ORIGINAL ARTICLE

Tomographic variable predictive of Acute Appendicitis

Variables tomográficas predictivas de apendicitis aguda

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ABSTRACT

Background: acute appendicitis is still a diagnostic and therapeutic challenge.

Objective: to determine the tomographic variables independently of acute appendicitis.

Method: a retrospective observational case-control study was carried out with a universe of 200 patients with suspected acute appendicitis at the Cuban Hospital of Qatar, from January 2018 to December 2019. The sample was made up of 80 patients, 27 cases and 53 controls. The following variables were studied: diameter, wall thickness, post-contrast enhancement of the wall, absence of oral contrast in the lumen, presence of fecaliths and periappendicular fat edema. The results were analyzed using frequency for qualitative variables and sample mean with standard deviation for quantitative variables, bivariate analysis by means of the chi-square test; multivariate analysis using binary logistic regression.

Results: for the case group the average age was 33,6 years, the diameter of the appendix was 12,7 mm and the wall thickness was 3,7 mm. In the bivariate analysis diameter, wall thickness, periappendicular edema, appendicolith, post-contrast enhancement of the wall and absence of oral contrast in the lumen were significant. The multivariate analysis showed that a wall thickness of more than 3 mm and the absence of oral contrast in the lumen were independent and multiply the probability of acute appendicitis in 24,2 and 17,4 times, respectively.

Conclusions: the wall thickness and the absence of oral contrast in the lumen of the appendix have independence on the diagnosis of acute appendicitis.

Keywords: APPENDICITIS; TOMOGRAPHY; ACUTE ABDOMEN; EDEMA.

Descriptors: APPENDICITIS; TOMOGRAPHY; ABDOMEN, ACUTE; EDEMA; DIAGNOSIS.

RESUMEN

Fundamento: la apendicitis aguda continúa siendo un reto diagnóstico y terapéutico.

Objetivo: identificar las variables tomográficas con independencia sobre la apendicitis aguda.

Métodos: se realizó un estudio observacional retrospectivo de casos y controles, en un universo de 200 pacientes con sospecha de apendicitis aguda, en el Hospital Cubano de Catar, desde enero 2018 hasta diciembre 2019. La muestra quedó constituida por 80 pacientes, 27 casos y 53 controles. Se estudiaron las variables: diámetro, grosor de la pared, realce post-contraste de la pared, ausencia de contraste oral en la luz, presencia de fecalitos y edema de grasa peri-apendicular. Los resultados fueron analizados: usando frecuencia para las variables cualitativas y media muestral con desviación estándar para variables cuantitativas; análisis bi-variado por medio de la prueba de Chi cuadrado; análisis multivariado mediante regresión logística binaria.

Resultados: para el grupo de casos la edad promedio fue 33,6 años, el diámetro del apéndice 12,25 mm y el grosor de la pared 3,7 mm. En el análisis bi-variado: el diámetro, grosor de la pared, edema peri apendicular, apendicolito, realce post-contraste de la pared y ausencia de contraste oral en la luz fueron significativos. El análisis multivariado muestra que el grosor de la pared de más de 3 mm y la no presencia de contraste oral en la luz resultaron con independencia, multiplican la probabilidad de apendicitis aguda en 24,2 y 17,4 veces, respectivamente.

Conclusiones: el grosor de la pared y la ausencia de contraste oral en la luz del apéndice tienen independencia sobre el diagnóstico de apendicitis aguda.

Palabras clave: APENDICITIS; TOMOGRAFÍA; ABDOMEN AGUDO; EDEMA.

Descriptores: APENDICITIS; TOMOGRAFÍA; ABDOMEN AGUDO; EDEMA; DIAGNÓSTICO.

INTRODUCTION

Acute appendicitis (AA) refers to the inflammation of the vermiform appendix, and is the most common cause of emergency surgical abdomen. In North America, the incidence is 100 per 100,000 people / year, with almost 400,000 diagnoses in 2015. The incidence is increasing in the newly industrialized countries of Asia, the Middle East, South America, and Africa since 2000. [1]

Tools exist, such as the Alvarado score, widely used in the diagnosis of AA, which makes it possible to speed up the diagnosis and reduce risky and unnecessary white laparotomies for patients. [2,3]

Computerized axial tomography (CT), is the imaging study of choice for diagnosis, dilation of more than 6 mm, wall thickening of more than 1 mm, post-contrast IV enhancement of the wall, edema of peri-appendicular fat, fluid accumulation, and the presence of appendicolith, are the tomographic signs suggestive of AA described by some authors. [4,5] Other investigators describe the absence of oral contrast in the lumen, distention of more than 10 mm and thickening of the walls of more than 3 mm, enlarged mesenteric nodules, and peri-appendicular inflammation or fluid. [6-8] Sometimes it is necessary to resort to the use of other complementary tests to reach the diagnosis in confusing cases. [9]

Appendectomy and / or the use of antibiotics are part of the most used therapeutic behaviors, the first option is the preferred one in adults because high prevalence rates of recurrent appendicitis have been detected in studies. [10,11]

In our institution, the diagnosis of AA becomes a real challenge for the radiologist in not very evident images, no study defines the independent tomographic variables in this pathology, despite what has already been mentioned about the existence of tomographic variables, such as appendicular diameter, wall thickness, wall enhancement after intravenous contrast administration, absence of oral contrast in the lumen, presence of fecaliths, and peri-appendicular fat edema, which may have an independent influence on the diagnosis of AA. [4-8]

The present investigation is framed in this context; whose primary objective was to determine the tomographic variables independently of acute appendicitis. In this sense, it was considered as a null hypothesis that the described tomographic variables had no independent influence on the diagnosis of AA; and as an alternative hypothesis, that the described tomographic variables had an independent influence on the diagnosis of AA.

MATERIALS AND METHODS

A retrospective observational study of cases and controls was carried out in a universe of 200 patients admitted to the "Cuban Hospital" of Qatar with a clinical diagnosis of acute appendicitis (AA), from January 2018 to December 2020. The sample consisted of 80 patients; sample size calculated using the OpenEpi online tool.

The sample was divided into two groups: cases and controls. The cases were characterized by having a histological diagnosis of acute appendicitis, the controls were chosen from the same sample at a ratio of 2: 1 and AA was ruled out.

Children under 14 years of age, pregnant women, employees of the corporation, suboptimal studies and diagnoses different from or associated with acute appendicitis, such as tumors, chronic appendicitis, mucoceles, etc., were excluded.

The data were collected blindly, from the Hamad corporation's radiology computer system, on a data sheet emptied into an Excel document for analysis. The images were de-identified and re-analyzed by two radiologists with 10 years of experience. All data were coded to avoid vulnerability in the identification of patients.

The study was approved by the Qatar IRB, no informed consent was required, ethical issues were addressed following the Declaration of Helsinki.

The dependent variable defined as the state of the appendix, dichotomous, defined with appendicitis (evaluated by the pathologist and reported the presence of polymorphonuclear cells in the muscle layer) or no appendicitis (evaluated by the radiologist and the surgeon as CT without tomographic signs of appendicitis); Within the independent variables, all the quantitative variables were converted into dichotomous for the bi-varied analysis, the age in completed years in its quantitative version and in its dichotomous version in less than 45 years and more than 45 years; the diameter of the appendix in mm, dilated ≥10 mm or not dilated <10mm, thickness of the wall in mm, thick 3 mm or normal <3 mm in its dichotomous version; gender, qualitative ordinal, male or female; the presence of peri-appendicular edema, present or absent; appendicolith, present or absent; the presence of oral contrast in the lumen of the appendix, present or absent; Ring-shaped enhancement of the appendicular wall, present or absent. [6-8]

In the univariate analysis, the absolute and relative frequency was used to describe the qualitative variables; also, the sample means and standard deviation for quantitative variables. In the bivariate analysis, Chi-square was used, p values equal to or less than 0,05 were defined as statistically significant. For the multivariate analysis, the binary logistic regression of the SPSS 25 statistical package was used, using variables with p values lower than 0,10, values lower than 0,05 will be defined as significant.

RESULTS

All calculations were performed on the sample of 80 selected patients; most of the patients were male and young, the results of the tomographic variables are shown in the **table 1**.

TABLE 1. Uni-varied descriptive analysis of the variables studied

Quantitative variables	Means, SD			
	Appendicitis (n=27)		Normal (n=53)	
Age (years)	33,6	8,4	30,5	9,9
Diameter (mm)	12,25	2,4	6,4	2,3
Thickness of the wall (mm)	3,7	0,7	1,7	1
Qualitative variables	**Frequency**			
	Apendicitis (n=27)		Normal (n=53)	
P.A fat edema	21	77,77 %	7	13,2 %
Appendicolith	11	40,7 %	3	5,6 %
Enhancement of the wall	21	77,77 %	6	11,3 %
Absence of oral contrast	1	3,7 %	11	20,75 %
Male gender	24	88,88 %	36	79,24 %

In the bivariate analysis, only age and sex were not significant, **table 2**.

Nagelkerke's R squared was calculated, resulting in 0,756, the diagnostic sensitivity of the model is 89 % and 94,3 % to rule it out, the specificity 92 %. The Hosmer and Lemeshow fit test are 0,735.

Table 3 shows the results of the multivariate analysis, obtained from logistic regression binary by the step-forward method.

TABLE 2. Result of the bi-varied analysis

Variables	CHI-Square	df	p-value
Age	1,908	1	0,167
Diameter	46,319	1	0,000
Thickness of the wall	52,023	1	0,000
P.A fat edema	32,782	1	0,000
Appendicolith	15,247	1	0,000
Enhancement of the wall	35,332	1	0,000
Absence of oral contrast	41,061	1	0,000
Gender	0,029	1	0,864

TABLE 3. Result of multivariate analysis using Wald Forward step binary logistic regression with a significance level of 95 %

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Thickness of the wall	3,186	0,892	12,755	1	0,000	25,198	4,211	139,053
Absence of oral contrast	2,855	1,202	5,642	1	0,018	17,375	1,648	183,251

DISCUSSION

The results of our study showed that appendicitis affects more young men; the veracity of the alternative hypothesis is demonstrated since the wall thickness of more than 3 mm and the absence of contrast in the lumen of the appendix have an independent influence on the diagnosis of acute appendicitis, which allows rejecting the null hypothesis. The remaining variables did not show enough statistical independence, so care must be taken when taking therapeutic behaviors based on these; however, a direct relationship with the diagnosis was demonstrated, except for age and sex.

To avoid data collection biases, the process was performed double-blind, as was the interpretation of the images; besides, a good selection of cases was made based on the definition of appendicitis by pathological anatomy according to the bibliography, pairing it with two controls. To avoid spurious relationships and confounding variables, binary logistic regression was used.

The reviewed bibliography describes works on the prediction of appendicitis using clinical and laboratory variables, [12,13] no study was found with a design like ours of cases and controls and that uses tomographic variables in the prediction of appendicitis. Therefore, from now on, the results of this research can be used as a complement to the scales and clinical diagnostic tools developed previously, however, we intend to investigate including the laboratory variables described in the bibliography.

Jenning et al., In 2020, concluded that undefined diagnostic tests increase the time of diagnosis and the cost for patients and institutions, therefore they propose a logical sequence to reverse this situation; [14] with our tool, a predictor of appendicitis, you will improve the effectiveness of diagnostic tests and, consequently, reduce the number of undefined cases, the number of tests to be performed, the patient waiting time, the patient's costs and the institutions.

The mean age of the sample was 33,6 years for patients with appendicitis and 30,5 years for controls; Regarding sex, the majority in both groups, cases, and controls, belong to the male sex. This is because the predominant population in the area where the hospital is located is mostly made up of male migrants, construction workers. In a study by Sartelli et al. In 2018, [15] Sosa-Frias, 2020, [16] and Spina et al., 2018, [12] the predominant sex was also male in the appendicitis group and the average age was 29,3, and 28,9 years, respectively.

The results of the tomographic findings for Spina et al. [12] differ from ours; In order of frequency, they defined appendix dilation 82,39 %, periapendicular fat edema 60,93 %, free fluid 32,89 %, wall thickening 21,19 %, and others; In our study, the main findings in cases of appendicitis according to frequency were edema of the peri-appendicular fat 89,28 %, dilation of the appendix 85,71 % and thickening of the wall 75 %, this difference could be related to the etiology of inflammation of the organ.

The result obtained in our investigation shows that the independent variables to predict AA were the thickness of the wall and the absence of contrast in the lumen of the appendix. Lai V and collaborators, [17] in a study carried out in China in 2012, and Basaldua and collaborators 2020 in Peru, [18] separately, concluded that the diameter of the appendix was the finding with statistical independence on appendicitis, the differences in the results may be because the images analyzed by them were taken from CT scans performed without EV contrast, which makes it difficult to measure the wall.

Eurboonyanun et al., 2020, demonstrated in their study that there are no differences in sensitivity for diagnosis in CT scans performed with or without EV contrast. [19] Although our study has a different design, we evaluated the wall enhancement variable differently after the administration of IV contrast and the results were somewhat similar, independence of the same was not demonstrated with the variable outcome, which means that there would be no differences if we had not used EV contrast, although we must emphasize that the administration of EV allows defining the wall of the appendix, for more accurate measurement of its thickness in doubtful cases, and improves the visualization of other pathologies, which justify the pain in the right iliac fossa, also enhances the blood vessels, allows to identify adenopathies, among other benefits.

In 2019 Varun et al. Defined the measurements for the normal appendix, with diameter 6.87 mm and standard deviation 1,73 mm, wall thickness 1,99 mm and standard deviation 0.9 mm; [20] our results showed in the control group 6.4 mm in diameter and 2,3 mm standard deviation and 1,7 mm of normal wall thickness and 1 mm standard deviation, similar to theirs. It is important to set these values to be able to identify the limits between normal and pathological.

Regarding treatment, the management of appendicitis in our corporation is carried out through an appendectomy for minimal access, some authors suggest that the use of antibiotics is a viable option, as a treatment in non-perforated appendicitis. [9,10,21]

When the controls were selected, we found four patients who did not accept the appendectomy as a treatment, although it was the one suggested by the doctor, the leave the hospital under DAMA (Discharge Against Medical Advice) and was prescribed medical treatment with antibiotics, therefore they were excluded from the sample and there is no record of subsequent appendectomy in these patients. The bibliography reports between 14 and 24 % relapses between one and five years, [21] other patients were also excluded from the group of controls with diagnoses of associated early-stage neoplasms, which changed the definitive behavior, and chronic appendicitis, which could be associated with the number of appendicitis with recurrences if the appendectomy has not been performed, so we suggest surgical treatment to allow early diagnosis of neoplasms, which present as acute appendicitis, and chronic appendicitis, which leads to non-resolution of the pathology or a future surgical intervention.

By way of conclusion, it should be emphasized that our predictive model proposes that for patients with a wall thickness above 3 m, the probability of acute appendicitis is multiplied 24.2 times and the absence of oral contrast in the lumen increases 17,4 times the probability of suffering from this pathology. The

variables diameter greater than 10 mm, peri-appendicular edema, presence of appendicolith alone do not have enough weight on the diagnosis; however, their combination could be a guide. The double contrast technique used for this mathematical model demonstrated high enough sensitivity, specificity, and veracity to be considered in other institutions.

This work constitutes an update of a controversial issue at present because its diagnosis and treatment continue to be a challenge for science. Population variations must be assessed when generalizing these results, therefore, we suggest the combination of this tool and already proven clinical tests. Carrying out an investigation, where the laboratory tests described by other authors are included as variables, is a pending task soon.

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Authors' contribution

Alexander Sosa-Frias | https://orcid.org/0000-0001-5170-2916. He participated in conceptualization and ideas; investigation; data curation; formal analysis; display; original draft wording; writing, revision, and editing.

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Conflict of interests

The authors declare that there are no conflicts of interest.