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PEDIATRIC BOWEL OBSTRUCTION

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Introduction:

Hi everyone, my name is Kevin Verhoeff and I am a general surgery resident at the University of Alberta. This PedsCases podcast is designed to help you understand, identify, and manage an important pediatric emergency, pediatric bowel obstruction. Compared to adults, pediatric bowel obstructions have a much broader differential diagnosis, present in a variety of ways and at various ages, and require surgical management in most scenarios.

This podcast was created with help from Dr. Simon Byrns, a pediatric surgery fellow, and staff pediatric surgeon, Dr. Bryan Dicken.

Objectives:

There are three main objectives of this podcast:

1. Optimize your history and physical exam for a patient with suspected bowel obstruction.
2. Develop a broad, systematic, and organized approach to your differential diagnosis for a child presenting with bowel obstruction.
3. Describe the initial workup and stabilization of pediatric patients with bowel obstruction.

This podcast is meant to be a review of the differential diagnosis for pediatric bowel obstructions, while highlighting the important diagnosis of malrotation and volvulus.

Pathophysiology

Let's start with a brief discussion about pathophysiology. A bowel obstruction occurs when there is a mechanical blockage of the GI tract. This obstruction can occur anywhere from the stomach, as is seen in pyloric stenosis, to the anus such as in Hirschsprung disease. The obstruction can be constant or intermittent. In a bowel obstruction, gastric contents cannot move past the blockage leading to symptoms such as abdominal cramping and pain. If the obstruction is distal, you will also note abdominal distention. Since gastric contents cannot move forward, they move backwards resulting in nausea and vomiting. Notably, bile can reflux backwards from the proximal small intestine into the stomach leading to dark green bilious emesis. Bilious emesis is a big red flag for obstruction, but may not be present in every case. Bowel obstruction may impair the blood supply to the intestines leading to necrosis, and perforation. This is why a bowel obstruction can be a surgical emergency.

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History and Physical Exam:

As always, the first thing to complete is a full pediatric history. Unique aspects on history to highlight when considering bowel obstruction include:

- Vomiting with a focus on it being bilious or not. Bilious vomit appears dark green, think army green. This means that the obstruction is distal to the ampulla of Vater in the 2nd part of the duodenum, where bile enters the GI tract.
- Abdominal pain
- Obstipation, which is lack of flatus (aka farting), including how long the child or parents think that no gas has passed.
- Constipation and how long there hasn't been a bowel movement.
- History of meconium passage in the first 24 hours after birth.
- Bright red blood in the stools or melena stools.
- Irritability and lethargy.
- Hydration assessment including wet diapers, drinking, etc.
- Diet change.
- Straining or crying while stooling, which may support constipation.

Physical exam is also key and involves all the aspects of a typical exam with focus on the following:

- Vitals because kids with bowel obstruction can be very sick and possibly unstable. This can be due to dehydration, ischemic bowel, or sepsis.
- abdominal exam particularly looking at:
 - full exposure including the groins looking for bulges that may indicate a hernia.
 - abdominal distention.
 - examining for peritoneal signs. Peritoneal findings include pain to percussion or light palpation, unconscious rebound tenderness, rigidity, and may present with a child who is motionless to avoid pain and whose hips are flexed, this is to limit tension and movement of an inflamed peritoneum.
- Examining the anus for patency and digital rectal exam if suspecting hirschprung's disease is also important. It should be noted that you should achieve consent from the child and parents and have the most senior medical person complete this portion of the exam to limit the number of times this is done, ideally to one.

Newborn Differential Diagnoses:

Given the large differential for bowel obstruction in children it is helpful to break it up into conditions that present in the newborn period, and other conditions that present later in infancy and childhood.

Let's relate what we've learned to two clinical cases and consider conditions that present in the newborn period.

A 2-week-old girl is brought to the emergency room with acute onset bilious vomiting. Further history demonstrates that she passed meconium in the first 24 hours, was doing well with 2 normal yellow stools every day with no blood or melena, but on presentation today has not stoolled in the last 24 hours. She has been febrile and is irritable with distention and peritoneal findings on exam.

In a second case, you are on your pediatrics rotation and rounding on a newborn boy with known Down syndrome. The boy's vitals are within normal ranges but after speaking with the parents they are concerned because he has been vomiting bilious material since delivery shortly after every feed. He has also not had any bowel movements. On exam, the boy appears well, but has not tolerated any oral intake since birth.

Neonatal causes for bowel obstruction occur primarily due to congenital processes. The most common embryological defect is malrotation. Recall embryological development of the gut, the midgut elongates and herniates out of the umbilical stalk, rotates a total of 270 degrees counter clockwise around the superior mesenteric artery and completes its rotation with the cecum, the first part of the colon, positioned in the right lower quadrant^{2,3}. If this process fails, the cecum is often in the right upper quadrant and fibrous bands (called Ladd bands) can extend from the right lateral peritoneal reflection and attach to the cecum. These bands cross over the duodenum and distal small bowel and can result in bowel obstruction. In addition, the shortened mesenteric base predisposes the bowel to twisting on itself, resulting in a volvulus. If this occurs, the blood supply to a significant portion of the bowel can become compromised, leading to an acute abdomen. If this occurs, there is a risk of bowel ischemia, necrosis, perforation, and it is a surgical emergency. Both volvulus and obstruction due to Ladd bands may present with bilious vomiting, abdominal distention and pain, and 50% of these cases present before 1 month of age⁴. Without prompt diagnosis and surgery, patients with malrotation and volvulus can have irreversible necrosis of the majority of their intestinal tract, leading to short gut syndrome, and lifelong dependence on total parenteral nutrition.

The first case represents malrotation and volvulus, and is one of the pediatric presentations that may have "RED FLAG" symptoms requiring immediate attention. Any patient presenting with new onset BILIOUS emesis, marked abdominal distension, associated with a fever, elevated white blood cell count, and physical signs of localized and/or generalized peritoneal findings should be considered a surgical emergency. These findings signify an acute abdomen. A stable patient with these symptoms may be investigated with an urgent upper GI contrast study to exclude malrotation with volvulus, even in the middle of the night. An unstable patient such as the one in our case may better served with an urgent laparotomy.

Other congenital issues and causes for neonatal bowel obstruction exist as well. Incomplete recanalization of the bowel during development leads to gastrointestinal atresia, meaning there is a luminal stricture or complete absence of a bowel lumen. Duodenal atresia is one example and is associated with Down Syndrome, as in case 2. Abdominal X-ray in duodenal atresia will classically show the "double bubble" sign with large dilated bubbles of air in the stomach and the proximal duodenum. Duodenal atresia will successfully be diagnosed with an upper GI contrast study followed by surgical consultation for intervention.

Your differential for neonates should also include meconium ileus (which is often the first clinical sign of cystic fibrosis), Hirschsprung disease, abdominal wall defects (including gastroschisis and omphalocele), and imperforate anus. Finally, incarcerated inguinal hernia is a common and often overlooked cause of bowel obstruction in the premature population. To learn more, there are great PedsCases podcasts on both Hirschsprung Disease and Pediatric Hernias.

Infancy and Childhood Differential Diagnoses:

After approximately the first 4-weeks of life up to 2 years of age your differential should shift to consider other causes of bowel obstruction. Consider the following 2 clinical cases:

You are seeing a 6-week-old first born male in a pediatrician's clinic who appears unwell. His father tells you that for the last 2 weeks he has had more frequent episodes of non-bilious, projectile emesis that occurs after being breast fed. The dad tells you that recently, he has projectile vomiting after each feed, that he is lethargic, has been having fewer stools with no bowel movements in the last 2 days, appears to be losing weight, and has fewer wet diapers. On exam, you recognize a 6-week old child with sunken eyes and delayed capillary refill. Abdominal exam is benign with no distention, no pain, and a scaphoid abdomen.

In the second case, a 15-year-old male with a history of neurodevelopmental delays, G-tube feeds and a fundoplication presents with abdominal pain, bilious vomiting, and obstipation. He is not tolerating any feeds without vomiting. On exam, you note surgical scars on the abdomen, with significant distention, and tenderness to light percussion.

The differential diagnosis during infancy and childhood should include things such as intussusception, pyloric stenosis, annular pancreas, necrotizing enterocolitis associated adhesions, surgical adhesions, neoplasm, and cystic fibrosis. Of course, don't overlook the possibility of functional constipation in these patients. To learn more, there are great PedsCases podcasts on intussusception, and necrotizing enterocolitis.

Of note, another diagnosis that should always be part of any differential diagnosis for acute abdominal symptoms is appendicitis. Appendicitis is known to be a great mimicker of multiple pathologies. A perforated appendix and abscess can cause a non-mechanical bowel obstruction. Young children may present with a several days' history of vague abdominal symptoms, fever, obstruction and emesis.

In the first case we discussed, the infant has had progressive worsening of symptoms, non-bilious but projectile vomiting after feeds, and appears quite unwell. There is no mention of abdominal distention, pain, or peritoneal signs and the progressive nature and other signs would suggest pyloric stenosis as the diagnosis. Symptoms were not immediate at birth, and worsened as the pylorus became tighter as it hypertrophied. The vomit in pyloric stenosis is not bilious because the obstruction is in the pylorus of the stomach, proximal to where bile is released into the GI tract. In these cases, you may also note an "olive pit" like mass in the patient's epigastrium and commonly find hypochloremic, hypokalemic, metabolic alkalosis on the bloodwork. Abdominal ultrasound is the gold standard imaging modality and can demonstrate a thickened pylorus obstructing the gastric outlet. An upper GI series can also be completed if ultrasound is non-diagnostic and would show lack of contrast flow past the stomach.

In the second case, a complex male with a history of abdominal surgery presented with classic signs of a bowel obstruction due to adhesions. This is important to consider in any patient with a history of prior abdominal surgery. An abdominal X-ray showed dilated loops of bowel with multiple air-fluid levels, supporting the diagnosis.

Workup and Stabilization:

Some cases may present with classic "textbook presentations" for a pediatric bowel obstruction. However, always remember that despite "classic" presentations, these cases may all present with non-specific symptoms of not passing stool or gas, abdominal pain, nausea and vomiting,

abdominal distention, failure to thrive, or even sepsis. The key to properly investigating and diagnosing these children is to approach each case with a complete history, physical exam, and a broad differential diagnosis.

You must be aware of the most common causes of pediatric bowel obstruction. Let's review those:

On your differential, you should consider diseases such as: intussusception, Hirschsprungs, malrotation and volvulus, inguinal hernias and other congenital hernias, duodenal atresia, pyloric stenosis, obstruction due to adhesions, cystic fibrosis, meconium ileus, annular pancreas, neoplasia, enteric duplication cysts, and always consider constipation as a diagnosis of exclusion¹.

A good history can often lead to the correct diagnosis. For children with signs and symptoms of an acute abdomen, urgent surgical referral should be considered as they may benefit from laparotomy. However, if the patient is stable, confirmatory testing is usually accomplished with radiologic tests.

As mentioned, a stable patient may be investigated with an upper GI contrast study to exclude malrotation with volvulus. This study involves having the patient drink contrast with subsequent abdominal X-ray to delineate the esophagus, stomach, and duodenum. Therefore, if the patient cannot tolerate oral intake because they are vomiting, this may not be possible. If malrotation is present, contrast will flow from the patient's left upper quadrant in the stomach to the right upper quadrant in the duodenum, but will not cross back across the spine to the left because the duodenal C-loop will be inappropriately positioned on the patient's right. With proximal obstruction, either due to volvulus or other causes, contrast will not flow into the jejunum and remaining small bowel.

Plain abdominal X-rays may be beneficial in stable patients who cannot tolerate oral intake. Proximal duodenal obstruction, such as duodenal atresia may demonstrate a "double bubble" sign, where there is one air bubble in the stomach, a gap where the pylorus is, and then another air bubble in the proximal duodenum before the obstruction. The plain films should also be evaluated for small bowel dilation (which may suggest a distal obstruction), gasless colon, masses, free air, and pneumatosis, which is the presence of gas in the bowel wall. Multiple air fluid levels or air fluid levels at different heights in the same small bowel loop can also help your diagnosis of small bowel obstruction.

Ultrasound is another valuable modality that can be useful for diagnosing intussusception, pyloric stenosis and neoplasms. Ultrasound waves do not penetrate air however, so this modality is less useful when multiple air filled loops of bowel are present.

Despite the cause, your thought process for the initial management of pediatric patients with bowel obstruction should be similar. These patients, especially when young, may have extreme electrolyte and metabolic disturbances, can be dangerously fluid and nutrient deplete, and may require urgent surgical referral. Ordering electrolytes and/or capillary gases is crucial, while making the patient Nil Per Os (NPO) and supporting them with fluids targeted at correcting metabolic disturbance. An NG tube should be also inserted and placed on low-intermittent suction to allow for drainage and decompression of abdominal contents.

Summary:

Let's summarize what we've learned.

Pediatric bowel obstruction presents in many ways, has a broad differential diagnosis and it is important to recognize the overlap between clinical presentations for each cause of pediatric bowel obstruction.

You may get a great "classic" history of red currant jelly stools (intussusception), delayed meconium passage with explosive diarrhea with digital rectal examination (Hirschsprung's disease), or a child who is not passing flatus or stools, has generalized abdominal pain, and nausea and vomiting. It is important to approach these cases with a broad differential and systematic approach to properly diagnose and manage these patients. First, complete a history and physical exam, ensuring to cover the specific questions and examinations that we discussed. It is at this point that you should recognize red flags of an acute abdomen and consider urgent surgical referral if needed and begin appropriate targeted resuscitation. Remember to rule out emergency causes of pediatric bowel obstruction early, such as malrotation. This usually requires an urgent upper GI contrast study, even at 3 O'clock in the morning!

If your patient is stable, review the causes for pediatric bowel obstruction and identify any potential classic history. Then, narrow your differential using neonatal obstruction vs infancy and childhood and the history and physical exam you have completed.

Remember, the initial management of pediatric bowel obstruction should focus on resolving electrolyte, fluid, and nutrient disturbance, which can be life threatening in this population. Start resuscitation and consider an early pediatric surgical consultation if an acute abdomen exists or if surgical cause of bowel obstruction is suspected.

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