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REVIEW ARTICLE

Constipation in Childhood. An update on evaluation and management

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Abstract

Objective: Constipation is a frequent problem in childhood and may be defined as delay or difficulty in defecation that persists for longer than two weeks. It is one of the ten most frequent pathological conditions that a general paediatrician deals with. The aim of this review is to provide the general paediatrician an overview of constipation in children discussing the etiology, differential diagnosis, signs and symptoms and patient evaluation.

Methods: We provide an overview on the pathogenesis, the diagnostic approach and the management of constipation based on electronic literature searches using the best available evidence from PubMed, Medline, Google Scholar, the European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the North American Society of Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN).

Results: The most common type of constipation is functional accounting for 90-95% of all cases. In a small percentage of children, who may have an organic cause of constipation, an appropriate laboratory investigation and imagine studying is warranted.

Conclusions: Functional constipation remains a frequent problem in childhood. Treatment options differ between infants and children. Emphasis on recommended regimens for maintenance and how to reduce medication will help to improve the long-term outcome. Moreover, it is of great importance to follow constipated children closely and restart medication promptly. On treatment failure or on suspicion of organic disease the patient should be referred for further evaluation. Hippokratia 2015, 19 (1): 11-19.

Keywords: Constipation, children, gastroenterology, nutrition, evaluation, management

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Introduction

Constipation is typically characterized by lack of periodicity in defecating, bulky stools and difficulty or pain during defecation. Constipation is one of the ten most frequent problems that a general pediatrician deals with, accounting for 25% of referrals to pediatric gastroenterologists worldwide[1]. According to the diagnostic criteria for constipation, a patient must have experienced less than 3 bowel movements per week. Prevalence rates of constipation range from 0.7% to 29.6% of the worldwide general population. Up to 84% of functionally constipated children suffer from fecal incontinence, while more than one third of children present with behavioral problems primary or secondary due to constipation[2,3]. Most studies do not report prevalence difference between boys and girls or correlation with socioeconomic factors[4]. The Northern American Society of Gastroenterology, Hepatology and Nutrition (NASPGHAN) defines constipation as a delay or difficulty in the defecation present for two weeks or more[5].

The frequency of defecation depends on the child's age. In the neonatal period and early infancy, defecation may occur more than 4 times a day and progressively decreases to 1-2 per day, at the age of 4 years, in which 98% of the children have gained voluntary control of the sphincter. The normal frequency of bowel movements is correlated to age. According to literature neonates and infants up to 3 months use to have 2.0 to 2.9 bowel movements per day. Older infants and children up to 3 years have 1.8 and 1.4 defecations/day respectively. Children over 3 years have about 1.0 defecation per day[6]. Terms which have been used to describe constipation, such as fecal leakage, fecal soiling and encopresis, do not describe the condition accurately. Fecal leakage may occur without co-existing constipation and can be either voluntary or involuntary. Encopresis is defined as voluntary or involuntary passage of stools in inappropriate places[7]. The terms encopresis and fecal leakage are often replaced by the term incontinence.

The Paris consensus on childhood constipation terminology[8] includes a number of specific criteria that have been developed and complete the Rome III diagnostic cri-

Table 1. The Paris consensus on childhood constipation terminology[8] and Rome III constipation diagnostic criteria[7,9,10]. A diagnosis of chronic childhood constipation is established according to Paris Consensus when 2 or more of the following symptoms or signs lasting for more than 8 weeks must be present.

Paris consensus constipation criteria
Less than 3 bowel movements per week
More than one episode of fecal leakage per week
Large in diameter stools that cause rectal outlet obstruction
Demonstrate withholding posture and behavior
Painful bowel movements
Definitions of bowel evacuation pathology
Fecal Incontinence: Passing stool in inappropriate places
Organic fecal incontinence: Fecal incontinence due to organic disease (neurological disorders, sphincter disorders, etc)
Functional bowel incontinence: Non-Organic disease divided into two categories:
Fecal incontinence associated with constipation: Functional bowel incontinence associated with constipation
Fecal incontinence non stool withholding (not associated with constipation: Passing stool in inappropriate places in children older than 4 years of age without evidence of constipation based on the medical history and the clinical evaluation
Fecal impaction: Large fecal mass in the rectum or the abdomen which is unlikely to pass through the rectal sphincter. Fecal impaction can be demonstrated by examining the rectum or the abdomen
Pelvic floor dyssynergia: A paradoxical contraction of pelvic floor muscles with defecation.
Rome III, Criteria for constipation diagnosis
According to the Rome III criteria a diagnosis of chronic constipation in childhood is established when 2 or more of the following are present for at least one month for infants and children up to 4 years. For children over 4 years of age, symptoms should last for at least two months.
• Two or less bowel movements per week
• At least one episode of fecal incontinence per week after the child has acquired complete bowel control.
• History of extensive fecal retention or withholding behavior by the child
• Having hard and painful stools
• Large fecal mass on digital rectal examination
• Large in diameter stools that cause rectal outlet obstruction

teria[9,10]. These criteria include, among else, bowel movement frequency, stool consistency and fecal incontinence (Table 1).

The term infantile dischezia is used to describe a pathological disorder, relatively often seen in infants by the pediatrician, characterized by pelvic floor dysfunction resulting in loose or watery stool and difficulty in defecating, often accompanied by irritability and crying. These babies are unable to coordinate the increased intra-abdominal pressure with the relaxation of the pelvic floor. This type of defecation may occur several times a day and last up to 20 minutes each time. The first signs of symptoms begin in the neonatal period and resolve automatically when muscle coordination is achieved. Parents can be reassured that this phenomenon is part of the learning process of the child and that does not require any additional intervention[9-11].

Etiology

The majority of children with constipation have functional constipation, accounting for 95% of cases[1,12]. The peak incidence of constipation occurs between 2 and 4 years of age, when the toilet training starts[11].

Available research suggests that several factors may contribute to constipation, such as lower parental educational level, increased body weight, reduced physical activity, a low fiber diet, positive family history and psychological factors[3,13,14]. The etiology of functional constipation is shown in Table 2. It relates mostly to fecal retention, when a child is trying to avoid an unpleasant defecation[7].

However, only a small percentage of children (5%) experiences an organic cause of constipation, such as neuromuscular diseases, drug side effects, food allergies, celiac disease, etc (Table 2)[7,15,16].

Hirschsprung's disease must be differentiated from idiopathic constipation. Hirschsprung's disease is a colonic motility disorder, resulting from segmental colonic aganglionosis. It is believed to account for 20 to 25 per cent of

Table 2. Causes of functional and organic constipation (synthesis of data available in current literature)[7,15,16].

Idiopathic				
Functional constipation				
Developmental disorders (behavioral disorders, ADHD, Autism)				
Occasional constipation (forced toilet training, phobia, sexual abuse, exaggerated parental interventions)				
Psychological (eg. depression)				
Lazy colon				
Genetic predisposition				
Environmental (organochlorine insecticides or heavy metals)				
Dietary (low dietary fluid and fiber intake, malnutrition)				
Organic				
Neuromuscular disorders	Anatomical lesions	Systemic diseases	Drugs	Other
Congenital megacolon	Congenital or acquired	Cystic fibrosis	Ferrum	Cow's milk allergy
Intestinal neuronal dysplasia	rectosigmoid stenosis	Connective tissue	Diuretics	Celiac disease
Vertebral lesions	Ectopic anus	disorders	Codeine/	
Embedded filament	Congenital colon	Diabetes Mellitus	Narcotics	
Neurofibromatosis	defects	Diabetes Insipidus	Antidepressants	
Cerebral palsy	Gastroschisis	Hyperthyroidism	Aluminium	
Botulism		Hypokaliemia	antacids	
		Hypothyroidism	Lead	
		Down syndrome	poisoning/	
		Pelvic tumors	Vitamin D	
		MEN 2B Syndrome		

all cases of neonatal intestinal obstruction[9]. It can lead to severe enterocolitis with fever, diarrhea, and severe prostration, which may be fatal if the diagnosis is not made early. Most affected infants develop difficulties with defecation during the first few weeks of life. Other signs and symptoms associated with the condition include abdominal distention, refusal to feed, and bilious vomiting. In the older infant or child, in whom the diagnosis is not made early in life, there may be persistent abdominal distention, recurrent fecal impaction, and failure to thrive. In some patients with short segment or ultra short segment Hirschsprung's disease, the diagnosis may not be made until later in life. Those patients have long periods of chronic constipation and may have normal ganglion cells in rectal biopsy, despite anorectal manometric findings consistent with Hirschsprung's disease.

Magnetic resonance imaging (MRI) of the lumbosacral spine and colonic manometry may be necessary to identify occult spine abnormalities and occult myopathy or neuropathy of the gastrointestinal tract[16,17].

Risk factors

Several risk factors have been identified in association with pediatric constipation. Low consumption of dietary fiber has long been considered as one of the leading risk factors. Undigested fibers in the colon are thought to increase the colonic transit and increase stool output. Lee *et al*[18] found that kindergarten children with constipation took significantly lower median dietary fiber than non-constipated children. Furthermore, fruits and total plant food intake were significantly lower in the constipated group[18]. Two other studies, among older children, also noted that children with constipation consume significantly less amount of dietary fiber than controls[19,20]. Studies from Asia also show that fiber consumption in Asian countries such as Hong Kong[18,21] and Maldives[22] is lower than the recommended values.

Several studies have demonstrated its relationship with psychological factors. Inan *et al*[23] has shown that physical or psychological trauma and personal health problems were associated with constipation, in school-aged children. Furthermore, they have found that abnormal oral habits (which were considered to correlate with psychological stress) also showed a significant association with constipation[23]. A study from Sri Lanka, involving school age children (10-16 years old), noted that school-related stressful events such as separation from best friend, bullying at school, failure of exam and family-related events, such as severe illness of family member, parents' job loss and frequent punishment by parents, were predisposing them to develop constipation[24]. Psychological factors including emotional stress are likely to modulate colonic and rectal functions, through the brain gut axis, leading to constipation.

Cow's milk protein allergy is considered as a risk factor for constipation. Several studies have reported reduction of constipation by elimination of cow's milk from diet[25,26]. However, further studies are needed to confirm this association and to introduce cow's milk-free diet to infants and children with constipation. Others demonstrated risk factors are extreme low birth weight[27], positive family history[19,28] and living in urban areas[28,29]. High consumption of junk foods with low fiber content and sedentary life style might have contributed to the higher prevalence of constipation, reported in children living in urban areas.

Table 3. Alarm signs symptoms and physical findings distinguishing organic constipation from functional constipation (synthesis of data available in the current literature)[12,42].

Constipation starting extremely early in life (<1 month)
Abdominal distention
Passage of meconium >48 hours
Ribbon stools
Blood in the stools in the absence of anal fissures
Failure to thrive
Fever
Bilious vomiting
Occult blood in the stool
Extreme fear during anal inspection
Lack of lumbosacral curve
Pilonidal dimple covered by tuft hair
Midline pigmentary abnormalities of the lower spine
Sacral dimple
Sacral agenesis
Anteriorly displaced anus
Perianal fistula
Perianal scars
Abnormal position of anus/ Patulus anus/ Flat buttocks
Abnormal thyroid gland
Family history of Hirhspung's disease
Tight, empty rectum in the presence of palpable abdominal fecal mass
Gush of liquid stool and air from the rectum on withdrawal of finger
Gluteal cleft deviation
Absence or delay in relaxation phase of the lower extremity deep tendon reflexes
Absence of anal wink
Absent anal or cremasteric reflex
Decreased lower extremity tone and/or strength/reflex

Pathophysiology

The pathophysiology of constipation in children is multi-factorial and is associated with interactions of many risk factors. Many organic diseases cause constipation. However, the majority of patients with constipation secondary to organic conditions, usually have other clinical features suggestive of the relevant underlying organic disease. Organic diseases presenting as isolated constipation are rather uncommon.

Borowitz *et al*[30] reported painful defecation as the commonest factor for constipation. If there is pain during defecation, children usually withhold stools. During the withholding, rectal mucosa absorbs water from the fecal mass, which becomes harder and larger as the time passes and ultimately defecation becomes difficult. Therefore, when the desire to pass stools comes, children adopt retentive posture, hide from parents till the urge pass off. Passage of this fecal mass is painful and sometimes results in anal fissures, which further aggravate pain and precipitate stool

withholding. This sets up a vicious cycle of stool retention.

Accumulation of stools in rectum causes gradual dilatation leading to megarectum resulting in loss of rectal sensation and urge for defecation. It had been shown that children with megarectum have high sensory threshold for rectal sensation[31,32]. Several studies have demonstrated slow colonic transit in 25%-69% of children with constipation[33-35]. Furthermore, those with slow transit constipation had more severe symptoms, including night time soiling[33]. Laparoscopic biopsies of the colon have shown deficiency of neurotransmitters such as substance P in some children[36,37]. Furthermore, it was shown that number of antegrade pressure waves in the colon was significantly decreased in children with slow transit constipation[38,39].

Symptoms

Signs and symptoms may vary according to the age of the child. Infants may present with clinical features, such as straining, turning red in face and crying. Toddlers may present with passing painful and hard stool that may be associated with bleeding per rectum, secondary to a small tear in the anal canal which leads to further withholding. Parents may note that the child resists the urge to defecate.

Patients may also present with retentive fecal soiling secondary to withholding that can be mistaken as diarrhea and will force parents to seek medical care. Other manifestations include abdominal pain, distention, and feeling of incomplete disimpaction causing nausea and decreasing appetite. Some patients also present with enuresis and urinary tract infections, because stool masses press on the urinary tract and block normal urinary flow[40].

Diagnosis and differential diagnosis

The approach to making diagnosis includes the patient's medical history, physical examination and an appropriate laboratory investigation[41].

Although the most common type of constipation is functional constipation, an underlying pathology should be excluded. The physical findings distinguishing organic constipation from functional constipation (Table 3).

The most important step of the diagnostic approach to constipation is a thorough medical history, including a constipation diary and a careful physical exam.

A complete medical history should include information regarding the symptom onset (age, duration, severity), description of bowel movements (frequency, stool composition and volume, co-existing symptoms), use of medication, psychological state, dietary habits, the existence of a positive family history, co-morbidities and possible related etiologic factors[43-45].

On clinical examination, the child's somatometric features should be obtained and possible systemic or neurological diseases (skin, facial features, etc) should be sought. An examination of the thorax, the abdomen, the lumbosacral part of the vertebral column and the perineum should be performed as well. A digital rectal examination is also required and the cremasteric reflex, as well as the lower extremity reflexes, should be tested.

Most children with functional constipation only need a thorough history and physical exam and do not require laboratory investigation. If the patient does not respond to initial treatment, further laboratory tests need to be performed, which include thyroid function test, serum electrolytes (calcium, potassium), lead level and celiac disease antibodies.

If the initial laboratory investigation is negative, the treatment for constipation has failed and an organic cause of constipation is suspected, then further laboratory testing is required, as shown in Table 4[7].

Plain radiographs of the abdomen may be necessary to establish fecal impaction in a child who refuses rectal examination, and in the obese child when abdominal and rectal examinations are suboptimal to assist fecal load[16]. Barium enema on unprepared colon, rectal biopsy, and anorectal manometry study are performed in case of suspicion of Hirschsprung's disease. Anorectal manometry is also helpful to identify functional abnormalities in some children with chronic idiopathic constipation, including an increased rectal sensory threshold, decreased rectal contractility on attempted defecation and paradoxical contraction of the external anal sphincter and puborectalis muscles, during attempts at defecation[16,46].

Warning signs for organic causes of constipation are also shown in Table 4[1,7,11,12].

Management of constipation in infants and children

Treatment of constipation includes close medical supervision, dietary instructions, behavioral changes and instructions regarding toilet training (most preferably after meals). An algorithm for evaluation of pediatric constipation (organic or functional) is shown in Figure 1 and a treatment algorithm for pediatric functional constipation is shown in Figure 2[42]. Treatment differs between infants and children.

Infants

Babies (3-12 months) are offered juices which contain sorbitol, diluted with water, twice a day (Table 5). Honey and syrup of plant origin should be avoided[5,11]. Some infants may benefit from avoidance of cow's milk. Breastfed infants may benefit from a cow's milk restricted diet followed by the mother[25].

According to a recent study, the use of an infant formula with a high proportion of Sn-2 palmitate [palmitic acid is esterified in the sn-2 (b) position of triglycerides], may lead to softer stools in constipated infants because free palmitic acid may form insoluble calcium fatty acid soaps, which are excreted via the feces, resulting in firmer stools. Stool hardness has been positively associated with the presence of calcium fatty acid soaps in the stools. In human milk however, palmitic acid, esterified at the Sn-2 position of the triacylglycerol molecule, is well absorbed as 2-monopalmitin, since it readily forms mixed micelles with bile acids[48]. However, further investigation is necessary to generalize this recommendation.

For infants older than 6 months of age adequate dietary intake of fiber, according to the age, is recommended. In-

Table 4. Laboratory testing for constipation and warning signs for organic cause (based on current literature)[1,7,11,12].

Initial testing
Complete blood count
Urinalysis & urine culture
Thyroid function tests, calcium, electrolytes, magnesium, lead
Total IgE, RAST (milk, egg, fish, wheat)
Serological testing for celiac disease
Sweat test
Fecal occult blood test
Further investigation
Chest radiograph
Barium enema
Defecation proctography/defecography
Colonic manometry
Rectosigmoidal manometry
Rectal biopsy
Magnetic Resonance Imagine of lumbosacral part of the spine
Warning signs for organic constipation (red flags)
Symptom onset before 12 months of age
Delayed passage of meconium
Lack of fecal retention
Lack of fecal leakage (soiling)
Malnutrition
Empty rectal ampulla
Pigmentary abnormalities
Positive fecal occult blood test
Extraintestinal manifestations
Gallbladder diseases
Resistance to standard treatment

crease in cooked and pureed fruits and vegetables, as so as cereals, may be an option. If needed, addition of guar powder (rich in fiber, available in developed countries), may be also useful. Moreover, increased fluid intake, particularly of juice containing sorbitol, such as prune, pear and apple, are very helpful[25]. Wherever dietary interventions have failed, osmotic stool softeners, such as lactulose, lactitole and sorbitol may be needed. Rectal disimpaction has been effectively performed in infants by using glycerine suppositories[46].

Excessive administration of phosphate enemas may result in systemic absorption and leads to symptoms associated with hyperphosphatemia and hypocalcemia and even death, particularly in very young infants and in patients with Hirschsprung's disease[49,50]. If treatment fails, or the infant has delayed passage of meconium, or the presence of red flags such as fever, vomiting, bloody diarrhea, failure to thrive, distention, or tight empty rectum, further evaluation is required to exclude Hirschsprung's disease. If the patient has delayed passage of meconium and Hirschprung's disease is excluded, sweat test to rule out cystic fibrosis, is recommended[42].

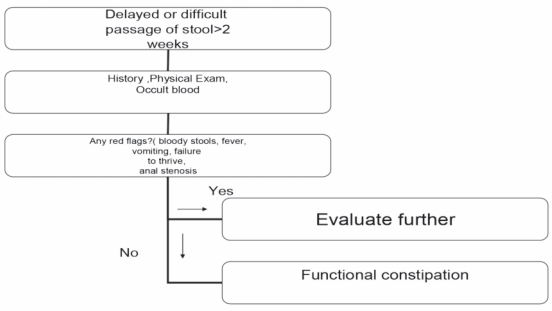

Figure 1. Algorithm for evaluation of pediatric constipation (organic or functional) (based on current literature)[12,27,42].

Children

The goals of treating constipation in childhood are to produce soft, painless stools and to prevent the re-accumulation of feces. These outcomes are achieved through a combination of education, behavioural modification, daily maintenance stool softeners and dietary modification. Fecal disimpaction may be necessary at the outset of treatment. Initial laboratory and radiographical investigations are not necessary, unless history and examination suggest organic disease[47,51]. Treatment in children usually consists of 3 phases (Table 5). The first phase in constipation treatment for older children (>12 months) is the clean-out phase, with a goal of clearing out the hard, chronically accumulated stool. Fecal impaction is identified by the presence of a large and hard mass in the abdomen or dilated vault filled with stool on rectal examination, and often substantiated by a history of overflow incontinence (an abdominal radiograph is not necessary to diagnose fecal impaction). Fecal disimpaction can be accomplished with oral use of osmotic agents and laxatives, as well as, in some cases with the need of enemas and/or suppositories. This phase lasts a couple of days. In phase II, which lasts between 2 and 6 months, treatment aims to restore muscle tone to the sphincter and the return of the gut diameter to its normal size. The previous therapeutic targets are achieved by stool softeners, hyperosmotic laxatives, non-absorbable salts or combinations. Management also includes keeping a stool diary, dietary instructions for constipation and instructions for toilet training.

In phase III, which lasts between 4-6 months, therapeutic targets are to restore regular bowel movements and avoidance of relapses. These goals can be achieved by cutting down laxative use and by increasing daily fiber and fluid intake[52-54]. Commonly used drugs for pediatric constipation, drug dosage and drug side effects are shown in Tables 5 and 6.

A high dose of mineral oil and polyethylene glycol solution (PEG) has found to be effective, as an oral medication for disimpaction[55]. Disimpaction can be achieved by either oral or rectal medication. In a double-blind uncontrolled study, Youssef *et al*[56] showed that the three-day administration of PEG 3350, at a dose of 1 g/kg/day to 1.5 g/kg/day (maximum dose 100 g/day), successfully disimpacted 95% of children and was well tolerated[56]. Another study showed that a regimen of daily enemas, for six days, was equally effective as PEG 3350 (1.5 g/kg/day) in relieving disimpaction, but may be less well-tolerated[57]. Patients who do not respond to enema or oral polyethylene glycol solution, may need manual disimpaction, under general anesthesia[16,58].

Once the impacted stool has been removed, the focus of the treatment should be on preventing recurrence.

Table 5. Treatment management of chronic constipation in infants and children. Constipation treatment in childhood has 3 phases. The first phase aims to clear out hard, chronically accumulated stool (disimpaction) with oral use of osmotic agents and laxatives. The second phase aims to restore muscle tone to the sphincter by the use of stool softeners, hyperosmotic laxatives, non-absorbable salts or combinations. The third phase aims to restore regular bowel movements and to avoid relapses by cutting down laxative use and by increasing daily fiber and fluid intake[12,42,45,47].

Infants		
Juice consumption containing sorbitol diluted with water twice a day		
Syrup of plant origin and honey should be avoided		
Adequate dietary intake of fiber according to the age for infants older than 6 months of age		
Laxative administration (lactulose, lactitole, sorbitol) for infants older than 6 months of age		
Glycerine suppositories for occasional constipation		
Enemas avoidance		
Juice consumption containing sorbitol diluted with water twice a day		
Syrup of plant origin and honey should be avoided		
Children		
Phase I in constipation treatment for older children		
Target	Duration	Treatment*
Bowel emptying	1- 3 days	Per rectum: Phosphate enemas, Paraffin oil enemas, salt enemas Bisacodyl suppositories Per os: Paraffin oil, magnesium hydroxide, Magnesium citrate, lactulose, sorbitol, senna, bisacodyl
Phase II in constipation treatment for older children		
Target	Duration	Treatment*
Restore muscle tone stool softeners to the sphincter & Return of the gut diameter to its normal size	≥ 2-6 months	Paraffin oil Hyperosmotic laxatives: lactulose, lactitole, sorbitol Non-absorbable salts: magnesium hydroxide or combinations Macrogol Constipation diary Dietary instructions Toilet training
Phase III in constipation treatment for older children		
Target	Duration	Treatment*
Restore regular bowel movements & Relapse avoidance	≥ 4-6 months	Gradual laxative reduction Fluid intake Fiber intake

*On treatment failure: polyethylene glycol electrolyte solution.

Maintenance therapy should be started immediately after disimpaction, to prevent re-impaction. Medications have been shown to be more effective than behavioural change alone in the treatment of constipation[59]. A systematic review of laxative treatments for childhood constipation has been recently published, and acknowledges the relative paucity of well-designed trials for laxatives in children and the resultant difficulty in establishing first-line therapy[60]. Available medication includes lubricants such as mineral oil, osmotic laxatives such as lactulose, sorbitol and PEG.

Mineral oil has a risk of aspiration and should be avoided in infants and in children who resist taking it or have dysphagia or vomiting. Mineral oil, lactulose or sorbitol is equally efficacious, the choice among these being based on safety, cost, the child's preference and the practitioner's experience[42,58].

There is growing evidence to support the efficacy and safety of PEG 3350 in the maintenance treatment of children with constipation[61]. PEG 3350 without electrolytes is a tasteless, odourless, osmotic laxative. It is available in powder form, and dissolves well when mixed in juice or water. It is absorbed only in trace amounts from the gastrointestinal tract and, unlike other colonic lavage solutions, carries no risk of electrolyte imbalance. The effects of PEG 3350 start within the first week of treatment. It has been reported that PEG is a safe and effective laxative in a dose of 0.8 g/kg/day with fewer side effects than lactulose. PEG did not cause persistent gas, abdominal pain, or perianal irritation in children[62,63]. PEG has been shown to be equally as effective as milk of magnesia, although better tolerated[64]. Dose-finding studies for PEG 3350 used starting doses of 0.4 to 0.8 g/kg/day, as either a single or twice-daily dose and, when tailored to effect, a range of doses from 0.27 to 1.4 g/kg/day[65], and 0.3 to 1.8 g/kg/day[66] were reported. Maintenance doses of 0.4 to 1.0 g/ kg/day have been shown to be effective and well tolerated[63,65,66]. A common reason for the lack of response to stool softening ther-

Table 6. Commonly used medication for pediatric constipation (comprehensive data from literature)[12,42,45,47].

Osmotic Laxatives	Dosage	Adverse effects	Comments
Lactulose (solution)	Solution 1-3 ml/kg per day in divided doses	Flatulence, abdominal cramps, hypernatremia	Synthetic disaccharide. Well tolerated long term
Lactitole (solution)	0.375-2 ml/kg per day in 1-2 divided doses (also available as sachets powder)	Same as lactulose	Synthetic disaccharide. Well tolerated long term
Sorbitol (solution)	1-3ml/kg per day in divided doses	Same as lactulose	Same as lactulose
Magnesium salts (liquid 16.7%)	<6 years, 1-3ml/kg per day; 6-12 years, 100-150ml/day;> 12 years, 150-300ml/day; in single or divided doses	Infants susceptible to magnesium poisoning. Overdose can lead to hypermagnesemia, hypophosphatemia, and secondary hypocalcemia	With caution in patients with renal insufficiency
Polyethylene glycol-electrolyte solution	For disimpaction: 25ml/kg per hr (to 1000 ml/hr) by nasogastric tube until clear or 20ml/kg for 4 hr/day	Difficult to take. Nausea, bloating, abdominal cramps, vomiting and anal irritation	Caution for electrolyte imbalance and dehydration May require hospital admission and nasogastric tube
	For maintenance: (older children) 5-10, and ml/kg per day	Aspiration, pneumonia, pulmonary edema, Mallory-Weiss tear	
Lumbricants			
Mineral oil	<1 year old; not recommended. Disimpaction: 15-30ml/yr of age, up to 240ml daily. Maintenance: 1-3ml/kg per day	May cause lipid soluble vitamins malabsorbtion. Lipoid pneumonia if aspirated foreign body reaction in intestinal mucosa	Softens stool and decreases water absorption. More palatable if chilled. Anal leakage indicates dose too high or need for clean-out
Stimulant Laxatives			
Senna	2-6 years old: 2.5 7.5ml/day; 6-12 years old: 5-15ml/day. Available as syrup, 8.8mg of sennosides/ 5ml. Also available as granules and tablets	Idiosyncratic hepatitis, Malanosis coli, Hypertrophic osteoarthropathy analgesic nephrology	Melanosis coli improves 4-12 months after medications discontinued
Bisacodyl (tablets or suppositories)	≥2 years old: 0.5-1 suppository 1-3 tablets per dose. Available in 5-mg tablets and 10-mg suppositories	Abdominal pain, diarrhea and hypokalemia abnormal rectal mucosa and (rarely) proctitis. Case reports of urolithiasis	
Stool Softeners			
Glycerin suppositories		No side effects	use for disimpaction in older infants

apy is inadequate dosing; physicians should not hesitate to start PEG therapy at a higher dose of 1.0 g/kg and then decrease as necessary. The safety profile for PEG 3350 has been favourable. Clinical adverse effects are minor and can include bloating, flatulence, abdominal pain and loose stools[61,63,65-67]. In none of the aforementioned trials was PEG 3350 discontinued due to side effects related to the medication.

The prolonged use of stimulant laxatives such as senna is not recommended, but they may be used intermittently as a rescue therapy to prevent re-impaction. The patient should be weaned away from stimulant laxatives, as early as possible, to prevent dependence[16,42].

General aspects of constipation management

Behavioral Modification

Time dedicated for defecation, as part of toilet training, is valuable. Most people who have normal stooling habits, tend to defecate at the same time each day[47]. The

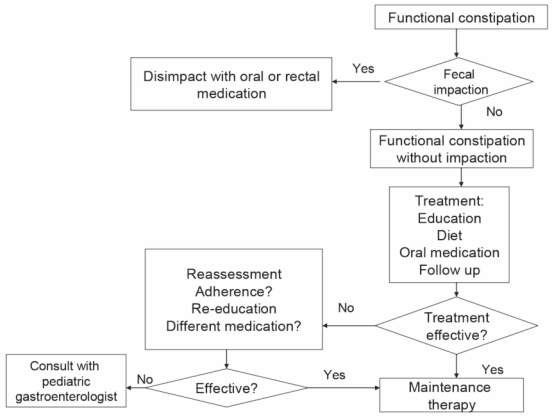

Figure 2. Treatment algorithm for pediatric functional constipation. (based on current literature)[12,27,42].

reflex of defecation tends to occur within 1 hour of eating, and usually during morning hours. A constipated child should have a routine scheduled toilet sitting for three to ten minutes (age dependent), once or twice a day. Ensure that the child has a footstool on which they can support their legs to effectively increase intra-abdominal pressure (valsalva manoeuvre). There should be no punishment for not stooling during the toileting time; praise and reward for stooling and the behaviour of toilet sitting, can be offered. It is helpful if children and their caregivers keep a diary of stool frequency to review at the next appointment. Regular physical activity can be recommended, although its role in treating constipation remains unclear[23].

Dietary Modification

A balanced diet that includes grains, fruits and vegetables is recommended as part of the treatment of constipation in children[5]. Carbohydrates (especially sorbitol) found in prune, pear and apple juices can cause increased frequency and water content in stools[5]. The American academy of pediatrics recommends a fibre intake of 0.5 g/kg/day (to a maximum of 35 g/day) for all children[68]. Fibre intake below the minimum recommended value has been shown to be a risk factor for chronic constipation in children[20,18].

Although excessive milk intake may exacerbate constipation, there is insufficient evidence that eliminating it from the diet improves refractory constipation. For children unresponsive to adequate medical and behavioural management, consideration could be given to a time-limited trial of a cow's milk-free diet[5]. Intolerance to cow's milk, particularly in children with atopy, has been associated with chronic constipation[25].

Probiotics in Constipation

Two studies have addressed the use of probiotics in treating constipation in children. The addition of *Lactobacillus rhamnosus GG* in the first study, showed that it was not an effective adjunct to lactulose in treating constipation[69]. The second study's sample size was too small, to draw any meaningful conclusion[70]. Currently there is no sufficient evidence for recommending probiotics as a treatment option for children suffering from constipation.

Prognosis

Parents should be informed that there is a risk of constipation recurrence in 50% of all cases. The prognosis for full recovery, defined as no soiling and no constipation while off medication, has been reported as 48% at 5 years follow up[16]. Treatment failures are reported in 20% of children. Early onset of symptoms during the first year, family history of constipation, poor self esteem and prior sexual abuse are associated with poor prognosis[16,71]. In case of recurrence the treatment protocol will have to be repeated.

Conclusions

Constipation remains a frequent problem in childhood. The most common type of constipation is functional. A small percentage may have an organic cause and appropriate laboratory investigation is warranted. A complete medical history and clinical examination are important to guide the practitioner to the diagnosis and further work-up or referral to a specialist. Treatment of constipation includes close medical supervision, dietary instructions, behavioral changes and instructions regarding toilet training. Patients who do not respond to treatment, should have further evaluation to exclude an organic etiology.

Conflict of Interest

The authors report no conflict of interest.

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