

The Effect of Body Mass Index on the Clinical Course of Appendicitis in Children

Apandisit Tanısı Alan Çocuklarda Beden Kitle İndeksinin Klinik Seyire Etkisi

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ABSTRACT Objective: A retrospective study was performed to evaluate the effect of body mass index (BMI) on the clinical course of appendicitis in children. **Material and Methods:** Patients between 6 and 18 years of age, who had undergone appendectomy in the last 2 years, were evaluated for age, sex, BMI, time from the beginning of complaints to diagnosis, acute or perforated appendicitis, duration of hospitalization and complications retrospectively. BMI was evaluated according to percentiles developed for Turkish children between 6 and 18 years of age. Patients with percentiles between 10 to 75 were accepted as the normal BMI group, lower than 10 was the low BMI group and more than 75 was assessed as the high BMI group. **Results:** Ninety-six patients were included in the study. The median age was 13 (min: 6, max:16) in the normal BMI group [n=37, male/female (M/F)=1.84], 12 (6-16) in the low BMI group (n=38, M/F=1.53) and 9 (6-15) in the high BMI group (n=21, M/F=3.2). The acute/perforated appendicitis ratios were 3.1, 2.8 and 1.3, respectively in the normal, low and high BMI groups. There was no significant difference between the groups regarding the time from the beginning of complaints to diagnosis and duration of hospitalization ($p>0.05$). Although complication rates showed no difference between the normal and low BMI groups, the high BMI group had a higher incidence of complications compared to the normal and low BMI groups ($p=0.04$ and $p=0.018$, respectively). The follow-up period of the patients were 2 months to 2 years and the most common complication was wound infection. **Conclusion:** Children with high BMI have higher complication rates during the clinical course of appendicitis compared to children with low and normal BMI.

Key Words: Body mass index; appendicitis; child

ÖZET Amaç: Apendektomi yapılan çocuklarda beden kitle indeksi (BKİ)'nin klinik seyire etkisini değerlendirmek amacıyla retrospektif bir çalışma yapılmıştır. **Gereç ve Yöntemler:** Son 2 yıl içerisinde apendektomi yapılan 6-18 yaş aralığındaki olgular; yaş, cinsiyet, BKİ, şikayetlerin başlamasından tanı anına kadar geçen süre, akut veya perfore apandisit olma durumu, yatis süresi ve komplikasyonlar açısından incelenmiştir. BKİ değerleri 6-18 yaş Türk çocukların için geliştirilen yaşa göre persentil eğilerine göre değerlendirildi. Persentil değerler 10-75 arası olan hastalar normal BKİ grubunu, 10'nun altında olanlar düşük BKİ grubunu, 75 üzerinde olanlar ise yüksek BKİ grubunu oluşturdu. **Bulgular:** Çalışmaya 96 hasta dâhil edildi. Normal BKİ grubunda [n: 37, erkek/kız (E/K):1,84] yaş ortancası 13 [çeyrekler arası aralık (caa): 11-14], düşük BKİ grubunda (n: 38, E/K: 1,53) 12 (caa: 10,5-14) ve yüksek BKİ grubunda (n:21, E/K: 3,2) 9 (caa:7-10,5) idi. Normal, düşük ve yüksek BKİ gruplarında akut/perfore apandisit oranları sırasıyla 3,1, 2,8 ve 1,3 olarak izlendi. Şikayetlerin başlamasında tanı anına kadar geçen süre ve yatis süreleri bakımından gruplar arasında fark yoktu ($p>0,05$). Normal ve düşük BKİ'li gruplar arasında komplikasyon sıklığı bakımından fark bulunmazken, yüksek BKİ olan grupta normal ve düşük BKİ'li gruba oranla komplikasyon oranlarında belirgin artış gözlandı ($p<0,05$). Hastaların izlem süreleri 2 ay ila 2 yıl arasında olup en sık görülen komplikasyon yara yeri enfeksiyonu olarak izlendi. **Sonuç:** BKİ'leri normale göre yüksek olan çocuklarda apendektomi sonrası görülen komplikasyon sıklığı artmaktadır.

Anahtar Kelimeler: Beden kitle indeksi; apandisit; çocuk

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Appendicitis is one of the most frequent emergency surgical conditions of childhood and the most common cause of abdominal surgery. A lifelong possibility of appendicitis is 7% on average and the mean age is around 11-12.¹ Although, several factors affect the clinical course of appendicitis, the increasing incidence of obesity among children becomes a matter of interest for evaluating the clinical course and outcome of appendicitis in children.

Obesity is associated with numerous physiological effects on cardiac, respiratory and immune functions.^{2,3} It has been thought that obesity increases the risk of surgical technical difficulty and problems that may develop during surgery and postoperatively in adult patients.³⁻⁶ In addition, it has been considered as an independent factor increasing the risk of wound infection.⁶ However, this matter has not been proven for the pediatric population.⁷ Therefore, a retrospective study was performed to evaluate effect of body mass index (BMI) on the clinical course and postoperative complications in children with appendicitis.

MATERIAL AND METHODS

A total number of 96 patients, aged between 6 and 18 years, who underwent open appendectomy within the previous two years were included in the study. Patients were divided into three groups according to their BMI such as normal, low and high BMI groups. BMI was evaluated according to percentiles developed for Turkish children between 6 and 18 years of age.⁸ The BMI groups were formed as normal for those with a BMI between the 10th and 75th percentile, low for those below the 10th percentile and high for those above the 75th percentile, according to the age-related percentile curves developed for Turkish children. Since BMI percentile was developed for children between 6 to 18 years of age, patients under the age of 6 were excluded.

The data for each group obtained from the medical reports were evaluated for age, gender, time until presentation, operative diagnosis (acute-perforated), duration of hospitalization and complications.

OPERATIVE PROCEDURE

All patients included in the study was operated by the same surgical team under general anesthesia. After a single dose antibiotic prophylaxis (sulbactam+ampicillin 40 mg/kg, ornidazole 15 mg/kg and amikacin 5 mg/kg), open appendectomy was performed via Rockey-Davis incision. A penrose drain was inserted into the peritoneal cavity in perforated cases. Postoperative antibiotic regimen included sulbactam+ampicillin (150 mg/kg/day), ornidazole (30 mg/kg/day) and amikacin (15 mg/kg/day) for 2 days for acute appendicitis and 7 days for perforated appendicitis. During the clinical course of appendicitis, antibiotic regimen and duration of antibiotic treatment reconstituted according to postoperative complications and peritoneal culture results. Therefore, all patients included in the study received the same antibiotic regimen during the postoperative period.

During follow-up, patients with incisional hyperemia, swelling, induration, wound discharge, breakdown or dehiscence were diagnosed with wound infection. In those cases, antibiotic treatment was prolonged until healing.

The groups were evaluated using the Kruskall-Wallis and the Chi-square tests. A p value <0.05 was accepted as significant. Descriptive values was given as median (min-max).

RESULTS

The median age was 13 in the normal BMI group (range 6-16 years), 12 in the low BMI group (range 6-16 years), and 9 in the high BMI group (range 6-15 years). The age difference between the groups was not statistically significant ($p>0.05$). The BMI was normal in 37 [male/female (M/F)=1.84], low in 38 (M/F=1.53) and high in 21 (M/F=3.2) of the 96 patients included in the study. The median time until diagnosis was 48 hours in all three groups. The rates of perforated appendicitis were 27%, 23.6% and 42.9% in the normal, low and high BMI groups, respectively. The perforation rates were evaluated with Chi-square test and no significant difference was found ($p>0.05$). The duration of hospitalization was 7 days (range 4-24), 6.5 days (range

4-12) and 7 days (range 4-25), respectively. No significant difference was detected among the groups for duration of hospitalization (Table 1).

The distribution of postoperative complications in groups was listed in Table 2. Analysis of the complications showed no statistically significant difference between the complication rates of the normal BMI group (21.6%) and the low BMI group (18.4%) while the complication rate of the high BMI group (52.4%) was significantly higher than the normal and low BMI groups ($p=0.04$ and $p=0.018$ respectively) (Table 1). Only one patient in the high BMI group required a second surgery for adhesive intestinal obstruction. All other complications were treated by conventional methods. Wound infections made up 61.6% of all complications. The mean follow-up time was 8.5 months (range: 2 months-2 years).

DISCUSSION

Obesity or being overweight becomes a matter of interest in adult surgery as they may cause problems during surgery or postoperatively.³⁻⁶ Although there is limited data in adult groups, the relationship between the BMI of patients undergoing surgery and

their response to surgery has not been adequately studied in the field of pediatric surgery.⁷ We therefore chose a group that was more likely to encounter surgical problems and tried to obtain data regarding the selection of less invasive interventions and a more cautious approach in this group.

Being obese or overweight is not only a physical characteristic but also influences many physiological functions of the individual. Individuals with high BMI have been shown to have a series of cardiac, pulmonary and immune function differences that compromise their response to surgical intervention.^{2,3} Besides these physiological differences, the technical difficulties during surgery in obese patients and the resultant prolonged surgery time have been blamed for the postoperative problems in this group.³⁻⁷ However, it has been suggested that obesity may challenge the diagnosis of appendicitis; Towfigh et al. showed no influence on time of diagnosis in adult population.⁵ Similarly, our results confirm that patients with high BMI have similar time of diagnosis with low and normal-weight children.

The retrospective investigation of patients had surgery for appendicitis in our clinic in the previous two years provided statistical data showing no sig-

TABLE 1: Distribution of age, gender, presentation time, perforation rate and inpatient duration by body mass index.

	Normal BMI	Low BMI	High BMI	p
n	37	38	21	
Age	13(6-16)	12(6-16)	9(6-15)	0.369
M/F ratio	1.84	1.53	3.2	0.476
Presentation time (hours)	48(24-72)	48(24-54)	48(21-72)	0.506
Perforation rate (%)	27 (n=10)	23.6(n=9)	42.9(n=9)	0.290
Complication (%)	21.6 (8)*	18.4(7) [†]	52.4(11)*, [†]	0.037
Duration of hospitalization (days)	7(4-24)	6.5(4-12)	7(4-25)	0.646

BMI: Body mass index; M: male; F: female.

A p value <0.05 was accepted as significant. * $p=0.04$, [†] $p=0.018$.

TABLE 2: Distribution of complications by body mass index.

BMI (n=96)	Wound infection	Adhesive obstruction	Intra-abdominal abscess	Total complications
Normal (n=37)	5 (13.5%)	2 (5.4%)	1 (2.7%)	8
Low (n=38)	5 (13.1%)	1 (2.6%)	1 (2.6%)	7
High (n=21)	6 (28.5%)	3 (14.2%)	2 (9.5%)	11

BMI: Body mass index.

nificant difference among the perforation rates and duration of hospitalization in patients with high BMI and normal or low BMI while the surgical complication rate of the high BMI group was significantly higher. The data about the complication rates seem to support the general literature information showing an increased incidence of complications after surgical intervention in patients with high BMI.^{2,3,6,7} This increased rate of complications may be due to the physiological problems of obesity or the related technical difficulties encountered during the surgery.^{3,7} Besides these reports, some authors report that obesity does not affect appendicitis treatment except for a longer hospital stay.⁵ However, our results did not confirm that obese children had a longer duration of hospitalization.⁷

The relation between obesity and an increase in the incidence of wound infection has been more clearly demonstrated in adults.^{3,4} Obese children have been reported to have abnormal cytokine production, increased acute phase reactants and a chronic inflammatory response characterized by activation of inflammatory signal pathways. Obese and overweight persons have been shown to have increased levels of inflammatory markers such as C-reactive protein, interleukin-6, TNF-alpha and leptin and overweight people have been reported to have characteristic macrophage infiltration in the adipose tissue.⁹ Davies and Yanchar reported that overweight children with perforated appendicitis have higher rates of wound infections and longer operative time,

which is the most important cause of wound complications.⁷ Among our patients, either with acute or perforated appendicitis, rate of wound infection increased two-fold in children with high BMI.

Here, we have limited number of patients with the results of open surgery as a limitation of our study. In the light of these data, the expectation of a high complication rate in patients with a high BMI forced us to search for minimal invasive methods such as laparoscopy. It has been suggested that laparoscopic appendectomy may reduce the rate of wound complications in obese children. Even with the single port appendectomy, this suggestion has not been proven in pediatric population.¹⁰ In contrast, obesity is considered as an important cause of conversion to open surgery and it is found technically difficult compared to the procedures in normal weight children.^{7,10} Therefore, no protective strategy has been provided yet to reduce the complication rates in obese children. Laparoscopic interventions can technically ease appendectomy and prevent exposure difficulties in children with high BMI. Not only for appendicitis, but also for other surgical outcomes, we should consider obesity as a variable factor while evaluating.

In conclusion, children with high BMI have higher complication rates compared to children with low and normal BMI during the clinical course of appendicitis. We suggest that surgeons should be aware of all complications while they are dealing with children with high BMI.

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