Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.1318825

Anatolian Curr Med J. 2023;5(4):350-354

The relationship between oral and dental health and appendicitis

Semih Sağlık[1], Enver Ay[2], Veysel Bakır[3], Necip Nas[4]

[1]Department of Radiology, Faculty of Medicine, Siirt University, Siirt, Turkey
[2]Department of General Surgery, Siirt Training and Research Hospital, Siirt, Turkey
[3]Siirt Oral and Dental Health Center, Siirt, Turkey
[4]Department of Internal Medicine, Siirt Training and Research Hospital, Siirt, Turkey

Cite this article as: Sağlık S, Ay E, Bakır V, Nas N. The relationship between oral and dental health and appendicitis. *Anatolian Curr Med J.* 2023;5(4):350-354.

Received: 23.06.2023 ◆ **Accepted**: 18.08.2023 ◆ **Published**: 27.10.2023

ABSTRACT

Aims: In this study, we aimed to evaluate the relationship between the scores of the "Simplified Oral Hygiene Index" (OHI-S) indicating poor oral hygiene and the "Decayed, Missing and Filled Teeth" (DMFT) index indicating oral health impairment, and acute appendicitis (AA).

Methods: Eighty four patients who were operated on with the diagnosis of acute appendicitis between April 2022 and May 2023 were included. The control group included 32 individuals without a history of appendectomy. In our study, oral health was evaluated using the DMFT and OHI-S indices. The DMFT index is one of the indices quantifying dental health status based on the number of cavities. OHI-S is an index used to evaluate oral hygiene.

Results: The OHI-S index scores of the patients with AA were significantly higher than those of the control group (3.53±1.43, 2.56±1.24, $p<0.05$, respectively). DMFT index scores of the patients with AA were significantly higher than the DMFT scores of the control group (12.09±5.51, 8.4±4.73, $p<0.05$, respectively). Among all individuals who participated in the study, OHI-S and DMFT index values of those who never or occasionally brushed their teeth were significantly higher than those who brushed their teeth at least once a day ($p<0.05$).

Conclusion: In this study, the OHI-S index scores indicating poor oral hygiene, and the DMFT index scores indicating poor oral health status were found to be higher in patients operated for AA; It suggests that poor oral health may increase the risk of appendicitis.

Keywords: Appendicitis, oral health, decayed missing and filled teeth, simplified oral hygiene index

INTRODUCTION

Acute appendicitis (AA) is the most common cause of acute abdomen in all age groups and one of the leading pathologies of emergency abdominal surgery.[1-3] Although approximately 7% of the entire population is diagnosed with acute appendicitis at some point in their lives, AA is most common between the ages of 10 and 30.[4] Delayed diagnosis may result in complications such as abscess, plastron, perforation or peritonitis and may lead to mortality in complicated cases. Even though the cause of acute appendicitis is not exactly clear, the most common causes include fecaliths, lymphoid hyperplasia, parasites, malignant and benign tumors.[5-7] Furthermore, it was also reported that appendicitis is a polymicrobial process and both aerobic and anaerobic bacteria play a role in cases of both acute and complicated appendicitis.[8,9]

Oral health is defined as the absence of periodontal (gum and surrounding tissues) disease, dental cavities and tooth loss, and psychosocial well-being without any biting, chewing, smiling and speaking difficulties.[10] There is a powerful and complex relationship between oral health and systemic health. Periodontitis, a chronic inflammatory disease, is one of the common chronic infections. If left untreated, it can lead to gum problems and tooth loss. Periodontitis may sometimes be asymptomatic and thus remain untreated for years. It has been reported that circulating proinflammatory bacterial constituents are significantly increased in patients with periodontal disease compared to those with healthy gums.[11] In recent studies, poor oral health has been associated with a number of systemic diseases including cardiovascular disease, pneumonia, diabetes, obesity, rheumatoid arthritis and kidney diseases.[12]

Corresponding Author: Semih Sağlık, drsmhsglk@gmail.com

This study aims to address the relationship between oral and dental health and appendicitis.

METHODS

The study was carried out with the permission of Siirt University Non-invasive Clinical Researches Ethics Committee (Date: 18.05.2023, Decision No: 2023/05/01/01). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Eighty four patients who underwent surgery with the diagnosis of AA which was confirmed by postoperative histopathologic examination between April 2022 and May 2023 were included in the study. The patients' demographic characteristics, complete blood count parameters at admission, radiologic results, operative findings and postoperative pathology data were recorded. The control group consisted of 32 subjects with no known systemic diseases or history of appendectomy who were admitted to the dental hospital for treatment and who consented to participate in the study. Patients younger than 18 years of age, patients with a known systemic disease, patients who underwent periodontal treatment within the last six months and patients with neoplastic lesions, parasites or foreign bodies causing appendicitis were excluded.

After consent forms were signed by the patients who agreed to participate in the study, oral examinations were performed by an experienced dentist. In our study, "Decayed, Missing and Filled Teeth" (DMFT) and "Simplified Oral Hygiene Index" (OHI-S) indices were used to evaluate oral health.[13-15] The DMFT index is an index evaluating all teeth to establish the cavity rate. The DMFT index is widely used worldwide to detect dental cavities in epidemiologic studies. The DMFT score is the sum of the number of decayed, missing and filled or crowned teeth. If a tooth has both decay and a filling, only one is scored.

OHI-S index is an index system used in the assessment of oral hygiene. In this index system, 3 regions in the upper and lower jaw, namely the right-posterior region, left-posterior region and anterior region, are assessed. A total of 12 measurements are made on 6 teeth in the mouth in terms of both dental plaque and calculus. In our study, buccal surfaces of upper first molars, lingual surfaces of lower first molars, and labial surfaces of upper right and lower left incisors were examined. As a result of the examination, the dental plaque and calculus indices were calculated separately and the total score obtained was accepted as the oral hygiene index score.

Statistical Analysis

SPSS for Windows Version 18.0 software was used for the statistical evaluation of our trial data. Mean ± standard deviation (SD) was used to describe the data related to quantitative variables; numbers (n) and percentages (%) were used to describe the data related to qualitative variables.

The Shapiro Wilk normality test was used to establish whether the quantitative variables were normally distributed. According to the results of the normality test, Student's t-test and Mann-Whitney-U test were used to compare the quantitative data of the two groups, and Pearson Correlation Analysis was used to test whether there was a correlation between the quantitative variables.

Categorical values were compared with Pearson's chi-square test. The results were evaluated at 95% confidence interval while significance was assessed at $p<0.05$ level.

RESULTS

A total of 116 patients, including 84 patients who underwent surgery due to AA with histopathological confirmation and 32 patients for control group, were included in our study. The control group was named Group 1 and Group 2 included the patients with AA. Demographic characteristics such as age, gender and OHI-S and DMFT index scores of both groups were compared (**Table 1**).

Table 1. Comparison of demographic characteristics, OHI-S and DMFT scores between groups

	Group 1 (n=32)	Group 2 (n=84)	p
Age ±SD	27.1±6.4	29.8±9.1	0.134
Female ±SD	25.5±5.5	29.5±10	0.179
Male ±SD	28.9±7.1	29.7±8,5	0.726
OHI-S ±SD	2.56±1.24	3.53±1.43	<0.05
DMFT ±SD	8.4±4.73	12.09±5.51	<0.05

OHI-S: Simplified Oral Hygiene Index, DMFT: Decayed, Missing and Filled Teeth, SD: Standard deviation

The mean age of subjects in group 1 and group 2 were was 27.1±6.4 and 29.8±9.1 years, respectively, and no statistically significant difference was found between the two groups (p=0.134).

Of the study participants, 65.5% brushed their teeth either never or occasionally, while 34.5% brushed their teeth at least once a day. Of the study participants, OHI-S scores of those who brushed their teeth either never or occasionally were significantly higher than those who brushed their teeth at least once a day (4±1, 1.8±0.9 respectively, $p<0.05$). DMFT scores of those who brushed their teeth either never or occasionally were significantly higher than those who brushed their teeth at least once a day (13.8±4, 5.8±4 respectively, $p<0.05$) (**Table 2**).

Table 2. Comparison of OHI-S and DMFT index values according to tooth brushing habits of all individuals participating in the study

	Regular (n=40)	Irregular (n=76)	p
OHI-S ±SD	1.8±0.9	4±1	p<0.05
DMFT±SD	5.8±4	13.8±4	p<0.05

Regular: brushes teeth at least once a day, Irregular: never or occasionally brushes teeth, OHI-S: Simplified Oral Hygiene Index, DMFT: Decayed, Missing and Filled Teeth, SD: Standard deviation

The comparison of the OHI-S index scores between the groups revealed that the OHI-S index scores of patients with AA were statistically significantly higher than those in the control group (3.53±1.43, 2.56±1.24 respectively, p<0.05). DMFT index scores of patients with AA were statistically significantly higher than those in control group (12.09±5.51, 8.4±4.73 respectively, p<0.05) (**Figure**).

DISCUSSION

Although appendicitis is one of the common causes of acute abdomen, its etiology remains unclear in most cases.[16] Despite the fact that luminal obstruction is considered to be the most significant factor in the etiology, some evidence suggests that obstruction is not the main cause in the majority of cases.[17,18] In some studies, it was even suggested that the obstruction is not a cause but a result.[19,20] Andreou et al.[21] reported that although fecaliths were observed in histopathologic examinations of appendicitis specimens, they were rare. Arnbjörnsson et al.[22] found that intraoperative intraluminal pressure measurements were normal in cases of appendicitis and elevated only in advanced stages. The submucosa of the appendix contains abundant lymphoid follicles and acute mucosal and submucosal inflammation were suggested as the primary cause of appendicitis.[23] Infections are thought to cause appendicitis by stimulating lymphoid hyperplasia, which obstructs the appendix by leading to luminal obstruction.[24] This view is supported by the fact that appendicitis occurs between the ages of 10 and 30, i.e., the period when lymphoid tissue is most dense.

According to the data obtained by molecular biology methods, the oral cavity, which hosts more than 700 microorganisms, is a region containing more microorganisms than other parts of the body. Oral cavity microorganisms or their products can cause infections in different parts of the body. Metastatic infection due to bacterial displacement, metastatic damage caused by microbial toxins, and metastatic inflammation due to weak immune system can play a role in their pathogenesis.[25] Blod et al.[26] reported that they detected several oral bacterial pathogens in the appendix lumens and suggested that the oral cavity may be a reservoir for AA. Aiyoshi et al.[27] stated in their study that ectopic colonization of the appendix by oral *Fusobacterium* species may play an important role in the pathogenesis of AA. In addition, oral bacteria such as *Parvimonas*, *Alloprevotella*, *Streptococcus*, *Prevotella*, *Peptostreptococcus* and *Porphyromonas* have been isolated in the appendix lumen of AA patients.[28] Among them, *Parvimonas*, which has the highest rate, is among the pathogens that cause periodontal disease.[29] Microorganisms such as *Fusobacterium* and *Parvimonas* in the appendix, may form a biofilm that causes mucosal inflammation.[26]

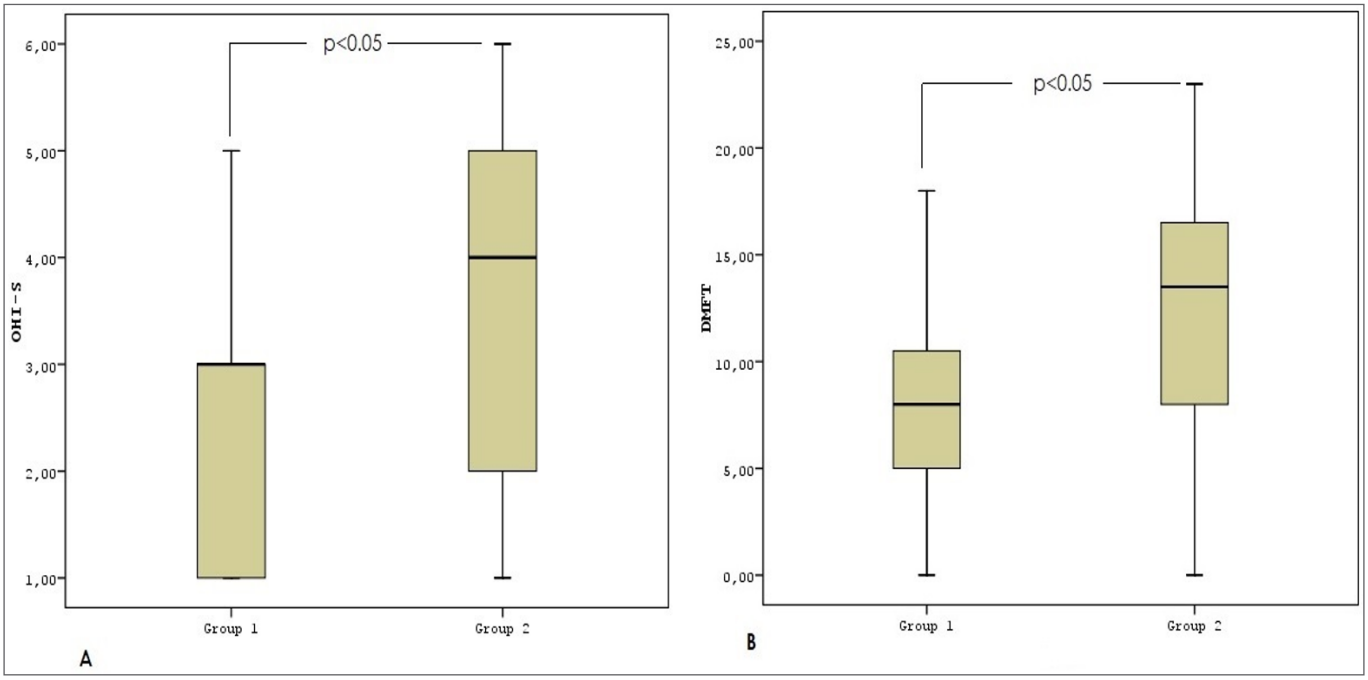

Figure. Box plots A and B showing OHI-S and DMFT index values for group 1 (control group) and group 2 (subjects with appendicitis). The horizontal lines inside each box represent the mean values while the bottom and top rows of each box represent the minimum and maximum values respectively.

In some studies, bacteria belonging to *Fusobacterium* genus, which are abundant in the oral cavity, were isolated in bacteriologic studies conducted by using microbiologic culture techniques on appendectomy specimens.[30,31] Swidsinski et al.[32] found that Fusobacteria spp. were an important constituent of mucosal and submucosal inflammation in 62% of appendectomy specimens and correlated positively with the severity of appendicitis. In addition, *Fusobacterium* spp. were isolated in most cases of suppurative appendicitis in recent studies.[32,33] In a study conducted by Guinane et al.[28] it was observed that oral pathogens, especially *Parvimonas* and *Gemella* spp., were found abundantly in appendix samples. However, it is unknown whether these microorganisms are primarily accountable for the etiology of appendicitis or whether they proliferate secondary to inflammation. In our study, indicators of oral hygiene, namely OHI-S and DMFT index values, were significantly higher in appendectomy cases compared to the control group, suggesting that these microorganisms may be involved in the etiology of appendicitis.

Some authors have argued that diet and hygiene play an important role in the etiology of acute appendicitis.[34-37] According to this view, a diet poor in fiber but rich in meat and sugar causes an increase in the incidence of AA. It has been reported in some studies that the incidence of appendicitis is significantly lower in third world countries where people consume a diet that mainly consist of cereals, legumes, vegetables and high-fiber foods.[38,39] Low fiber intake may cause the colonic transit time to shorten and the fecal reservoir in the lumen to increase, and thus cause appendicitis.[40] Studies showing that unhygienic environments may lead to an increase in the incidence of AA are available.[41,42] Furthermore, an increase in the prevalence of appendicitis has been demonstrated in societies with poor personal hygiene care.[43-45]

Oral health is one of the most prominent indicators reflecting personal hygiene. Attin et al.[46] stated that brushing teeth at least once a day protects oral health and prevents caries and periodontal diseases. In our study, we found that OHI-S and DMFT index values, which are oral health indicators, were higher in individuals who never or occasionally brushed their teeth compared to individuals who brushed their teeth at least once a day. While diet may cause oral health problems, poor oral health may lead to nutritional issues.[47] Moreover, adverse changes in nutrition and the digestive system arising out of inadequate chewing, which may be due to poor oral and dental health, may cause fecaliths to form.

In this study, OHI-S that indicate a lack of oral hygiene, and DMFT index values that indicate poor oral health were found to be higher in patients who underwent surgery for appendicitis, which in turn led us to correlate appendicitis with oral health. If these findings are confirmed, measures against and information about poor oral health may help reduce the incidence of appendicitis.

There were several limiting factors in our study. Firstly, due to the small number of patients, our findings need to be supported by studies with a larger patient population. Secondly, the control group consisted of subjects who applied to the dental hospital for treatment, which resulted in a difference in the study groups.

CONCLUSION

Our findings suggest that poor oral health may increase the risk of appendicitis. From this standpoint, it may be useful to consider oral health in the etiology of appendicitis in future studies. Furthermore, to the best of our knowledge, this is the first ever study to investigate the relationship between appendicitis and oral health.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Siirt University Non-invasive Clinical Researches Ethics Committee (Date: 18.05.2023, Decision No: 2023/05/01/01).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

REFERENCES

1. Menteş Ö, Eryılmaz M, Yiğit T, Tascı S, Balkan M, Kozak O. 60 yaş üstü apandektomili olgularımızın retrospektif analizi. *JAEM.* 2008;36-41.
2. Powers RD, Guertler AT. Abdominal pain in the ED:stability and change over 20 years. *Am J Emerg Med.* 1995;13(3):301-303.
3. Bostancı MT, Yılmaz İ, Cimen S, Koşmaz K, Gökçe A, Avcı MA. Are scoring systems detecting acute appendicitis reliable? a prospective clinical study. *J Health Sci Med.* 2022;5(1):167-172.
4. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol.* 1990;132:910-25.
5. Jones AE, Phillips AW, Jarvis JR, Sargen K. The value of routine histopathological examination of appendicectomy specimens. *BMC Surg.* 2007;7:17.
6. Akbulut S, Tas M, Sogutcu N, et al. Unusual histopathological findings in appendectomy specimens:a retrospective analysis and literature review. *World J Gastroenterol.* 2011;17(15):1961-1970.

7. Yabanoglu H, Caliskan K, Aytac HO, et al. Unusual findings in appendectomy specimens of adults:retrospective analyses of 1466 patients and a review of literature. *Iran Red Crescent Med J.* 2014;16(2):e12931.
8. Lamps LW. Appendicitis and infections of the appendix. *Semin Diagn Pathol.* 2004;21(2):86-97.
9. Pieper R, Kager L, Lindberg AA, Nord CE. Acute appendicitis and Bacteroides fragilis. *Scand J Infect Dis Suppl.* 1979;(19):92-97.
10. World Health Organization. Oral health. 2020. Available at: https://www.who.int/health-topics/oral-health#tab=tab_1
11. Wilson M, Reddi K, Henderson B:Cytokine-inducing components of periodontopathogenic bacteria. *J Periodontal Res.* 1996;31(6):393-407.
12. Külekçi G, Gökbuget A. Ağız mikroflorasının genel sağlığa etkisi. *Ankem Derg.* 2009;23(3):137-145.
13. Bischoff JI, Van der Merwe EHM, Retief DH, Barbakow FH, Cleaton-Jones PE. Relationship between fluoride concentration in enamel, DMFT index, and degree of fluorosis in a community residing in an area with a high level of fluoride. *J Dent Res.* 1976;55(1):37-42.
14. Greene JG, Vermillion JR. The simplified oral hygiene index. *J Am Dent Assoc.* 1964;68(1):7-13.
15. Bakır EP, Çitaker ÖK, Bakır Ş. Relationship of socioeconomic status and oral-dental health in the Southeastern Anatolia. *J Health Sci Med.* 2021;4(5):622-629.
16. Surel AA, Güngörer B. The predictors of complicated acute appendicitis:large unstained cells, gamma-glutamyl transferase, monocyte to platelet ratio, age and gender. *J Health Sci Med.* 2020;4(4):477-481.
17. Petroianu A, Villar Barroso TV. Pathophysiology of Acute Appendicitis. *JSM Gastroenterol Hepatol.* 2016;4(3):4-7.
18. Wagner M, Tubre DJ, Asensio J. Evolution and current trends in the management of acute appendicitis. *Surg Clin N Am.* 2018;98.5:1005-1023
19. Carr NJ, Weldon F. The pathology of acute appendicitis. *Ann Diagn Pathol.* 2000;4:46-58.
20. Lamps LW. Infectious causes of appendicitis. *Infect Dis Clin North Am.* 2010;24(4):995-1018.
21. Andreou P, Blain S, Boulay CD. A histopathological study of the appendix at autopsy and after surgical resection. *Histopathology.* 1990;17(5):427-431.
22. Arnbjörnsson E, Bengmark S. Obstruction of the appendix lumen in relation to pathogenesis of acute appendicitis. *Acta Chir Scand.* 1983;149(8):789-791.
23. Kim SY, Oh DJ, Park B, Park IS, Choi HG. Increased risk of appendectomy in patients with asthma. *Medicine.* 2019;98(38):e17203.
24. Alder AC, Fomby TB, Woodward WA, Haley RW, Sarosi G, Livingston EH. Association of viral infection and appendicitis. *Arch Surg.* 2010;145(1):63-71.
25. Özan Ü, Özan F, Er K. Oral mikroorganizmalara karşı propolisin antimikrobiyal etkinliği. *Acta Odontol Turc.* 2015;32(1):36-41.
26. Blod C, Schlichting N, Schülin S et al. The oral microbiome—the relevant reservoir for acute pediatric appendicitis?. *Int J Colorectal Dis.* 2018;33:209-218.
27. Aiyoshi T, Kakihara T, Watanabe E, et al. A comprehensive microbial analysis of pediatric patients with acute appendicitis. *J Microbiol Immunol Infect.* 2023;56(4):695-704.
28. Guinane CM, Tadrous A, Fouhy F, et al. Microbial composition of human appendices from patients following appendectomy. *mBio.* 2013;4(1):e00366-12.
29. Siqueira JF, Rôças IN. Microbiology and treatment of acute apical abscesses. *Clin Microbiol Rev.* 2013;26(2):255-273.
30. Zhong D, Brower-Sinning R, Firek B, Morowitz MJ. Acute appendicitis in children is associated with an abundance of bacteria from the phylum Fusobacteria. *J Pediatr Surg.* 2014;49(3):441-446.
31. Rogers MB, Brower-Sinning R, Firek B, Zhong D, Morowitz MJ. Acute appendicitis in children is associated with a local expansion of fusobacteria. *Clin Infect Dis.* 2016;63(1):71-78.
32. Swidsinski A, Dörffel Y, Loening-Baucke V et al. Acute appendicitis is characterised by local invasion with *Fusobacterium* nucleatum/necrophorum. *Gut.* 2011;60:34-40.
33. Swidsinski A, Dörffel Y, Loening-Baucke V et al. Mucosal invasion by fusobacteria is a common feature of acute appendicitis in Germany, Russia and China. *Saudi J Gastroenterol.* 2012;18:55-58.
34. Barker DJP, Osmond C, Golding J, Wadsworth MEJ. Acute appendicitis and bathrooms in three samples of British children. *Br Med J (Clin Res Ed).* 1988;296(6627):956-958.
35. Barker DJ, Liggins A. Acute appendicitis in nine British towns. *Br Med J (Clin Res Ed).* 1981;283(6299):1083-1085.
36. Barker DJ. Acute appendicitis and dietary fibre: an alternative hypothesis. *Br Med J (Clin Res Ed).* 1985;290(6475):1125-1127.
37. Barker DJ, Morris JA, Simmonds SJ, Oliver RH. Appendicitis epidemic following introduction of piped water to Anglesey. *J Epidemiol Community Health.* 1988;42(2):144-148.
38. Trowell HC. Non-infective disease in Africa. Edward Arnold, London. 1960;481.
39. Burkitt DP, Trowell HC. Appendicitis in refined carbohydrate food and disease. *N York Acad Press Ine.* 1975;87-97.
40. Sulu B. Demographic and epidemiologic features of acute appendicitis. appendicitis-a collection of essays from around the world. *Rijeka: InTech.* 2012;169-178.
41. Abeş M, Petik B, Kazıl S. Nonoperative treatment of acute appendicitis in children. *J Pediatr Surg.* 2007;42(8):1439-1442.
42. Gardikis S, Giatromanolaki A, Kambouri K, Tripsianis G, Sivridis E, Vaos G. Acute appendicitis in preschoolers:a study of two different poppulations of children. *Ital J Pediatr.* 2011;37(1):35.
43. Budhi I. B, Azka R, Yudhani RD. Describing the role of personal hygiene on non-complicated pediatric appendicitis patients. *Highlights on Medicine and Medical Science.* 2021;16:91-95.
44. Rothrock SG, Pagane J. Acute appendicitis in children:emergency department diagnosis and management. *Ann Emerg Med.* 2000;36(1):39-51.
45. Sakellaris G, Tilemis S, Charissis G. Acute appendicitis in preschool-age children. *Eur J Pediatr.* 2005;164(2):80-83.
46. Attin T, Hornecker E. Tooth brushing and oral health: how frequently and when should tooth brushing be performed? *Oral Health Prev Dent.* 2005;3(3):135-140.
47. Lieffers JR, Vanzan AGT, Rover de Mello J, Cammer A. Nutrition care practices of dietitians and oral health professionals for oral health conditions: a scoping review. *Nutrients.* 2021;13(10):3588.