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Ultrasound Evaluation of Gallbladder Mobility in Children with Chronic Functional Constipation

*Mohammad Ghasem Hanafi[1], Mohammad Momengharibvand[1], Hazhir Javaherizadeh[2], Mohammad Mehdi Ahmadi[1]

[1] Department of Radiology, Faculty of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
[2] Department of Pediatric, Faculty of Medicine,Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

Abstract

Background: Constipation as a common disease in children can cause significant complications for this age group, so that one third of children have chronic symptoms which may continue into adulthood. The causes of chronic functional constipation are largely unknown; and it may be a multifactorial disorder. Gallbladder dysfunction in chronic idiopathic constipation may be an underlying cause of idiopathic constipation. Hence, this study aimed to evaluate the gallbladder mobility ultrasound in children with chronic functional constipation in Imam Khomeini Hospital of Ahvaz.

Methods: Children between the ages of 3 to 13 years in Imam Khomeini Hospital of Ahvaz, who suffered from functional constipation, were visited by a pediatric digestive and liver subspecialty physician after referring to the pediatric gastroenterology clinic of the hospital and were referred to us for conducting gallbladder ultrasound. In this study, 50 patients with chronic functional constipation and 50 healthy individuals (control group) were studied.

Results: The mean age of the participants in this study was 6.96 with a standard deviation of 2.44 years. In this study, 40 patients (40%) were boys and 60 patients (60%) were girls. The mean volume of gallbladder in fasting mode (preprandial) and after meal (postprandial) in individuals of the case group were 5.66 and 4.17 cm3 with standard deviations of 0.80 and 0.64, respectively, and in the control group were 6.08 and 3.06 cm^3 with standard deviations of 0.97 and 0.75, respectively. The thickness of the gallbladder wall in the fasting mode (preprandial) and after meal (postprandial) in the case group was 1.50 and 1.67 mm with standard deviations of 0.24 and 0.29 mm, respectively, and in the control group, it is equal to 1.39 and 1.69 with standard deviations of 0.22 and 0.28, respectively.

A significant difference was observed between case and control groups ($P < 0.05$) in terms of gallbladder volume after meals, but no significant relationship was found between gallbladder volume and the gallbladder wall thickness in the fasting mode and after meal in neither of the case and control groups ($P > 0.05$).

Conclusion: Due to the slow mobility of the gallbladder in patients with chronic functional constipation, it can be concluded that generalized hypomobility may be present in the children with constipation.

Key Words: Chronic functional constipation, Gallbladder, Ultrasound.

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Corresponding Author:

Mohammad Ghasem Hanafi, Department of Radiology, Faculty of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. Email: gasemhanafi@yahoo.com

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1- INTRODUCTION

Constipation is considered as a common disease in different age groups (1). Almost 3% of the referrals to pediatric outpatient clinics are due to constipation (2), which includes a quarter of the referrals to pediatric gastrointestinal clinics (3). About 30% of children develop chronic symptoms, which may continue into adulthood (4, 5).

Chronic constipation without any structural, endocrine or metabolic disease is called functional or idiopathic constipation. The causes of chronic functional constipation are largely unknown, and it may be a multifactorial disorder. Slow intestinal transit can be one of the most common forms of chronic idiopathic constipation and can be identified with a long history without etiologic factors. This disease may be associated with dysfunction of other organs of the gastrointestinal tract such as the stomach, small intestine, colon, and anorectal function (6-10).

Gallbladder dysfunction occurs in approximately half of the patients suffering from constipation with slow intestinal transit (11). Identification of gallbladder function in chronic idiopathic constipation may determine the underlying cause.

There are several imaging methods for measuring gallbladder contraction after a fatty meal, but it is still largely unclear whether gallbladder contraction has a causal effect on chronic idiopathic constipation in children. Ultrasound is a safe and non-invasive method for determining gallbladder volume and for assessing gallbladder contraction. Unlike Cholecystography and traditional scanning, ultrasound is fast and simple and does not have the complications of x-rays (13-14).

Penning et al. (17) studied gallbladder emptying in adults using ultrasound in response to neuronal, cephalic-vagal stimulation, and in response to hormonal stimulation with cholecystokinin. They found that fasting gallbladder volume was significantly reduced in patients with chronic idiopathic constipation in comparison to the control group. However, gallbladder emptying was not evaluated after symptoms.

Various studies show that gallbladder function varies between groups of different races, but this concept may be true for all children (19). Therefore, this study was aimed to evaluate gallbladder mobility ultrasound in children with chronic functional constipation in Imam Khomeini Hospital of Ahvaz.

2- MATERIALS AND METHODS

2-1. Study design

This prospective study was performed on children between 3 and 13 years of age who had referred to Imam Khomeini Hospital of Ahvaz suffering from functional constipation. The study was performed after receiving the approval of the dissertation and ethics committee of the university. The patients were referred to us by pediatric digestive and liver subspecialty physician after referring to the pediatric gastrointestinal clinic of the hospital.

2-2. Ethical considerations

The participation of individuals in this study was completely conscious and voluntary. First, the method and conditions of the study were fully explained to the patients and if they wanted, they could enter the study. In the study process, gallbladder ultrasound was performed on the patients; and they were insured about the confidentiality of the results.

2-2. Sample size calculation method

$$n = \frac{Z^2_{1-\alpha/2} \cdot P(1-P)}{d^2}$$

$$Z_{1-\alpha/2} = 1.96$$

For 90% confidence

$P = 0.94$

$d = 0.05$

$$n = \frac{1.96^2 \,.\, 0.94(0.06)}{0.05^2}$$

According to the above formula, the sample size was equal to 50 patients.

In this study, 50 patients with chronic functional constipation and 50 healthy individuals (control group) were examined. Conscious consents were obtained from the parents of all participants.

2-3. Case group

The case group included 50 patients (aged 3 to 13 years) with chronic functional constipation. Children with a history of at least 2 bowel movements per day for 2 months of the following symptoms according to the Paris Pediatric Constipation Consensus (Paris Consensus on Childhood Constipation Terminology, PACCT): (1) Hard stools and large diameter; (2) Discomfort or pain when passing stool; (3) Stool incontinence at least once a week; (4) Frequency of defecation <3 times a week; (5) Excessive pressure and feeling of incomplete emptying; and (6) Existence of palpable fecal mass and/or contraction of feces.

Children were excluded from the study if they had any intestinal neuropathy disease, kidney or metabolic abnormalities, endocrine disorders (hypothyroidism), spinal or anal abnormalities, history of any previous colon surgery, mental or motor disability, history of jaundice, history of gallstones, and medication use except laxatives.

2-4. Control group

The control group consisted of 50 healthy children in terms of clinical features, age and gender who matched with the patients in the case group. They were selected from a group of children who had referred for regular immunization and health monitoring. In particular, these children had no symptoms of constipation or gastrointestinal complaints.

2-5. Measuring the gallbladder

The participants in both case and control groups underwent gallbladder ultrasound after complete preparation of the patient. Twenty-four hours before the ultrasound, the patients in the case and control groups were asked to refrain from taking the laxative. All cases and controls were fast for at least 6 hours before the ultrasound examination. All ultrasound examinations were performed using an E6 (voluson GE HealthCare) ultrasound machine. All of these examinations were performed by a radiologist using a 2-5 MHz convex probe and the images were stored. Ultrasound evaluation of the gallbladder included: (1) Gallbladder wall thickness (anterior wall) (normal size of that measurement is determined up to 3 mm).

(2) Gallbladder volume (determined through Dodd formula (21and 22)

$$V = \Pi / 6 \times (L \times W \times H)$$

L is the length, W is the width, and H is the height of the gallbladder, and Π/6 is equal to 0.52.

For ultrasound calculation of gallbladder volume, transverse images were obtained at the site of maximum gallbladder width and longitudinal images were obtained through the long axis of the gallbladder (**Fig. 1**).

Gallbladder volume was measured using the Dodd formula in preprandial and postprandial modes in both groups. For each variable, three measurements will be recorded, and on average, three ultrasounds will be recorded to provide an average value. For fasting mode and 1 hour (60 minutes) after a standard defined meal containing 30 grams of fat per child (regardless of the age, a cube of butter (30 grams) and a piece of bread (a palm) will

be fed after consulting a pediatric gastroenterologist according to our inclination criteria.

Based on the gallbladder area, the gallbladder contraction index (GBCI) was calculated using the following formula:

GBCI (%) = {(fasting gallbladder Volume (cm3) - postprandial gallbladder Volume (cm3)) /fasting gallbladder Volume (cm3)} × 100

%GBCI< 25% lack of mobility was defined as the research goal (7-21).

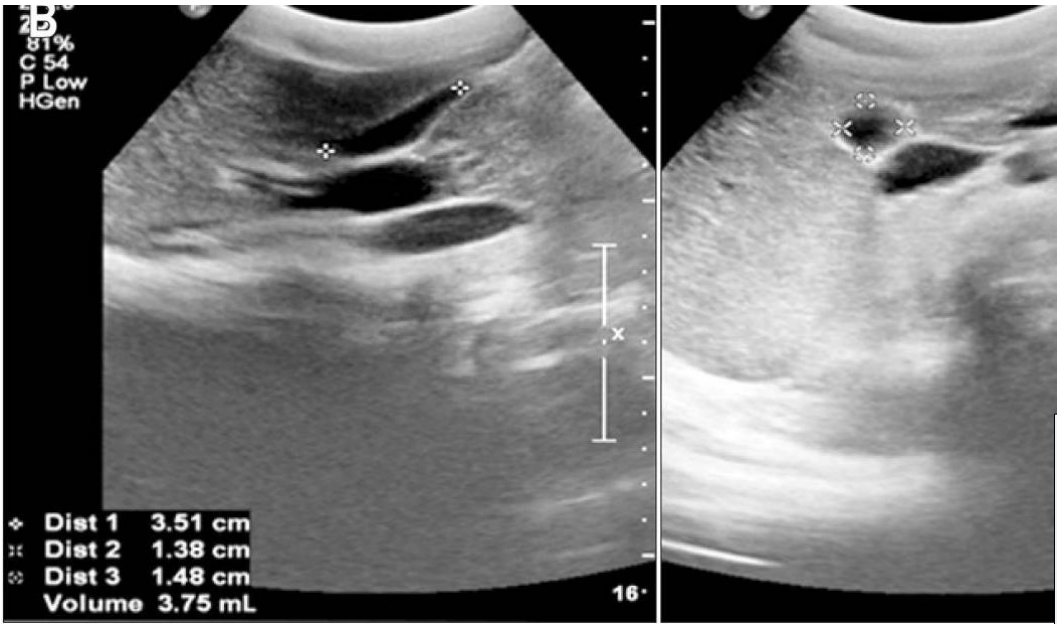

Fig. 1: Calculation of gallbladder volume on ultrasound in two longitudinal (left) and transverse (right) sections

2-6. Data analysis

Logistic regression analysis was used to control the effect of possible confounding variables (age, gender, and weight). Mean and standard deviation for anterior gallbladder wall thickness were calculated in preprandial and postprandial. Chi-square test was used to study the patient's clinical data for possible associations with gallbladder motility, and to compare the fit between the cases and the control. Mann-Whitney test was also used to compare GBCI between the patients and the control group.

3- RESULTS

In our study, out of 100 participants (50 in the case group and 50 in the control group) between the ages of 3 to 13 years, the mean age of the participants in the case group was 6.68 years with a standard deviation of 2.19 and the mean age of those in the control group was 7.24 years with a standard deviation of 2.66. Among the participants, 40 were boys (40%) and 60 were girls (60%). The mean fasting volume of the gallbladder in the case and control groups were 5.66 and 6.08 cm^3 with standard deviations of 0.80 and 0.97, respectively. Also, the mean volume of gallbladder in one hour after eating fatty food in the case and control groups were 4.17 and 3.06 cm^3 and the standard deviations were 0.64 and 0.75,

respectively. Gallbladder wall thicknesses in fasting mode in the case and control groups were 1.5 and 1.39 mm, and the standard deviations were 0.24 and 0.22, respectively; and in the one-hour after eating fatty food ikey were1.67 and 1.69 mm with the standard deviations of 0.29 and 0.28, respectively. Also, gallbladder volumes in the fasting mode in case and control groups were 2.94 and 3.04 cm^3 and standard deviations of 0.44 and 0.46; and one-hour after eating fatty food, they were equal to 2.11 and 1.39 cm^3 with standard deviations of 0.35 and 0.32, respectively (**Table 1**).

Table-1: The mean volume and thickness of gallbladder in fasting mode and one hour after fatty meal in the case and control groups

group	The volume of the gallbladder in the fasting mode (and one hour after receiving a fatty meal) cm^3	The thickness of the gallbladder in the fasting mode (and one hour after receiving a fatty meal) mm
case	5.66±0.80(4.17±0.64)	1.5±0.24(1.67±0.29)
control	6.08±0.97(3.06±0.75)	1.39±0.22(1.69± 0.28)

In this study, no relationship was found between the gender and age of the individuals with the volume and thickness of the gallbladder wall in the fasting mode and one hour after a fatty meal (P> 0.05).

The findings revealed a significant difference between gallbladder volume one hour after a fatty meal in case and control groups (P <0.05).

GBCI analysis showed that the mean GBCI% in the case and control groups were 28.2 and 54.4% with standard deviations of 13.4 and 19.3, respectively. One individual (2%) in the control group and 22 individuals (44%) in the case group had GBCI less than 25% (**Table 2**).

Table-2: The mean and GBCI frequency percentage in the case and control groups

group	Mean (standard deviation)	GBCI≥25% Frequency (percentage)	GBCI<25% Frequency (percentage)
case	28.2%(13.4)	28(56%)	22(44%)
control	54.4%(19.3)	49(98%)	1(2%)

4-DISCUSSION

The results of our study demonstrated that the mean CI in the control group (healthy) was higher than that in the case group (patient) (P <0.05), which indicates a decrease in gallbladder mobility in patients with chronic functional constipation.

A study by Di Ciaula et al. (22) showed that dysfunction and mobility of the stomach and gallbladder is a cause of obesity. Rakesh et al. (23), in a study indicated that the mean postprandial gallbladder volume was lower in children with chronic constipation, which was consistent with the results of our study. Another study on gallbladder contraction in children with chronic functional constipation, conducted by Veras Neto et al., also showed gallbladder motility disorders in a subset of children with chronic constipation (18).

Gunay et al., evaluating the cause of gallbladder emptying dysfunction as the underlying cause of chronic constipation, reported that the gallbladder immobility was observed in 44.4% of the patients (14). In our study considering GBCI<25% as the cut off of gallbladder mobility defects in patients with chronic functional constipation, about 44% of gallbladder morbidity defects were observed, which was consistent with the study of Gunay et al (11).

In another study conducted by Lehtonen et al. (20), chronic constipation was investigated in infants under one year of age. They found a significant relationship between gallbladder volume before and after feeding. However, in our study, chronic constipation was only correlated with the volume of gallbladder after food.

The results of the present study are in line with those by Lehtonen et al. (20), who examined chronic constipation in infants under one year of age, showing that chronic constipation is significantly correlated with gallbladder volume both before and after feeding.

5- CONCLUSION

Overall, the findings revealed that in children with chronic functional constipation, gallbladder emptying after a meal is slow. Due to the slow mobility of the gallbladder in these patients, it can be concluded that generalized hypomobility may be present in the children with constipation. Therefore, it is important to pay attention to gallbladder disorders and its function in the evaluation and treatment of constipation disorders.

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