

Review Article

Vomiting in Children : How to Identify the Surgical Masqueraders ?

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Vomiting in children is a common problem and some of causes include surgical conditions, which require intervention. The spectrum of cases which presents with vomiting are different from adult population. Vomiting due to surgical conditions vary from common conditions like pyloric stenosis to uncommon conditions like splenic torsion and superior mesenteric artery syndrome. Newer imaging modalities of diagnosis ranges from conventional imaging to nuclear scan and in some cases diagnostic laparoscopy.

To identify these potentially salvageable conditions require recognition of red flag signs which indicates these conditions. This review will discuss common surgical conditions presenting with vomiting in children and an algorithm is proposed to workup these cases.

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Key words : Vomiting, Bilious, Non-bilious, Malrotation, Hirschsprung's Disease.

Vomiting in children attracts more attention when associated with other systemic involvement like ear, nose and throat infection, urinary tract infection, meningoencephalitis and pneumonia. Hence, it is pertinent for pediatric health care providers to have a high index of suspicion for such potentially fatal surgical entities masquerading in the mundaneness of vomiting. It is imperative to intervene early in vomiting child if surgical etiology is under consideration if presents with red, bilious or feculent color, projectile nature with associated hemodynamic instability. Future management strategy of cases aims more specific procedures based on better understanding of underlying pathophysiology and may include more minimal invasive approach including robotic surgery¹.

Vomiting is one of the most common presentations in pediatric emergency department². The multitude of etiologies for vomiting in children range from benign, self-limiting conditions to life threatening surgical emergencies³.

The rationale of this narrative review is to highlights features which are harbinger of sinister outcome among

Editor's Comment :

- Vomiting in children is a common problem.
- Diagnostic dilemma remains when it is prolonged and recurrent.
- To identify surgically correctable conditions, high index of suspicion is required.
- In the history enquiry should be made about colour of vomiting, whether blood is there or associated localised pain in abdomen.
- During examination, visible peristalsis, localised tenderness, palpable mass, high pitched bowel sounds alongwith haemodynamic instability are suggestive of underlying surgical aetiology.

those appears innocuous and normal looking vomiting in children. This article attempts to focus on vomiting in children caused by conditions warranting surgical intervention by reviewing a systematic approach to establish the 'red flag' signs and symptoms (Table 1) pointing towards a possible surgical etiology along with summarizing the pathophysiology and key features of common surgical conditions presenting as vomiting in

Table 1 — Red flag Symptoms and Signs

Symptoms :

- Bilious Vomiting
- Acute, Localised Pain Abdomen
- Drawing up legs with incessant cry
- Hematemesis
- Haematochezia

Physical Signs :

- Visible Peristalsis
- Localised Tenderness
- Palpable mass
- High Pitched Bowel Sounds
- Haemodynamic Instability

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children. The emphasis is focused on identifying underlying morbid aetiology in the form of obstructive, motility disorder, inflammatory and conditions which gives rise to compromised vascularity of gut.

PATHOPHYSIOLOGY

The pathophysiology of vomiting is mediated by the lateral medullary reticular formation of the midbrain. Afferents to this vomiting center originate from at least four different sources which include chemoreceptor trigger zone (CTZ) or area postrema; vestibular system; vagal afferents and higher cortical centers such as amygdala⁴. The neurotransmitter receptors involved include muscarinic (M1), dopamine (D2), histamine (H1), serotonin (5HT3) and substance P (neurokinin 1). In case of emesis caused by surgical conditions, the afferents are primarily through the vagal fibers which are activated by abdominal distension and bowel irritation. In case of unabated emesis leading to hemodynamic compromise, CTZ may also get activated.

SYSTEMATIC APPROACH TO VOMITING

Is it Vomiting ?

The first step in evaluation of concerns of vomiting in children, especially infants, is to establish whether it's true vomiting or an age defined physiologic response such as regurgitation. Unlike vomiting, in regurgitation, the stomach contents are brought to mouth without contraction of abdominal and diaphragmatic musculature⁵. Regurgitation is a physiologic attribute, with no adverse impact on infant's growth, which mostly resolves by infancy and does not warrant intervention, medical or surgical.

What are the Characteristics of Vomitus ?

Bilious vs non-bilious : One of the strongest pointers for a possible surgical etiology for vomiting is bilious nature of vomit which indicates a possible post-ampullary obstruction until proven otherwise⁶. Bilious vomiting in newborn is seen in 6 per 10,000 live births, always raises suspicion of surgical

aetiology⁷. However, Cullis *et al* reported that only 11.7 % of all cases of bilious vomiting have underlying surgical pathology⁸. It is, however, pertinent to recognize that proximal obstructions such as idiopathic hypertrophic pyloric stenosis present with non-bilious vomiting. Table 2 summarizes different causes of bilious and non-bilious vomiting.

Projectile or non-projectile : Projectile vomiting is generally indicative of sinister causes such as meningitis, conditions giving rise to raised intracranial pressure and metabolic diseases from medical perspective. For a surgeon, a persistent projectile vomiting in 3rd to 6th week of life is characteristic of infantile hypertrophic pyloric stenosis (IHPS).

What are the Accompanying Symptoms ?

Abdominal pain: Abdominal pain associated with vomiting is a common feature for both medical and surgical etiologies of emesis; however, acute, localized pain may signify the peritoneal involvement in visceral inflammation such as appendicitis.

Incessant cry : An inconsolable infant with emesis requires emergent evaluation for sinister causes such as intussusception or incarcerated inguinal hernia. Drawing up of legs with incessant cry in an infant can be subtle pointer towards intussusception.

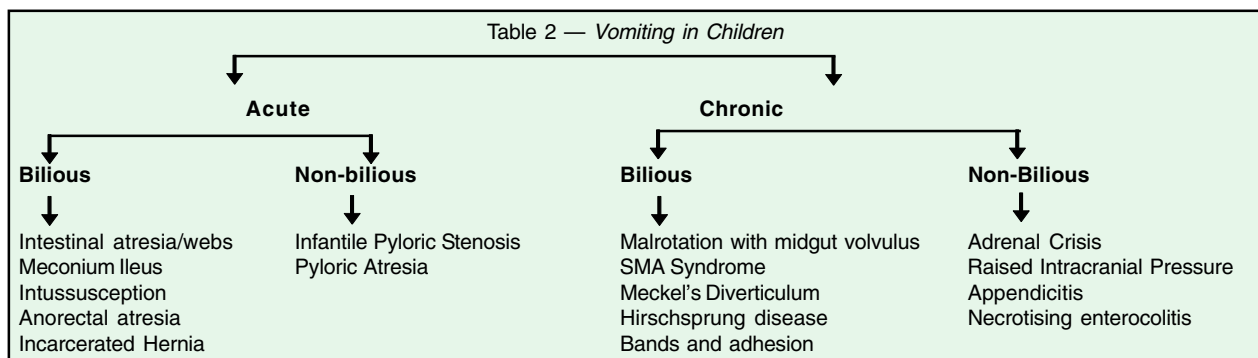
Abdominal distension : Distension of the abdomen may be suggestive of bowel obstruction but it may arise out of gastroparesis caused by sepsis or hypokalemia.

Hematemesis : Presence of upper gastrointestinal bleed may point towards surgical emergencies such as Mallory Weiss tear.

Hematochezia : It is a common accompaniment of mucosal disease of large bowel such as inflammatory bowel diseases but if present in an infant with emesis, hematochezia requires evaluation for intussusception.

What are the Accompanying Signs ?

Visible peristalsis : Presence of visible peristalsis across abdomen or a visible 'olive' is characteristic of IHPS⁹.



Abdominal tenderness : Localized abdominal tenderness helps in localization of underlying visceral inflammation; while a diffusely tender abdomen with guarding or rebound tenderness points towards peritonitis.

Palpable masses : Certain characteristic findings on palpation can provide crucial diagnostic clues. A palpable 'olive' at the lateral border of rectus abdominis is consistent with hypertrophic pyloric stenosis while if a 'sausage shaped' mass is felt in right upper quadrant, intussusception should be considered.

Bowel sounds : Bowel sounds may be increased in bowel obstruction or absent in case of ileus. High pitched bowel sound are also indicative of intestinal obstruction.

Inguinal and genital signs : A tender, non-reducible inguinal mass with erythema of overlying mass is suggestive of incarceration of inguinal hernia. Swollen, tender, retracted, bluish testicle is the classical description of torsion of testis.

Specific signs : Empty or scaphoid right lower quadrant of abdomen is characteristic of intussusception (Dance sign).

Acute or Chronic Vomiting :

The duration of vomiting which is described as acute is 24-48 hours. The common spectrum of pathologies which give rise to acute presentation of vomiting are rotational anomalies of gut, congenital metabolic abnormalities, enterocolitis induced by food protein. Dehydration is common feature.

Longer duration of vomiting qualifies for chronic criteria and these presents rarely with features of dehydration and dyselectrolytemia. Common etiologies includes gastric erosion, peptic dyspepsia and hepatobiliary pathologies¹⁰.

Clues from Imaging :

X-ray abdomen: X-ray abdomen is the quickest modality to look for mechanical bowel obstruction in child with emesis. However, the classical features of dilated bowel loops and stacked air-fluid levels may not be present in all cases. In case of intussusception, paucity of gas in right lower quadrant is strong pointer while presence of gas in cecum excludes intussusception¹¹. Presence of bowel gas in hemiscrotum is suggestive of incarcerated hernia. Gas in the intestinal wall ie, pneumatosis intestinalis is seen in necrotizing enterocolitis. The pitfalls of plain imaging needs reiteration as entities like malrotation of gut or hypertrophic pyloric stenosis may have normal X-ray abdomen.

Upper GI series : Role of upper GI series is helpful

in delineation of anatomy and is considered useful in conditions such as midgut volvulus with malrotation of gut or IHPS.

USG Abdomen : USG abdomen is the most utilized imaging modality in evaluation of surgical causes of emesis. It allows direct visualization of a hypertrophied pylorus and is a sensitive modality to document malrotation of gut. USG with color doppler is the diagnostic modality of choice as it localizes the site of intussusception along with estimating the vascular perfusion of involved gut.

CT abdomen : CT scan allows anatomical delineation and has definite role in evaluation of malrotation of gut, appendicitis or pancreatic pathologies.

Diagnostic Laparoscopy :

Role of diagnostic laparoscopy especially in cases of early appendicitis, malrotation of gut, Meckel's diverticulitis, early cases of intussusception has been emphasized recently. In situations of pain abdomen having diagnostic dilemma diagnostic laparoscopy helps.

COMMON SURGICAL CONDITIONS IN A CHILD WITH VOMITING

Infantile Hypertrophic Pyloric Stenosis :

IHPS typically presents around 6th week of life with non-bilious, postprandial, forceful vomiting. It has a global incidence of 2-3 per 1000 live births and is more common in male infants. For this multifactorial entity, postulated etiology include genetic factors and environmental influences such as use of macrolides. The incessant vomiting may lead to disturbances of fluid and acid-base homeostasis – hypochloremic metabolic alkalosis with paradoxical aciduria. Diagnosis is based on USG where a pyloric muscle thickness greater than 3-4mm or pyloric muscle length greater than 15-19mm is suggestive of IHPS. Definitive management is pyloromyotomy after correction of dehydration and electrolyte abnormalities¹². Laparoscopic pyloromyotomy results are comparable to open pyloromyotomy¹³.

Midgut Volvulus with Malrotation of Gut :

Malrotation of the gut results from interrupted embryological process of rotation of embryonic gut. Incomplete rotation of gut and its aberrant fixation predisposes to torsion and obstruction and presents as midgut volvulus. The most common presentation is bilious vomiting. Other clinical features include abdominal tenderness and distension along with features of hemodynamic compromise. Upper GI series has been traditionally considered the diagnostic

modality of choice but USG has been shown to be equally optimal diagnostic tool¹⁴. Management is focused on establishing hemodynamic stability. Surgical exploration with Ladd's procedure is the definitive treatment.

Intussusception :

Intussusception is the most common cause of intestinal obstruction in children less than 3 years of age which results from invagination of a bowel segment (intussusceptum) into adjacent distal segment (intussusciens) and if untreated, leads to catastrophic consequences of bowel ischemia resulting in necrosis, perforation and peritonitis¹⁵. The classical presentation is of colicky abdominal pain, red currant jelly stool and a palpable mass. Vomiting is one of the most common symptoms of intussusception and is seen in 70% of cases. A high index of suspicion is must in children with vomiting with or without diarrhoea, rectal bleeding abdominal pain accompanied with altered mental status. USG with color doppler is the diagnostic modality of choice as it not only delineates the site of intussusception but also ascertains complications such as poor vascular perfusion in affected segment. Nonsurgical reduction by instilling a contrast medium such as air, barium or saline, is the treatment of choice in a child with intussusception who is hemodynamically stable and has no evidence of perforation or peritonitis. Surgical intervention in form of open laparotomy and manual reduction of intussusception is needed only in cases where nonsurgical reduction fails or child is hemodynamically unstable with signs of perforation & peritonitis. It has been seen that after successful enema reduction in 12.7% cases recurrence may occur.

Incarcerated Hernia :

Incarceration of inguinal hernia mostly occurs in infancy and is more common in girls. Typical presentation is of an incessantly crying infant with vomiting and abdominal distension. Examination reveals a tender inguinal mass extending upto scrotum or labia majora with erythema of the overlying skin. USG is the diagnostic modality of choice. Manual reduction is attempted in all children with no signs of peritonitis. Surgical reduction is rarely needed as manual reduction is successful in >95% of cases. Once the inflammation is subsided herniotomy should be done in the same admission.

Appendicitis :

Appendicitis is the most common surgical cause for emergent surgery. Though the defining symptom of appendicitis is pain abdomen, emesis is the second

most common clinical presentation of appendicitis in young children. Other classical features include periumbilical pain with migration to right lower quadrant, fever, and anorexia. Examination reveals right lower quadrant tenderness. The underlying inflammatory pathology is reflected in leukocytosis and rise of acute phase reactants. Multiple clinical scoring system such as pediatric appendicitis score, Alvarado score are used in diagnostic algorithms. Imaging modalities utilized include USG and CT abdomen. Management focusses on fluid therapy and analgesia. Appendectomy is the definitive surgical intervention. Laproscopic appendectomy is now getting acceptance with comparable intra – or postoperative complications¹⁶.

Hirschsprung's Disease :

Hirschsprung's disease presents in early infancy with features of distal bowel obstruction, The main symptoms are constipation, abdominal distension and vomiting which may be nonbilious to start with and changing into bilious later. Etiopathogenesis includes either arrest of caudal migration of neural crest cells which give rise to ganglion cells or disruption in maturation into ganglion cells¹⁷. Many genetic mutations have been attributed in the development of HD mainly endothelin, glial cell line-derived neurotrophic factor, RET proto-oncogene and also SOX-10 gene^{18,19}. Enterocolitis may be a life threatening complication with features of high degree of pyrexia, vomiting, diarrhea and abdominal distension. The management of HD has seen evolution through multi staged pull through surgery to single-stage transanal pull-through with comparable results.

Superior Mesenteric Artery Syndrome :

SMA-syndrome is a functional obstruction of third part of duodenum due to vascular compression by superior mesenteric artery as it takes origin from abdominal aorta an angle of less than 25 degree than normal of 45 degree. Entrapment of third part duodenum between superior mesenteric artery and abdominal aorta leads to dilatation of second and third part of duodenum²⁰.

It has been precipitated by excessive weight loss in short time, corrective surgeries of spine and immobilization in body casts, burn, postoperative state and accidents. Patients present with abdominal pain, post prandial bilious vomiting and early satiety. Diagnostic workshop includes upper GI contrast studies, CECT abdomen or contrast enhanced angiography or magnetic resonance angiography. Failure of conservative management through nutritional

support is an indication of surgical intervention in the form of duodenojejunostomy either open or laparoscopically²¹.

Meckel's Diverticulum :

Meckel's diverticulum in children presents most commonly with features of gastrointestinal obstruction and gastro-intestinal bleeding. Inflammation in the form of diverticulitis is an uncommon presentation. Laparoscopic method is also being undertaken for managing a case of meckel's diverticulum²².

Gastric Volvulus :

Vomiting is main presentation and diagnosed by imaging with the help of barium. Surgical intervention is done in the form of gastropexy and gastrostomy. Some cases require gastric resection. Esophageal narrowing was common post-operative complication²³.

Pancreatic Injury :

Severe pain abdomen and relief in pain in stooping position with vomiting is a common presentation. Serum amylase and serum lipase are raised. Multidetector CT scan is very accurate in diagnosis. Conservative management proves effective in hemodynamically stable cases. Pancreatic injury which is confined to proximal part can be better managed by roux-en-y pancreaticojejunostomy in distal part²⁴.

Raised Intracranial Pressure :

Any space occupying lesion in the cranium, head injury can give rise to nausea and vomiting by compression of medullary area postrema due to raise intracranial pressure. The presentations will be vomiting, headache, change in mental alertness and may be associated with neurological deficit. The vomiting in these cases are characterized by projectile, no accompanying nausea and precipitated by abrupt change in body posture. Fundus examination to see papilledema along with CT head or MRI brain can show herniation, enlarged ventricles or tell-tale sign of mass effect. Management includes measures to reduce intracranial pressure and treatment of underlying cause²⁵.

Adrenal Crisis :

It is one of the important entities giving rise to vomiting in infancy presenting between first and fourth weeks of life. Usually babies have nonbilious vomiting with metabolic picture of hyponatremic, hyperkalemic acidosis associated with unexplained hypotension. Mostly it is due to 21-hydroxylase deficiency giving rise to congenital adrenal hyperplasia. Female patients

may have disorder of differentiation in external genitalia. Low cortisol level in plasma along with high ACTH level may be seen in some cases. Electrolyte imbalance correction and hormonal supplementation is needed in these cases²⁶.

Author's Experience :

Our experience where, in six years, from June, 2013 to June, 2019, in 131 (8.8%) of the 1475 surgeries, the chief presenting complaint was vomiting. Hirschsprung's Disease, diaphragmatic pathologies and Infantile Hypertrophic Pyloric Stenosis were the most important surgical conditions presenting as vomiting.

CONCLUSION

Vomiting is a common clinical presentation in children whose etiologies range from benign conditions to potentially life threatening ones. Many surgical conditions present with emesis as initial symptom which if not recognized early can have catastrophic consequences. Hence, a high index of suspicion and a systematic approach is warranted in evaluation of a child with vomiting.

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