BILIOUS VOMITING IN THE NEONATE

Bilious vomiting in the newborn should be taken to mean intestinal obstruction until proved otherwise. Intestinal obstruction is one of the commonest admission diagnosis in a neonatal surgical unit and accounts for 22 - 30 % of all neonatal surgical admissions.(1)

One thing that needs to be emphasized is that early diagnosis and early surgical intervention is very important in any neonatal intestinal obstruction since any delay can cause numerous and often fatal complications like :(1)1) Respiratory distress which is due to either splinting of the diaphragm secondary to abdominal distension ; or due to aspiration of the vomitus into the lungs.2) Severe dehydration due to repeated vomiting along with almost no oral intake .3) Electrolyte and metabolic disturbances caused by prolonged starvation and dehydration , along with loss of electrolytes, poor tissue perfusion and metabolic acidosis.4) Ischemic necrosis of obstructed bowel may result in perforation of distended bowel proximal to the obstruction or even gangrene and septicemia.

Bilious vomiting in the neonate can be due to various causes almost all are of surgical nature and this being a book for Pediatricians, I shall restrict to enumerating the causes , giving a short account of the pathological anatomy of the individual condition followed by general signs and symptoms , later a discussion of the radiological signs in individual conditions and lastly the therapy in short.

The etiology of bilious vomiting in a neonate are either Mechanical or Functional as seen in the **Table 1.** The fact that the vomiting is bilious is a pointer to the fact that the obstruction is distal to the opening of the bile duct into the duodenum, thus ruling out gastric outlet obstruction like Pyloric Stenosis, Pyloric Atresia as well as Gastroesophageal reflux , or vomiting due to central causes like raised intra cranial pressure, or uremia and other non surgical causes.

A short description of the **pathological anatomy** of these individual conditions will help in understanding the radiological diagnosis and the further therapy.

Duodenal Obstruction: (Fig 1)

Duodenal atresia or stenosis: Intrinsic obstruction of the duodenum may be complete (atresia) , or incomplete (Stenosis). The site of obstruction is frequently in the vicinity of the Ampulla of Vater. Various types of duodenal obstruction can be recognized (**Fig.1**)Thus the proximal and the distal segments may end blindly , or the ends may be in apposition , joined by a fibrous cord , or separated by a gap- these are all atresias. Duodenal stenosis may be in the form of a simple stricture usually short or may be longer cord- like segment , or a perforate diaphragm having a small orifice at the centre or at times even eccentric . Occasionally the diaphragm may have more than one orifice. The

Wind - Sock diaphragm is a thin diaphragm which has ballooned distally due to peristalsis.(2) **(Fig 1)**

Annular Pancreas: A collar or ring of pancreatic tissue surrounds the second part of the duodenum. The lumen of the gut is usually either markedly narrowed or may be totally obliterated, but the underlying obstruction may be due to a diaphragm. Annular Pancreas is usually classified as a cause of extrinsic obstruction of the duodenum within the collar of the annular pancreas is not simply compressed by pancreatic tissue , but on cross section shows an all round narrowing .(3)

Malrotation 0f Gut:

Since normal rotation of the gut is complicated, it is very likely that many things can go wrong and that the gut may take up a considerable number of abnormal positions

a) Complete Non Rotation- the neonate has a common longitudinal mesentery which serves the small bowel and large bowel and runs vertically downwards in the midline of the abdominal wall.(4, 5)

b) Incomplete rotation - in these neonates, the duodenum and small intestine remain on the right side of the superior mesenteric artery, and the cecum and colon remain on the left side. This is further complicated by formation of congenital adhesions between coils and of bowel and parietal peritoneum.

c) Malrotation - this is the commonest type wherein the duodenum lies behind the superior mesenteric artery or fails to cross the midline and lies totally to the right of the artery. The Cecum lies anterior to the duodenum, and abnormal adhesions form running from the cecum across the duodenum to parietal peritoneum in the right hypochondrium, these are called Ladd's Bands. There are other less common and complicated types of malrotation as seen in **Fig. 2 .**

Intestinal Atresias(Small bowel & Colonic).

These are total obstructions of the small & large bowel lumen and are of 4 types:-

Type I : Continuity of the bowel wall lumen is blocked by one or more septa.

Type II : Two blind ends of the gut connected by a fibrous cord of varying length. The mesentery is either intact or may show a V- shaped defect. This could also be seen as two intestinal segments separated by a gap, frequently with a V - shape gap in mesentery.

Type III : Multiple atresias- the segments of bowel producing an appearance of " string

of sausages"

Type IV : Apple peel atresia- the intestine is found to be arranged in a spiral around a central mesenteric vessel, the mesentery runs like a spiral staircase from the central vessel to the intestine.(6, 7) **(Fig 3)**

Duplications:

Intestinal duplications are spherical or tubular structures and have 3 characteristics:

a) They are firmly attached to at least one point of the alimentary tract.

b) They have a well developed coat of smooth muscle.

c) Epithelial lining always resembles some part of the alimentary tract.(8)

Duodenal duplication cysts rarely communicate with the gut . More commonly abdominal duplications are attached to the jejunum, ileum or the ileo - cecal region.They may occur as globular cysts which project into the lumen of the gut or are closely attached along the mesenteric border of the intestine, or may be tubular in type. Large cysts in the mesentery may cause torsion and volvulus of the intestine. Small intraluminal cysts usually occur near the ileo - cecal region and may cause intussusception. Duplication of the colon and rectum is less common. Cysts similar to those associated with small bowel are found in the proximal colon, these cysts cause intestinal obstruction either by occlusion or by forming the head of an intussusception. Cystic duplications of the rectum lie behind the rectum and tend to obstruct the rectal lumen by their bulk.

Necrotizing Enterocolitis:

This can affect any part of the bowel, though the duodenum and rectum are rarely affected. The bowel is dilated and friable and may be frankly necrotic with hemorrhagic areas adjoining necrotic ones. The bowel wall is thinned out , serosa is often covered with fibrinous exudate. Air bubbles may be seen in the bowel wall. Mucosa shows ulceration and sloughing. Perforations may be present in necrotic areas with large gaps in the bowel wall on the anti mesenteric side.(9) Nearby bowel, viscera and omentum are sometimes successful in sealing off perforations with a walled off cavity with meconium and feces.

Meconium Peritonitis:

This occurs when meconium enters the peritoneal cavity through a perforation in the intestinal tract. Once meconium reaches the peritoneal cavity, it induces a n intense peritoneal reaction and numerous adhesions form.(10)

1) If the perforation does not seal off and there has been a considerable leak of meconium with possible extensive infarction of the bowel, then the classic meconium cyst will be formed with the walls made of matted coils of intestine adherent to each other, lined by a fibrinous plaque stained with meconium. Progress of the disease after birth depends on the underlying pathoetiology.(10)

2) A single perforation and no distal obstruction which may have sealed off locally, there will be no sign of obstruction after birth. The condition may be diagnosed by the accidental radiological finding of calcification in the abdomen.

3) The perforation may have sealed off but extensive adhesions may cause intestinal obstruction.

4) If the perforation has occurred proximal to an obstruction, then the primary obstruction will still be present after birth and will require correction.

5) If the perforation is patent after birth, the sterile meconium will soon be converted to bacterial peritonitis and hence will require therapy.

Meconium Ileus:-

In this condition, it is the abnormal exocrine secretions that lead to the common surgical manifestations, the abnormal mucus leading to sticky meconium in the neonate, giving rise to an intraluminal type of intestinal obstruction.(11)

Meconium Plug Syndrome:-

It has been suggested that colonic immaturity may allow an unusual amount of water to be reabsorbed from the meconium in late fetal life to make it harder, thus causing a postnatal intraluminal intestinal obstruction, leading to bilious vomiting.(11)

Milk Curd Obstruction :

Obstruction is due to a hard dry mass of milk curd in the lower ileum, usually a few cms from the ileo- cecal valve extending proximally for a variable distance. This occurs in those infants on artificial milk formula as opposed to breast milk.(11)

Hirschsprung's Disease:

Aganglionosis of the large bowel that begins from the rectum and extends proximally for variable distance, causing distal intestinal functional obstruction. The basic pathology is that the aganglionic segment has functional obstruction, it does not relax due to various reasons like excessive Cholinergic activity, absence of Adrenergic inhibitory activity, as well as non adrenergic non cholinergic inhibitory activity. The obstruction is anatomically at the junction of the ganlionic and aganglionic segment, causing at times acute intestinal obstruction in the neonate though, often it may present as constipation later on in life.(12)

Anorectal Malformations:

These are those children who are born without an anal opening in the normal anatomical position, thus it may be absent, it may be opening anteriorly or it may be opening through a fistula into another abnormal place such as vagina, vestibule, bladder etc. The anal opening may be present at the normal position but will be stenotic and hence give rise to obstruction, or may be atretic and hence give a total obstruction. This is a very vast chapter by itself and hence cannot be dealt in detail, but suffice it to say that one of the causes of intestinal obstruction with bilious vomiting in the neonate is any anorectal malformation, which needs to be recognised early and dealt with soon; in fact, if bilious vomiting is the reason that this anomaly is picked up, then we are very late in diagnosis, which is obvious even on inspection.(13)

Obstructed Inguinal Hernia:

Many a times a proper examination of a crying distended neonate with bilious vomiting may reveal an inguino - scrotal swelling on either side , suggesting the diagnosis of an obstructed inguinal hernia due to a patent processus vaginalis, where the bowels are into the sac which has not closed anatomically, so that the bowel can enter into the inguino scrotal region, get obstructed at the internal or external ring and give rise to intestinal obstruction due to irreducibility.(1)

Paralytic Ileus:

This could be part of neonatal septicemia, where there is paralytic ileus, thus the bowels are in a state of paralysis and hence there is no movement of the feed, giving rise to passive bilious vomiting , associated with distension caused by the dilatation of the loops of bowel due paralysis, and this is important, since exploration of such a neonate can be fatal, as there is no physical intestinal obstruction, and a major surgical intervention will be unnecessary as well as tilt the balance against the neonate.(14)

CLINICAL FEATURES:

Bilious vomiting: This is a very important sign and the details of this symptom is of extreme value for clinically judging the type and possible site of intestinal obstruction. The onset of the bilious vomiting occurs early if the obstruction is proximal in the bowel like doudenal obstruction, whereas if the bilious vomiting occurs later after 48 hours, then obviously the site of obstruction is distal in the small bowel or even in the colon or rectum. Another important aspect is the volume, more proximal the obstruction, lesser the volume of vomitus, and more distal the obstruction, more the volume of the vomitus. Additionally, in cases of complete obstructions, like atresias, the vomiting will occur early and be persistent, whereas if the obstruction is incomplete, like malrotation, or Hirschsprung's disease, then the vomiting will tend to be late and intermittent. Occasionally , bile stained vomiting is associated with intracranial hemorrhage. At times, vomiting of meconium stained liqor swallowed before birth may also be confused with bilious vomiting.(1,14)

Delayed gastric emptying: Aspiration of large volumes of fluid from the stomach is of diagnostic value in neonates with intestinal obstruction who may not have vomited. Any volume over 15 ml clear or bile stained is an indication for further radiological investigations along with other clinical signs to come to a final diagnosis.

Distension: This is a variable sign, and may or may not be present in all cases with bilious vomiting. In duodenal obstruction, there may be only upper abdominal or epigastric distension, or in malrotation with volvulus, there may be no distension of the abdomen. Lower intestinal obstruction will present with more generalised distension, with bulging of the flanks in late cases.(14)

Visible loops or visible peristalsis: This again depends upon the site of obstruction; upper duodenal obstruction may show few or no visible loops except probably gastric peristalsis. However, if the obstruction is in the small bowel or in the colon, the loops of bowels proximal to the site of obstruction will be dilated, distended and show numerous palpable loops across the neonatal abdominal wall. Meconium ileus may show that the loop of visible peristalsis in that loop with the abnormally sticky meconium. These visible loops are also a sure sign of some distal intestinal obstruction.(1)

Constipation: This is a very vital part of the history, which needs to be elicited and which is often lacking at times because the parents often are unaware since the baby in the first few days of life is looked after more by the nurses of the hospital where the birth has taken place than the mother. Meconium passage is the first important part of the history which many times gives a clue as to the type of obstruction. Usually, in atresias of the bowel, the neonate does not pass any meconium, only plugs of mucus may be passed, and unless properly observed, this may be mistaken for normal meconium, and the diagnosis may be delayed or altogether missed , as has happened to me on at least 3 occasions .However, if meconium has been passed, a diagnosis of complete obstruction can be ruled out, and in fact, the other possible diagnoses have to be ruled out, of which, the most important is to eliminate the diagnosis of malrotation with volvulus where any delay in correction can lead to gangrene of the bowel from the duodeno- jejuno flexure to the mid transverse colon, and causing short bowel syndrome, with a high fatality rate.

Dehydration: This occurs late in a neglected neonate or a neonate not adequately treated, due to profuse, persistent and bilious vomiting. Non correction of fluid and elctrolyte losses lead to weight loss and disturbances of blood chemistry. These problems need to be corrected before going on to the definite correction of the individual anomaly to avoid intra op and post operative complications. (1)

INVESTIGATIONS:

A) RADIOLOGY:

1) **Plain x - ray Chest & Abdomen(Vertical):** This very simple, easily available and important investigation along with the above mentioned clinical signs will help to come

to a diagnosis in a large number of cases, and only in a few cases will there be the necessity of doing a contrast study to make a diagnosis.For a better quality of the x ray, the plain x - ray can be taken after injecting 10 - 20 ml air thru the infant feeding tube. Air is a very safe contrast medium with no risk of aspiration into the lungs unlike any other contrast medium. This will show the intestines and the site of obstruction adequately clear.(1,14)

Duodenal obstruction:

Duodenal atresia will show a " Double Bubble " appearance, with a large air fluid level in stomach, and a smaller one in proximal duodenum, with no air in the rest of the abdomen and in cases of distal duodenal atresia, there will be 2 duodenal fluid levels.(2,3)Duodenal stenosis will also show a "Double Bubble" appearance, but the proximal duodenum is less distended, and some air will be seen in the distal bowel loops.**(Fig 4)**

Annular Pancreas : occasionally the diagnosis is suggested by two areas of gas one above the other separated by a narrow opaque band, this is very rare. Usually, the x- ray mimics duodenal atresia/ stenosis.

Malrotation:

This can be seen in various forms depending on the timing of the x- ray. There may be evidence of partial obstruction by outlining a distended stomach and proximal duodenum with little or no air in the rest of the intestine. There may be also a picture of distal intestinal obstruction in the form of multiple air fluid levels due to the volvulus of the small bowel with obstruction. Another picture is of dilated small bowel on the left and undilated small bowel enclosed in mesocolic hernial sac. Intramural air seen in plain x - ray is ominus evidence of infarction of the bowel; presence of intraperitoneal air is indicative of perforation of the dilated distended bowel proximal to the obstruction.(5)

Intestinal Atresia: (Fig 5)

This will be seen as numerous air fluid levels, the number of levels will depend upon the site of obstruction, upper jejunal may show only few levels, distal ileum will show multiple air fluid levels. There will be no air distal to the last air fluid level which will have to be correlated with the clinical picture. Calcification in the abdomen will show associated meconium peritonitis.Air bubbles in the distal colon may be wrongly interpreted as distal gas , but is likely to be gas introduced into the colon during a rectal examination.(6,15)

Abdominal Duplications:

These may be seen as a dense mass displacing the intestine. Occasionally , if it communicates with the bowel, a large cyst with a fluid level may be observed. Duplication may give rise to complications like intestinal obstruction (multiple air fluid

levels) or perforation(free gas under the diaphragm).However, even if there are fluid levels, there will still be air distally, differentiating these from an atresia. (8,16)

Necrotizing Enterocolitis:(NEC)

The hall mark of necrotizing enterocolitis is intramural gas which may be present in 19-98% of cases. Pneumatosis intestinalis is commonly an early rather than late finding. Two forms of pneumatosis intestinalis are identified - cystic and linear. The cystic form presents as a granular or foamy appearance and is thought to represent an accumulation of gas in the submucosa.Linear pneumatosis coexists with the cystic form or develops soon after. Small bubbles form a thin curvilinear pattern outlining a segment of the intestine by the gas within the muscularis and subserosa.(9, 17) **(Fig.6)**Multiple gas filled loops of bowel on lateral decubitus veiws, is an early sign of NEC, and are visible in 55 - 100 % of cases.The degree of dilatation and distribution of dilated loops is related to the clinical severity and progression of the disease.Pneumoperitoneum - free air in the peritoneal cavity associated with perforation of the intestine can be demonstrated in 12 - 32 % of cases of NEC.However, not all cases of NEC with intestinal perforation may show x - ray evidence of free air.Portal Vein gas- seen as an arborising pattern in the right upper quadrant over the liver shadow, represents gas dispersed thru the fine radicles of the portal venous system. The presence of gas in the portal vein was associated with a poor prognosis, but not any longer.The gas may accumulate first in the bowel wall as a result of bacterial invasion, dissect into the venous system and travel to the fine radicles of the portal vein, or it may represent the action of gas forming bacteria within the portal venous system.

Intraperitoneal Fluid - x - ray findings suggestive of free fluid in the peritoneal cavity are Grossly distended abdomen devoid of gas; gas filled loops of bowel in the center of the abdomen, surrounded by opacity out to the flanks; increased haziness within the abdomen; separation of the loops of bowel.(17)

Persistent dilated loops - that is dilated loops of bowel that remain unchanged in positon and configuration on serial x -rays; these develop full thickness necrosis. This sign of persistent dilated loop signifies compromised bowel and requires exploration.(17)

Meconium Peritonitis:

This can present as the basic problem like intestinal obstruction. In addition, intra abdominal calcification is frequently found. If present along with an atresia, then there will be multiple air fluid levels with no air distally, and calcification. If the perforation is persistent, then there will be free gas under the diaphragm and calcification.There will be a large air fluid level with free gas in the abdomen a **meconium pseudocyst.**(10)

Meconium Ileus:

Gross distension of intestine frequently seen, especially in the upper abdomen; there are scanty or even absent air fluid levels, this is because the meconium is sticky and does not give the classic fluid levels. There may be mottled or coarsely granular appearance especially in the right iliac fossa region i.e. in the terminal ileum - **Neuhauser's sign**. this is caused due to air bubbles forced into the sticky meconium.(11) This sign is not always present and may be seen in other cases. When prenatal perforation has occurred, calcification will be present in the peritoneum, are seen on plain x - ray abdomen.

Meconium plug syndrome:

This shows gaseous intestinal distension but fluid levels are uncommon, but non specific.

Milk curd obstruction:

This will again show only typical signs of low intestinal obstruction. In some cases, the picture is similar to that in meconium ileus, with grossly distended loops, Neuhauser sign, and the absence of fluid levels. Clinical correlation of artificial milk intake helps.

Hirschsprung's disease:

The picture may be variable. the x - ray may be totally normal in those who may have deflated themselves ; or it may show multiple fluid levels similar to any distal intestinal obstruction. Most commonly, there may be multiple loops of distended bowels with an occasional fluid level.Dilated colon is difficult to distinguish as there are no haustrations in the neonate. There will also be an absence of rectal shadow, or no gas in the pelvis.(12) Intramural gas may also be visible in some cases complicated with enterocolitis, as well as pneumoperitoneum.(9)

Anorectal malformations:

Radiology plays a very important role mainly in the males with an absent anal opening, as, there is complete obstruction, where as in females , usually, there is a recto vaginal / vestibular fistula thru which meconium is passed and hence the obstruction is relieved. An invertogram done properly(details not within the scope of this chapter), and based upon fixed bony landmarks help in diagnosing the type of the anomaly i.e. low or high. This is important because the approach in case of low is direct and local anoplasty, whilst in the high variety, a colostomy is done first, followed up later with a definite anorectoplasty.

The pubococcygeal line **-(PC Line)** a line from the center of the pubis to the inferior margin of the fifth sacral vertebral body. The Ischial point **(I point)** , is the inferior end of the comma shaped ischial shadow.(13) Taking these two radiological markers, it can be

concluded that, lesions with gas above the PC line are high, those between the PC line and the I point are intermediate ; and below the I point are low. Other things to be looked for in the plain x - ray vertical in these cases are presence of multiple air fluid levels, air within the bladder, just behind the pubis in the lateral film, also the presence of 5 sacral pieces or sacral agenesis (partial or total).

CONTRAST STUDY:

In some cases, it may not be possible to reach a diagnosis, based only on the plain x -ray, and here a contrast study is useful, and it is safer to use non ionic contrasts.

Duodenal Obstructions:

This will show a dilated stomach and proximal duodenum, no contrast going distal proves atresia, however, if some contrast goes beyond, a diagnosis of stenosis or annular pancreas is made.(2)

Malrotation:

Contrast enema may show a high or abnormally mobile caecum, suggesting a shortening of the mesenteric attachment. The caecum may be directed transversely or have a fixed position. With a volvulus, there may be an obstruction in the transverse colon. Examination of the upper GI tract, one looks for an abnormal position of the ligament of Treitz; obstruction of the duodenum- with a spiral or corkscrew appearance; the presence of the jejunum on the right side. The duodenum in malrotation will lie to the left side of the spine. In chronic obstruction and volvulus, there is thickening of the mucus membrane of the small intestine. With a right mesocolic hernia, the relation of the ascending and the transverse colon may be abnormal, with entrapment of the small bowel.(4)

Intestinal Atresias:

The contrast enema is useful in case of doubt of the total obstruction, where , a Micro colon (unused colon) is seen, hence diagnosis of complete atresia is confirmed

Intestinal Duplications :

A contrast meal is of little use in these cases, if the duplication communicates with the intestinal lumen, some contrast may remain in the duplication long after the rest has passed from the intestine. Cecal duplications can be demonstrated by a contrast enema.(16)

Meconium Ileus:

In these cases, a contrast enema may be done to confirm the diagnosis before surgery, but the contrast acts both as diagnostic as well as therapeutic (please check therapy).(18)

Meconium Plug Syndrome:

A suspected case of meconium plug needs a contrast enema, which will reveal a normal rectum and colon and the plug will be seen as a translucent area low in the colon or in the rectum. Contrast like Gastrograffin or Conray are preferred as they are effective also in stimulating peristalsis and emptying of the bowel.(11)

Hirschsprung's Disease:

Contrast enema studies are of extreme importance in the diagnosis of this condition. A narrowed affected segment of the colon is seen followed by a transitional zone and then proximally dilated normal bowel is considered as classic of this condition. Fluoroscopic screening may show abnormal or absent peristalsis of the distal bowel. Irregular contractions of the rectum gives a saw toothed appearance suggestive of enterocolitis, rarely even mucosal ulceration may be seen.A 24 hour film taken shows retention of the contrast proximal to the aganlionic segment and also is considered diagnostic.This will also give an estimate of the length of the aganglionic segment for planning both the colostomy as well as the definitive surgery.(12)

B) BIOCHEMICAL:

These investigations are useful for preparation of the patient for further therapy either conservative or operative, depending on the diagnosis.They help in knowing the current status of the neonate as far as infection, electrolyte imbalance, acidosis or alkalosis etc., and also fitness for surgery in case required in the near future.(1, 14)

Complete Blood Count

Blood group and cross matching

Urine routine

Serum Electrolytes

Blood gas study

Blood Sugar / BUN

Preoperative Therapy:

This is a common approach to all neonates who present with bilious vomiting, irrespective of the final diagnosis of the anomaly.General care of any critical neonate - watch for hypothermia, accurate weight of the neonate to calculate the drug doses. Keep the child warm,in head high position.Since the child is vomiting, an infant feeding tube must be inserted as early as possible to avoid further vomiting with chances of

aspiration, thus put in as big a tube as feasible, preferably a number 8 or 9 Fr.This ensures better decompression of both the liquid contents as well as the air which the crying neonate tends to swallow and later may aspirate the vomitus into the lungs. I make it a point to make multiple side holes in the infant feeding tube before inserting it in the neonate, so the chances of blockage are minimum when the tube is being aspirated every 1 hour or so.A good intravenous line is taken for starting maintenance intravenous fluids, as the eonate is kept nil orally. Blood collection can be done thru this line, and antibiotics started thru this line, as well as for preoperative correction of the electrolyte and acid - base imbalance that may be detected on investigations. Injection Vitamin K is given to all neonates who may require surgery within the next 24 hours, as prophylaxis against bleeding tendencies due to physiological deficiency of same. Lungs are examined to look for signs of aspiration of the vomitus that may have occurred before the child has been seen by you .If there are signs of pneumonitis, specific antibiotics are begun to take care of the chest, including nebulisation, physiotherapy.

The operation theatre is kept ready for the exploration under anesthesia after the blood is ready if required to be transfused during surgery. With adequate preparation, and proper care of the neonate, it is safe to take up the child for surgery at an appropriate time. If contrast study has been done for the diagnosis, it is very important to wash out the contrast from the bowel as soon as the x - rays have been taken, so that the contrast does not remain in the bowel as there is danger of aspiration or spillage during the surgery.

THERAPY:-

Many of these neonates will require surgical correction of their anomalies, and since this is a book for the pediatric physicians, I shall only describe the principles of the surgery without going into the details of the incision etc.

Obstructed Inguinal hernia:

In these cases, urgent inguinal exploration is the necessity. In such cases, it is essential to explore and look at the bowel trapped in the sac, whether the bowel is gangrenous, reducible after exploration. If the bowel is gangrenous, then resection and re anastomosis requires to be done.In neonates, it is essential to look at the ipsilateral testis, as many times with an obstructed hernia, there may be testicular infarction and if so,requires orchidectomy in addition to the repair of the hernia.If the hernia is detected and explored in time, then there may be no gangrene of the bowel or the testis and a herniotomy is all that is required. Post operatively, if bowel handling was done, then the child is nil orally for 3 - 4 days, more if resection was required, antibiotics need to be given and feeds introduced gradually.

Duodenal Obstruction:

Duodenal atresia- the ideal correction of this anomaly is a duodeno - duodenostomy, after adequate mobilisation of the duodenum and a diamond shaped anastomosis is done.(19)Annular pancreas also a duodenoduodenostomy is again done in front of the

annulus as often there is associated atresia or stenosis with this anomaly, and the ring of the annulus is never cut or else, this will cause a pancreatic fistula and further morbidity.However, this duodenoduodenostomy is not possible in all cases, then a duodeno jejunostomy is ideal.(2)Duodenal diaphragm either a bypass procedure is done, or incision or excision of the diaphragm together with duodenoplasty is done.a similar procedure is done for duodenal stenosis by longitudinal incision and a transverse suturing.(2, 3)

Malrotation of the gut:

This can be an absolute emergency only if there is a volvulus of the intestine. The volvulus is always in clockwise direction, and it will have to be untwisted before the bowel becomes gangrenous.In general, in malrotation of the gut, the principle of correction is based on the basic anomaly which has a short root of the mesentery, and hence, this root of the mesentery has to be elongated. The root of the mesentery extends from the duodenojejunal flexure(DJ) to the ileo cecal junction. With the high cecum, the root is very narrow. Thus, since the DJ flexure is on the right of the midline, in order to elongate the root and avoid the volvulus, the ileocecal junction with the caecum is placed in the left iliac fossa.The bands across the duodenum compress the same and hence have to be incised.All adhesions in the intestines must be released, all kinks also need to be released to relieve obstruction.If the bowel is gangrenous, there will be a need to resect a very large segment of the bowel and may give rise to short bowel syndrome and its associated complications.(4, 5)

Intestinal Atresias:

Whatever the type of the atresia and whichever the bowel involved, the basic principles will remain the same.The affected(atretic) segment of the bowel will have to be resected, a part of the dilated bowel that is just proximal to the atresia also needs to be resected and then an end - to - end anastamosis of the bowel is done.In cases of multiple atresias, there will be multiple resections or a long segment with atresias will be resected and then anastamosed. Postoperatively, these neonates have a long period of ileus and require to be kept nil orally for 7 days, and these neonates are given Parenteral hyperalimentation to prevent catabolic losses, and have a positive Nitrogen balance, to prevent weight loss, promote healing and decrease the length of convalesence.(6, 7, 15)

Duplications of the Bowel:

Duodenal Duplications - if possible, the cyst must be excised and the duodenum is closed. But, if in some cases this is not possible, then at least stripping of the opened mucosa of the cyst should be done or a cystoduodenostomy is done.(16)Jejuno ileal duplications - resection of the cyst with the segment of the bowel is done as separation of the duplication from the bowel is not possible.At times, this will necessitate resection of a large length of the bowel.Another method that is open is to anastamose the distal end of a tubular duplication to adjacent normal small bowel to allow free drainage.It is also now possible to separate the two sysytems of the bowel and the duplication along with their

respective blood supply and achieve bowel lengthening.(20)Ceacal duplications - may be excised as before; however, if the duplication is tubular and long , then a longitudinal anastamosis with the normal colon is done, and the unused duplication mucosa is stripped off.

Necrotizing Enterocolitis:(NEC)

It is of utmost importance to recognize this acquired condition as early as possible so as to avoid surgery and decrease both morbidity and mortality. If this disease is diagnosed early, the method of therapy is always conservative .

Conservative Therapy:

The initial therapy of NEC is aggressive and non operative and entails the following - Oral feeding is withdrawn and nasogastric suction is begun. Besides other steps outlined in the preoperative therapy, blood and stool cultures are sent ; the antibiotics of choice in this condition are an Aminoglycoside with a Cephalosporin, and Metronidazole until culture reports are available.Enteral aminoglycosides used to be advocated in the past, but not any longer now. It is important not to allow the neonate to become hypoxic or hypothermic. Regular monitoring of the blood pressure, urine output, blood cell counts and platelet counts and serial abdominal x - rays are a must. Correction of electrolytes and acid - base imbalances is a must. If disseminated intravascular coagulation sets in, fresh frozen plasma and platelet concentrates in addition to fresh blood transfusion are required.(9)

Surgical therapy

Surgery in NEC is necessary only if there is bowel perforation or gangrene.(9, 17)

Absolute indications for surgery in NEC are :

Pneumoperitoneum on plain x - ray abdomen suggesting perforation.

Persistent dilated intestinal loop on serial x - rays.

Palpable abdominal mass with tenderness

Abdominal wall erythema

Positive abdominal tap - if volume is > 0.5 ml, brown color and shows bacteria on Gram staining.(21)

Relative indications for surgery in NEC are :

Presence of persistent acidosis , or progressive thrombocytopenia.

Presence of other congenital defects.

Persistent bleeding per rectum.

Surgical Procedures:

For isolated bowel perforation - always a limited resection with end - to-end anastomosis. In cases with gangrenous bowel - the principles of surgery are followed i.e.Resection of all non viable bowel Cleansing of the peritoneal cavity Enterostomy of the viable bowel ends, never try a primary anastomosis. Decompression of the entire bowel, second look laparotomy after 24 hrs.(22)Multiple lesions require multiple resections, and multiple enterostomies.If doubtful viable bowel segment is very long, and resection may leave a short gut syndrome, then closure after resection of only definitely gangrenous bowel is done and followed by a second look laparotomy after 24 hours to assess requirement of additional resection of the bowel.(22)After enterostomy and the child settled , a distal contrast study of the distal loop to rule out a stricture and then is followed by closure with end to end anastomosis.In some critically ill neonates with intestinal perforation, where laparotomy is not possible, then just peritoneal drainage is a useful adjunct, and if required, after the condition of the child stabilizes, a regular exploration may be done.(23) Postoperative critical care with parenteral nutrition, adequate decompression of the bowel and proper monitoring of the vital parameters is essential to avoid complications. The mortality is about 20 % in these cases in the best of centers, and a morbidity > 30%.

Meconium Pertonitis:

Most of the neonates with peritonitis are extremely ill and in shock at the time of admission and surgery cannot be contemplated till they are stabilized as described earlier. In addition to decompression of the bowel, intravenous fluids, antibiotics, endotracheal intubation and mechanical ventilation may be required. If the free air in the peritoneal cavity is causing respiratory distress, then removal of trapped air by insertion of a needle into the cavity may be life saving in these neonates.(10)Surgery involves isolation of the perforation, cleaning of the peritoneal cavity. If there is only perforation without distal obstruction is seen, simple closure of the perforation is done, or if the bowel ends are non viable, resection may be required. If the bowel is gangrenous, a large segment needs to be resected and the viable bowel is exteriorised. However, if , there is a distal obstruction beyond the site of the perforation as in atresia or volvulus or stenosis, that basic pathology needs to be tackled also. If the peritonitis is mild, then resection as required and a primary anastomosis can be attempted. The mortality in this condition is about 50 % at the best of the centres.

Meconium Ileus:

Since the severity of the obstruction varies, some can be relieved by conservative means and avoiding surgery in this condition. Conservative Therapy: This can be done using a

contrast like Gastrograffin 76%, which has a high osmolarity(1900 mosm/ L) unlike plasma which is 300 mosm/L. This contrast draws fluid into the bowel lumen, and loosens the obstructing material.(18) This method is used in uncomplicated Meconium Ileus. The gastrograffin is warmed and is injected after half dilution with normal saline thru a soft plain catheter placed in the rectum with a 20 ml syringe under fluoroscopy control. The solution is injected under vision of the image intensifier, using small volumes gradual slow injection.This is continued till the contrast reaches the dilated ileum. The procedure may be repeated after 8 hours.However, if there is leakage of contrast into the peritoneal cavity (perforation), or the ileum is not seen after 45 minutes, the injection of solution is stopped. surgery may be required in these cases.Surgery is the method in complicated meconium ileus, as with meconium peritonitis, perforation or atresia is present or if enema treatment is unsuccessful. If the bowel is grossly dilated and is of doubtful viability, resection of the bowel is needed, but never a primary anastomosis as leakage chances are very high. The ideal procedure is to do a double barrelled ileostomy temporarily. A better alternative is to do a Bishop - Koop Roux - en - Y ileostomy for decompression. Washouts with warm normal saline are given and later after a distal contrast study, the ileostomy is closed. The postoperative care after the ileostomy is very important to ensure good results in the long run. Survival in meconium ileus should be around 90% at 1 week, though long term survival is very poor because the disease affects multiple organs like lungs.(11)

Meconium Plug Syndrome:

The contrast study done for diagnosing this condition, is also therapeutic, and once the plugs of meconium are passed, abdominal decompression occurs and gradually oral feeds an be started and surgery can be avoided.howevre, these neonates must be followed up on a long term basis to rule out Hirschsprung's Disease.

Hirschsprung's Disease:

Though a contrast enema gives us a possible diagnosis of this condition, but the most accurate diagnosis can only be made by a Full thickness rectal biopsy which shows a aganglionosis along with hypertrophic plexuses. Once the diagnosis is made, the first mode of therapy is diversion with decompression of the obstruction. This is achieved by doing a right transverse colostomy with multiple colonic and rectal biopsies to mark the ganglionic and aganlionic bowel for the definitive therapy. The second stage is done after a year, wherein the aganglionic bowel is resected and ganlionic bowel is pulled down to the anal verge and followed by the third stage of closure of the colostomy. Sudden decompression in the first stage is critical and intensive care is required in these neonates many of whom also have enterocolitis due to the stasis of liquid bowel contents proximal to the aganlionic bowel .

Anorectal Malformations:

Here again the diagnosis is obvious on proper observation, and the further details are known by the invertogram. The final therapy in cases with low malformations is an Anoplasty under local anesthesia, however, if the anomaly is high or intermediate in nature then the first step is to decompress the obstruction by doing a colostomy. Nowa days the choice of site of colostomy is the Pelvic colostomy in the neonatal stage.This takes care of the obstruction as an emergency, the next stage is after the child is older and a definitive pull thru with the neo anal opening made followed by closure of the colostomy. The definitive therapy can be of different techniques details of which are superfluous in this chapter.

Conclusion:

Bilious vomiting in the neonate is most commonly due to a surgical cause. Other causes which are medical in nature must be ruled out. One of the most important part is to take a proper history in detail , followed by a thorough clinical examination and simple radiological examination which is available in all nursing homes and hospitals anywhere in the country. It is the interpretation of the amalgamation of all these that helps one to come to a final diagnosis, regarding not only the need of surgery but also the type of surgery. An early accurate diagnosis followed by early reference and early and proper surgery will go a long way in decreasing both the mortality and the morbidity of these surgical conditions and improve the overall results in the time to come.

TABLE 1

ETIOLOGY OF BILIOUS VOMITING IN A NEONATE

MECHANICAL	FUNCTIONAL
Duodenal Atresia	Adynamic Ileus
Duodenal Stenosis	Small Left colon Syndrome
Annular Pancreas	Necrotizing Enterocolitis

Malrotation & Volvulus

Small Bowel Atresia

Small Bowel Stenosis

Intestinal Duplications

Colonic Atresias

Meconium Peritonitis(Complicated)

Meconium Ileus

Meconium Plug Syndrome

Milk Inspissation Syndrome

Anorectal Malformations

Hirschsprung's Disease

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