

ORIGINAL ARTICLE

Analysis of Risk Factors for Appendicitis in Children: A Multicenter Epidemiological Study**Çocuklarda apandisit için risk faktörleri analizi: Çok merkezli epidemiyolojik çalışma**

Serkan Arslan¹, Bahattin Aydogdu¹, Mehmet Serif Arslan¹, Hikmet Zeytun¹, Mehmet Hanifi Okur¹, Erol Basuguy¹, Ali Erdal Karakaya², Ibrahim Uygun¹, Selcuk Otcu¹

¹ Department of Pediatric Surgery, Medical Faculty of Dicle University, 21280 Diyarbakir, Turkey

² Department of Pediatric Surgery, Medical Faculty of Sutcu Imam University, Kahramanmaraş, Turkey

Corresponding author: Serkan Arslan, Dicle Üniversitesi Tıp Fakültesi, Çocuk Cerrahi A.D. Diyarbakir, Turkey

e_mail: drserkanarslan@hotmail.com

Abstract

Objectives: In our study, the assessment of age, gender, incidence and seasonal differences in the regions related to appendicitis were investigated.

Methods: 676 patients that received an operation following a diagnosis of appendicitis in 3 hospitals from 3 different regions of Turkey occurring at different dates were examined retrospectively after being categorized by region. The differences among groups were compared to each.

Results: The mean age of male (63%) (n = 426) and female (37%) (n = 250) patients (total = 676) was 10.8 years (range, 1-18 years). The percentage of female patients in the The Black Sea Region (BR) group was significantly higher (48%) than that in the other two groups (%33 for SR, 30% for MR) (P = 0.001). The frequency of appendicitis was higher (36%) in the spring and winter (25%) than that during summer or fall. The number of cases increased the most in the BR group in spring (47%) (P < 0.001). When the types of appendicitis in the different age groups were compared with season, acute appendicitis (P < 0.02) was more frequently (93%) seen in the child-adolesan (CA) group in the spring; however, perforated appendicitis (45%) was greater in the Infant-Preschool (IPS) group (P < 0.02). Acute appendicitis comprised 55% and perforated appendicitis comprised 45% of cases in the IPS group, whereas acute appendicitis comprised 78% and perforated appendicitis comprised 22% in the CA group.

Conclusion: According to the results of our study, appendicitis was most frequently seen in the spring and winter seasons and more frequent in boys between the ages of 10-13 years. As age decreases, the frequency of perforated appendicitis increases. Appendicitis is affected by environmental factors. Reducing the incidence of appendicitis may be possible by establishing regional and specific studies related to this subject and the etiologies of the disease.

Key words: Season, children, regional, appendicitis, age.

Özet

Amaç: Çalışmamızda apandisitinin yaşı, cinsiyeti, insidansı ve mevsimsel olarak bölgesel farklılıkların değerlendirilmesi amaçlanmıştır.

Yöntemler: Bu çalışmada Türkiye'nin 3 farklı bölgesindeki, 3 hastanede çeşitli tarihlerde apandisit tanısı ile ameliyat edilen 676 hasta bölgelerine göre gruplandırılarak gruplar arasındaki farklar birbirleri ile karşılaştırıldı.

Bulgular: Toplamda (n = 676) hastaların %63'ü (n = 426) erkek, %37'si (n = 250) kız, yaş ortalaması 10.8 yıl (range, 1-18 years) idi. The Black Sea Region (karadeniz bölgesi) (BR) grubundaki kız hastaların yüzdesi diğer iki gruba karşılaştırıldığında istatistiksel olarak anlamlı derece yüksek (%45, p=0.001) idi. Mevsimsel olarak değerlendirildiğinde en sık (%36) ilkbahar ve kış (%25) aylarında apandisit rastlandı. İlkbaharda en çok BR grubunda hasta sayısı artmıştır (P < 0.001). Farklı yaş gruplarında apandisitinin tipi mevsimler olarak karşılaştırıldığı zaman akut apandisit (%93) ilkbaharda child-adolesan (çocuk-erişkin) (CA) grubunda daha sık idi (P < 0.02). Ancak perforasyon (%45) Infant-Preschool (bebek-okul öncesi) (IPS) grubunda daha fazla idi (P < 0.02). IPS grubunda Akut apandisit %55, perforated apandisit %45 buna karşın CA grubunda akut apandisit %78, perforated apandisit %22 oranında görüldü.

Sonuç: Çalışmamızın sonuçlarına göre apandisit en sık ilkbahar ve kış mevsimlerinde, 10-13 yaşlar arasındaki erkek çocuklarda daha çok görülmüştür. Yaş küçüldükçe perforated apandisit sıklığı artmıştır. Apandisit çevresel faktörlerden etkilenmektedir. Bu konuda yapılacak bölgesel ve spesifik çalışmalar ile etiolojiler tespit edilerek apandisitinin azaltılması gelecekte mümkün olabilir.

Anahtar kelimeler: Mevsim, çocuk, bölgesel, apandisit, yaş

INTRODUCTION

Appendicitis is an inflammation of the appendix vermiformis and is the most common surgical condition in children who present with abdominal pain. About 7% of people may have appendicitis in any period of their lives [1]. The cause of acute appendicitis is unknown but is probably multifactorial. It may be induced by various factors, such as genetic predisposition, various infections, vascular diseases, stress, and cigarette smoking. Several studies have reported a correlation between appendicitis and season [2,3]. Although studies related to age, sex, and seasonal differences have been carried out, the reason for these variations remain unclear [4-6].

Although appendicitis is a common surgical condition in children, little information is known about its epidemiology in Turkey [3]. Thus, in our study, age, sex, incidence of appendicitis, and seasonal differences were investigated.

METHODS

In this study, 676 patients who underwent surgery at different times following a diagnosis of appendicitis at three hospitals from three regions in Turkey were examined retrospectively after being categorized by region [Southeast Anatolia Region (SR) group (n = 231), January 2009–May 2014, Dicle University Hospital; The Black Sea Region (BR) group (n = 218), January 2012–May 2013, Kastamonu Dr. Munif Islamoglu Children's Hospital; Mediterranean Region (MR) group (n = 171), and January 2011–January 2014, Necip Fazil Kahramanmaras Children's Hospital]. Negative appendectomies were not included in the study. The patients were also classified into two groups [0–5 years, Infant-Preschool (IPS) group; 5–18 years, Child-Adolescent (CA) group] by age. Differences among groups were compared after age, sex, and type of appendicitis (acute/perforation) were considered, within the context of season of the operation and region.

It was performed ultrasonography (US) to patients who thought apandisitis. However, in patients it was not decided by the US, we decided with clinical follow-up or computed tomography for surgery. In addition it was performed on hemogram, electrolyte, coagulation factors, hepatitis markers before surgery.

The data were statistically analyzed with SPSS ver. 15.0 for Windows software (SPSS Inc., Chicago, IL, USA). A chi-square test and one-way analysis of variance were used for data analysis. A P-value < 0.05 was considered statistically significant.

RESULTS

The median age of male (63%) (n = 426) and female (37%) (n = 250) patients (total = 676) was 10.8 years (range, 1–18 years). The percentage of female patients in the BR group was significantly higher (48%) than that in the other two groups (33% for SR, 30% for MR) (P = 0.001). The frequency of appendicitis was higher (36%) in the spring and winter (25%) than that during summer or fall. The number of cases increased the most in the BR group in spring (47%) (P < 0.001). The details are summarized in Table 1.

Table 1: Gender and seasonal comparisons of the patients (n=676) according to the regions. Gender was less frequently seen in females in BR region, compared to SR and MR (p<0.001). Frequency of appendicitis was significantly greater in the spring in the BR region, compared to SR and MR (p<0.001).

	SR (n=287) %	BR (n=218) %	MR (n=171) %	Total %	P
Male	193 (67)	113(52)	120 (70)	426(63)	
Female	94 (33)	105(48)	51 (30)	250(37)	0.001
Winter	113(39)	17 (29)	39 (22)	169(25)	
Spring	83 (29)	103 (47)	59 (34)	245 (36)	0.001
Summer	32 (11)	47 (21)	55 (32)	134(19)	
Autumn	59 (34)	51 (23)	18 (10)	128(18)	

Gender was less frequently seen in females in BR region, compared to SR and MR (p<0.001). Frequency of appendicitis was significantly greater in the spring in the BR region, compared to SR and MR (p<0.001).

[Southeast Anatolia Region group (SR); The Blacksea region group (BR); Mediterranean Region (MR)]

When the types of appendicitis in the different age groups were compared with season, appendicitis ($P < 0.02$) was more frequently (93%) seen in the CA group in the spring; however, perforation (45%) was greater in the IP group ($P < 0.025$). The range of ages according to season and type of appendicitis is summarized in Table 2.

Table 2: Acute/perforation and seasonal range of the age groups of the patients (n=676) Appendicitis frequency was greater in older children in the spring ($p=0.02$). The incidence rate of perforated appendicitis was greater in younger children ($p<0.001$) between 0-5 years Infant-Preschool (IPS), between 5-18 ages child-adolescent (CA)

	IPS Group (n=64) %	CA Group (n=612) %	Total n=676	
Summer	18 (13)	116 (87)	134 (20)	
Spring	18(7)	227(93)	245 (36)	0.025
Autumn	18 (14)	110 (86)	128 (19)	
Winter	10 (6)	158 (94)	169(25)	
Acute	35 (55)	478(78)	513	
Perforated	29 (45)	134 (22)	163	$P<0.001$

Appendicitis frequency was greater in older children in the spring ($p=0.02$). The incidence rate of perforated appendicitis was greater in younger children ($p<0.001$) between 0-5 years Infant-Preschool (IPS), between 5-18 ages child-adolescent (CA) ($p<0.001$). 0-5 year Infant-Preschool (IPS), 5-18 year child-adolescent (CA)

Sex did not have an effect on type of appendicitis or season. The details are summarized in Table 3.

Table 3: The seasonal acute/perforation range of the genders.

	Male (N=426) %	Female (n=250) %	Total (n=676)	P
Acute	317(62)	195 (38)	512 (76)	
Perforated	109(78)	55(22)	164(24)	0.542
	Male	Female		
Summer	79 (59)	55(41)	134 (20)	
Spring	151(62)	94 (38)	245 (36)	0.513
Autumn	85 (66)	43 (33)	128 (19)	
Winter	111 (66)	58 (34)	169(25)	

Acute appendicitis comprised 55% and perforated appendicitis comprised 45% of cases in the IPS group, whereas acute appendicitis comprised 78% and perforated appendicitis comprised 22% in the IP group. The details are summarized in Table 3.

DISCUSSION

Appendicitis in children is one of the most frequent reasons for acute abdominal pain. Many factors are associated with the etiology of appendicitis, including obliteration of the appendix lumen, lymphoid hyperplasia, and anatomical thinning and elongation of the appendix [4].

Appendicitis cases are frequently seen in patients 6–12 years of age and particularly in males > 10 years (3-5). The median age within the scope of our study was 10.8 years (range, 1–18 years); this was regionally comparable with the literature.

While the incidence of appendicitis over a lifetime is 7%, this rate can be 8% for males and 6% for females [4]. Noh et al. reported that 61% of patients were males and 39% were females [7], which was similar to our study, in which 63% of patients were male and 37% were female. However, age group may vary by region and season. Kapischke et al. reported that 52% of females and 48% of males in their cohort had appendicitis [8]. In our study, the sex ratio in BR was close to that in the study by Kapischke et al. While the ratios were closer to each other in BR, appendicitis was more frequently seen (58%, $P < 0.01$) in males in MR (70%) and SR (67%). Appendicitis was less frequently seen in girls in BR, compared with SR and MR when the regional range in the sex ratio was considered ($P < 0.001$). Moreover, the age group with the most cases of appendicitis varied seasonally. For example, appendicitis was specifically higher in males in BR in autumn (88%) but was more frequently seen in females in winter and spring. This may be due to appendicitis cases being affected by factors

related to the environment, sex, and differences in certain regions.

Changes in the frequency of appendicitis with season are controversial. Some studies show more cases of appendicitis in winter months, while others describe more in summer [9-12]. Yildiz et al. reported more appendicitis cases in autumn and spring months [1]. Many other studies have described an increased frequency of appendicitis in winter and autumn [13]. When we examined all regions in our study, appendicitis was most frequently seen in spring (36%), followed by winter (25%). Appendicitis was seen more frequently in winter in SR (39%), but it was more frequent in spring months in BR (47%) and MR (34%). The reason for this may be that upper respiratory tract infections and lymphoid hyperplasia induced by allergic diseases have higher incidence rates during winter and spring. Moreover, factors related to nutrition may also contribute. The incidence of appendicitis varied with regional differences in feeding habits; it was significantly higher in BR in spring, compared with SR and MR ($P < 0.001$). Appendicitis was more frequently seen in males during all seasons, and in males, it was most frequently seen during spring (35%).

The most frequent season for appendicitis in females was spring at a rate of 38%. No differences were detected between sex and season ($P = 0.513$).

In children with appendicitis, there are some gender differences. The frequency of perforated appendicitis in all children > 2 years is reported as 15–60%, and ranging between 50–70% in preschool age children [15,16]. The frequency of perforated appendicitis in all age groups was 44% in a study by Gunsar et al. [17]. Yildiz et al. reported that the rate of perforated appendicitis was 20%. In our study, the frequency of perforated appendicitis was 45% in children 0–5 years, 19% in those 5–18 years, and 21% among all age groups. Lower rates were reported by the present study and that by Yildiz et al, which may be attributed to an earlier diagnosis due to special

ultrasonography devices and experienced radiologists. However, a perforated appendicitis may be more frequent because an abdominal examination is more difficult to perform in younger children, with minimal patient adherence and because the patients cannot express themselves. The perforation rate increased significantly in the younger age groups ($P = 0.02$).

CONCLUSIONS

The frequency of appendicitis varied by season and region. Appendicitis was most frequently seen in spring and winter and more frequently in 10–13-year-old boys. The frequency of perforated appendicitis increased in younger children. Appendicitis is affected by environmental factors. Reducing the incidence of appendicitis may be possible by establishing regional and specific studies related to this subject and the etiologies of the disease.

Declaration of Conflicting Interests: The authors declare that they have no conflict of interest.

Financial Disclosure: No financial support was received.

REFERENCES

1. Yıldız T, Bozdağ Z, Erkorkmaz U, et al. Analysis of risk factors for the development of pediatric appendicitis. *Ulus Travma Acil Cerrahi Derg* 2013;19:554-8.
2. Oguntola AS, Adeoti ML, Oyemolade TA. Appendicitis: Trends in incidence, age, sex, and seasonal variations in South-Western Nigeria. *Ann Afr Med* 2010;9:213-7.
3. Al-Omran M, Mamdani M, McLeod RS. Epidemiologic features of acute appendicitis in Ontario, Canada. *Can J Surg* 2003;46:263-8.
4. Başaklar AC, Türkyılmaz Z. Karın ağrısı ve akut apandisit, In: Başaklar AC (ed), *Bebek ve Çocukların Cerrahi ve Ürolojik Hastalıkları*. Palme Yayıncılık, Ankara, 2006;pp:991-1013.
5. Sulu B, Günerhan Y, Palanci Y, İşler B, Çağlayan K. Epidemiological and demographic features of appendicitis and influences of several environmental factors. *Ulus Travma Acil Cerrahi Derg* 2010;16:38-42.
6. Yazici M, Ozkisacik S, Oztan MO, Gürsoy H. Neutrophil/lymphocyte ratio in the diagnosis of childhood appendicitis. *Turk J Pediatr* 2010;524:400-3.
7. Noh H, Chang SJ, Han A. The diagnostic values of preoperative laboratory markers in children with complicated appendicitis. *J Korean Surg Soc* 2012;834:237-41.
8. Kapischke M, Pries A, Caliebe A. Short term and long term results after open vs. laparoscopic appendectomy in childhood

- and adolescence: a subgroup analysis. *BMC Pediatr* 2013;13:154.
9. Stein GY, Rath-Wolfson L, Zeidman A, et al. Seasonal and day of the week variations of perforated appendicitis in US children. *Pediatr Surg Int* 2010;26:691-6.
10. Lee JH, Park YS, Choi JS. The epidemiology of appendicitis and appendectomy in South Korea: national registry data. *J Epidemiol* 2010;20:97-105.
11. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: racial, gender, and seasonal variation. *Epidemiology* 1991;2:323-30.
12. Choi JY, Ryoo E, Jo JH, et al. Risk factors of delayed diagnosis of acute appendicitis in children: for early detection of acute appendicitis. *Korean J Pediatr*. 2016;59:368-73.
13. Günşar C, Karaca İ, Ceylan H, et al. Sex differences in the epidemiology, seasonal variation, and trends in the management of patients with acute appendicitis. *Langenbecks Arch Surg* 2012;397:1087-92.
14. Salö M, Ohlsson B, Arnbjörnsson E, Stenström P. Appendicitis in children from a gender perspective. *Pediatr Surg Int*. 2015;31:845-53.
15. Curran TJ, Muenchow SK. The treatment of complicated appendicitis in children using peritoneal drainage: results from a public hospital. *J Pediatr Surg* 1993;28:204-8.
16. Neilson IR, Laberge J-M, Nguyen LT, et al. Appendicitis in children: current therapeutic recommendations. *J Pediatr Surg* 1990;25:1113-16.
17. Günşar C, Karaca İ, Ceylan H, et al. Diagnostic values of ultrasonographic criteria in the diagnosis of childhood acute and perforated appendicitis. *Akademik Gastroenteroloji Dergisi* 2004;3:88-92.