extension, and prognosis. *Surg Endosc* 2015;29:3132-9.
 12. Feng S, Lai XH, Lou Y, Liu W. Diagnostic value of procalcitonin and C-reactive protein level for predicting appendiceal perforation in children. *HK J Paediatr (New Series)* 2021;26:3-7.
 13. Mahuli K, Mahakalkar C, Yeola M. Diagnostic utility of procalcitonin and Crp in the detection of bacterial infection in patients of abdominal sepsis. *Ann Roman Soc Cell Biol* 2021;25:3339-45. Available from: URL: <https://www.hkjpaed.org/details.asp?id=1315&show=1234>. [Last accessed on 2022 Aug 20].