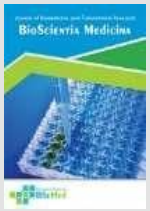
eISSN (Online): 2598-0580



Bioscientia Medicina: Journal of Biomedicine & Translational Research

Journal Homepage: www.bioscmed.com

Sodium Levels as a Predicting Factor for the Occurrence of Perforated Appendicitis in Children at Dr. M. Djamil General Hospital Padang

Syukri Alhamda[1*], Jon Efendi[1], Budi Pratama Arnofyan[1]

[1]Department of Surgery, Faculty of Medicine, Universitas Andalas, Padang, Indonesia

ARTICLE INFO

Keywords:
Perforated appendicitis
Hyponatremia
Predictive factors

***Corresponding author:**
Syukri Alhamda

E-mail address:
tanjudinalasi@gmail.com

All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/bsm.v6i9.571

A B S T R A C T

Background: Perforation of the appendix can lead to life-threatening complications. Early identification of a perforation before surgery has important clinical implications. Hyponatremia was previously proposed as a marker to differentiate between perforated and non-perforated acute appendicitis. This study aims to determine the role of sodium levels as a predictive factor in the incidence of perforated appendicitis in children at Dr. M. Djamil General Hospital Padang. **Methods:** This research is an analytic observational study with a cross-sectional design. The research took place from March to May 2022 at Dr. M. Djamil General Hospital Padang. Samples were taken by consecutive sampling with criteria aged 0-18 years and diagnosed with acute appendicitis at Dr. M. Djamil General Hospital Padang. **Results:** A total of 112 samples with most of the patients (52.7%) aged 6-11 years and found a greater proportion of men (57.1%). Most of the patients underwent laparotomy procedures (57.2%). Hyponatremia was found in 58% of patients. Perforation occurred in most (59.8%) patients. SPSS results showed a significant difference between the incidence of hyponatremia in perforated and non-perforated appendicitis with a p-value <0.001. **Conclusion:** There is a significant relationship between sodium levels and the incidence of perforation, where the lower the sodium level, the higher the incidence of perforation.

1. Introduction

Appendicitis is inflammation of the vermiform appendix. Acute appendicitis and its complications are indications for emergency surgical intervention in clinical practice. In clinical terms, acute appendicitis is divided into simple and complicated. Complicated appendicitis includes appendiceal mass, appendiceal abscess, and perforated appendicitis.[1–3] Appendicitis is one of the most common causes of acute abdominal pain, with a lifetime risk of 8.6% in men and 6.7% in women. Appendicitis most commonly occurs between the ages of 5 and 45 years. In 2019, there were an estimated 17.7 million cases with an incidence of 228/100,000 and 33,400 deaths.[1,4,5] Less than 19% of children develop acute complications of appendicitis. Therefore, most children with acute appendicitis who do not have perforation can be considered for non-operative or operative therapy. Non-operative therapy in acute appendicitis without perforation has a 97% effectiveness with antibiotics. Non-operative therapy also leads to lower morbidity, fewer days of hospitalization, and lower costs than operative therapy.[5]

Although acute appendicitis is successfully treated with early diagnosis and an appropriate approach, perforation can occur in 16-39% of cases and can lead to life-threatening complications. Perforated

appendicitis is 3 times more likely to cause morbidity than appendicitis without perforation.[6] Perforated appendicitis may lead to local abscess or peritonitis.[7] Perforation is an important factor in patient morbidity and is associated with an increased frequency of postoperative complications. Early identification of the presence of perforation before surgery and surgical intervention in patients with perforated appendicitis has important clinical implications.[8] A total of 24 patients had perforated appendicitis out of 44 patients with appendicitis overall, which is quite high (>50%) so it is quite worrying.[9] Previously, several markers have been proposed as predictors to differentiate perforated and non-perforated appendicitis. Leukocytes, CRP, and neutrophils have been used to differentiate these two types of appendicitis, but high sensitivity and low specificity have been found in many studies, making it difficult to distinguish simple acute appendicitis from perforated appendicitis.[10] Leukocyte and neutrophil counts in patients with suspected acute appendicitis in the ED are not helpful in determining the risk of perforated appendicitis.[11] Several recent studies have proposed hyponatremia as a marker to differentiate between perforated and non-perforated acute appendicitis. Interleukin levels IL-1b and IL-6, which play a role in the inflammatory response, are increased in cases of perforated appendicitis and increase antidiuretic hormone (ADH), causing hyponatremia.[7,8]

Children with perforated appendicitis had a longer duration of symptoms, higher leukocyte counts, CRP levels, neutrophil percentages, and lower serum sodium levels. Serum sodium was significantly lower in children with acute perforated appendicitis.[10] There was an association between hyponatremia and perforated appendicitis in 7 studies conducted in six different countries.[8] In patients with perforated appendicitis, there is a lower sodium value, and this study proposes hyponatremia as a marker of perforated appendicitis in the pediatric population due to the high sensitivity and specificity values, namely 94.7% and 88.5%, respectively.[12] A study used a threshold value of 134 mEq/L and found sodium levels lower than this limit as a predictor of perforated appendicitis.[7] assessment is very important in cases of acute appendicitis to assess the possibility of perforation because it is cheaper than the testing other inflammatory markers that have been used previously such as CRP.[6] This study aims to determine the role of sodium levels as a predictor of the incidence of perforated appendicitis in Dr. M. Djamil General Hospital, Padang.

2. Methods

This study is an analytical observational study with a cross-sectional to see the relationship between sodium levels and perforated appendicitis in children. This study used data from the medical records of acute appendicitis patients who were treated at Dr. M. Djamil General Hospital, Padang. A total of 112 subjects participated in this study, of which the research subjects met the inclusion criteria: patients diagnosed with acute appendicitis at Dr. M. Djamil General Hospital, Padang aged 0-18 years, and patients who have complete medical record data and sodium laboratory results. This study has been approved by the medical and health research ethics committee of Dr. M. Djamil General Hospital, Padang, Indonesia (No. LB.02.02/5.7/168/2022).

Univariate analysis was used to describe the frequency distribution of research variables in tabular form. Bivariate analysis was performed using the Chi-Square test to see a significant relationship between sodium levels and the incidence of perforated appendicitis. It is said to be meaningful if the p-value < 0.05. All data were analyzed using a computer program and SPSS version 25.

3. Results

Table 1 shows that the age group with acute appendicitis is 6-11 years old, which is 59 patients (52.7%), then 12-18 years old, as many as 34 patients. (30.4%) and age 0-5 years 19 patients (17%). The highest proportion of gender in cases of acute appendicitis was male (57.1%). Most of the acute appendicitis patients underwent a laparotomy

procedure (57.2%), then 30.4% underwent laparoscopy, and the rest (12.5%) underwent appendictomy. Based on the data, hyponatremia occurred in 65 (58%) patients, while 45 (40.2%) patients had normonatremia, and 2 (1.8%) patients had hypernatremia. From 112 samples of acute appendicitis, 67 (59.8%) patients had perforation.

Table 1. Characteristics of research samples

Characteristics	Frequency	%
Age		
0-5 years	19	17.0
6-11 years	59	52.7
12-18 years	34	30.4
Gender		
Female	48	42.9
Male	64	57.1
Sodium levels		
Hyponatremia (<135)	65	58.0
Normonatremia (135-145)	45	40.2
Hypernatremia (>145)	2	1.8
Treatment		
Appendicectomy	14	12.5
Laparoscopic	34	30.4
Laparotomy	64	57.2
Appendicitis		
Non-perforated	45	40.2
Perforated	67	59.8

Table 2. Relationship of sodium levels and incidence of perforated and non-perforated appendicitis.

Sodium level	Appendicitis				p-value
	Non-perforation		Perforation		
	Frequency	%	Frequency	%	
Hyponatremia	4	6.2	61	93.8	<0.001
Normonatremia	39	86.7	6	13.3	
Hypernatremia	2	10.0	0	0.0	

Table 2 shows that out of 65 patients who had hyponatremia, 61 patients (93.8%) are perforated appendicitis, and data obtained that most patients with non-perforated appendicitis have normal sodium levels. From the chi-square test, a p-value <0.001 was obtained, which indicated that there was a significant difference between the incidence of hyponatremia in perforated and non-perforated appendicitis.

4. Discussion

The serum sodium level is a low-cost routine laboratory test that can act as an additional marker to assist surgeons in the early identification of gangrenous or perforated acute appendicitis. Another study found that hyponatremia (≤134 mmol/L) was independently associated with intestinal ischemia, and this finding appears to be related to the etiology of ischemia in perforated appendicitis. In a study evaluating the association between hyponatremia and complicated appendicitis in children, it was found that the risk of complicated appendicitis was increased 3-fold in patients with hyponatremia. Other studies also found the same thing where hyponatremia had the strongest relationship with appendicitis outcome. In addition to assessing the possibility of perforation, it was reported that several independent factors, such as age younger than 5 years, duration of symptoms more than 24 hours, and hyponatremia were at risk of developing other complicated appendicitis. The theory of hyponatremia as a marker is based on ADH.

Cytokines that cross the blood-brain barrier act on neurons originating in the supraoptic and paraventricular nuclei and transduce their signaling via activation of Janus tyrosine kinases (JAK) and related transcription factors, the so-called signal transducer and activator of transcription (STAT) family. Furthermore, cytokine-mediated non-osmotic ADH secretion results in increased renal tubular free water reabsorption and dilutional hyponatremia.[12-15]

In this study, there were 4 patients with non-perforated appendicitis who had hyponatremia. Previous studies also found that 29.1% of patients with non-complicated appendicitis had hyponatremia. This study states that although sodium is a predictor of complicated appendicitis, its sensitivity and specificity are still low. Another study also found that 2.5% of patients with non-perforated appendicitis had hyponatremia. In addition to infection that enters the blood vessels, hyponatremia can occur due to the release of electrolytes through vomiting or diarrhea experienced by patients with acute appendicitis, so although sodium is decreased more in patients with complicated appendicitis, a decrease in sodium may occur in acute appendicitis in general due to vomiting symptoms, and diarrhea experienced by the patient. In addition, the inflammatory response in each individual can also be different, so the infection threshold to cause cytokine release is also different per individual. As previously discussed, hyponatremia is influenced by the release of cytokines that cause a decrease in ADH, which leads to hyponatremia.[16-19]

5. Conclusion

There is a significant relationship between sodium levels and the incidence of perforation, where the lower the sodium level, the higher the incidence of perforation.

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