

Analysis of Diagnostic Accuracy of Computed Tomography for Acute Appendicitis

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ABSTRACT

Background: Acute appendicitis is considered one of the primary reasons for abdominal pain and needs emergency treatment. In the United States, every year, 250,000 cases of appendicitis are reported. All around the world, this condition on sights demands surgical interventions. To avoid unnecessary laparotomies, screen imaging is an important method to diagnose the cases. Computed tomography is supposed as one of the best tools for examining the pelvic, abdominal area. With its high sensitivity and specificity, different hospitals used this method of diagnosed acute appendicitis cases. This study aims to analyze the diagnostic accuracy of computed tomography and correlation with Alvarado score for acute appendicitis.

Method: This comparative descriptive study was conducted in histological Department of Khyber medical University Peshawar within duration of two years from Jan 2018- Jan2020. Total 320 patients were selected who underwent through 16 slices multi detector scanner was used for the abdominal CT. With the lowest exposure, 3-dimensional images with 5mm slice thickness were obtained.

Results: We observed 85.4% sensitivity and 65.0% specificity with 2.4411PLR and 0.224 NLR in the Alvarado score. At the same time, sensitivity and specificity of CT were relatively good 94.2, 90, respectively, with 9.4175 PLR and 0.0647 NLR.

Conclusion: In patients with low Alvarado score, Computed tomography is a reasonable solution for the identification of specific or alternative diagnoses among them.

Keywords

Computed tomography, Alvarado score, acute appendicitis, 3 dimensional images, negative appendectomies.

Introduction

Acute appendicitis is considered one of the primary reasons for abdominal pain and needs emergency treatment. In the United States, every year, 250,000 cases of appendicitis are reported. All around the world, this condition on sights demands surgical interventions. (Pinto et al, 2013). Even though the number of acute appendicitis cases expanded day by day, still, its diagnosis remains challenging for many physicians. The initial symptoms are so vague that sometimes it's hard to indicate the upcoming severity of the disease. Numerous physicians found sudden abdominal pain with vomiting and nausea as the initial stage of acute appendicitis. Some other physicians examined the location of abdominal cramps and insist that it begins from the right lower quadrant. This pain came to be severe with cough or pressure during feases. During diagnosis, leukocytes and fever were identified in many patients and speculated as common symptoms of acute appendicitis.(Jackson, Blamey, Stephen, 2005) These symptoms are not observed in many cases, especially among 30-35% of children and cause delays in diagnosis and sometimes mistreatment.[3] Researchers saw a 1% mortality rate among the instances of nonperforated appendicitis; meanwhile, this ration is four times high in perforated cases. Causes of acute appendicitis are still unknown but increased 7-8% lifetime risk. Every year, 90-100 patients from 100 000 population are diagnosed with acute appendicitis in developed countries. Frequency of these cases are noticed during the second and third decade of life and increased in decreased instances of acute appendicitis. Cases of appendicitis are on the peak in South Korea (16%), United States (9.0%), and decidedly less in the African region (1.8%).[4]

In some researches, physicians observed high lifetime risk among males (8.6%) as compared to females (6.7%).[5] Further studies demonstrate less undergoing appendectomy risk among males (12) and approximately three times higher risk among the female population (33%).[5] Due to the inadequate laboratory testing and delay in diagnosis, the rate of unnecessary laparotomies is very high

in some regions of the world.[6] For the prediction of acute appendicitis, different scoring systems were introduced and practiced to assess the probability of acute appendicitis. In 1986, the Alvarado score was presented to demonstrate the clinical findings of acute appendicitis. This scoring method is based on history and laboratory testing and is used to avoid negative appendicectomies.[7]

To avoid unnecessary laparotomies, screen imaging is an important method to diagnose the cases. Computed tomography is supposed as one of the best tools for examining the pelvic, abdominal area.[8] With its high sensitivity and specificity, different hospitals used this method of diagnosed acute appendicitis cases.[9] From all the other methods of screening, CT has 94-96% high sensitivity and specificity, which helps in a better understanding of acute appendicitis.[10,11] With the help of CT, physicians quickly observed the dilute appendix (>6 mm).[12,13] CT also saw extraluminal fluids, periappendiceal inflammation, appendicolith.[14] Enlargement of reactive nodal, lateroconal fascia thickness, fats, cecal apex thickness, and a wall thickness of the appendix can be easily observed with CT diagnosis.[15,16].

In Pakistan very few studies were conducted on examination of severe appendicitis cases with the help of Alvarado score. In 2017, 71-97% ratio was examined regarding the clinical diagnosis of acute appendicitis cases all around the world. With the help of advancement in methodology still 20% negative appendectomy rate observed in 2017. So, the major rationale of our study is to diagnose the clinical symptoms of acute appendicitis cases through CT and Alvarado scoring system. The major objective of this study is to analyze the diagnostic accuracy of computed tomography for acute appendicitis cases along with another objective to predict the probability of acute appendicitis with the help of the Alvarado score method. Through this research, we examine the accuracy of CT in severe appendicitis cases with the help of the Alvarado score.

Material and Methods

The study was conducted with the help of the histological Department of Khyber medical University Peshawar. In a period of 2 years, researchers observed 1200 cases of appendicitis at District Hospital MankiShareefNowshera. From these 1200 cases, 30-40% standard cases of the appendix were found. This ratio helps the researcher to produce a work with the help of Alvarado score and abdominopelvic CT to reduce the risk of negative appendectomy. Solvin formula was used to calculate the sample size for this study. A total of 320 patients was selected by using a 95% confidence interval in a sample size method. Type 1 error was selected on 0.05 error. After selecting the sample size, the researcher set some inclusion and exclusion criteria for his study. All the patients who were diagnosed with acute appendicitis were chosen for this research. All the pregnant women, a person undergone through abdominal laparotomies in the past, those patients who suffer from peritonitis, sepsis were excluded from the study. Researchers generate a form for the demographic and CT scan information of a person. Alvarado score was calculated from all the filled forms of patients and compared them with the likelihood ratios of CT scan. The initial CT findings were not shared with the other two researchers who were measuring the Alvarado score of patients. This step was taken to prevent the chance of biases in our study. Score >7 was considered a positive sign for the research. In time-frame of two years prospective study, total 112 undergone from CT scan, whereas 57 patients discharged from the hospital without any surgical intervention. Researchers trace these 57 patients and categorize them into non-appendicitis for this research. The rest of the 263 patients face appendectomy intervention. IV oral contrast and no oral difference with 16 slices multidetector scanner were used for the abdominal CT. With the lowest exposure, 3-dimensional images with 5mm slice thickness were obtained.[17]

After the appendectomy patients were further analyzed for histopathological observations. Those patients whose histopathology report show the presence of acute appendicitis were suspect of therapeutic appendectomy. While those who report revealed, normal appendix was categorized into negative appendectomy. For AS a CT, all the sensitivity information, specificity were assessed through SPSS 24.0 version. Positive and negative predictive values (PV) and likelihood ratio (LR) were also observed for the two genders of our studies. T-test was applied at a confidence interval of 99%. P-value < 0.05 is considered as significant for research.[17]

Results

For this research, the Alvarado score was set for the acute appendicitis signs, symptoms, and laboratory tests. To all these symptoms score was set as point 1. Whereas for the signs, we include right iliac fossa tenderness, rebound tenderness, and temperature higher than 37 degrees. We set 2 points for measuring leukocytosis and right iliac fossa tenderness (Table 1).

Table1: Alvarado score of laboratory test, signs and symptoms

Variables	Scores
SYMPTOMS	
Right iliac fossa pain	1
Anorexia	1
Nausea	1
SIGNS	
Right iliac fossa tenderness	2
Rebound tenderness	1
Temperature > 37° C	1
LABORATORY TEST	
Leukocytosis > 10.0 * 10 ⁹ / L	2
Neutrophils > 75%	1

Out of 320 patients 263 patients were undergone through the appendectomy. These appendectomy cases were held without the consideration of AS score. Their histopathological results disclose 224 cases of acute appendicitis. Five cases were observed with the appendiceal tumor. After the profound observation, our study found 14.3% of cases of negative appendectomy. We observed a low Alvarado (< 7) score among 15 patients, but interestingly, their CT was standard and showed no case of AA. During observations, one example had diabetes mellitus and carrying no appendicitis. This case was discharged without surgical intervention.[17]

The mean age of the male population was 26.1 years and the female mean age of the study was 25.6 years. Analyzing the mean time duration of symptoms we found 27.7 minutes for males and 18.4 minutes for the female population. Out of 320 patients, 224 appendectomies were done along with 32 cases of negative appendectomy. Comparing the Alvarado scoring performance we analyze the 7.53 mean value among male and 7.74 mean score among female population.

Table 2: Demographic observations with clinical of AA cases

Criteria	Male	Female	Overall
Number	196	124	320
Age (mean± SD)	26.1 ± 9.3	25.6 ± 8.9	27.9 ± 10.8
Mean duration of symptoms (range/ h)	27.7 (18-72) minutes	18.4 (12-60) minutes	22.4 (12-72) minutes
White blood cell count (mean± SD)	16.4 ± 4.3	15.2 ± 3.6	15.9 ± 4.7
Alvarado score (mean± SD)	7.53 ± 1.1	7.74 ± 1.1	7.61 ± 1.1
Computed tomography scan done	49	63	112
No surgery	25	32	57
Therapeutic appendectomy	150	74	224
Negative appendectomy	21	18	39
Negative appendectomy rate (%)	12.28	19.56	14.83

In our study, we observed 93.7% CT sensitivity among males and 94.9% among females. Comparatively the specificity rate of females is low as compared to men (89.5% and 90% respectively). Total 92% accuracy of CT found in our results.

Table 3: CT measurements of selected participants

Criteria	Overall	Female %	Male %
Sensitivity %	94.2 (87.75- 97.83)	94.9	93.7
Specificity %	90 (74.49- 96.24)	89.5	90
PPV %	94.2 (87.75 - 97.83)	90.2	96.7

NPV %	90 (79.49-96.24)	81.8	94.4
(+) LR %	9.42 (4.40- 20.15)	9.37	9.01
(-) LR %	0.06 (0.03 - 0.14)	0.57	0.07
Accuracy %	92.6	92.2	92.8

We observed 85.4% sensitivity and 65.0% specificity with 2.4411PLR and 0.224 NLR in the Alvarado score. At the same time, sensitivity and specificity of CT were relatively good 94.2, 90, respectively, with 9.4175 PLR and 0.0647 NLR.[17]

Table 4: Comparative table of Alvarado score and CT

Criteria	CT	Alvarado score	p-value
Sensitivity %	94.2	85.4	0.0382
Specificity %	65	90	0.0010
PLR %	2.4411	9.4175	0.0003
NLR %	0.224	0.0647	0.0101

Discussion

Acute appendicitis is considered one of the primary reasons for abdominal pain and needs emergency treatment. In the United States, every year, 250,000 cases of appendicitis are reported. All around the world, this condition on sights demands surgical interventions. Even though the number of acute appendicitis cases expanded day by day, still, its diagnosis remains challenging for many physicians.[1] The initial symptoms are so vague that sometimes its hard to indicate the upcoming severity of the disease [2]. This research was conducted for histological analysis of acute appendicitis cases with the help of CT. In this study we use Alvarado scoring system which was first introduced in 1986 used for the diagnosis of acute appendicitis. In this study scoring system is based on the symptoms, signs, and tests in suspected patients. It is a 10 point score we used to achieve better results and measure the future risk factors of patients [18]. This clinical score procedure further help us in reduction of admission in hospital and minimize negative appendectomy rates.[19 In past] some studies observed that the clinical scoring system is enough to analyze suspected patients. It also reduces the imaging need and laparoscopic surgeries among acute appendicitis patients.[19] But in other studies, the Alvarado score did not provide enough information and was used by the emergency department only to reduce the hospital stay and avoid imaging on patients. So, we conducted this study to check the performance of Alvarado scoring system in our study. An extensive retrospective study found 9 Alvarado scores on their total male population confirmed by the surgical pathology [20]. In our study, we saw an average of 7.5 scores on the male population comparatively low as compared to female population of our study (7.74 average store). While comparing these results another study those researchers found ten ratings of Alvarado score on the female population [19], whereas our studies only found 7.74 average scores which provides a big distinction in both studies. Some studies demonstrate that the Alvarado score is not enough to differentiate complicated and uncomplicated cases.[21,22] But our studies found 77.5% accuracy of Alvarado score. For measuring the risk factors many researchers used the RIPASA scoring system for getting better sensitivity and specificity and failed to gain better results through the Alvarado score.[23] Many researchers found 90% specificity and sensitivity in adults with the help of Alvarado score. Our results were only in accordance to the previous study of Singala [24]. The 90% studies which designed for measuring the AS score on the behalf of ethnicity failed to prove the benefit of AS in acute appendicitis [25]. So due to these poor results we avoid the ethnicity factor.

In 2016, a prospective study was performed by Tan et al. in which he compared the Alvarado score and CT findings of 350 acute appendicitis cases found a high Alvarado score along with positive likelihood ratio as compare to the CT.[26] But in our research, we found a high likelihood ratio of the CT (9.41%) than Alvarado patients (2.4411%). Different studies revealed 78.9% sensitivity and 80% specificity among the Alvarado group.[27,28] But these studies were explicitly designed for studying pregnant females. These studies associate the Alvarado score with the vomiting and Nausea conditions of female pregnancy. Our focus was not particularly on pregnant women still, we found overall 85.4% sensitivity, from which 79.7% sensitivity score was notified among the female groups. But on the other hand, we found a massive difference in the findings related to the specificity of the Alvarado group. We observed 65% overall specificity, with 38% specificity among the female population.

Many studies found that fever, right lower quadrant tender, and neutrophilia are the significant sensitive markers in predicting acute appendicitis.[29] We only examine fever and right tenderness. Our studies found 22.4 mean duration of symptoms from which right tenderness was on a high score. In one of the studies, the researcher found top (65%) positive tender value in predicting acute appendicitis.

Computed tomography is the best imaging option in male patients. However, it is not a viable option for children and women due to their radiation risk. But physicians used a low dose of CT for women and children.[30] It is considered as the best technique to avoid negative appendectomies from 25% to 3% among acute appendicitis cases.[31] In past years Alvarado score is observed as a helpful technique to find a correlation between histopathological findings and screen imaging. In the past, a good source of information was produced to keep the Alvarado score and imaging correlation for pregnant women and pediatric patients.[32] However, there is very little literature on the Alvarado score of acute appendicitis. In the majority of our study population, we observed AS score equivalent to 5. Only 30% of the this study population is diagnosed with acute appendicitis on CT imaging with AS score of 6.[33]

CT scan criteria were beneficial for our study. Our results of CT are in correspondence to many previous studies.[33,34] Many studies were previously conducted on the thickened appendix (6mm) due to wall enhancement, appendicolith, peri-appendiceal fat stranding, enlarged adjacent mesenteric lymph nodes, that enhances the risk in acute appendicitis.[35,36] For this study, CT was generally conducted by the general surgeon instead of an emergency department. In previous research of Yazıcı P et al.[37] We observed high AS score among the patients who were referred to the general surgeon at the initial stage. CT performance was relatively good (92.6%) in our study.

In our study, the initial Alvarado score was far good in females as compared to the male. The overall accuracy of CT was observed 92.6% among all cases of our study. We did not perform any laparoscopy in our study due to its high cost but we suggest it for further studies, on the other hand, it will miss the cases of microscopic appendicitis which may increase the cases of NARs. Due to the limitation of our study we did not perform any surgical intervention especially did not get any CT imaging of acute cases after surgery.

Conclusion

After performing this research, we conclude that the diagnosis of acute appendicitis through clinical indication and physical inspection is challenging. The value of the likelihood ratio is low in patients of acute appendicitis. CT imaging assists in determining the stage of appendicitis in many patients. But due to its high radiation number of CT imaging decrease day by day. Alvarado score is a useful tool for minimizing negative appendectomy, but it's hard to distinguish the complex cases of appendicitis through Alvarado score. Correlation of Alvarado score and CT imaging may lessen the hospital stay and overwhelm the burden on the health care department. But it is a consuming and lengthened method. In patients with low Alvarado score, Computed tomography is a reasonable solution for the identification of specific or alternative diagnoses among them.

Conflict of interest

There was no conflict of research during studies.

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