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Ultrasonographic Evaluation of the Sacrococcyx and Spinal Canal in Children with Constipation

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Abstract

Background

The occult neurological disorders are an important cause of constipation in children. This study aimed to evaluate the spinal canal and lumbosacral by ultrasound in pediatric constipation to better identifying neurological causes of constipation.

Materials and Methods

In this case-control study, 100 children with constipation (age range 1 to 14 years) without previously known chronic illness referred to the Radiology Department of the Mashhad Pediatric Dr. Sheikh Hospital were selected. After recording clinical data, the patients were undergone sacral and spinal cord ultrasound examinations and the results were compared with the control group (healthy children with transient illness (otherwise constipation or urinary disorders) who had referred to radiology department for sonographic examination).

Results

The mean age of patients was 6 ± 3.3 years old. The tethered cord and occult intrasacral meningocele were observed in 2% of patients group. Spina bifida was found in 64% patients, and 31% control subjects with significant difference (P = 0.009). About one third of cases with spina bifida were found in lumbar L5 vertebra, and another two third were in high sacral vertebrae (S1 or S2). Various degrees of caudal regression were observed in 8% patients suffering from constipation and in control group, 2% children had coccyx hypoplasia. No significant correlation was found between case and control groups regarding the location of spina bifida and non-formation of the posterior arch of the sacrum, the mean coccyx length, dural diameter and the ossification age of first vertebra of coccyx.

Conclusion

In pediatric age, lumbosacral spinal anomalies can easily evaluate with ultrasound. The prevalence of spina bifida and caudal regression in children with constipation was significantly higher compared with normal control group.

Key Words: Children, Constipation, Neurologic cause, Ultrasound.

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1- INTRODUCTION

Constipation refers to any condition in which there is difficulty in emptying the bowels or defecation for more than two weeks (1). Common causes of chronic constipation include inadequate fiber or fluids intake, colonic dysmotility, functional disorders of anus and rectum and rectal outlet obstruction (2). The constipation of recent onset may be a symptom of an important organ disease such as tumors or stricture (3-6). Another important underlying disorder is neurological disorders, especially dysraphism, caudal regression disorders (sacrococcyx hypoplasia or agenesis), and neurogenic bladder disorders (4). The early diagnosis of such diseases can lead to significant changes in the management of the disease. Different imaging techniques have been used to study constipation in children; Barium enema is used in the diagnosis of anatomic abnormalities such as Hirschsprung's disease, colonic transit time is used for functional disorders and MRI is used for spinal (neurogenic) causes (5). Pelvic X-ray is used for diagnosis spinal anomaly, sacral ratio and fecal retention (7). Ultrasound examination can provide lots of information about the status of rectum, bladder, pelvic cavity, spinal cord, spine and sacrococcyx. In various studies, pelvic ultrasound has been known as an effective, safe, accessible and affordable method for evaluating children's constipation. In pelvic ultrasound, symptoms of constipation can be found such as fecal retention, increased rectal diameter and pressure effect on the bladder as well as neurogenic bladder signs such as irregular thickening of the bladder wall, and possibly the pelvic masses (6). Although spinal ultrasound can be detect many of occult spinal disorders with high accuracy especially during infancy, in the literature review, we could not find any comprehensive study on spinal cord and lumbosacral ultrasound findings in children with chronic constipation. In this study, we evaluated ultrasound findings of spinal canal and lumbosacrococcyx for identification of underlying neurological and spinal causes of constipation.

2- MATERIALS AND METHODS

2-1. Study design

The research was conducted as a case-control study between 2014 and 2016 in the Radiology Department of Dr. Sheikh Pediatric Hospital, Mashhad University of Medical Sciences, Iran, after approval of the Research council and the Ethics Committee of the University (ID number: IR.MUMS. REC.1394.351).

2-2. Participants

One hundred children less than 14 years old with constipation (history of constipation more than 2 weeks), who were referred to the radiology department for diagnostic studies such as ultrasound, barium enema or colonic transit time were selected. Exclusion criteria were; age older than 14 years, heavily obesity with limitation in adequate bending, previously known patients, obvious underlying diseases such as myelomeningocele, long-term chronic illnesses etc. The control group was 100 children with similar age and gender (P = 0.257) which were randomly selected among healthy children with transient illness (otherwise constipation or urinary disorders) referred to radiology department for sonographic examination. The above ultrasound variables were also recorded for 100 children in the control group which were randomly selected among healthy children with similar age and gender (P = 0.257).

2-3. Methods

Spinal and sacral ultrasonography in lateral recumbent and bended position with knees to chest position was performed by an expert pediatric radiologist using multi-

frequency linear superficial probes (7 to 12 MHz). After posterior arch ossification, the spinal cord was evaluated from inter-laminar space. The ultrasound devices used in this study was Esaote; MyLab™50 or class C. After recording the general information, obtaining the history and physical examination, the sacrococcygeal and spinal cord ultrasound findings, were recorded in a special questionnaire. The study variables were: age, gender, history of constipation, presence of associated bowel disorders such as encopresis, associated urinary disorders such as Nocturia and incontinence, conus medullaris location, dural sac diameter of lumbosacral area, presence of spina bifida, presence of spinal cord lesions such as tethered cord, bone abnormalities such as hemi vertebrae, sacral and coccyx length, location of non-formation of the posterior arch of the sacrum (**Figure.1**), and presence or absence of sacrum or coccyx and coccyx hypoplasia. Sacrum in ultrasound can be identified by smaller spinous process in comparison with lumbar spinous process, non- formation of posterior arch, dural sac termination in S2 or S3 level and two bony prominences of sacral cornua. On sonographic images, normal coccyx in pediatric age has cartilages context without posterior arch with few ossification centers with a convex curve. Complete ossification of first coccyx vertebra occurs in 6.7±2 years old. Spina bifida, consisting of a defect in the closure of the posterior vertebral arch, can be identified by non-formation of spinous processes and failure of fusion on the posterior tips of the corners of vertebral laminae that is seen as two distinct echogenic foci (8). The non-formation of the posterior arch of the spinal column is identified by non-formation of spinous process and vertebral laminae that spinal canal is seen as a U-shaped osseous structure in ultrasound image. In coccyx hypoplasia, some of five of coccyx vertebrae and the final spinal curve is not formed (**Figure.2**).

2-4. Data Analyses

After the variables recording and data collection, the data were entered into SPSS version 16.0 software for statistical analysis. The descriptive statistics (frequency, ratios, percentage, mean, variance and standard deviation), were used to answer the research questions, while the statistical tests of chi-square, T-student and Mann-Whitney were used to test the hypotheses. P-value less than 0.05 were considered as statistically significance.

3- RESULTS

3-1. Participants

The 51% of study cases were female and the mean age of case group was 6 ± 3.3 years. Children with constipation were mostly in the pre-school ages (1 to 6 years, 53.3%), and then, in school ages (6 to 14 years, 39.5%), and ages less than 1 year (7%), respectively. No significant difference was found between case and control group regarding the ages of children (p = 0.257).

3-2. Test results

The most frequent presentation and clinical chief complaint of patients group was constipation (50%). The associated urinary dysfunctional symptom (nocturia and urinary incontinence) was seen in 36% of patients. The prevalence of other symptoms was urinary tract infection (13%), abdominal pain (2%) and other symptoms (5%), respectively.

In **Table 1**, spinal sonographic parameters between constipation group and the control group were compared. Spina bifida was found in 64% patients, and 31% control subjects. The difference in the prevalence of spina bifida in spinal cord ultrasound of children with constipation disorder and the control group was statistically significant

(p = 0.009). About one third of cases with spina bifida were found in lumbar L5 vertebra and another two third were in high sacral vertebrae (S1 or S2). The difference in location of spina bifida between this two area in two groups was not statistically significant (p = 0.845). Also, there wasn't strong relation between location of spina bifida and type of clinical symptom (p=0.014).

Non-formation of the posterior arch of the sacrum usually occurs in S3 or S4 vertebra, although occasionally S2 also involved. The difference of location of non-formation of the posterior arch of the spinal column ultrasound between children with constipation and the control group was not statistically significant (p = 0.209). Various degrees of caudal regression were observed in 8% patients suffering from constipation and in control group, 2% children had coccyx hypoplasia (**Figure.1**), but mean coccyx length in two groups of patients had not significantly different statistically (p=0.051). However, but mean coccyx length in constipated patients group was shorter than patients that had constipation plus urinary dysfunctional symptom group with significant difference (p=0.016). Ossification age of first vertebra of coccyx in normal group is 6.7±2 years. This ossification age in two groups was not different (P=0. 376).

The maximum dural diameter of the spinal canal in lumbosacral region was 13.4 ± 1 mm in children with constipation, and 13.2 ± 1.4 mm in the control group. The difference was not statistically significant (p= 0.664). There was not a significant relation between dural diameter and exist of spina bifida or urinary dysfunctional symptom (p>0.05).

The other spinal cord lesions (tethered cord and occult intrasacral meningocele) were observed in 2% of patients in spinal ultrasound examination.

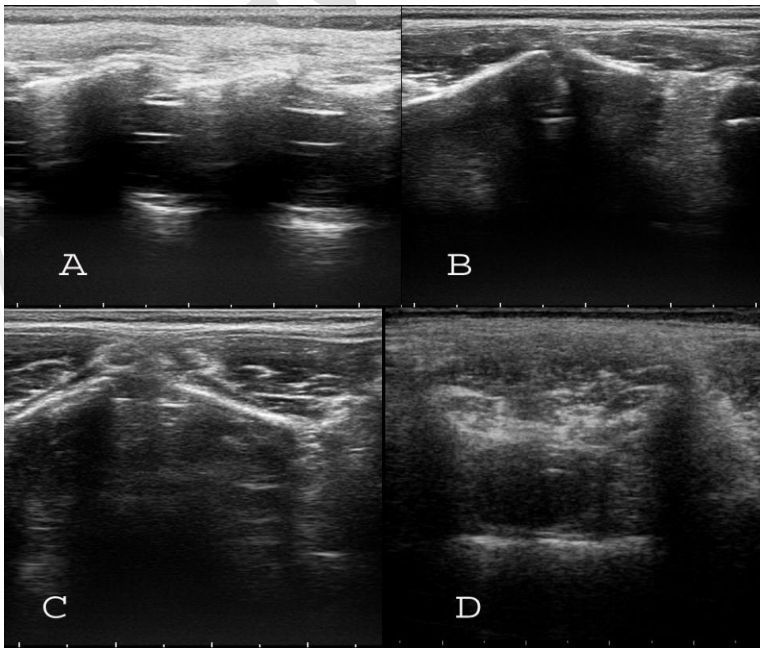

Fig.1: A) Mild dural ectasia and filum terminalis easily see from inter-laminar space after posterior arc ossification. B) Mild spina bifida as nonformation of spinus process. C) Moderate form of spina bifida. D) Posterior arc opening and obvious visualization of dura.

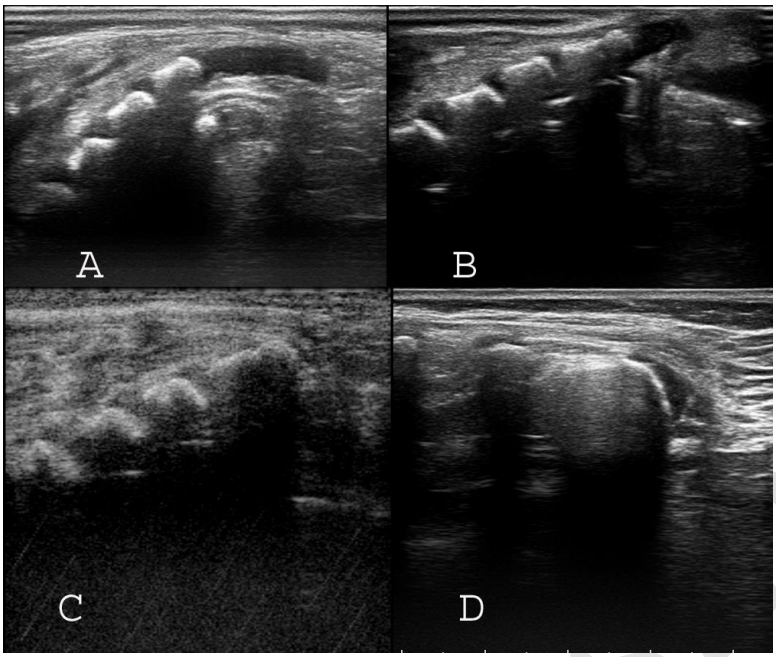

Fig.2: Sacrococcyx Ultrasound: A) Normal Sacrococcyx. B) Coccyx Hypoplasia. C) Coccyx Agensia. D) Sacral Agenesia.

Table-1: The prevalence of spinal disorder in children with constipation and control group

Type of disorder	Study groups	Rate	P-value
Spina bifida	Case group	64%	0.009
	Control group	31.5%	
Non-formation of the posterior arch of S3 vertebra	Case group	21.5%	0.209
	Control group	26%	
Coccyx length	Case group	21.6 mm	0.051
	Control group	24.5 mm	
Ossification age of First vertebra of coccyx	Case group	5.7 y	0.376
	Control group	6.7 y	
Dural diameter	Case group	13.4 mm	0.664
	Control group	13.2 mm	

4- DISCUSSION

Constipation is a common clinical complaint of children, which is an important symptom of many pediatric diseases (7-9). Early diagnosis of the underlying cause of constipation and its appropriate treatment can facilitate the patients' treatment and prevent many complications which causes by chronic constipation (10). The most common cause of constipation in the age group below 1 year has been reported to be Hirschsprung's disease (HD), while in older patients, the causes are functional (10). The aim of different imaging techniques which are used in the study of this disorder is to diagnose its underlying cause. Since the sonography is a safe, available, inexpensive imaging technique with valuable diagnostic information in the diagnosis of the underlying causes of constipation, pelvic ultrasound is widely used for diagnosis, treatment and follow-up in children (10-12).

Although usefulness ultrasound in constipated children was confirmed with demonstration increase the rectal diameter, increases the recto-pelvic index value greater than 0.189 (10-12), an increase in rectal wall thickness, irregularity and thickness bladder wall, but we didn't find any paper in literature about its application in evaluation of sacrococcyx and spinal cord. In our study, children with constipation were mostly in the pre-school ages (1 to 6 years) and then, in the school age (6 to 14 years), and the most frequent presentation and clinical chief complaint during referring was constipation (50%).

The other common complaints were urinary dysfunctional symptom such as nocturia and urinary incontinence (36%), urinary tract infection (13%), urinary incontinence (13%), abdominal pain (2%), and other symptoms (5%) which in turn, represent the wide range of clinical presentations of the patients. The main complaint of about half of patients was not remarked as constipation and the constipation were revealed in more detailed description of their condition. In a study by Loening-Baucke et al. acute and chronic constipation were the most frequent causes of acute abdominal pain, occurring in 48% of subjects (13). In our patients, the chronic abdominal pain was less prevalent. The evaluations of spinal column, sacrococcyx and spinal cord have an important role in children with constipation. In a study by Rosen et al., 9% of patients had spinal disorders and the most frequent disorder was tethered cord (75%) (14). In our study, spinal disorders (tethered cord and meningocele), were observed in only 2% of patients. In another study, spinal cord ultrasound and abdominal radiography revealed that the incidence of spina bifida in patients with constipation is 47.7% with significant difference than control group (14). In our study, the prevalence of spina bifida was 64% compared the control group. That may be due to more sensitivity of spinal sonogram in compare with spinal radiograph. The radiological diagnosis of spina bifida is possible after complete posterior arc ossification, but its ultrasound diagnose is unrelated to patient age. According to the mentioned data, the results of this study make a question mark about the usage of plain spinal X-ray for diagnose of spina bifida in these patients. The maximum diameter of the spinal canal in lumbosacral region was measured for evaluation of widening of the dural sac in the lumbosacral region or dural ectasia. The mean diameter was 13.4 mm in children with constipation and 13.2 mm in the control group, and the difference was not statistically significant (p=0. 376). We did not find this result in other studies.

Although the best ages for spinal ultrasound is less than 6 month, but our study showed that the spinal cord and column was easily seen from inter-laminar space among children less than 14 years in bended position. Because limitation in adequate bending, we excluded heavily obese child form study. As various degrees of caudal regression are associated with spinal cord malformation, results of this study suggest that neurological factors in constipation are more common than previous thought. In our study, various degrees of caudal regression which were diagnosed by ultrasound were significant and important finding in the ultrasound of sacrococcyx area of patients.

These findings were observed in 8% of the patients which was quite different from the control group. Although, the relationship between sacral ratio and anatomic abnormalities (such as imperforated anus, and functional bowel disorders has been established in several studies (7,15). But sonographically, mean coccyx length in two groups of patients had not significantly difference (p=0.051). Of course, all of sacral ratio studies have been based on the measurement of pelvic X-ray.

4-1. Limitations of the study

This study had few limitations, especially in estimating the ranges of values, relation of ultrasound detected caudal regression with radiographic sacral ratio and importance of these findings in therapeutic planning or treatment response, which needs further more accurate studies.

5- CONCLUSION

Diagnosis of spina bifida and caudal regression by ultrasound is perhaps the most important finding of this study. Using X-ray methods (plain radiography) in pelvic and genital system area is always associated with limitations due to the harmful effects of ionizing radiation. Thus, the use of ultrasound to determine the presence or absence of caudal agenesis can be very helpful and effective. However, determining the relationship between radiological sacral ratio and coccyx agenesis in diagnostic sonography requires further studies. In pediatric age, lumbosacral spinal anomalies can easily evaluate with ultrasound. The prevalence of spina bifida and caudal regression in children with constipation was significantly higher in comparison with normal control group.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENTS

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