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The surgical procedure of Appendectomy: Delivering Effective Relief from Appendicitis and explain the role of anesthesia

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Abstract:

Background: Appendicectomy is a commonly performed surgical procedure in general surgery which involves the removal of the appendix with the aim of preventing complications arising from appendicitis. The procedure can be carried out using either the open or laparoscopic method and can be conducted under either general or regional anaesthesia. The objective of the study was to evaluate the surgical outcomes associated with effective surgical techniques in appendectomy under anaesthesia.

Methods: All clinical data for patients in Baghdad hospitals - Iraq was collected for a period between March 16, 2022, to August 25, 2023. The clinical data of the patients was divided into two groups, the first of which included laparoscopic appendectomy (74) patients and open appendectomy. This study compared patients in the two groups in terms of duration of surgery, length of hospital stays, postoperative pain and complications, and quality of life.

Results: The length of the surgical procedure played a critical role in the results achieved. The laparoscopic appendectomy had a mean duration of 53.66 ± 15.74 minutes, in contrast to the relatively shorter mean duration of 30.51 ± 12.82 minutes for open appendectomy. Clinical outcome analysis revealed that the laparoscopic appendectomy group experienced only four instances of blood loss, while the open appendectomy group had 8 cases. Hypertension was detected in two cases in the laparoscopic group and five cases in the open appendectomy group. The postoperative phase showed differences in the complication rate, with 15 cases in the laparoscopic appendectomy group and 25 in the open appendectomy group. The most encountered complications were wound infections, paralytic ileus, and vomiting. The pain scores of patients in the laparoscopic appendectomy group were found to be successful compared to the open appendectomy group over a

period of 72 hours. The hospital stay duration for open appendectomy patients (2.5 ± 2.8) was longer than those who underwent laparoscopic appendectomy (1.7 ± 0.3).

Conclusion: The study found that laparoscopic appendectomy is the preferred surgical procedure for patients under general anesthesia due to its higher effectiveness, success rate, and safety compared to open appendectomy.

Key words:

Laparoscopic appendectomy; Open appendectomy; VAS Scale; Appendicitis; and Post-operative complications.

Background:

Appendicitis, an inflammatory condition targeting the appendix, is the primary cause of acute abdominal pain in developed countries. It affects approximately 7 to 9% of individuals throughout their lifespan [1]. It tends to be more common in the demographic spanning from four to 25 years of age, with the highest incidence seen within the 10–19-year age bracket [2]. A notable gender disparity exists, with males being more frequently affected than females [3].

An appendectomy, the surgical removal of the appendix, is a common procedure in the medical field, particularly under the circumstances of appendicitis. The surgical approach to an appendectomy is predominantly laparoscopic, thus minimally invasive, and is considered the gold standard in healthcare [4]. This procedure, however, necessitates specific expertise regarding the various techniques that might be employed, which are contingent on the patient's health status and the severity of their appendicitis.

A typical surgical procedure, such as an appendectomy, involves several distinct stages. It begins with comprehensive patient preparation, which includes the administration of general anaesthesia for pain management during the operation. The surgeon then assesses the patient's overall health and reviews the events leading up to the procedure [5, 6].

In cases where appendicitis is presumed, it is advised to perform an appendectomy as promptly as feasible, ideally within a 48-hour window. Timely intervention is crucial to prevent further complications. The surgical approach can be either traditional (open) or laparoscopic [7].

Two main techniques are employed for an appendectomy: the open appendectomy and the laparoscopic appendectomy. Each technique has its unique advantages and potential drawbacks. The choice of technique depends on a variety of factors, such as the patient's clinical condition, the surgeon's experience, and other related variables [8].

The open appendectomy, traditionally the preferred method, involves dissecting and removing the appendix through an incision made in the right lower quadrant of the abdomen beneath the navel line. Following this, the cecum's juncture is sutured, and the incision is closed either with sutures or clamps [9]. This method, despite providing direct access and enabling the surgeon to inspect the area thoroughly, may lead to increased postoperative pain and a heightened risk of wound infection compared to the laparoscopic technique [10].

The appendix can also be removed through a laparoscopic procedure, which is a less invasive approach compared to traditional open abdominal surgery. In this procedure, an optical system and specific surgical tools are inserted via three small incisions in the abdominal wall. The surgeon then uses a monitor to visualize the surgical area while excising the inflamed appendix [11]. This method adheres to the same fundamental principles as open abdominal surgery, but the extraction of the infected tissue is accomplished using a trocar.

Laparoscopic appendectomy is a minimally invasive surgery in which the surgeon makes several small incisions in the abdomen. Specialized surgical instruments and a laparoscope, an

instrument featuring a camera, are used for visualization and execution of the procedure [12,13]. This methodology has several advantages. Being less invasive, it typically results in less post-operative discomfort and accelerates the recovery process. It also reduces the likelihood of wound infections. However, this technique demands specialized training and equipment. In more complex cases of appendicitis, its efficacy may be diminished [14].

One of the key benefits of laparoscopic surgery is that it avoids the need for a long incision through the skin and abdominal layers, providing a cosmetic advantage and potentially reducing postoperative complications and discomfort. Furthermore, as a diagnostic and therapeutic technique for addressing non-specific lower abdominal pain, it allows for simultaneous surgery. A laparoscopic appendectomy is generally associated with shorter hospital stays and a more rapid return to everyday activities [15,16].

However, there are concerns that laparoscopic procedures may increase the risk of intra-abdominal abscesses [17]. Moreover, the surgeon's expertise becomes paramount due to the unfamiliarity with longer tools and the two-dimensional perspective of the surgical field during a laparoscopic appendectomy. It's also worth noting that laparoscopic appendectomy tends to be more costly, given the high expense of the equipment and the potential for a slower procedure [18].

Patients and methods:

A comprehensive cross-sectional study was executed, centering on patients in Baghdad hospitals within Iraq, spanning the duration from March 16th, 2022, to August 25th, 2023. The study was principally concerned with the examination and assessment of clinical outcomes, particularly those pertinent to the employment of efficacious techniques within the surgical procedure of appendectomy.

The study considered various clinical demographic characteristics such as age, sex, body mass index, comorbidities, symptoms, the influence of smoking, and ASA. In addition, the study encompassed the examination of patient data from which histopathology and ultrasound diagnosis were allotted to both preoperative patient groups. The classification of patients' appendicitis was carried out into acute uncomplicated appendicitis, gangrenous appendicitis, appendicitis abscess, and peritonitis.

The treatment regime for both patient groups entailed the administration of third-generation cephalosporin and metronidazole alongside general anesthesia. Surgical outcomes were subsequently analysed in terms of operative time, added anesthesia (general and regional), blood loss, and hypertension.

With respect to postoperative outcomes, specific postoperative data were gathered, including the patient's return to normal activity, the initiation of oral diet, and bowel movements. The hospital stay duration was calculated by the number of days patients remained in the hospital. Comparative analysis was undertaken between both patient groups undergoing appendectomy, focusing on postoperative complications.

The level of postoperative pain experienced by patients undergoing both laparoscopic and open appendectomy was evaluated utilizing the standardized VAS scale (ranging from 0 to 10) for a period of 72 hours following surgery. Lastly, an evaluation of patients' postoperative quality of life was also conducted within the scope of our study.

Statistical analyses:

The dataset for patients who underwent an appendectomy was presented as the number of patients and as a percentage. The study compared patient outcomes between the laparoscopic and open appendectomy groups based on treatment effectiveness. Exclusion criteria comprised pediatric

and adolescent patients, as well as geriatric patients over 50 years of age. Additionally, patients with severe illnesses and a history of previous surgical operations were excluded. Our research calculated and analysed the appropriate sample sizes for both surgeries by assessing clinical data on surgery time, length of hospital stay, pain levels, complications, and post-surgery follow-up. A P value of 0.05 was considered significant. The results of the clinical data for appendectomy patients were evaluated using SPSS, version 22.0.

Results:

Table 1: Preoperative clinical and demographic outcomes of appendectomy.

Characteristics	LA [74]	OA [63]	P-value
Age [mean ± SD]	34.4 ± 12.5	35.5 ± 11.2	0.680
Gender			
Male	48 [64.86%]	35 [55.56%]	0.50
Female	21 [28.38%]	28 [44.44%]	0.55
BMI [Kg/m2]			
< 30	30 [40.54%]	27 [42.86%]	0.22
> 30	44 [59.46%]	36 [57.14%]	0.262
Co-morbidities			
Coronary artery disease	13 [17.57%]	15 [23.81%]	
Hypertension	24 [32.43%]	26 [41.27%]	
Chronic obstructive pulmonary disease	17 [22.97%]	14 [22.22%]	
Diabetes mellitus	20 [27.03%]	8 [12.70%]	
Smoking			
Smokers	42 [56.76%]	35 [55.56%]	0.632
Non-smokers	43 [34.24%]	28 [44.44%]	0.641
Indicators			
Abdominal pain	26 [35.14%]	20 [31.75%]	0.16
Diarrhea	15 [20.27%]	18 [28.57%]	0.025
Nausea and vomiting	13 [17.57%]	11 [17.46%]	0.201
Fever	20 [27.03%]	14 [22.22%]	0.045
ASA			
I	21 [28.38%]	17 [26.98%]	0.426
II	23 [31.08%]	14 [22.22%]	0.0626
III	16 [21.62%]	21 [33.33%]	0.067
IV	14 [18.92%]	11 [17.46%]	0.650

Table 2: Examine preoperative histopathological of patients with appendectomy.

Histopathological			
Findings	**Normal appendix**	**Inflamed appendix**	**P-value**
Laparoscopic appendectomy	6 [8.11%]	68 [91.89%]	< 0.0001

Open appendectomy	8 [12.70%]	55 [87.30%]	< 0.0001
Ultrasound			
Laparoscopic appendectomy	26 [35.14%]	48 [64.86%]	< 0.0001
Open appendectomy	13 [20.63%]	50 [79.37%]	< 0.0001

Table 3: Surgical outcomes associated with appendectomy.

Findings	Laparoscopic appendectomy [74]	Open appendectomy [63]	P-value
Uncomplicated acute appendicitis	50 [67.57%]	41 [65.08%]	0.068
Gangrenous appendicitis	4 [5.41%]	11 [17.46%]	0.0715
Appendiceal abscess	13 [17.57%]	4 [6.35%]	0.0691
Peritonitis	7 [9.46%]	7 [11.11%]	0.0725

Table 4: Intraoperative and clinical findings of appendectomy.

Findings	LA [74]	OA [63]	P-value
Operative time [min], [mean ± SD]	53.66 ± 15.74	30.51 ± 12.82	0.00027
Types of Anesthesia, N [%]			0.212
General	46 [62.16%]	35 [55.56%]	
Regional	28 [37.84%]	28 [44.44%]	
Blood Loss, N [%]	4 [5.41%]	8 [12.70%]	0.0013
Hypertension, N [%]	2 [2.70%]	5 [7.94%]	0.0451
Parenteral analgesics (doses/day)	1.2 ± 0.3	1.6 ± 0.5	0.0015
Oral analgesics (doses/day)	1.73 ± 1.27	1.80 ± 2.35	0.0146

Table 5: Post-operative clinical outcomes.

Findings	LA [74]	OA [63]	P-value
Bowel movements, N [%]	69 [93.24%]	45 [71.43%]	< 0.001
Hospital Stay (day)	1.7 ± 0.3	2.5 ± 2.8	0.0146
Returning to a normal level of activity [DAYS]	12.41 ± 3.5	20.41 ± 2.8	0.0018
Time until the start of the oral diet	68 [91.89%]	42 [66.67%]	0.0024
Follow-up	7.1 ± 2.8	11.2 ± 3.5	0.0152

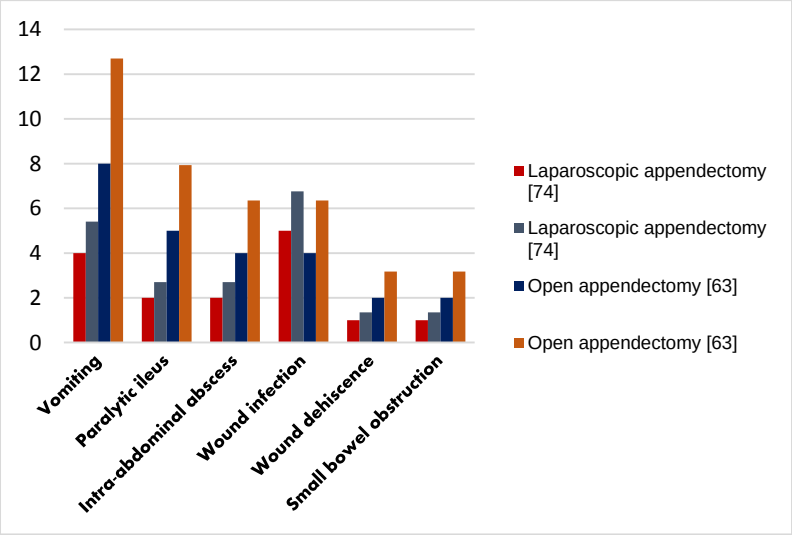

Figure 1: Post-operative complications.

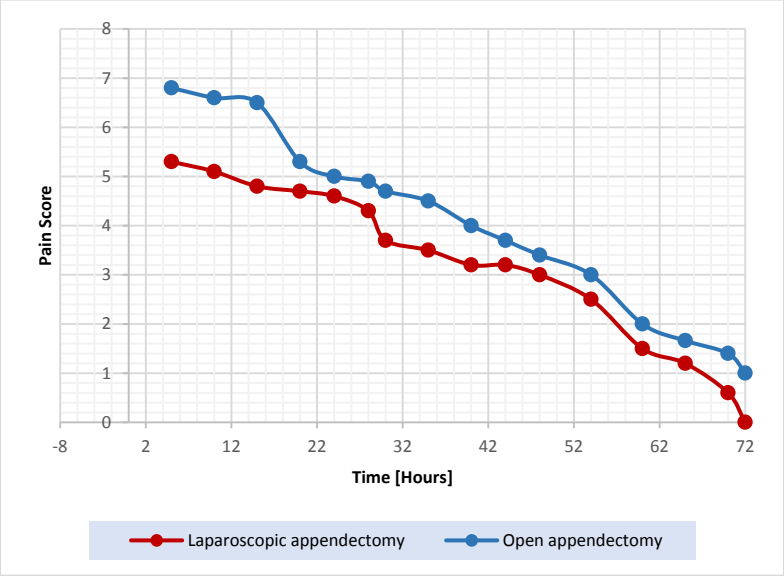

Figure 2: Assessment of pain score of patients after appendectomy surgery by VAS.

Table 6: Multivariable regression of risk factors associated with patients undergoing appendectomy.

Findings	**OR [95% CI]**		
Risk factors	**LA 74]**	**OA [63]**	**P-value**
Age	1.04 [0.40 - 2.452]	0.78 [0.35 - 1.1.6]	0.52
BMI	1.06 [0.68- 3.11]	1.2 [0.80 - 1.672]	0.241
Hypertension	0.821 [0.55 – 3.26]	0.71 [0.501 – 1.48]	0.55
Diabetes mellitus	1.42 [0.73– 3.67]	2.75 [0.92 – 5.42]	0.03
Abdominal pain	1.311 [0.912 – 3.56]	1.41 [0.75 – 2.80]	0.16
Uncomplicated acute appendicitis	2.65 [1.54 – 6.43]	2.2 [1.77 – 5.57]	0.021
Vomiting	1.213 [1.6 – 8.2]	1.22 [0.64 – 4.75]	0.152
Paralytic ileus	0.54 [0.26 – 2.87]	0.68 [0.32 – 2.64]	0.443
Wound infection	1.081 [0.75 – 1.43]	1.02 [0.81 – 2.77]	0.815

Table 7: Patient satisfaction with anesthesia technique for appendectomy.

Techniques	Excellent	Good	Poor
[RA]	40 [54.05%]	19 [25.68%]	15 [20.27%]
[GA]	24 [38.10%}	14 [22.22%]	25 [39.68%]

Table 8: Assessment of health quality-life of patients with after appendectomy in the long term by **SF-36 questionnaire**

Items	LA 74]	OA [63]	P-value
Physical functioning	82.4 ± 14.1	74.7 ± 12.5	0.0021
Bodily pain	87.5 ± 4.5	74.21 ±5.52	< 0.001
General health perceptions	68.51 ± 6.8	63.82 ±4.6	0.041
Social role functioning	75.2 ± 7.31	66.44.5.2	0.0016
Mental health	64.91 ±3.5	67.78 ±5.42	0.0463

Discussion:

An examination of demographic data provides insight into patient outcomes, revealing noticeable differences based on gender, body mass index (BMI), comorbidities, and preoperative symptoms. In the context of appendectomies, two surgical methods were considered - laparoscopic and open appendectomy. A higher incidence of infection was observed among male patients, with 48 and 35 patients in the laparoscopic and open appendectomy groups, respectively. This infection rate overshadowed that of female patients, recorded at 21 in the laparoscopic group and 28 in the open appendectomy group.

In terms of BMI, patients with a BMI greater than 30 displayed elevated rates, accounting for 59.46% and 57.14% in the laparoscopic and open appendectomy groups, respectively. This was in contrast to the patients with a BMI less than 30, representing 40.54% and 42.86% of the first and second groups, respectively.

When evaluating comorbidities, hypertension and diabetes were primarily observed in patients who underwent laparoscopic appendectomy, with 13 and 20 patients affected, respectively. On the other hand, the open appendectomy group reported hypertension in 26 patients and coronary heart disease in 15 patients.

Preoperative symptoms, notably abdominal pain, served as a significant indicator for patients, with rates of 35.14% and 31.75% in the laparoscopic and open appendectomy groups, respectively. The ASA classification further revealed a predominance of ASA II level in the laparoscopic appendectomy group at 31.08%, while the open appendectomy group exhibited a higher incidence of ASA III. This demographic data is comprehensively encapsulated in **Table 1**.

The study also considered clinical and histopathological findings, specifically focusing on appendicitis. Within the laparoscopic appendectomy group, an average of 6 cases presented a normal appendix, while 68 patients were identified with an inflamed appendix. Similar trends were observed in the open appendectomy group, with eight patients demonstrating a normal appendix and 55 patients displaying an inflamed appendix.

Ultrasound results further affirmed these findings, identifying 48 patients with an inflamed appendix in the laparoscopic group and 50 patients in the open appendectomy group. These results are detailed in **Table 2.**

The outcomes of the surgical procedures provided significant insight into the specific nature of inflammation patients were afflicted with. A scrutiny of the data revealed that acute uncomplicated appendicitis was diagnosed in 67.57% of the patients who underwent laparoscopic appendectomy and 65.08% of those who were subjected to open appendectomy, as discerned from the data presented in **Table 3.**

The duration of the surgical procedure was a crucial factor in the results obtained. The laparoscopic appendectomy procedure had a mean duration of 53.66 ± 15.74 minutes, whereas the open appendectomy procedure was relatively quicker, with a mean duration of 30.51 ± 12.82 minutes. Anesthesia played a pivotal role in both types of appendectomy, with equal instances of regional anesthesia, being 8 cases in both categories. In contrast, general anesthesia was favored in 46 instances in the laparoscopic appendectomy group and 36 instances in the open appendectomy group. An examination of the clinical outcomes highlighted that there were four instances of blood loss in the laparoscopic appendectomy group against 8 in the open appendectomy group. Hypertension was observed in 2 cases in the laparoscopic group and 5 in the open appendectomy group. These findings are visually represented in **Table 4.**

The postoperative phase revealed disparities in the complication rate, with 15 cases in the laparoscopic appendectomy group and 25 in the open appendectomy group. The most frequently encountered complications were wound infection, paralytic ileus, and vomiting. The Visual Analogue Scale (VAS) was employed to evaluate the results, indicating a pain stabilization at an average of 5 after 24 hours in the laparoscopic appendectomy group, which eventually declined to zero after 72 hours. Conversely, the open appendectomy group exhibited an initial escalation in pain averaging 7, which mitigated to 1 after 72 hours. The follow-up duration for patients across both groups varied between one to two weeks. The length of hospital stay was longer for open appendectomy patients (2.5 ± 2.8) as compared to those who underwent laparoscopic appendectomy (1.7 ± 0.3). These findings are visually represented in **Table 5, Figure 1, Table 6, Table 7, and Figure 2**

Last studies indicate that laparoscopic appendectomy surgery is the optimal surgical approach, with lower rates of post-operative pain and complications compared to open appendectomy surgery due to shorter incisions and less tissue trauma [19]. Furthermore, previous studies have found that laparoscopic appendectomy surgery is the safest and most effective procedure in treating appendicitis. The study conducted in the United States indicated that laparoscopic appendectomy posed a lower risk of surgical site infections when compared to open appendectomy. Several clinical studies have demonstrated that patients who undergo the procedure experience shorter hospital stays, which hastens their recuperation and enables their prompt return to daily activities [20]. Additionally, such patients benefit from improved dietary habits after undergoing the surgery. Furthermore, laparoscopic appendectomy yields superior cosmetic outcomes when compared to open appendectomy, as it results in smaller scars [21]. Variations and disparities have been observed among previous research studies in terms of the inclination towards regional anesthesia or general anesthesia. Regional anaesthesia provides patients with significant pain relief during and after surgery, shorter hospital stays, and better recovery [22]. Nevertheless, it also comes with severe complications such as nerve injury, infection, or bleeding at the point of injection. In comparison to general anaesthesia, a French study discovered lower occurrence rates of postoperative nausea and vomiting as well as longer recovery periods. [23]

Conclusion

Although both laparoscopic appendectomy and open appendectomy are common and preferred surgical procedures, laparoscopic appendectomy is more effective, successful, and safe than open appendectomy. This study presents several advantages of laparoscopic appendectomy, including shorter hospital stays, significantly reduced postoperative pain, quicker return to activity for patients, and a lower complication rate. Furthermore, the study revealed significant levels of patient satisfaction and a preference for regional anaesthesia during laparoscopic appendectomy.

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