https://doi.org/10.47108/jidhealth.Vol7.Iss6.366
Jaber AMT, Journal of Ideas in Health (2024); 7(6):1174-1180
Journal of Ideas in Health

Assessing knowledge and readiness of senior medical students in diagnosing appendicitis, Iraq

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Abstract

Background: Acute appendicitis, a common atraumatic surgical emergency, peaks in the second and third decades but can affect individuals of all ages. This study aims to evaluate the knowledge and preparedness of senior medical students in accurately diagnosing appendicitis.

Methods: A cross-sectional study was conducted from February to May 2024, targeting final-year medical students at the Faculty of Medicine, University of Diyala, Iraq. Using a universal sampling approach, a semi-structured questionnaire was employed, covering socio-demographic data and 30 questions assessing appendicitis knowledge and preparedness. Data were analyzed with SPSS version 21.0, applying descriptive statistics, with statistical significance set at $P < 0.05$.

Results: The study surveyed 119 senior medical students on demographics, appendicitis knowledge, risk factors, and diagnostic methods. Most participants were female (73.9%), single (83.2%), and had completed a General Surgery course (75.6%). Knowledge of appendicitis was high, with 86.6% recognizing it as appendix inflammation and 78.2% understanding perforated appendicitis. Clinical exposure was limited, with only 41.2% encountering appendicitis cases. Surgical treatment was preferred (94.9%), with laparoscopic appendectomy slightly favored (54.6%). Common symptoms like pain localization and digestive issues were well-recognized, but awareness of risk factors like diabetes (42.8%) and obesity (59.7%) varied. CT scans (74%) and ultrasound (63.1%) were considered the most effective diagnostic methods, while MRI received mixed responses (27.7% agreement).

Conclusion: This study emphasizes the need for enhanced clinical exposure, focused training on atypical presentations, education on risk factors and less common complications, and improved understanding of supportive diagnostic tests to strengthen medical students' diagnostic and procedural readiness for appendicitis.

Keywords: Appendicitis, Emergency, Medical Students, Inflammation, Iraq

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How to cite: Jaber A. Assessing knowledge and readiness of senior medical students in diagnosing appendicitis. J Ideas Health. 2024 Dec. 31;7(6): 1174-1180
doi: 10.47108/jidhealth.Vol7.Iss6.366

Article Info: (**Original Research**)
Received: 22 August 2024
Revised: 19 September 2024
Accepted: 30 September 2024
Published: 31 December 2024

Journal Home page: https://www.jidhealth.com

e ISSN: 2645-9248

Background

The risk of infection with appendicitis ranges between 9 % for males and 7 % for female, which makes high preparation for appendicitis to be managed by surgical intervention a priority for both doctors and surgeons [1,2]. The mortality rate associated with appendectomy is remarkably low, ranging from 0.07% to 0.7%. However, postoperative complications are significantly more common, occurring in approximately 10% to 19% of cases with uncomplicated acute appendicitis and increasing to around 30% in cases of complicated acute appendicitis. These figures highlight the relative safety of the procedure but also underscore the potential for adverse outcomes, particularly in more severe cases [3]. Acute appendicitis represents one of the most frequent causes of sudden abdominal pain in both adults and children presenting to emergency departments [4]. The standard treatment involves surgical removal of the appendix, a procedure known as an appendectomy. This operation can be performed using either the traditional open surgery method or a minimally invasive laparoscopic approach [5]. Every surgical procedure carries inherent risks that may arise either during the operation or in the postoperative period. These complications can vary in duration, ranging from short-term issues to more prolonged challenges [6]. Recent research [7] has highlighted the benefits of laparoscopic appendectomy, noting its lower complication rates compared to open surgery. Findings suggest that laparoscopic techniques are associated with reduced mortality, morbidity, and shorter hospital stays. However, distinguishing between uncomplicated

and complicated appendicitis remains crucial for tailoring management strategies and anticipating potential complications effectively [8]. Uncomplicated acute appendicitis refers to inflammation of the appendix without evidence of perforation, while complicated appendicitis involves tissue necrosis, which may progress to perforation. Treatment for uncomplicated cases typically involves appendectomy, considered the most effective approach, or antibiotic therapy as an alternative [9]. On the other hand, surgical intervention is often necessary for managing complicated appendicitis [10]. Recent research has indicated that appendectomy can be performed as an outpatient procedure, although the traditional approach remains the standard treatment for acute appendicitis [11,12,13]. The exact cause of acute appendicitis remains uncertain and is a topic of ongoing debate. One serious complication associated with the condition is the obstruction of the appendiceal lumen, which can lead to increased pressure within the lumen. This elevated pressure may result in transmural necrosis of the appendiceal tissue. Following tissue necrosis, bacterial invasion typically occurs, culminating in inflammation of the appendix [14]. Research conducted by Chen et al. [15] indicates that postponing appendectomy in cases of acute appendicitis poses significant risks, including a higher likelihood of postoperative complications and prolonged hospital stays. Conversely, some studies recommend a more conservative approach, questioning the urgency of immediate surgery. According to the same research, advanced age (over 55 years) was identified as a critical risk factor for perforation and a predictor of postoperative complications. Furthermore, delayed surgery (beyond 24 hours) was associated with extended hospitalization, leading to increased healthcare costs for patients due to prolonged recovery periods [16]. Inadequate diagnosis of appendicitis can result in delayed treatment, significantly increasing the risk of complications [15]. One of the primary challenges in early diagnosis lies in patient-related factors, such as delayed medical consultation or insufficient knowledge about the condition, often stemming from a lack of public awareness [16]. While limited research has focused on the postoperative complications of appendectomy, further investigation into this area is warranted. This study, therefore, aims to evaluate the knowledge and readiness of senior medical students in diagnosing appendicitis within the Iraqi community.

Methods

Study design

A cross-sectional study was conducted from February 1 to May 31, 2024, using a universal sampling approach. The study targeted senior medical students enrolled in their final year at the Faculty of Medicine, University of Diyala, Iraq.

Sample size

The required sample size was calculated assuming a knowledge rate of 50%, with a ±7% margin of error, a 90% confidence level, and a 10% non-response rate. Using the formula $N = [Za^2 \times P \times Q / (M.E.)^2]$, a sample of 152 students (138 + 14 for non-response) was determined.

Inclusion and exclusion criteria

Participants included all final-year medical students of both genders who were present during the study period and willing to participate. Students from other academic years were excluded.

Data Collection Instrument

The study utilized a semi-structured questionnaire consisting of two sections. The first section focused on gathering information about socio-demographic characteristics and appendicitis-related details. The second section comprised 30 questions aimed at evaluating the students' knowledge and preparedness regarding appendicitis.

Statistical analysis

Data analysis was performed using SPSS Statistics for Windows, version 21.0 (IBM Corp, Armonk, New York). Statistical significance was set at $P < 0.05$. Descriptive statistics (mean, median, and standard deviation for numerical variables; frequencies and percentages for categorical variables) were calculated.

Results

Table 1 summarizes the demographic characteristics and clinical knowledge related to appendicitis among 119 medical students completed the questionnaire successfully. The mean age of the participants was 24.7 years (SD ± 5.6), with ages ranging between 24 and 28 years. The majority of the respondents were female (88, 73.9%), while males accounted for 31 (26.1%). Regarding marital status, most were single, divorced, or widowed (99, 83.2%), with only 20 (16.8%) being married. When asked about completing the General Surgery course, 90 (75.6%) indicated they had finished it, while 29 (24.4%) had not. Awareness of appendicitis as an inflammation of the appendix was high, with 103 (86.6%) responding correctly. Similarly, 93 (78.2%) correctly identified perforated appendicitis as acute peritoneal inflammation caused by infection. Regarding clinical experience, 49 (41.2%) reported having encountered a patient diagnosed with appendicitis, while 70 (58.8%) had not. Most participants (113, 94.9%) favored surgical treatment in the acute phase of appendicitis, with laparoscopic appendectomy (65, 54.6%) being slightly more preferred than open appendectomy (54, 45.4%). Table 2 presents an overview of students' knowledge and readiness concerning the clinical presentation of appendicitis symptoms. The responses reveal a mix of awareness and uncertainty among participants. A significant number of students (63, 52.9%) did not believe acute appendicitis could present without clear clinical symptoms, while 47 (39.5%) agreed that it could, and 9 (7.6%) were unsure. Most students (83, 69.8%) recognized that pain associated with appendicitis might feel dull or nonspecific, while 25 (21.0%) disagreed. Regarding pain localization, 93 (78.1%) correctly identified that appendicitis pain often begins in the epigastric or umbilical region, eventually shifting to the lower right abdomen, as noted by 110 (92.4%). Similarly, 95 (79.8%) acknowledged that pain may radiate internally or follow a visceral pattern. In pregnant individuals, 88 (73.9%) understood that pain location differs due to anatomical changes, although 22 (18.5%) were unsure. A connection between suprapubic pain and urination or defecation discomfort was identified by 45 (37.8%), with 43 (36.1%) expressing uncertainty. Digestive symptoms such as nausea, vomiting, and loss of appetite were well-recognized, with 105 (88.2%) identifying these as typical symptoms and 91 (76.5%) linking appetite loss to appendicitis. Most (79, 66.4%) also highlighted abdominal pain as a key symptom.

Table 1: The medical students' demographics and clinical features (n=119)

Variables	Categories	N (%)
Age	Mean ± SD)	24.7 (± 5.6) years
	Range:	24-28 years
Gender	Male	31(26.1)
	Female	88(73.9)
Marital status	Married	20(16.8)
	Single, divorce, widow	99(83.2)
Have you finished the General Surgery course?	Yes	90(75.6)
	No	29(24.4)
Appendicitis means inflammation of the appendix	Yes	103(86.6)
	No	16(13.4)
Perforated appendicitis is an acute inflammation of the peritoneum secondary to infection of the appendix	Yes	93(78.2)
	No	26(21.8)
Have you ever encountered a patient diagnosed with appendicitis?	Yes	49(41.2)
	No	70(58.8)
Which of the following treatments is suggested in the acute phase?	Medical	6 (5.1)
	Surgical	113 (94.9)
Which surgical procedure do you favorite?	Open appendectomy	54(45.4)
	Laparoscopic appendectomy	65(54.6)

Table 2: Students' knowledge and readiness regarding appendicitis symptoms

Questions	**Yes**	**No**	**I don't know**
Does acute appendicitis sometimes present without clear clinical symptoms?	47 (39.5)	63 (52.9)	9 (7.6)
Could the pain associated with appendicitis feel dull or nonspecific in nature?	83 (69.8)	25 (21.0)	11 (9.2)
Is the pain initially perceived as originating in the epigastric region or near the umbilicus?	93(78.1)	19 (16.0)	7 (5.9)
Does the pain eventually shift to the lower right side of the abdomen?	110 (92.4)	7 (5.9)	2 (1.7)
Does the pain radiate internally or follow a visceral pattern?	95 (79.8)	22 (18.5)	2 (1.7)
In pregnant individuals, does the location of the pain differ due to anatomical changes?	88 (73.9)	9 (7.6)	22 (18.5)
Do you think there is a link between suprapubic pain and discomfort experienced during urination or defecation?	45 (37.8)	31 (26.1)	43 (36.1)
Is abdominal pain commonly described as a key symptom by patients with appendicitis?	79 (66.4)	37 (31.1)	3 (2.5)
Are digestive issues such as nausea, vomiting, indigestion, or abdominal discomfort typical symptoms of appendicitis?	105 (88.2)	8 (6.7)	6 (5.1)
Is loss of appetite frequently associated with appendicitis?	91 (76.5)	11 (9.2)	17 (14.3)

Table 3 provides insight into students' knowledge and perceptions of various risk factors associated with appendicitis. The responses demonstrate varying levels of awareness and uncertainty. A majority of students (81, 68.1%) disagreed that advancing age increases the likelihood of infection, while only 15 (12.6%) agreed, and 23 (19.3%) were unsure. When asked about the influence of personal or family history of surgical conditions on risk, 39 (32.8%) believed it to be a factor, while 63 (52.9%) disagreed, and 17 (14.3%) were uncertain. Regarding lifestyle-related risk factors, only 29 (24.4%) agreed that smoking elevates the risk of infections, while 57 (47.9%) disagreed, and 33 (27.7%) were unsure. However, a larger proportion (51, 42.8%) recognized diabetes as a risk factor, though 35 (29.4%) were uncertain. Obesity was more commonly identified as a contributing factor, with 71 (59.7%) agreeing. Similarly, 57 (47.9%) noted that children under ten may be more susceptible to infections, though 21 (17.7%) were unsure. Lastly, responses were mixed on whether gender plays a role in appendicitis risk: 43 (36.1%) disagreed, 30 (25.2%) agreed, and 46 (38.7%) were unsure.

Table 3: Students' knowledge and readiness regarding risk factors for appendicitis

Questions	**Yes**	**No**	**I don't know**
Does the likelihood of infection increase with advancing age?	15 (12.6)	81 (68.1)	23 (19.3)
Can a personal or family history of surgical conditions contribute to the risk?	39 (32.8)	63 (52.9)	17 (14.3)
Does smoking elevate the risk of developing infections?	29 (24.4)	57 (47.9)	33 (27.7)
Is diabetes associated with a heightened risk of infection?	51 (42.8)	33 (27.7)	35 (29.4)
Could obesity be a contributing factor to infection risk?	71 (59.7)	38 (31.9)	10 (8.4)
Are children under the age of ten more susceptible to such infections?	57 (47.9)	41 (34.4)	21 (17.7)
Does gender play a role in the likelihood of developing appendicitis?	30 (25.2)	43 (36.1)	46 (38.7)

Table 4 outlines the students' opinions regarding the effectiveness of various diagnostic investigation methods for appendicitis, rated on a five-point scale from "Strongly disagree" to "Strongly agree." Evaluation of white blood cell (WBC) levels was recognized as effective by 52 students (43.7%) who agreed or strongly agreed, while 30 (25.2%) disagreed or strongly disagreed. For neutrophil levels, 52 (43.7%) also agreed or strongly agreed, while 38 (31.9%) disagreed or strongly disagreed. Most students (74, 62.3%) disagreed or strongly disagreed with the General Urine Exam's effectiveness, while only 24 (20.1%) agreed or strongly agreed. Opinions were mixed about abdominal radiography, with 45 (37.8%) disagreeing or strongly disagreeing, and 39 (32.8%) agreeing or strongly agreeing. Ultrasound (Echo) was considered effective by 75 students (63.1%) who agreed or strongly agreed. CT scan is widely regarded as effective, with 88 students (74%) agreeing or strongly agreeing. Views about MRI were divided, with only 33 (27.7%) agreeing or strongly agreeing, and 54 (45.4%) disagreeing or strongly disagreeing. Overall, CT scans and ultrasound were the most favored diagnostic methods among the students.

Table 4: Knowledge about the most effective investigation methods to diagnose appendicitis (n=119)

Investigation methods	**Strongly disagree**	**disagree**	**N**	**Agree**	**Strongly agree**
Blood test: evaluation of white blood cell (WBC) levels	11 (9.2)	19 (16.0)	37 (31.1)	25 (21.0)	27 (22.7)
Blood test: assessment of neutrophil levels	13 (10.9)	25 (21.0)	29 (24.4)	37 (31.1)	15 (12.6)
General Urine Exam	42 (35.4)	32 (26.9)	21 (17.6)	13 (10.9)	11 (9.2)
Imaging: abdominal radiography	28 (23.5)	27 (22.7)	25 (21.0)	17 (14.3)	22 (18.5)
Ultrasound examination, Echo	7 (5.9)	16 (13.4)	21 (17.6)	42 (35.4)	33(27.7)
Computed Tomography (CT) scan	4 (3.3)	9 (7.6)	18 (15.1)	36 (30.3)	52 (43.7)
Magnetic Resonance Imaging (MRI)	25 (21.0)	29 (24.4))	32 (26.9)	19 (16.0)	14 (11.7)

Table 5 highlights students' awareness of complications that can arise before and after surgery for appendicitis. Considering the Pre-Surgical Complications, Visceral Perforation was Recognized by 99 (83.2%) as a possible complication, while 14 (11.7%) disagreed, and 6 (5.1%) were unsure. Most students (109, 91.6%) identified Peritonitis as a likely complication, with only 8 (6.7%) disagreeing and 2 (1.7%) uncertain. Awareness was high about the Appendicular Abscess, with 108 (90.8%) agreeing, 7 (5.9%) disagreeing, and 4 (3.3%) unsure. Regarding the Post-Surgical Complications, Bleeding was identified by 101 (84.9%) as a potential complication, with 16 (13.4%) disagreeing and 2 (1.7%) unsure. Almost all students (112, 94.1%) recognized Wound Infection as a risk, while 6 (5.1%) disagreed and 1 (0.8%) was uncertain. Awareness about Urinary Retention was divided, with 46 (38.7%) agreeing, 30 (25.2%) disagreeing, and 43 (36.1%) unsure. Intraperitoneal Abscess was Identified by 95 (79.8%), with 19 (16.0%) disagreeing and 5 (4.2%) unsure. Fistulas was Recognized by 88 (73.9%) as a complication, while 21 (17.6%) disagreed and 10 (8.4%) were uncertain. Intestinal Obstruction and Adhesions Noted by 105 (88.2%) as a possible risk, with only 8 (6.7%) disagreeing and 6 (5.1%) unsure. Overall, students demonstrated strong knowledge of most complications, particularly peritonitis, wound infections, and appendicular abscess, with slightly less awareness of urinary retention.

Table 5: Students' knowledge and readiness about possible complications of pre and postoperative appendicitis

Possible complications	Categories	Yes	No	I don't know
Before surgery	Visceral perforation	99 (83.2)	14 (11.7)	6 (5.1)
	Peritonitis	109 (91.6)	8 (6.7)	2 (1.7)
	Appendicular abscess	108 (90.8)	7 (5.9)	4 (3.3)
After surgery		Yes	No	I don't know
	Bleeding	101 (84.9)	16 (13.4)	2 (1.7)
	Infection of the wound	112 (94.1)	6 (5.1)	1 (0.8)
	Urinary retention	46 (38.7)	30 (25.2)	43 (36.1)
	Intraperitoneal abscess	95 (79.8)	19 (16.0)	5 (4.2)
	Fistulas	88 (73.9)	21 (17.6)	10 (8.4)
	Intestinal obstruction and adhesions	105 (88.2%)	8 (6.7)	6 (5.1)

Discussion

The demographic characteristics and clinical knowledge outlined in Table 1 align with trends observed in medical education research. The predominance of female participants (73.9%) reflects the increasing enrollment of women in medical schools globally, particularly in developing regions [17,18,19]. The high awareness of appendicitis (86.6%) and perforated appendicitis (78.2%) among students aligns with studies emphasizing the importance of theoretical teaching in medical curricula [20]. However, only 41.2% of participants reported clinical exposure to patients with appendicitis, indicating a potential gap in hands-on training, a concern echoed in other studies advocating for improved clinical rotations [21]. The strong preference for surgical management (94.9%) is consistent with established guidelines recommending appendectomy as the primary treatment [22,23]. Notably, laparoscopic appendectomy was

slightly favored (54.6%), reflecting its growing preference due to reduced recovery time and complications [24]. The findings from Table 2 indicate varying levels of knowledge among students about the clinical presentation of appendicitis, with some gaps aligning with trends reported in other research. Most students recognized key symptoms like pain migrating to the lower right abdomen (92.4%) and digestive symptoms such as nausea and vomiting (88.2%), reflecting alignment with established diagnostic criteria [25]. However, uncertainty about atypical presentations—such as appendicitis without clear clinical symptoms (39.5% agreed, 7.6% unsure)—is consistent with literature emphasizing diagnostic challenges in atypical or early cases [26]. The high acknowledgment of pain's visceral nature (79.8%) and its anatomical shift during pregnancy (73.9%) aligns with advanced understanding reported among medical students [27]. However, only 37.8% linked suprapubic pain to urination or defecation discomfort, a less commonly recognized association. The findings in Table 3 reveal variability in students' understanding of appendicitis risk factors, with some misconceptions and knowledge gaps. For example, 68.1% correctly disagreed with advancing age as a risk factor, consistent with research indicating appendicitis is more common in younger individuals, particularly those aged 10–30 [25]. Awareness of obesity as a contributing factor was higher (59.7%), aligning with studies showing increased intra-abdominal pressure and inflammation associated with obesity [28]. The recognition of diabetes (42.8%) and smoking (24.4%) as risk factors, though less robust, is supported by literature highlighting systemic inflammation and impaired immune responses associated with these conditions [26]. However, uncertainty about gender's role (38.7%) reflects the ongoing debate, as evidence suggests a slightly higher prevalence in males but no definitive gender-based predisposition [29]. The results in Table 4 highlight students' varying opinions regarding the effectiveness of different diagnostic methods for appendicitis, with a clear preference for CT scans and ultrasound. CT scans were deemed highly effective, with 74% agreeing or strongly agreeing, consistent with established literature citing its superior sensitivity and specificity in diagnosing appendicitis [30]. Similarly, 63.1% of students favored ultrasound, which aligns with its recognized utility as a first-line diagnostic tool, especially in pediatric and pregnant patients [31]. Conversely, blood tests assessing white blood cells (WBC) and neutrophil levels received mixed support, with only 43.7% endorsing them as effective. While these tests are helpful in identifying inflammatory markers, they are less specific for appendicitis diagnosis [32]. The low endorsement of the General Urine Exam reflects its limited diagnostic value. MRI's divided opinion among students mirrors its restricted application, primarily for special populations like pregnant women. Although it is not typically considered a first-line imaging modality for appendicitis, some studies report that its diagnostic accuracy is comparable to that of computed tomography (CT) scans [33]. The results in Table 5 reflect students' strong awareness of major pre- and post-surgical complications associated with appendicitis, aligning with findings in existing literature. High recognition of pre-surgical complications, such as peritonitis (91.6%), appendicular abscess (90.8%), and visceral perforation (83.2%), is consistent with well-documented risks in untreated or delayed cases of appendicitis. Peritonitis and appendicular abscesses are known to significantly increase morbidity if surgical intervention is delayed [25]. Post-surgical complications, particularly wound infections (94.1%), bleeding (84.9%), and intestinal adhesions (88.2%), were also well-recognized. These are commonly reported in the literature, with wound infections being a frequent issue, particularly in open appendectomies compared to laparoscopic procedures [34]. However, awareness of urinary retention was lower (38.7%), reflecting the less common yet documented occurrence of this complication, typically linked to anesthesia or postoperative immobility.

Conclusion

The study assessed medical students' knowledge, clinical readiness, and perceptions regarding appendicitis, highlighting key findings across demographic characteristics, symptom recognition, risk factors, diagnostic methods, and complications. The majority of participants demonstrated a solid foundational understanding of appendicitis, with 86.6% identifying it as inflammation of the appendix and 94.9% favoring surgical intervention. However, gaps emerged, especially in recognizing atypical presentations and lesser-known complications, such as urinary retention and fistulas. Students showed strong awareness of typical symptoms, such as abdominal pain and digestive issues, and most understood pain patterns and anatomical variations during pregnancy. Diagnostic preferences favored CT scans and ultrasounds, but confidence in other tests like Magnetic Resonance Image (MRI) and urine analysis was limited. Risk factor awareness was mixed; obesity and diabetes were frequently recognized, while smoking and age were less often linked to appendicitis risk. Students also demonstrated a high understanding of pre- and post-surgical complications, with nearly all identifying peritonitis, appendicular abscess, and wound infections as significant concerns. These findings underscore the need to enhance training on diverse clinical presentations and reinforce education on less-discussed risk factors and complications. Strengthening clinical exposure and emphasizing diagnostic and procedural skills are crucial for improving students' readiness for managing appendicitis effectively. This study highlights the need for increased clinical exposure to strengthen diagnostic and procedural readiness among medical students. These findings highlight the need for more focused training on the diverse and atypical presentations of appendicitis to improve diagnostic readiness. These results underscore the importance of enhancing educational efforts regarding risk factors to improve diagnostic acumen. These findings suggest students' preferences align with diagnostic accuracy trends but highlight gaps in recognizing the role of supportive tests. These findings highlight the importance of reinforcing education on less commonly discussed complications like urinary retention and fistulas.

Abbreviation

CT scan: Computed Tomography; SD: Standard Deviation; WBC: While Blood Cells; MRI: Magnetic Resonance Image

Declaration

Acknowledgment

None.

Funding

The authors received no financial support for their research, authorship, and/or publication of this article.

Availability of data and materials
Data will be available by emailing amjad.alsadi.aa@gmail.com

Authors' contributions
Amjed Mohammed Taqi Jaber was responsible for designing, conceiving the idea, data analysis, interpreted the results and curated and drafted the manuscript. The author read and approved the final manuscript.

Ethics approval and consent to participate
We conducted the research following the declaration of Helsinki. The ethical approval was obtained from Department of General Surgery, Alkalis General Hospital, Diyala Health Directorate, 32001, Diyala, Iraq (January 2024).

Consent for publication
Not applicable

Competing interest
The author declare that they have no competing interests.

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