



Cross-sectional Study

Role of preoperative computed tomography in the diagnosis of acute appendicitis and reduction of negative appendectomy rates: Retrospective cross-sectional study

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ABSTRACT

Background: Negative appendectomy rate (NAR) is defined as the incidence of pathologically normal appendices removed from patients suspected of having appendicitis. The objective of the present study is to determine the accuracy of CT and other modalities in diagnosing acute appendicitis, aiming to lower NAR in Saudi Arabia.

Method: Retrospective analytical study conducted across 4 hospitals in Makkah and Jeddah. A net total of 913 patients got included in the study. The data were entered and coded in excel sheet, then transformed to STATA R. software for analysis.

Results: A total of 911 patients who underwent appendectomy were included in this study; positive appendectomies were proven in (96.49%) of cases resulting in overall (3.51%) of cases of negative appendectomy when analyzing data based on age groups; adult patients who proceeded to the surgery based on clinical examination only had a NAR of (13.16% vs 2.66% who had one or more imaging studies $P = 0.000$).

Conclusion: Despite the fact that the diagnosis of acute appendicitis is often challenging, the patients who proceeded to the surgery based on clinical examination only had a NAR higher than those who underwent one or more imaging studies. The NAR was higher in women than men adult patients while no relation was observed in pediatric patients. Based on the present study's findings, efficient pre-operative radiological utilization is recommended in cases presented with suspicious acute appendicitis. Moreover, investing in radiological equipment and time for proper assessment can avoid the unnecessary appendectomy.

1. Introduction

Appendicitis lifetime occurrence is 7% [1]. Negative appendectomy rate (NAR) is defined as the incidence of pathologically normal appendices removed from patients suspected of having appendicitis [2]. Evidence suggests that the rate can be lowered through preoperative imaging [3]; therefore, preventing unnecessary postoperative complications and costs.

NAR historically ranged from 15 to 25%, and has decreased recently [4,5]. The latest NAR reported in the Makkah region reached almost 10% [5]. However, no study correlated a definitive diagnostic method in order to decrease that rate. The objective of the present study is to determine the accuracy of CT and other modalities in diagnosing acute appendicitis for the past five years, aiming to lower NAR in Saudi Arabia.

2. Materials and methods

Study design and setting. A retrospective analytic study done by reviewing records of (911) patients across 4 hospitals in the Makkah Region, Saudi Arabia.

Study population and sampling techniques. Individuals recruited were those living in the Western Region, who had a confirmed preoperative diagnosis of acute appendicitis in the period from 2015 to 2020 were eligible as participants in the study. Minimum sample size was calculated considering a level of confidence of 95%, expected prevalence of 50%, and precision of 0.05 and was found to be 384. For more accuracy, the study sample was enlarged to (913). To comply with the physical distancing rules in response to the COVID-19 pandemic, few numbers of data collectors were recruited to review medical records across the 3 hospitals.

Study tool. The data were obtained using a predesigned online questionnaire sheet accessible only by the research team stored on a secure computer to ensure patient data confidentiality. The following

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<https://doi.org/10.1016/j.amsu.2022.103609>

Received 18 February 2022; Received in revised form 7 April 2022; Accepted 7 April 2022

Available online 15 April 2022

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data were collected. (a) gender (b) age (c) weight (d) height (e) preoperative diagnostic tool (f) intraoperative pathology finding (g) hemoglobin value (h) heart rate value (i) respiratory rate value (j) temperature.

Ethical Considerations. Approval from the Ethics and Scientific Committees of King Abdullah International Medical Research Center (KAIMARC) “IRBC/1937/20”.

Data analysis. The data were entered and coded in excel sheet, then transformed to STATA R. software for analysis. For descriptive statistics, we used frequency and percentages to summarize categorical variables, and measures of central tendency and dispersion to summarize numerical variables. For inferential statistics, we used chi-square test or Fisher exact test for the categorical variables, whereas for continuous variables the Mann Whitney test was used. P-values < 0.05 will be considered statistically significant.

Mathew G and Agha R, for the STROCSS Group. STROCSS 2021: Strengthening the Reporting of cohort, cross-sectional and case-control studies in Surgery. International Journal of Surgery 2021; 96:106165 [19].

3. Result

A total of 911 patients who underwent appendectomy were included in this study; out of them there were 234 (25.69%) children (16 years or less) and 677 (74.31%) adult patients. The majority were male (63.70%) and Saudis (83.97%). Children’s ages ranged from 6 months to 16 years old with a median of 12.0 ± 5.0, while adult ages ranged from 17 up to 88 years old with a median of 30.0 ± 16.0. Positive appendectomies were proven in (96.49%) of cases resulting in overall (3.51%) of cases of negative appendectomy, and the rate was higher among pediatrics than adults (4.27% vs 3.25%, respectively). Among all the patients who underwent appendectomies “Pain in the right lower quadrant/right iliac fossa” was the most common symptom presented in (90.89%) of cases. Nausea and vomiting were the second common symptoms in (64.98%)

Table 1
Descriptive statistics for the patients’ characteristics.

Variables	Pediatric (n = 234) n (%)	Adult (n = 677) n (%)
Gender:		
Male	153 (65.67)	426 (63.02)
Female	80 (34.33)	250 (36.98)
Age in years (median + IQR)	12.0 ± 5.0	30.0 ± 16.0
Nationality:		
Saudi	176 (79.64)	573 (85.39)
Non-Saudi	45 (20.74)	98 (14.61)
Symptoms presented with:		
Nausea and vomiting associated with pain	161 (68.80)	431 (63.66)
Pain in the right lower quadrant/right iliac fossa	218 (93.16)	610 (90.10)
Temperature of 37.5C or higher	34 (14.53)	91 (13.44)
Loss of appetite	28 (11.97)	176 (26.00)
Leukocytosis	29 (12.39)	284 (41.95)
Diagnostic method:		
CT	47 (20.09)	455 (67.21)
Ultrasound	127 (54.27)	222 (32.79)
Symptoms and clinical examination (only)	67 (28.63)	38 (5.61)
Plain abdominal X-ray	23 (9.83)	137 (20.24)
Histology of the appendix:		
Inflamed	224 (95.73)	655 (96.75)
Non-inflamed	10 (4.27)	22 (3.25)
Vital signs:		
Hemoglobin level (mean + SD)	12.77 ± 1.36	13.17 ± 3.36
Systolic blood pressure	109.24 ± 16.57	118.80 ± 17.76
Diastolic blood pressure	65.93 ± 10.94	70.53 ± 11.43
Heart rate value	98.24 ± 20.00	87.29 ± 16.77
Respiratory	21.63 ± 4.62	20.10 ± 2.60
Temperature	37.09 ± 0.69	37.01 ± 0.53

of patients; followed by leukocytosis (34.36%), loss of appetite (22.39%), and high temperature (13.72%) (Table 1). shows descriptive statistics for the patients’ characteristics.

The majority of patients had one diagnostic method performed (70.69%), (17.78%) had more than one type, while (11.53%) proceeded to the surgery based on the clinical examination alone. CT was obtained in (55.10%), ultrasounds in (38.31%), and X-ray in (17.56%).

Overall, patients who proceeded to the surgery based on clinical examination only had a NAR of (5.71%) in comparison to (3.22%) of those who underwent one or more imaging studies. However, when analyzing data based on age groups; adult patients who proceeded to the surgery based on clinical examination only had a NAR of (13.16% vs 2.66% who had one or more imaging studies P = 0.000). Surprisingly, the NAR rate was lower among children who proceeded to the surgery without imaging (1.49% vs 5.39% who had one or more imaging studies P = 0.183).

In negative appendectomy cases, (53.12%) were female. There was a significant relation (P = 0.008) between NA and gender among the adult group (63.64% female vs 36.36% male), while no statistically significant relation among the pediatric group (P = 0.768) (Table 2). shows a comparison between patterns of adults against pediatric patients who got identified with negative appendectomies.

4. Discussion

The diagnosis of acute appendicitis is often challenging and includes a certain combination of clinical, laboratory, and imaging findings [3]. Additionally, diagnosis based on radiological findings of ultrasound (US), computed tomography (CT), or magnetic resonance imaging (MRI), is considered another controversy [7,8]. Furthermore, surgical removal of a not-pathological appendix exposes patients to unnecessary anesthesia and surgical complications, So, more effort should be given to reduce the NAR and its complications on patients as well as hospitals [9]. Therefore, this study was carried out to compare retrospectively the negative appendectomy rate between patients who proceeded to the surgery based on clinical examination only with those who underwent one or more imaging studies.

Table 2
Comparison between patterns of adults against pediatric patients who got identified with negative appendectomies.

Variables	Negative appendectomy			
	Pediatric (n = 10) % (n)	P-value	Adult (n = 22)	P-value
Gender:				
Male	4.58 (7/153)	0.768	1.91 (8/426)	0.008*
Female	3.75 (3/80)		5.93 (14/250)	
Age in years (median + IQR)	8.84 ± 6.45	0.433	38.18 ± 16.0	0.092
Nationality:				
Saudi	5.08 (9/177)	0.482	2.97 (17/573)	0.558
Non-Saudi	2.22 (1/45)		4.08 (4/98)	
Diagnostic method:				
Ultrasound (only)	1.96 (2/102)	0.124	4.71 (4/85)	0.418
CT (only)	18.18 (4/22)	0.001*	2.71 (8/295)	0.488
Symptoms and clinical examination (only)	1.49 (1/67)	0.183	13.16 (5/38)	0.000
X-ray (only)	7.14 (1/14)	0.584	1.16 (1/86)	0.243
Ultrasound + CT	9.52 (2/21)	0.212	2.42 (3/124)	0.564
Ultrasound + X-ray	0	-	6.67 (1/15)	0.450

In the current study, the patients who proceeded to the surgery based on clinical examination only had a NAR of (5.71%) in comparison to (3.22%) of those who underwent one or more imaging studies. Raja AS et al. (2010) revealed that between 1990 and 2007, the NAR reduced significantly in the USA from 23% to 1.7% and the patients who underwent appendectomy with preoperative CT increased significantly from 1% to 97.5% [3]. Also in another American study carried out by Webb et al. (2011), the NAR was decreased in adult patients who underwent preoperative CT compared with those who did not have any preoperative diagnostic imaging (4.7% vs. 12.8%) [10]. Other studies that were carried out in the USA and Saudi Arabia reported variable rates of NAR. It was 9% in the USA [11], 3% in Ar'ar city (Saudi Arabia) [12] and 6.4% in Jeddah (Saudi Arabia) [13]. In our present study, the overall rate of NAR was 3.51%.

Moreover, in the present study, when analyzing data based on age groups; adult patients who proceeded to the surgery based on clinical examination only had a NAR of 13.16% compared to only 2.66% among those who had one or more imaging studies, while in case of children the NAR rate was lower among children who proceeded to the surgery without imaging (1.49%) compared to 5.39% among those who had one or more imaging studies. However, this difference was not significant. Schok et al. reported a NAR of 12% and perforation rate (PR) of 18% among children aged below 18 years; 22% of patients received preoperative ultrasound examination, and 0.5% received a CT scan. The NAR and PR among children who received preoperative imaging were 8.4% and 15.7%, respectively, which did not differ significantly from those who did not receive any imaging [14]. In addition, quite similar findings have been reported by other studies in Germany [15]. However, three big studies that were carried out in the USA and Canada on childhood appendectomy reported lower rates of NAR ranged from 3.6% to 6.7% [16–18].

In the current study, the most frequently reported symptom among patients who underwent appendectomies was pain in the right lower quadrant/right-iliac fossa (90.89%), followed by nausea and vomiting (64.98%), leukocytosis (34.36%), loss of appetite (22.39%), and high temperature (13.72%). In other similar two Saudi studies carried out in Jeddah, the main presenting symptoms in NA patients was abdominal pain, followed by vomiting, nausea, anorexia, and fever [4,13].

In the present study and in accordance with others [17], there was no statistically significant difference regarding NAR between male and female children. However, among adults, the NAR was significantly higher in females compared to males. The same has been observed in other studies carried out in the USA [10] and Saudi Arabia [4].

Among strengths of the present study is the fact of being a multicentric study that includes enough cases. However, depending on medical records in obtaining information in the present study is subject to bias, as accurate results of clinical examination and radiological reports cannot be assured.

5. Conclusion

In conclusion, despite the fact that the diagnosis of acute appendicitis is often challenging, the patients who proceeded to the surgery based on clinical examination only had a NAR higher than those who underwent one or more imaging studies. The NAR was higher in women than men adult patients. Based on the present study's findings, efficient preoperative radiological utilization is recommended in cases presented with suspicious acute appendicitis. Moreover, investing in radiological equipment and time for proper assessment can avoid the unnecessary appendectomy.

Provenance and peer review

Not commissioned, externally peer reviewed.

Please state any sources of funding for your research

No funding for this research.

Ethical approval

Ethical approval has been given by the Institutional Review Board (IRB) of King Abdullah International Medical Research Center (KAIMARC) "IRBC/1937/20"

Consent

Ethical approval has been given by the Institutional Review Board (IRB) of King Abdullah International Medical Research Center (KAIMARC) "IRBC/1937/20"

Author contribution

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Registration of research studies

1. Name of the registry: N/A.
2. Unique Identifying number or registration ID: N/A.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): N/A.

Guarantor

Razan Abdullah Al-Suayri, corresponding author of the manuscript, accept full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish.

Funding sources

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

No conflict of interest.

Acknowledgements

The authors would like to extend their sincere thanks to Dr. Sumayyah Chapra, Ms. Maha Abuzanadah, Rozan Thaieb Almuta, Layan Mohammed Alsofiani, Sara Atif Fasehaldeen, Lama Adnan Althagafi, Futoon Faisal Afandy, Mussaan Mohammed Alsofiani, Sara Atif Fasehaldeen and Lama Adnan Althagafi for their assistance with data collection and Nada Yasser Baatiah for her assistance with data analysis; without them the completion of this project would not be possible.

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