REVIEW ARTICLE

PREDICTIVE VALUE OF PEDIATRIC APPENDICITIS SCORE, NEUTROPHIL-TO-LYMPHOCYTE RATIO AND ULTRASOUND IN PEDIATRIC ACUTE APPENDICITIS

[1,2]Erdenetsetseg Ch, [1]Bayartsetseg, A., [2]Ganbayar, G., [4]Ganbayar, L., [3]Davaalkham, D., [1]Zorig, D. and [1]Puntsag, Ch

[1]Department of Surgery, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
[2]Mongolian-Japan Teaching Hospital, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
[3]School of Public Health, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
[4] Mongolian National Center for Maternal and Child Health Hospital, Ulaanbaatar, Mongolia

ARTICLE INFO	**ABSTRACT**

Acute appendicitis is the common cause of surgery for acute abdominal pain in children. The diagnosis of acute appendicitis in pediatric patients remains a challenge internationally. This disease is most common among patients between the age of 10 and 19 years old. The aim of the study was to evaluate whether neutrophil-lymphocyte ratio (NLR) and ultrasound (US) results on admission could aid the diagnostic accuracy of the Pediatric Appendicitis Score (PAS) in pediatric patients with suspected acute appendicitis. Our study was performed on 480 children admitted for suspected acute appendicitis and underwent appendectomy at the MCHHC, Ulaanbaatar Mongolia, between May 2019 and December 2019. Patients were categorized into three groups based on the value of their PAS. The diagnosis of appendicitis was confirmed postoperatively with a histological study. Negative (NPV) and positive predictive values (PPV) of PAS, NLR and ultrasound were calculated. In the diagnosis of acute appendicitis in pediatric patients, the NLR and ultrasound methods are equivalent in terms of diagnostic accuracy. In children with a PAS value of 4 and 5, it more effective to use a combination of ultrasound and NLR to diagnose accurately.

INTRODUCTION

Acute appendicitis is the common cause of surgery for acute abdominal pain in children. The diagnosis of acute appendicitis in pediatric patients remains a challenge internationally. This disease is most common among patients between the age of 10 and 19 years old (Daldal, 2020). The main curative treatment is surgical remove of the appendix. Antibiotics can be used to treat uncomplicated cases (Varadhan, 2010; Wilms, 2011; Styrud, 2006). The surgical removal of a healthy appendix occurs in 15% of male patients and 26% of female patients with suspected appendicitis (Flum, 2002). The most common symptoms of appendicitis are pain in the right lower abdomen, nausea, vomiting and loss of appetite. In pediatric patients about 30% of cases have an abnormal presentation (Daldal, 2020; Jones, 2004).

Corresponding author: [2]**Erdenetsetseg Ch**
Department of Surgery, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia.
[2]Mongolian-Japan Teaching Hospital, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia.

A possible postoperative complication is the formation of adhesion at the site of the surgery which may lead to the obstruction of the bowel and lead to a second operation (Hansson, 2014). Delaying the treatment does not only increase the risk of complications but can also lead to death. Therefore, adequate diagnosis is essential to reduce the risk of unnecessary surgeries and perforation (Andersson, 2007). In recent years, there has been a significant increase in the use of imaging techniques in the diagnosis of acute appendicitis. Studies have shown that CT scans have a sensitivity and specificity of up to 95% in diagnosing appendicitis (Pickhardt, 2011; Rao, 1998). However, CT scans carry the risk of exposing children to radiation (Pogorelic, 2015; Russell, 2013). In addition, the increase in the outer width of the appendix is important in the diagnosis of appendicitis (Chabanova, 2011). Also, researches continue to confirm the effectiveness of blood cell tests. Numerous studies have highlighted the white blood cell, neutrophil to lymphocytes ratio, neutrophil cells, lymphocytes, C- reactive protein, mean platelet volume and platelet count in this study, (Boshnak, 2018; Shimizu et al., 2016; Khan, 2018; Poudel, 2017). The

aim of the study was to evaluate whether neutrophil-lymphocyte ratio (NLR) and ultrasound (US) results on admission could aid the diagnostic accuracy of the Pediatric Appendicitis Score (PAS) in pediatric patients with suspected acute appendicitis.

MATERIALS AND METHODS

Our study was performed on 480 children admitted for suspected acute appendicitis and underwent appendectomy at the MCHHC, Ulaanbaatar Mongolia, between May 2019 and December 2019. The diagnosis of suspected appendicitis was established preoperatively by one of the consultant pediatric surgeons. We recorded their information, physical examination signs and key laboratory results (neutrophil count, lymphocyte count, white blood cell count). Ultrasound was performed by experienced pediatric radiologists. Ultrasound were classified as positive or negative indicating the presence or the absence of an appendicitis. A positive report was considered when the maximum outer diameter of the appendix was greater than 7.5mm for PAS 3,4,5 and greater than 6.5mm for PAS ≥6. When the appendix couldn't be visualized using ultrasound imaging, indirect signs were assessed. Greater than 2 signs of appendicitis (large amounts of free fluid, enlargement of lymphoid tissue, or pericecal inflammatory fat changes) granted a positive report.

Negative reports included those in which the appendix measured less than 7.5mm for PAS 3,4,5 and less than 6.5 mm for PAS ≥6 and those without visualization of the appendix on ultrasound nor greater than two indirect signs of appendicitis. NLR upper reference limit for NLR was greater than 7 for PAS 3≥, 5.8 for PAS 4-5, 4.3 for PAS ≥6. Patients were categorized into three groups based on the value of their PAS. The diagnosis of appendicitis was confirmed postoperatively with a histological study. Negative (NPV) and positive predictive values (PPV) of PAS, NLR and ultrasound were calculated. Statistical significance was set at $p<0.05$. All data was analyzed using SPSS (Version 20.0,SPSS Inc., Chicago, IL, USA).

RESULTS

516 pediatric patients (≤18 years old) were suspected of having acute appendicitis and subsequently underwent surgery. 36 patients did not meet the selection criteria for this study and were excluded. From a total of 480 patients, 56% (n=269) were male, 44% (n=411) were female (gender ratio was 1.3:1). The average age was 10.57 ±3.53. The average duration of the disease was 58 ±49.8 hours and 93.3% of the patients presented with pain in the right lower abdomen. The histological examination noted that 33.9% were uncomplicated, 66.9% were severe and 25% (n=119) had no signs of appendicitis.

Table 1 . Clinical signs noted during PAS evaluation

№	Clinical signs of PAS	Value
1	Migration of pain to RLQ	1
2	Anorexia	1
3	Nausea and vomiting	1
4	Elevation of Temperature> 38^0 C	1
5	Pain in the right lower abdomen	2
6	Cough/percussion/heel tapping tenderness at RLQ	2
7	Leukocytosis >$10x10^9$/l	1
8	Left shift (Neutrophilia > 75%)	1
9	Total	10

Table 2.Clinical assessment of PAS and diagnostic accuracy of NLR and USG

	PAS	NLR	PAS+NLR	US	PAS+US	PAS+NLR+US
Sensitivity	90.8%	89.4%	94.4%	65.05%	94.1%	97.08%
Specificity	81.6%	83.3%	63.6%	87.2%	86.3%	100%
Positive predictive value	93.6%	94.15%	97.4%	92%	99%	100%
Negative predictive value	74.8%	72.4%	43.7%	35.8%	50%	47.05%
Diagnostic accuracy	88.5%	87.9%	92.5%	83.8%	93.6%	97.1%

Table 3. Negative and positive predictive values by PAS

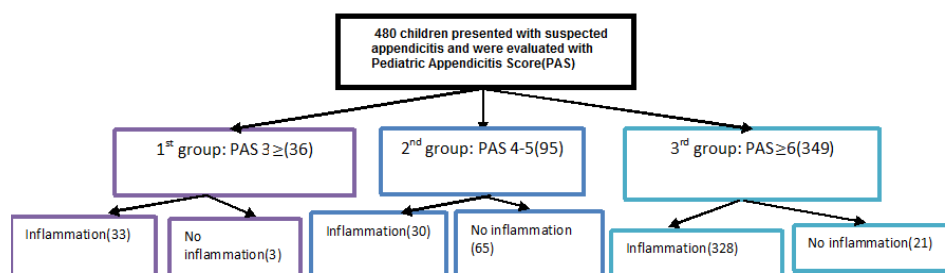| PAS	PV	PAS	PAS+NLR	PAS+US	PAS+NLR+US
≤3	NPV	80.5%	100%	100%	100%
4-5	NPV	62.2%	86.5%	87.4%	93.1%
≥6	PPV	93.6%	97.4%	99%	100%

Figure 3. Categorization of patients based on their PAS.

The sensitivity, specificity, positive and negative predictive values of PAS, NLR and ultrasound are presented in Table 2. PAS scoring system. The positive and negative predictive values by PAS category (≤3, 4-5,≥6) are presented in Table 3.

DISCUSSION

Acute appendicitis is the leading cause of emergency abdominal surgery in children. Early diagnosis reduces the risk of complications such as perforation and reduces the risks of performing surgery on a non-inflammatory appendix. According to Becker et al., 44% of all patients with acute appendicitis present with 6 or more abnormal signs(18). Diagnostic methods used vary across countries and between hospitals. The international community identified the use of peripheral blood tests, ultrasounds, CT scans and MRI imaging as the main diagnostic methods. A presentation to the hospital more than 24h after the onset of symptoms related to appendicitis correspond to an increased risk of perforation. Although acute appendicitis may present at any age, the diagnosis of this disease in children is more complex. The general symptoms they have may be caused by other common pediatric diseases. Perforation of the appendix occurs in 10-20% of cases in patients between 10-17 years of age. 80-100% of those cases occur in children under 3 years of age.In addition, 10-30% of suspected appendicitis are negative following the surgical investigation (Hansson et al., 2014).

The definitive method of diagnosis has not been yet identified. Clinical and computer-based diagnostic methods improved the accurate diagnosis of appendicitis in adults and reduced surgical interventions on non-inflammatory appendices. These findings were mainly reported on adult patients and very rarely reported in children. This study is the first of its kind in our country to assess the diagnostic methods that are currently used internationally to diagnose acute appendicitis in children. We observed that aggregating the PAS values into categories (low risk for PAS of 3, medium risk for PAS of 4-5, high risk for PAS ≥ 6) improved the diagnostic accuracy of the score. In our study, the diagnostic potential of peripheral blood NRL is higher than that of ultrasound to diagnose acute appendicitis. Determining the cut-off value of NLR in the low, medium, and highrisk groups of PAS values increased the diagnostic accuracy. Researchers believe that the PAS scoring system is better than the introduction of other numerous scoring systems. Recent studies have shown that a number of biomarkers have been studied in the diagnosis of acute appendicitis in children. NLR is simple, easy to perform, accessible, and superior in diagnostic capacity. In addition, a number of studies have been conducted on the diagnostic criteria when using ultrasound to diagnose appendicitis. Although the results of our study indicate that ultrasound is an accurate diagnostic method, it is not always possible to perform such investigation in the early stages of the evaluation. Thus, the NLR may be more appropriate. In a tertiary care hospital, the usage of all three diagnostic methods are appropriate. Other studies have also shown that in our country, it is possible to diagnose acute appendicitis without the use of CT which is associated with higher cost and low access, especially in children to whom we need to reduce exposure to high radiation.

Conclusion

In the diagnosis of acute appendicitis in pediatric patients, the NLR and ultrasound methods are equivalent in terms of diagnostic accuracy. In children with a PAS value of 4 and 5, it more effective to use a combination of ultrasound and NLR to diagnose accurately.

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