

# Progress of Pediatric Surgery: A Brief Review

**Rajendra K Ghritlaharey\***

Department of Pediatric Surgery, Gandhi Medical College and Associated, Kamla Nehru and Hamidia Hospitals, India

**\*Corresponding author:** Rajendra K Ghritlaharey, Department of Pediatric Surgery, Gandhi Medical College and Associated, Kamla Nehru and Hamidia Hospitals, Bhopal, Madhya Pradesh 462001, India, Email: [drrajendrak1@rediffmail.com](mailto:drrajendrak1@rediffmail.com)

**Published Date:** January 05, 2015

## ABSTRACT

Pediatric surgery includes care of the children from the neonatal period to adolescence with surgical disorders. This also includes, counseling for antenatal diagnosed surgical disorders, and fetal interventions. Like adults, every infant and child who suffers from an illness (medical or surgical) or disease, has the right to be treated in an environment devoted to their care, and by a specialist trained for the same. Pediatric surgery is the youngest subspecialty of surgery and neonatal surgery is the flagship for pediatric surgeons. Pediatric surgery is a highly specialized branch as it requires handling of delicate and miniature tissues with great deal of patience. Management of the newborns with surgical disease is one of the most challenging aspects of the pediatric surgery. In the World, great advancement and progress has occurred in this speciality in last fifty years. The progress occurred in the field of pediatric surgery are; better understanding of the pathophysiology of neonates with surgical diseases, advances in the antenatal and postnatal diagnosis of surgical diseases (ultrasonography, computed tomography scans, magnetic resonance imaging, pediatric nuclear medicine, etc), advancements in neonatal and pediatric anaesthesia, refinement in surgery and surgical techniques for infants and children (staplers, minimal invasive surgery, robotic surgery, etc), better post-operative care in neonatal intensive care units and pediatric intensive care units, cardio-respiratory supports as ventilators, extracorporeal membrane oxygenation and other monitoring devices, availability of total parental nutrition, antibiotics, fetal surgery, and organ transplantation. Progress and advancements that

occurred, directly or indirectly are helping in the better survival and outcome of the many of the neonates, infants, and children with surgical diseases. In last two decades there has been a rapid advancement in the computer and internet technology and this helps in a widespread, and instant dissemination of knowledge. Social websites are also helping in the rapid dissemination of the knowledge in varieties of ways.

**Key words:** Fetal surgery; India; Minimal invasive surgery in children; Neonatal surgery; Pediatric surgery; Pediatric urology; Pediatric robotic surgery; Pediatric organ transplantation

The total population of the World is more than 7.2 billion, and children aged 0-14 year of age accounts for 26% of the total world's population [1-3]. Congenital anomalies also described as birth defects, congenital disorders or congenital malformations, are estimated to occur in about 3% of infants, result in 3.2 million birth defect-related disabilities every year. An estimated 270,000 newborns die during the first 28 days of their life every year from the congenital anomalies [4]. Many of the birth defects (congenital anomalies) were known to ancient time and Hippocratic era, and physicians and surgeons of that era attempted to find out remedies for those defects [5,6]. Hippocrates, 5th century B. C. (460–377 BC), Greek physician and surgeon, *the father of medicine*, is thought to be the first physician to attempt and document the treatment of hydrocephalus [6,7]. In the early years, the surgical needs of children were mostly provided by general surgeons all over the world [8,9,10]. The development of pediatric surgery around the World begins around 1940-1950. Dr. William Edwards Ladd (September 8, 1900 – April 15, 1967), Boston USA, is regarded as “the father of Pediatric Surgery”. He started his career in pediatric surgery after the devastating explosion of Halifax that occurred on Dec 06, 1917. He developed policies and uniform methods of care for each surgical disease in children. Ladd's band and the Ladd's procedure are named after William E. Ladd, the surgical procedure he described in 1936. The Ladd Medal is awarded by the Surgical Section of the American Academy of Pediatric to respect his contribution in pediatric surgery [10-13]. Sir Denis Browne (April 2, 1892 – January 9, 1967) of the hospital for Sick children, Great Ormond street London is regarded as the “father of paediatric surgery” in the United Kingdom. Sir Denis Browne, an Australian who worked at London and he was the first surgeon in London to confined his practice to pediatric surgery. He contributed in the field of pediatric surgery, orthopedics, otolaryngology, plastic surgery and urology. Denis brown abdominal retractor, superficial inguinal pouch, technique for hypospadias repair, Denis Browne ring retractor in hypospadias surgery, undescended testis, Denis Browne splints for the treatment of talipes deformities are the contributions made by Sir Denis Browne. Denis Browne Gold Medal is awarded to respect his contribution by British Association of Paediatric Surgeons [10,14].

Most of the innovation, development and progress that occurred in the field of pediatric surgery can be categorized as followings; neonatal surgery, treatment of congenital anomalies, neonatal intensive care [15-18], pediatric gastrointestinal surgery [15,19,20], pediatric hepatobiliary surgery [21,22], pediatric thoracic surgery (excluding cardiac surgery) [23,24], pediatric urology

[25], pediatric oncosurgery [15,26], pediatric trauma [27,28], newer advancement of diagnostics in pediatrics [16,29], advancement in pediatric and neonatal anesthesia [17,30], pediatric minimal access surgery [18,20,21,25], pediatric robotic surgery [25,31], fetal surgery [15,16], pediatric organ transplantation [22,32], pediatric bariatric surgery [33], computer technology and internet in pediatric surgery practice [34,35].

## PROGRESS IN NEONATAL SURGERY

Neonatal surgery is a flagship for pediatric surgeons. Majority of the neonatal surgery includes correction of congenital anomalies. Management of the newborns with surgical disease is one of the most challenging aspects of the pediatric surgery. In the last fifty years there has been a great advancement in the understanding of the physiology of neonates with surgical diseases, advances in the diagnosis of neonatal surgical diseases, advances in neonatal anaesthesia, refinements in the surgical techniques, better post-operative care in neonatal intensive care units (NICU), ventilator supports and monitoring devices for neonates, availability of antibiotics, total parental nutrition (TPN), etc. All of the above are contributing (directly or indirectly) in the better survival of the many of the neonates with surgical diseases [10,15-18,23,36-52].

### Anorectal Malformations

The reported incidence of anorectal malformations (ARM) is approximately 1 in 4000 live births and approximately 3/4<sup>th</sup> of the cases are easily diagnosed by proper history and clinical examination. The aim of the surgical management of a child with ARM is to achieve good bowel, bladder, and sexual function, with normal social life. The low ARM is very well managed by perineal surgery with an excellent result and with minimal morbidity. The intermediate and high ARM cases are mostly managed by initial colostomy followed by definitive surgical procedures, and stoma closure thereafter; although intermediate and high ARM cases can also be done by single staged-procedures. The advancement and progress that occurred in the management of ARM cases are Pena's procedures, use of minimal access surgery, to name few of them. In 1982, Alberto Peña, et al reported the results of the use of a posterior sagittal surgical repair approach for ARM cases. Fecal incontinence following definitive surgery for ARM is one of the single most important problems, and every precaution must be taken during surgery to minimize the risk of fecal incontinence [10,15-18,36-38].

### Esophageal Atresia and Tracheoesophageal Fistula

Esophageal atresia (EA), with or without tracheoesophageal fistula (TEF) is most common congenital anomalies of the esophagus and it is reported to occur in 1 in 3500 to 1 in 5000 live births. EA was first described by William Durston in 1670 in one of a pair of female thoracopahus conjoined twins. Different types of EA and TEF was first classified in 1929 by Yogy, and this classification was modified in 1953 by Gross. Dr. William E. Ladd in Boston (1939), operated upon a newborn girl with esophageal atresia with distal TEF with first survival. He treated with feeding

gastrostomy, followed by later ligation of fistula and cervical esophagostomy. Antethoracic skin tube was used for the replacement of the esophagus. Dr. Cameron Haight, a thoracic surgeon at Ann Arbor, Michigan on March 15, 1941 performed the first successful primary single-stage operation in an infant born with TEF. The primary surgical correction is the best option for the managing an infant of EA with or without fistula and this can be executed either by open thoracotomy or by thoroscopically. Long gap EA is the most difficult to manage and mostly require staging procedures and esophageal replacement. At present at many centers in developed countries the overall survival of neonates born with EA with or without fistula are over 85%, but the survival in developing countries are still poor due to various reasons [10,15-18,39-41].

## Intestinal Atresias

Intestinal atresias can affect duodenum, jejunum, ileum or colon. Duodenal atresia is reported to occur in 1: 5,000 to 10,000 live births. In approximately 85% of cases, the duodenal atresia occurs in the second part of the duodenum, distal to the ampulla of Vater. Approximately half of infants with duodenal atresia and stenosis are associated with other congenital anomaly and are Down's syndrome, annular pancreas, congenital heart disease, malrotation of gut, oesophageal atresia, ARMs. As duodenal atresias are frequent associated with other congenital malformations suggests both anomalies are due to a development error in the early period of gestation. Duodenal atresia differs from other atresias of the small and large bowel. The errors in the recanalization are thought to be the primary cause of duodenal atresia and stenosis, while atresias of the small and large bowel are caused by mesenteric vascular accidents during later stages of development. The only treatment for duodenal atresia is surgery, and mostly treated with duodenoduodenostomy. Rarely the duodenal atresias are treated with duodenojejunostomy, or gastrojejunostomy. The mortality with duodenal atresia is mostly attributed to the prematurity and other associated lethal congenital anomalies. Jejunoileal atresia is one of the most common causes of intestinal obstruction in newborns. Dr. James Louw of Cape Town and Christian Barnard in 1955 demonstrated in fetal dog that most of the atresias involving jejunum and ileum were related to the late intrauterine vascular accidents to the fetal bowel or mesentery, rather than the previously accepted theory of inadequate recanalization of the intestinal tract. The Jejunoileal atresias can be corrected by resection of the diseased segment and anastomosis, resection of part of atretic segment / tapering jejunoplasty / ileoplasty and anastomosis, multiple anastomoses, creation of stoma, and all depends upon the type of atresia, site of atresia and the availability of remaining length of small bowel. Factors associated to the mortality in the management of a neonates with intestinal atresias are; intestinal perforation with peritonitis, presence of septicemia, need of creation of stoma, small residual length of small bowel, need and long duration of TPN, etc [10,15,17,42,43].

## Gastroschisis and Omphalocele

Gastroschisis is a full-thickness developmental defect in the abdominal wall usually just to the right of a normal insertion of the umbilical cord into the body wall, rarely it is located in a mirror-

image position to the left of the umbilical cord. The incidence of gastroschisis varies from 0.4 to 3 per 10,000 births. In 10-20% of the cases there is an associated other congenital anomalies, mostly related to gastrointestinal tract. It is possible to detect this anomaly during antenatal sonography. Postnatal the surgical management of a newborn with gastroschisis is to reduce the herniated intestine and other viscera into the abdomen and to close the abdominal wall defects. The reduction of the herniated intestine and other viscera into the abdomen can be achieved either with primary repair, delayed primary repair or staged repair using silo technique. The prognosis of cases of gastroschisis depends upon many factors and is weight, general condition, presence or absence of septicemia, condition of the exposed bowel, associated anomalies, need of long duration of INCU care and TPN. The overall outcome of gastroschisis is more than 90% at many centers. An omphalocele (also known as exomphalos) is a midline abdominal wall defect of variable size, with the herniated viscera covered by a membrane consisting of peritoneum on the inner surface, amnion on the outer surface, and Wharton's jelly between the layers. The omphalocele sac may contain part of intestine, and part of liver. The ultimate goal during the management of cases with omphalocele is to reduce the herniated viscera into the abdomen and close the abdominal wall with the minimal morbidity. In those cases of omphalocele where the membrane of omphalocele are intact and without intestinal obstruction that can be best managed by topical application silver sulfadiazine, etc and delayed repair of the epithelialized ventral hernia. In cases of omphalocele where the membrane is ruptured or associated with intestinal obstruction, that requires surgical management. Depending upon the size of the defect, a ruptured omphalocele may be managed with either of one; reduction of the herniated viscera and primary abdominal wall repair, reduction of the herniated viscera, skin closure and delayed repair, or staged repair using silo technique [10,17,44-46].

## Congenital Diaphragmatic Hernia

Congenital diaphragmatic hernia (CDH) is estimated to occur in 5 in 10,000 live-births, and it is defined by the presence of a defect in the diaphragm, more often on the left side. CDH may also be associated with lung hypoplasia and other anomalies. It is possible to detect the CDH during antenatal USG. Postnatal treatment consists of management of pulmonary hypertension, and surgical repair of the diaphragmatic defects, and this can be achieved either by open surgery or by using minimal access surgical techniques. Many of the neonates with CHD may require long duration of ventilation, NICU care, TPN, and may also need extracorporeal membrane oxygenation (ECMO). Robert Bartlett and Alan Gazzaniga in the 1960s instituted ECMO for infants with inadequate heart and lung functions (CDH, congenital heart diseases, meconium aspiration syndrome, etc). The factors affecting the survival of infants with CDH are antenatal detection of CDH, degree of pulmonary hypoplasia, pulmonary hypertension, associated congenital anomalies, need of ECMO, need of ventilator care, need of long duration of NICU care and TPN [10,17,18,23,47-49].

## Necrotizing Enterocolitis

Necrotizing enterocolitis (NEC) is mostly occurs in the second and third week of life, and mostly affects the premature and formula-fed infants, but it can also occur in term and near-term infants. It mostly involves the terminal ileum but can occur at any part of gut. It is characterized by variable degree of intestinal mucosal damage to full thickness bowel necrosis and perforation, and may involve multiple sites. The standard management of infants with NEC with intestinal perforation / intestinal necrosis is laparotomy, resection of the necrotic / perforated segment of bowel and anastomosis. In very sick infants or if bowel is not healthy, in these cases most often stoma formation is the safest option. Peritoneal drainage is an alternative to laparotomy and can be opted for infants either not fit for laparotomy or very poor weight or very sick, and this procedure can be performed bedside under local anesthesia in NICU. Many of the neonates with NEC may need long duration of ventilator support, NICU care, TPN, etc. The overall prognosis in the cases of NEC is better in infants who weigh more than 2500 g, as compare to infants who weigh less than 1500 g [10,17,50-52].

## PROGRESS IN PEDIATRIC GASTROINTESTINAL SURGERY

Progress and newer advancements that occurred in the management of pediatric gastrointestinal surgical diseases are that in the recent decades many of the surgeries are being performed by laparoscopically, and in recent decade robotic assisted surgery are also being done, but at selected centers around the world [19,20,36-38,53-68].

## Gastroesophageal Reflux (GER)

Gastroesophageal reflux (GER) is the term used to describe the backflow of gastric contents into the esophagus. Majority of GER in infants resolve by conservative / medical management and very rarely require surgical therapy. The surgical management for GER is fundoplication and this can be performed by conventional open surgical fundoplication, laparoscopic fundoplication, and robotic assisted fundoplication. The techniques for fundoplication are Nissen, although there are other techniques as well, I'd mention only Nissen by name. In recent years the minimal invasive surgical techniques are more frequently advocated and used for fundoplication in children. Nissen fundoplication with 360-degree wrap is a treatment of choice for GER in children. Laparoscopic fundoplication remains the gold standard for GER in children [53-56].

## Intussusception

The word intussusception is derived from Latin words “*intus*” (within) and “*suscipere*” (to receive). Intussusception is the invagination of one part of the intestine into another. Intussusception remains a common cause of bowel obstruction in infants and young children and results in significant morbidity and mortality, if not promptly treated. Most commonly it occurs in infants and young children, but it also occurs in adults. Adult intussusceptions are mostly (> 90%) due to secondary pathological conditions. More than 75% of the intussusception occurs within

the first two years of life, and more than 40% reported within 3-9 months of age. Although, Dr. William E. Ladd reported the use of diagnostic imaging with bismuth enemas and published the first photographs of roentgenologic pictures of an intussusception in 1913, but in recent decades the diagnosis of intussusception is made mostly on clinical history and examination and supported by sonography of the abdomen. The USG of abdomen is not only useful for diagnosis, but also used for the monitoring during air or saline reduction of intussusception. In the developed countries, cases with intussusceptions present early and diagnosed in early phase and for the same reasons mostly managed on non-operative medical therapy. This medical therapy consists of air or saline enema reduction and this can be monitored by USG. In developing countries due to various reasons surgical therapy is indicated and required in majority of the cases, and in more than 50% of cases bowel resection also require. Intussusception is also possible to deal successfully with laparoscopically with an added advantage of MIS [19,57-60].

## Hirschsprung's Disease

It is a developmental disorder characterized by absence of ganglion cells in the distal colon, resulting in a functional obstruction. In 85% of the cases the aganglionosis is confined to the rectosigmoid. In 1886 at the 'Berlin congress for children diseases', Harald Hirschsprung first described two infants who had died from constipation associated with dilatation and hypertrophy of the colon, and he published the same with details in 1888 in the German literature. This entity is named after Harald Hirschsprung. Most of the cases are being diagnosed during infancy and others during their early childhood. Hirschsprung's disease is suspected on clinical history and examination. The work up of a case of Hirschsprung's disease consists of anorectal manometry, enemas, and definitive diagnosis is made by rectal biopsy. Treatment of Hirschsprung's disease consists of surgical resection of the abnormal portion of colon, and pull-through of normal colon. The surgical treatment of Hirschsprung's disease is either staged - procedure or single - stage procedures. This pull-through operation can be performed by various techniques and are; Swenson procedure, Duhamel procedure, and Soave (endorectal) procedure. In 1948, Orvar Swenson (Boston, USA) published a paper in the New England Journal of Medicine and he recommended rectosigmoidectomy with preservation of the sphinctures for the treatment of Hirschsprung's disease. Duhamel procedure was first described in 1956 as a modification to the Swenson procedure. In Soave procedure which was introduced in the 1960s and in this technique the mucosa and sub-mucosa of the rectum is resected, and the ganglionic bowel is pulled through the aganglionic muscular cuff of the rectum and this procedure has been modified by Boley to include a primary anastomosis at the anus. Short-segment Hirschsprung disease is treated by anorectal myomectomy. Long segment Hirschsprung disease needs special attention and surgical planning. Keith Georgeson in 1995 first described laparoscopic surgical treatment of Hirschsprung's disease. Laparoscopic-assisted colons pull-through for Hirschsprung's disease not only diminishes the surgical trauma to the peritoneal cavity, but also reduces the peri-operative complications and post-operative recovery time as well. Each technique has its own merits and

demerits. Trananal endorectal pull-through is more preferable than transabdominal pull-through for single - stage surgery for Hirschsprung's disease [61-64].

## Anorectal Malformations

Low ARMs are managed by perineal surgical procedures during neonatal period / during infancy with an excellent result, and with minimal morbidity. Intermediate and high ARMs are mostly managed by initial colostomy followed by definitive surgical procedure (mostly via posterior sagittal approach), and stoma closure thereafter, although some intermediate and high ARMs may also be managed with a single – stage procedure.

A most important development / innovation of surgical techniques in the management of ARM are Pena's procedure (posterior sagittal anorectoplasty) and use of laparoscopy during definitive procedures. In 1953 Douglas Stephen's introduced the sacro-abdominal perineal pull-through for ARM cases. In 1982, Peña et al reported the results of the use of a posterior sagittal surgical repair for ARM. Pena's procedure is most frequent performed operation for ARM cases around the World. In recent years laparoscopic / laparoscopic assisted pull-through procedures for ARM cases are also being done and advocated by many. Fecal incontinence following definitive surgery for ARM remains one of the single most important and challenging problems, and every precaution must be taken during surgery to minimize the risk of fecal incontinence [20,36-38].

## Congenital Pouch Colon

Congenital pouch colon (CPC) is a congenital anomaly in which whole or part of the colon is replaced by a pouch like dilatation which communicates distally to the urogenital tract with a fistula, and is associated with ARM. CPC is reported mainly from the Indian subcontinent, though there have been few case reports from other part of the World. Singh and Pathak in 1972 from India first reported a series of such six cases, and named this condition as "short colon". In 1984, Narsimha Rao, et al suggested the name 'Pouch Colon Syndrome' and also proposed an anatomical classification of this condition which has been widely accepted and used. Wakhlu, et al in 1996 simplified the classification as "partial short colon" (Type A) with presence of > 8 cm of normal colon proximal to the pouch and "complete short colon" (Type B) with absence of normal colon or less than < 8 cm of colon proximal to the pouch. This anomaly is also known as congenital short colon and congenital short colon syndrome. CPC, which was not mentioned in the Wingspread classification of ARM in 1984, has now been accepted and included in the new International classification (Krickenberg) of ARM in 2005, as rare anomalies, being only regional. More than 65% of the cases of CPC are being diagnosed by invertogram / plain x-ray abdomen, and the cases of CPC can be managed either by single stage procedure or staged procedures. Staged procedures (two / three staged procedures) provide the better results with less morbidity and mortality during definitive procedures. Staged procedures for CPC are also advocated by most of the authors [65-68].

# PROGRESS IN PEDIATRIC HEPATOBIILIARY SURGERY

The hepatobiliary surgical procedures performed in children include; cholecystectomy, choledochal cyst excision and Roux-en-Y hepaticojejunostomy, Kasai portoenterostomy for biliary atresia and liver transplantation, etc [18,21,22,69-79].

## Cholelithiasis and Cholecystitis

Cholelithiasis and cholecystitis in children are not frequent, but diagnosed easily by sonography examination of the abdomen. In some of the children, choledocolithiasis also present along with cholelithiasis and many of the children are also associated with hemolytic disorders. Biliary stones (cholelithiasis and choledocolithiasis) are easily diagnosed by abdominal ultrasonography. Other invasive investigation; endoscopic retrograde cholangiopancreatography (ERCP), and intra-operative cholangiography are reserved for selected cases having clinical features or USG findings suggestive of choledocolithiasis. The treatment of cholelithiasis is cholecystectomy and this can be executed either by open surgery or by laparoscopic methods. Laparoscopic cholecystectomy is a gold standard for the cholelithiasis. Common bile duct exploration is indicated when there is choledocolithiasis and this can also be done through laparoscopic methods. Endoscopic extraction of bile duct stones is indicated and require in some cases [69,70].

## Choledochal Cysts

Choledochal cysts are congenital anomalies of the bile ducts and leads to cystic dilatation of biliary tree and this may be extra hepatic cyst, intra hepatic cyst, or both. It is most common amongst Asian population and reported to occur 3-4 times more in females. Choledochal cysts are mostly diagnosed during infancy and childhood, but also reported in adults. Clinically a child with choledochal cyst may be asymptomatic, or present with jaundice, abdominal pain, abdominal lump, and cholangitis. The abdominal pain, jaundice and abdominal mass are described as the classic triad of choledochal cyst but not observed in majority of the cases. Diagnostic work up for choledochal cysts consists of USG abdomen, magnetic resonance cholangiopancreatography (MRCP), ERCP, percutaneous transhepatic cholangiography (PTC). The treatment of extra hepatic choledochal cysts is excision of the cyst including gall bladder, and Roux-en-Y hepaticojejunostomy, and may also be done using laparoscopic techniques with excellent results. Robotic assisted choledochal cysts excision and Roux-en-Y hepaticojejunostomy in children has also been published, and authors concluded that robotic assisted resection of choledochal cysts in children is safe, with an added advantage of MIS. Total cyst excision is a must and needed to reduce the cyst related complications and risk of developing cholangiocarcinoma [18,21,71-76].

## Biliary Atresia

Biliary atresia was first described by John Thompson in 1892. He detailed 49 clinical cases of congenital biliary obstruction and documented the autopsy findings in each case. Biliary atresia is a progressive inflammatory destructive process of the bile ducts occurring in about 1:10,000

to 20,000 live births. Biliary atresia can lead to liver failure due to biliary cirrhosis and death in the first years of life, if the condition is left untreated. Biliary atresia is one of the most common surgical causes of cholestatic jaundice in neonates. The classic clinical triad of biliary atresia consists of (a) conjugated jaundice persisting beyond two weeks of life, (b) acholic, white stools and dark urine, and (c) hepatomegaly. The Japanese Society of Pediatric Surgeons classifies the biliary atresia according to the location of atresia into three types. More than 85% of the biliary atresia belongs to type 3, in which there is complete atresia of the extra-hepatic biliary tree including the right and left hepatic ducts. The only effective treatments for biliary atresia at the moment are Kasai operation and liver transplantation. Kasai operation is named after Japanese surgeon Dr. Morio Kasai (September 29, 1922 - December 6, 2008), the surgical procedure he first performed for biliary atresia in 1955. In 1957, Kasai published his first series detailing a precise anastomosis of a loop of intestine to the remnant of the hepatic ducts at the level of the hepatic capsule. The Kasai operation consists of constructing a new bile drainage system, generally by creating an anastomosis of the jejunum by a Roux-en-Y loop to the porta hepatis region to re-establish a connection between the intrahepatic bile ducts and the intestine. The Kasai hepatic portoenterostomy is mostly performed through open surgery, although this procedure is also feasible using laparoscopic techniques. Successfully executed Kasai operation increases the survival of children with biliary atresia and postpones subsequent liver transplantation, although most of them develop progressive liver failure. Bijl, et al recently published their review of 184 patients and concluded that it is possible for patients with biliary atresia to survive more than 20-years on their native liver after undergoing Kasai operation during early infancy, however most long-term survivors develop complications. Dr. Thomas Earl Starzl in 1960s popularized the liver transplantation. The liver transplantation is the only definitive treatment for biliary atresia. In fact, biliary atresia is the most common diagnosis leading to liver transplantation in children [22,77-79].

## **PROGRESS IN PEDIATRIC THORACIC SURGERY (EXCLUDING CARDIAC SURGERY)**

Thoracic surgery commonly performed during infancy and childhood are; repair of CDH, excision of lung cysts, and management of empyema thoraces, and all these can be executed either by open surgery or by use of MIS [23,24,47-49,80-83].

### **Congenital Diaphragmatic Hernia**

The progress and advancements that occurred in the management of the cases of CDH has already described at section of 'Progress in Neonatal Surgery'.

### **Lung Cysts**

Congenital cystic lesions of the lung in children are not much common but warrant an urgent investigation and surgery. Congenital cystic adenomatoid malformation (CCAM), pulmonary

sequestration, congenital lobar emphysema and bronchogenic cysts are the major cystic lesions of the lung. These cystic lung lesions may present with respiratory infection, respiratory distress and lung abscess, and needed an urgent workup to confirm the diagnosis. The excision of the lung cysts provides the best result and can be executed either by an open thoracotomy or by thoroscopic procedures. The asymptomatic cystic lung lesions should also be resected to prevent complication in future [24,80,81].

## Empyema Thoracis

An empyema is a localised or free collection of purulent material in the pleural space. Pleural empyema in children continues to be a serious problem despite recent advances in the management. Multiple therapeutic options are available for the treatment of empyema in children and includes; antibiotic therapy alone, tube thoracostomy, fibrinolytic agents therapy, and decortications. Video-assisted thoroscopic surgery (VATS) is gaining its place in the management of childhood empyema, not only during early phase of empyema but also useful for decortications [82,83].

## PROGRESS IN PEDIATRIC UROLOGY

In present era of technology, pediatric urology has also advanced and progressed from open surgical procedures to endoscopic, laparoscopic and robotic surgical procedures. Many of the pediatric surgical diseases are now managed by endoscopic, laparoscopic and robotic assisted techniques also. Urological surgical diseases in infants and children that requiring treatment are posterior urethral valve, urinary stones, hydronephrosis, and vesicoureteral reflux [32,84-98].

## Urinary Stones Management

The common sites for pediatric urinary stones are kidney, urinary bladder, ureter and urethra, and few of them may have stones at two anatomical sites. Kidney and urinary bladder are the most common sites for urinary stones. There may be an associated anatomical abnormalities or metabolic disorders. The aim of any technique is complete removal of stones. The management of pediatric urinary stones has improved in its techniques. The option available for urinary stone management includes; open surgery, endoscopic procedures, extra corporeal shock wave lithotripsy (ESWL), laparoscopic procedures, and robotic assisted procedures with their own merits and demerits [84-86].

## Posterior Urethral Valves

Posterior urethral valve (PUV) is one of the most common causes of obstructive uropathy in male children. It is possible to diagnose urinary bladder outlet obstruction and associated hydronephrosis during antenatal sonography evaluation. Postnatal evaluation for PUV is by USG and confirmed by micturating cystourethrogram. Many of the cases of PUV also have vesicoureteric reflux (VUR) and diminished renal functions and need further investigation. The endoscopic fulguration of PUV is the best and accepted technique for initial management. In some cases

urinary diversion in the way of vesicostomy and rarely high urinary diversion is needed. The newer technique for urethral valve fulguration is using laser technique. Additional procedures are also requiring in cases having VUR, not resolve in follow up period. Long duration follow-up protocol is needed in children managed with valve fulguration. Few of them progressed to end staged renal failure and require renal transplantation [32,87,88,98].

## Vesicoureteral Reflux

VUR may be primary or secondary due to some congenital anomalies, bladder or urethral obstruction, etc. The treatment options for VUR are; open surgical (extravesical or intravesical techniques) ureteric reimplantation, endoscopic procedures (STING procedure, or other procedures), laparoscopic reimplantation, and robotic assisted reimplantation of ureter. VUR may also progress to an end stage renal failure and an indication for renal transplantation in children [32,89-94,98].

## Hydronephrosis

It is mostly due to uretero-pelvic junction obstruction and best managed with pyeloplasty and can be executed either by open surgery, laparoscopically, or by robotic assisted techniques. In one meta-analysis of robotic assisted vs conventional laparoscopic and open pyeloplasty in children showed that largely all the available techniques for pyeloplasty have comparable results, while robotic and laparoscopic techniques have added advantage of MIS [95-97].

## Renal Transplantation

Many of renal congenital anomalies and renal diseases lead to end stage renal failure and require renal transplantation in children [32,98].

## PROGRESS IN MINIMAL ACCESS (INVASIVE) SURGERY IN CHILDREN

The first laparoscopic cholecystectomy in an adult was performed by the French gynaecologist Philippe Mouret on March 17, 1987 in Lyon, France. Minimal invasive surgery (MIS) is a well established branch of surgery in adults around the World [99-102]. The use of MIS as a diagnostic tool was used in pediatrics in the year 1970's. In 1973, Dr Stephen Gans and Dr Berci were the pioneers in pediatric laparoscopy (peritoneoscopy) and they used laparoscopy mainly for diagnosis and for obtaining biopsies. MIS is one of the most rapidly growing subspecialty within the pediatric surgery. Amongst pediatric surgeons, MIS is a well established and very well accepted, and MIS in infant and children are safely performed with excellent results for various diseases [18,74,103-107]. The indications for MIS in children are the same as they are for the open surgery. MIS may be categorized as laparoscopy, thoracoscopy, mediastinoscopy, retroperitoneoscopy, and ventriculoscopy according to the body compartment in which it is used. MIS is a gold standard in the diagnosis and treatment of impalpable undescended testis,

appendicitis, gall stones, early empyema, recurrent abdominal pain, and intersex problems. Other laparoscopic abdominal procedures done in infants and children are; Nissan's fundoplication, bowel resections, intussusception, Meckel's diverticulum, laparoscopic / laparoscopic assisted pull-through for Hirschsprung's disease, laparoscopic assisted anorectal pull-through for anorectal malformations, choledochal cysts excision. Commonly performed thoracoscopic procedures in infants and children are early empyema, lobectomy for CCAM, TEF repair, CDH repair. Most commonly performed laparoscopic urological procedures are; pyeloplasty for hydronephrosis, and ureteric re-implantation [18,20,21,25,38,56,64,74,103-107].

## ROBOTIC ASSISTED PEDIATRIC SURGERY

Robotic surgery is another way of doing laparoscopic surgery, albeit with better technical inputs and technology. The word 'robot' means forced labour come from Slavic word 'robota'. The Czech playwright Karel Capek is credited for introducing the word 'robot', who used the word robot in his play 'Rossum's Universal Robots' in 1921. A robot was initially designed for the military services, to perform an operation from distant. The World's first surgical robot was the *Heartthrob*, which was developed and used for the first time in Vancouver, Canada in 1983 [31,108-110].

Modern robotic system is the "da Vinci surgical system" made by Intuitive surgical Inc. USA. The food and drug administration (FDA) USA approved the "da Vinci surgical system" in 2000 for the use in both adult and children for use in urological surgical procedures, general surgical procedures, gynaecological procedures, non-cardiac thoracic surgical procedures. The da Vinci surgical system comprises three components; a surgeon's console, a patient-side robotic cart with four arms manipulated by the surgeon (one to control the camera and three to manipulate instruments), and a high-definition 3D vision system. The most recent edition is the *da Vinci Si*, and it was launched in April 2009 and this system also allows the addition of a second surgeon console for surgical training or combined two surgeon procedures. First robotic surgery was performed in the year 2000. The use of robotic surgical system is well established in adults. Robotic assisted pediatric surgical procedures are also gaining its place as an alternative to minimal access surgery. By the Jan 2013, more than 2000 units of robotic surgical systems (da Vinci surgical system) were sold out World-wide. Majority are installed in USA, followed by Europe and rest of the World. Robotic surgery in India is in its infancy and it was started in 2001. At present, only twenty five health centres are equipped with robotics and only few of them are doing pediatric surgical procedures [31,108-115].

### Robotics Surgery in Children

In July 2000, Heller K, et al (Germany) used the robot system for the first time on an 11-year-old girl for fundoplication to treat GER. Surgeons at Children's Hospital of Michigan in Detroit, USA on Jan 17, 2002 performed the first advanced computer-assisted robot-enhanced surgical

procedure at a children's hospital in a child, the first robotic assisted surgery in child in USA. First robotic assisted urological surgery was executed in children in 2002 [31,112]. The commonest surgical procedure performed by robotic assisted technique in children and infants is pyeloplasty for ureteropelvic junction obstruction with a success rate of 97% and all the authors reported that it is safe, effective tool for pyeloplasty in children and also feasible in infants. Other robotic assisted urological surgical procedures being performed in children are; ureteral re-implantation, uretero-ureterostomy, nephrectomy, pyelolithotomy, bladder neck reconstruction, augmentation cystoplasty, appendicovesicostomy [31,97,109,112-115]. Nissen's fundoplication for GER is the second most commonly performed surgical procedures by robotic assisted technique in children. In a case control study in children by Anderberg, et al, compared robotic assisted, laparoscopic assisted and open funduplications and concluded that open funduplications were fastest to performed (mean time = 121 min), followed by laparoscopic funduplications (mean time =189 min) and robotic assisted fundoplication the slowest to perform (mean time =213 min). They further concluded that although, robotic assisted funduplications taking more times, but it enable more refined hand-eye coordination and superior suturing skills [56,109]. Other robotic assisted surgical procedures being performed in children are; ligation of patent ductus arteriosus, cholecystectomy, Ladd's procedure for malrotation of gut, bowel resection, lung resection for congenital lung lesions, CDH repair, TEF repair, choledochal cyst excision, Heller's myotomy, Morgagni's hernia repair, Kasai portoenterostomy, splenectomy [31,55,109].

## Advantage of Robotic Assisted Surgery

Surgical procedures performed by robotic assisted technique are less invasive, less traumatic to the body, provides 10-12 fold magnification of the surgical field, more accurate for dissection and suturing, more freedom of movements for instruments, provide 3-D vision, reduces the surgeons hand tremor, and other benefits of minimal access surgery like less blood loss, less postoperative pain and discomfort, less risk of infection, shorter hospital stay and less scarring [31,108,112,115].

## Disadvantages of Robotic Assisted Surgery

Robotic surgical system is at present a costly affair, and an initial capital expenditure is very high and the recurring cost of robotic instruments is also high due to its disposable nature. This technology is a neutral one and the success of the surgical procedure depends upon the operator, who is doing the procedure. For many surgical procedures, robotic assisted surgery is also not superior to conventional laparoscopic techniques [31, 108, 109, 110].

## PEDIATRIC ORGAN TRANSPLANTATION

Dr. Joseph Edward Murray (April 1, 1919 - Nov 26, 2012) and his team on Dec 23, 1954 performed the World's first successful renal transplant between the identical Herrick twins at the Peter Bent Brigham Hospital (later Brigham and Women's Hospital), Boston, Massachusetts,

USA. Dr. Murray transplanted a healthy kidney donated by Ronald Herrick into his twin brother Richard, who was suffering of chronic nephritis. Dr Murray also credited to perform the World's first successful allograft in 1959, and in 1962 he performed the World's first cadaveric renal transplant. For his great contribution in the field of organ transplantation, Dr Murray (along with Dr. Edward Donnall Thomas) was honored with the Nobel Prize in Medicine in 1990. Dr Edward Donnall Thomas developed bone marrow transplantation as a treatment for leukemia [116-119]. Dr. Thomas Earl Starzl attempted / performed the World first human liver transplant on March 01, 1963 in a child of biliary atresia, who was on ventilator. He is also credited for first successful human liver transplant in 1967 and both the procedures were performed at the University of Colorado, Health Sciences Center, Colorado USA. He is also credited for performing the first simultaneous heart and liver transplant on a 6-year old child in 1984 [120,121]. Dr. Mohammed Rela, an Indian surgeon working in India and London, he is one of the World top liver transplant surgeon, performed more than 1200 liver transplant surgeries, including one on a five-day-old female child. He is a pioneer for the split liver transplantation technique and he has done the largest number of such operations in the World. He has also performed the largest number of pediatric transplant in the World. He is currently working in India, where he has set up a successful 'living donor liver transplant program' performing over 150 liver transplants a year [122]. Dr. Arvinder Singh Soin, presently working with Medanta, Gurgaon (Delhi – NCR) India and he is recognized all over the World for his pioneering work in the field of liver transplantation in India. Dr Soin has performed more than 1000 living donor liver transplants in India, which is the highest in the country and the second highest number in the World. Dr. Soin and his team are presently performing about 250 liver transplants every year [123]. The advancement and progress that occurred in the field of organ transplantation are relating to better understanding of the pathophysiology of the diseases, progress in the field of organ preservation and transport, refinements in surgical techniques, better immunotherapy, better pre and post-transplantation management, and all have contributed in the excellent outcome in the terms of survival of grafts and patients. Most common organs that are being transplanted in children are kidney and liver. Other organs that are also transplanted in children are; intestine, heart, lungs, pancreas, bone marrow, and multi-organ transplantation [22,32,98,121-135].

## Pediatric Renal Transplantation

Renal transplantation has become the accepted treatment of choice for end stage renal diseases (ESRD) in children. Renal transplantation provides the best opportunity for growth and development in children. Indications for renal transplantation in children are; congenital anomalies of urinary tract (renal aplasia, renal dysplasia hypoplasia / hypoplastic kidney), obstructive uropathy, reflux nephropathy, focal / segmental chronic glomerulonephritis, glomerulosclerosis. Donor kidney may be living-kidney donor or deceased donor. Living kidney donors transplant provide the best long term outcome and also preferred for kidney transplantation. Living donors may be related or unrelated to the recipient and the long term results are better than the deceased donors. Renal transplantation can also be safely performed in infants [32,98,124].

## Pediatric Liver Transplantation

Liver transplantation is the best definitive treatment with an excellent long term outcome for acute and chronic end stage liver diseases in children. Biliary atresia constitutes the major indication for liver transplantation in infants and young children. Other indications for liver transplantation in pediatric age group are; fulminating acute hepatic failure, Wilson's disease, congenital hepatic fibrosis, neonatal hepatitis, glycogen storage disease, cystic fibrosis, and others. Liver transplantation can be heterotopic or orthotopic liver transplantation, depending upon that the diseased liver is in situ or removed. Liver donors may be a living donors or deceased donors. Majority of liver donors are living liver donor. Liver transplant recipient may receive whole liver / full liver, partial liver graft, left lateral segment of liver, left lobe of liver, right lobe of liver. Liver transplantation can also be performed in infants younger than 6 months of age. Liver transplantation may be isolated liver transplantation or combined with intestine, kidney, and pancreas [22,121-123,125,135].

## Pediatric Intestinal Transplantation

Intestinal failure is characterized by the inability of the gastrointestinal tract to provide sufficient digestion and absorption capacities to cover the nutritional requirements in adults and for growth in children. The first line of management of child with intestinal failure is by providing parenteral nutrition, preferably home parenteral nutrition. Indications for pediatric intestinal transplantation are; gastroschisis, necrotizing enterocolitis, midgut volvulus, long segment Hirschsprung's diseases, functional bowel syndrome, short gut syndrome due to other. Donors for intestinal transplantation are usually deceased donor, although few living - intestinal donation have also been reported for isolated small bowel transplants. Intestinal transplantation may be an isolated or may be combined with other organ transplantation [126,127].

## Pediatric Heart Transplantation

Kantrowitz and colleagues performed the first pediatric heart transplant in 1967 to a 3 week-old infant with tricuspid atresia. Heart transplantation is a treatment option for the morbid congenital anomalies, lethal congenital heart diseases (CHD) not only in adults but also in children. CHD (hypoplastic left heart syndrome, aortic atresia, single ventricle, unbalanced arterioventricular canal, pulmonary atresia), and cardiomyopathies remain the most common indication for heart transplantation in children. Donor heart is from deceased donor. Heart transplantation in children for CDH is a promising therapeutic option for long-term survival of these children [128,129].

## Pediatric Lungs Transplantation

Isolated lungs transplantation is offered to children who are having end stage pulmonary parenchymal and vascular diseases. Indications for isolated lung transplantation in children are; cystic fibrosis, pulmonary fibrosis, primary pulmonary hypertension (PHT), pulmonary

hypertension associated with CDH, bronchiolitis obliterans. The lungs transplantation may also be a part of heart-lungs combined transplantation. At present the results following lungs transplantation are poor and for the same reasons results following combined heart and double lungs transplantation are also poor [130,131].

## Simultaneous Multi-Organ Transplantation

First simultaneous heart and liver transplant was performed on six year-old child in 1984 by Dr Starzl. Simultaneous organs transplantations are also being performed and are; combined simultaneous liver - intestine, combined liver - kidney, combined heart – kidney. Simultaneous combined liver - kidney transplantation is a rare operation in pediatric age group and only 10 – 30 operations per year are performed throughout the World. Combined heart and double lungs transplantation in children is a rare operation and offered to the cases with end stages failure of both the heart and the lungs and the outcome of heart and double lungs transplantation depends upon the lungs graft, and it is relatively also poor [120,123,126,128,131,133].

## FETAL SURGERY (IN UTERO INTERVENTION)

First human open fetal surgery in the World was performed on April 26, 1981 at division of pediatric surgery, children's hospital at the University of California, San Francisco (UCSF) by Dr. Michael R. Harrison and his team to treat advanced urinary tract obstruction. Fetus had a urethral valve and hydronephrosis, treated by vesicostomy and the disease was treated after birth. Dr. Michael R. Harrison is most famous for his work in the field of fetal surgery and for his great contribution in the field of fetal surgery and fetal intervention his is also regarded and widely known as the “*Father of Fetal Surgery*” [136-140]. Most of the prenatally diagnosed malformations are best managed after birth by an appropriate medical and surgical therapy. Only few of the anatomical malformations may require and benefit by antenatal fetal intervention. At present only few of the life threatening malformations are manageable by antenatal fetal procedures [140,141]. Advancement in antenatal fetal imaging, anesthesia, tocolytic therapy, surgical techniques for hysterotomy, refinement in fetal surgical procedures, fetal and maternal monitoring, better post-operative maternal and fetal ICU care, etc all help to perform fetal interventions with better outcome and a reality to benefits few of the fetuses with life threatening anatomic malformations [140,142,143,144]. Fetal procedures can be either of any; open fetal surgical procedures, videoendoscopic fetal procedures (FETENDO), and percutaneous fetal procedures and can be performed safely as life-saving therapy to many of the fetus in utero. Open fetal surgery involves maternal laparotomy through lower transverse abdominal incision, hysterotomy at appropriate site guided by per-operative USG, exposure of appropriate fetal part, and fetal incision and correction of fetal defect. After that, fetus is returned into the uterus, and closure of hysterotomy and laparotomy wounds. Because the mid gestation hysterotomy for fetal surgery is classical, and not in the lower segment of the uterus and poses potential risk for uterine disruption during labour and for the same reason after open fetal surgery and subsequent

deliveries should be by Cesarean method only [140,141]. In video endoscopic fetal procedures and percutaneous fetoscopic intervention, there is no need for uterine incision [138,140,141]. Fetal surgery should be restricted to interventions that are life saving to the fetuses and at present fetal anatomic malformations that are amenable by fetal intervention and are urethral outlet obstruction, CDH, CCAM, large sacrococcygeal teratoma, twin-twin transfusion syndrome, spina bifida, myelomeningoceles, etc [136,138,140-146].

## Justifications for doing Fetal Interventions

Prior to fetal interventions, it is must to justify the procedure in flowing grounds; (a) prenatal diagnosis of the disease / congenital anomalies must be accurate, (b) etiology, pathophysiology of the disease must be well understood, (c) the poor prognosis of the anomalies must be predictable, if pregnancy continues, (d) the fetal intervention / fetal surgical procedure must be beneficial to the fetus, and (e) minimal and acceptable risk to the mother as maternal safety is the first priority and prime concern.

## Urethral Outlet Obstruction

Most of the cases of fetal urethral obstruction are best managed after birth. Few of fetuses with urethral obstruction with hydronephrosis may produce pulmonary hypoplasia and renal dysplasia and may be life threatening to the fetuses, and these fetuses may require or benefit from fetal intervention. This cases may be managed either of one; vesico-amniotic drainage, USG guided percutaneous vesico-amniotic shunt, open vesicostomy, videoscopic vesicostomy, fetal cystoscopy and urethral valve ablation [136,138,140].

## Congenital Diaphragmatic Hernia

Pulmonary hypoplasia associated with CHD is one of the main factors for predicting the survival. CDH can be treated by antenatal procedures; open fetal repair of CDH (now abandoned around the World), open fetal tracheal occlusion, endoscopic tracheal occlusion, percutaneous tracheal occlusion, and tracheal PLUG [138,140,144,145].

## Congenital Cystic Adenomatoid Malformation

Some of the fetuses with CCAM, due to mass effect may lead to mediastenal shift, pulmonary hypoplasia of the other lobes in utero, and may develop hydrops and may die in utero or after birth. In these fetuses open fetal lobectomy may be the life saving procedure [140].

## Sacrococcygeal Teratoma

In cases with large SCT may develop hydrops and placentomagaly due to high output failure and such fetuses may die in utero or just after birth. In these subsets of fetuses may be benefitted by in utero tumor excision or by videoscopic vascular occlusion [140].

## Twin - Twin Transfusion Syndrome

In some of the twin pregnancies, abnormal chorionic blood vessels in the placenta connect the circulation of the two fetuses. This condition is best treated by endoscopic laser procedure, or by endoscopic division of the abnormal vessels [140,144-146].

## Hydrocephalus, Open Spina Bifida / Myelomeningocele

Gross hydrocephalus due to aqueductal stenosis may be benefitted by percutaneous ventriculo- amniotic shunt, or by open fetal ventriculo peritoneal shunt placement [140]. Adzick NS (2013) reported a prospective, randomized study on in utero repair of open spina bifida (the MOMS trial) and had shown that fetal surgery for open spina bifida / myelomeningocele before 26 weeks of gestation may preserve neurologic function, reverse the hindbrain herniation, and obviate the need for post natal placement of ventriculoperitoneal [143,145].

## Complications Following Fetal Intervention

Fetal intervention carries obvious risks to the fetus and mother. Complications may occur following fetal interventions and are maternal pulmonary edema, per-vaginal bleeding, amniotic fluid leaks from hysterotomy and through vagina, uterine disruption, premature labour, preterm birth, premature rupture of the membrane, and fetal loss [136,138,140,143,145]. Lee H, et al, analyzed maternal morbidity and mortality associated with different types of fetal interventions. They analyzed 187 fetal interventions performed between July 1989 and May 2003, at UCSF fetal Treatment center, and included open fetal procedures (n=87), endoscopic fetal procedures (n=69), and percutaneous fetal procedures(n=31) and concluded that there was no maternal mortality. The group of cases who had percutaneous fetal procedures had the least morbidity [141]. Although, first fetal surgery was performed in 1981, but due to various reasons, it is not well accepted as a modality of treatment for antenatal detected congenital anomalies and fetal centers are only available at limited centers around the World.

## CHILDHOOD OBESITY AND BARIATRIC SURGERY IN CHILDREN

Obesity is currently a global public health problem not only to the society, but also a challenge to the healthcare providers. Obesity is not only restricted to the adult population, but it also increasingly affects the children. Childhood obesity is associated with long term energy imbalance and may progress to adult obesity, if not managed properly. Major factors affecting weight regulation and the development of obesity in children are; biological, behavioral, social, environmental, and economic factors, and all that promote positive energy balance. Childhood obesity if not controlled, may progress to adult obesity, and may be associated with its co-morbidities also like type 2 diabetes, hypertension, cardio vascular diseases, sleep disturbance, psychological problems, etc. The role of bariatric surgery in children is a matter of debate, although bariatric surgery is one of the widely accepted techniques for the management of adult obesity and all meta-analysis that assessed weight loss found that bariatric surgery produced clinically

significant weight loss, resolution or improvement of type 2 diabetes mellitus and hypertension. The common bariatric surgical procedures performed for the management of childhood morbid obesity with their own merits and demerits and are; open gastric bypass, laparoscopic gastric bypass, open sleeve gastrectomy, laparoscopic gastrectomy, and laparoscopic gastric banding. Recent systemic reviews and meta-analysis done on bariatric surgery performed for childhood obesity showed sustained and clinically significant weight loss [147-151].

## COMPUTER TECHNOLOGY AND INTERNET IN PEDIATRIC SURGERY PRACTICE

In the era of technology; computer, internet and World Wide Web allow easy access to varieties of information in different forms, and also helping in the instant dissemination of the knowledge across the globe. **(a) Knowledge Gaining:** Information available in the form of words, power point presentations, images, videos, etc and can be seen, read, downloaded for offline reading. Now a day many of the text books, journals, etc are open access and available to reader easily. Information relating to pediatric surgery is also available on internet and one can access with his or her convenience. This information is certainly helpful in various ways to medical students, surgical residents, specialist and consultants working in the field of pediatric surgery. **(b) Knowledge sharing:** One can submit their research publication, presentation, operative images and videos, and other information, and all this can be done with finger tip from any corners of the World. **(c) Telecommunication:** Telemedicine, distance learning, video conferencing, conference proceedings, etc and all this helps in sharing knowledge, learning, diagnosis, opinions, etc, **(d) Record keeping:** Data keeping of case records as word format, images, excel, surgical and diagnostic procedures, videos, etc and possible to store in digital form. **(e) Socialization:** Social websites, apps, such as face book, twitter, linked in, YouTube, whatsapp, etc, are providing plate-form to view, interact, and share varieties of information in various forms. Recently Google has introduced a new technology “Google Glass” and it is gaining its place amongst surgeons also. Recently a pediatric surgeon used this Goole Glass and explored its applicability in the field of pediatric surgery practice [34,35,152-154].

## PROGRESS OF PEDIATRIC SURGERY IN INDIA

India is the second most populated countries in the World. Present total population of India is more than 1.27 billion and children 0-14 year of age accounts for 28.5% of the total population in India. Currently, there are about 51 births in India in a minute and approximately 26.8 million children are borne every year, and an estimated 3% of them are born with congenital anomalies and many of them require urgent surgical care. Pediatric surgery is one of the youngest subspecialty of surgery in India. The Indian Association of Pediatric Surgeons (IAPS) was established in Dec 1964 at Mumbai, as a section of the Association of Surgeons of India. Since its beginning, the IAPS has grown very rapidly from 15 to the 1345 member till Oct 2014, and it is also well recognized specialty within the India. In India, the stalwarts who made their contribution in the development

of pediatric surgery; Prof. UC Chakraborty (Calcutta), Prof. Subir K Chatterjee (Kolkata), Dr. S Dalal (Mumbai), Prof. RK Gandhi (Mumbai), Prof. MS Ramakrishnan (Chennai), Prof T Dorairajan (Madurai), Prof. Raman Nair (Trivandrum), Prof. D Anjaneyulu (Hyderabad), Prof. P Upadhyaya (New-Delhi), Prof. M Rohatgi (New-Delhi), Prof. IC Pathak (Chandigarh), Prof. SS Deshmukh (Mumbai), Prof. A. Wakhalu (Lucknow), Prof S Chooramani Gopal (Varanasi), Prof. KC Sogani (Jaipur), Prof. DK Gupta (New Delhi), Prof. KLN Rao (Chandigarh), to name few of them. Late Prof. RK Gandhi (Mumbai) also served as President (1981–1983) of World Federation of Association of Pediatric Surgeons (WOFAPS), a World representative body of National Pediatric Surgical Association and was formed in 1974, and at present having more than 120 countries as its members. Prof. DK Gupta (AIIMS, New Delhi) is present President of WOFAPS. Pediatric surgery specialty is growing rapidly not only in the field of patient care, but also in the field of training to the pediatric surgery and research in pediatric surgery. In India, at present 48 pediatric surgery centers including institutes, medical college are providing / imparting training to pediatric surgery, leading to the award of M. Ch. pediatric surgery degree. At present there are about 131 seats for the M. Ch. pediatric surgery course are available for admission per year. Prone cross table lateral view as an alternative to an invertogram for ARM cases has been invented / published in 1983 by Dr KLN Rao Chandigarh, India. Literatures in the field of congenital pouch colon, a congenital anomalies associate with high anorectal malformation are contributed by Indian authors to the World. Pediatric MIS is one of the most rapidly growing subspecialty of pediatric surgery, and at present a large number of pediatric MIS are being done, though at limited centers within the India. In India, currently 25 robotic surgical systems are working and only limited numbers of the pediatric surgery cases are done [1-4,10,31,64-68,106,107,113,115,155-161].

## CONCLUSION

As the knowledge, skills, experience, expertise, etc are continues to expand, and this also very truly fit to the pediatric surgery and pediatric surgeons. The aim of the pediatric surgeons and pediatric surgical associations around the World are to provide the best surgical care to the neonates, infants and children, improvement in the standard of education and research in pediatric surgery. The aim of the newer advancement must be to provide affordable and cost effective healthcare facilities to the society. The advances / innovations in the past, ongoing and the future advancement in the field of technology, diagnosis, management, and post-operative care, and all are certainly going to help the pediatric surgery speciality also to grow and expand more in the future.

## References

1. Population reference bureau. World population data sheet. 2014.
2. Miniwatts Marketing Group. The World population and the top ten countries with the highest population. 2014.
3. The World Bank. World development indicators: population dynamics. 2014.
4. WHO. Congenital anomalies: Media centre. 2014.
5. Raffensperger JG. Children's surgery: A Worldwide history. North Carolina: McFarland. 2012.
6. <http://en.wikipedia.org/wiki/Hippocrates>
7. Lifshutz JI, Johnson WD. History of hydrocephalus and its treatments. *Neurosurg Focus*. 2001; 11:2.
8. Chang Jack HT. Timelines in the history of pediatric surgery. *J Pediatr Surg*. 1986; 21:1068–1072.
9. Adzick NS, Nance ML. Pediatric surgery. First of two parts. *N Engl J Med*. 2000; 342: 1651-1657.
10. Grosfeld JL, O'Neill JA Jr. History of pediatric surgery: a brief overview. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery*. Amsterdam: Elsevier. 2012; 3-17.
11. Nance ML. The Halifax disaster of 1917 and the birth of North American pediatric surgery. *J Pediatr Surg*. 2001; 36: 405-408.
12. [http://en.wikipedia.org/wiki/William\\_E.\\_Ladd](http://en.wikipedia.org/wiki/William_E._Ladd)
13. Bill H. William E. Ladd, M.D.: great pioneer of North American pediatric surgery. *Prog Pediatr Surg*. 1986; 20: 52-59.
14. Dunn PM. Sir Denis Browne (1892-1967) and congenital deformities of mechanical origin. *Arch Dis Child Fetal Neonatal Ed*. 2005; 90: F88-91.
15. Losty PD. Recent advances: paediatric surgery. *BMJ*. 1999; 318: 1668-1672.
16. <http://www.eolss.net/sample-chapters/c03/E6-59-18-04.pdf>
17. [http://ether.stanford.edu/library/pediatric\\_anesthesia/neo%20natal%20anesthesia/NEONATAL%20SURGERY.pdf](http://ether.stanford.edu/library/pediatric_anesthesia/neo%20natal%20anesthesia/NEONATAL%20SURGERY.pdf)
18. Lin T, Pimpalwar A. Minimally invasive surgery in neonates and infants. *J Indian Assoc Pediatr Surg*. 2010; 15: 2-8.
19. Columbani PM, Scholz S. Intussusception. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery*. Amsterdam: Elsevier. 2012; 1093-1110.
20. Rangel SJ, de Blaauw I. Advances in pediatric colorectal surgical techniques. *Semin Pediatr Surg*. 2010; 19:86-95.
21. Son TN, Liem NT, Vu Xuan H. Transumbilical laparoendoscopic single-site surgery with conventional instruments for choledochal cyst in children: early results of 86 Cases. *J Laparoendosc Adv Surg Tech A*. 2014; 24: 907-910.
22. Kim JM, Kim KM, Yi NJ, Choe YH, Kim MS. Pediatric liver transplantation outcomes in Korea. *J Korean Med Sci*. 2013; 28: 42-47.
23. Migliazza L, Bellan C, Alberti D, Auriemma A, Burgio G, et al. Retrospective study of 111 cases of congenital diaphragmatic hernia treated with early high-frequency oscillatory ventilation and presurgical stabilization. *J Pediatr Surg*. 2007; 42: 1526-1532.
24. Karunasumetta C, Kuptarnond C, Prathanee S, Intanoo W, Wongbuddha C. Surgical outcomes for congenital lung malformations: 10 years experience at a single center. *J Med Assoc Thai*. 2014; 97:52-59.
25. Cundy TP, Harling L, Hughes-Hallett A, Mayer EK, Najmaldin AS. Meta-analysis of robot-assisted vs conventional laparoscopic and open pyeloplasty in children. *BJU Int*. 2014; 114: 582-594.
26. O'Leary M, Krailo M, Anderson JR, Reaman GH. Progress in childhood cancer: 50 years of research collaboration, a report from the Children's Oncology Group. *Semin Oncol*. 2008; 35:484-493.
27. Alexiou GA, Sfakianos G, Prodromou N. Pediatric head trauma. *J Emerg Trauma Shock*. 2011; 4: 403–408.
28. McFadyen JG, Ramaiah R, Bhananker SM. Initial assessment and management of pediatric trauma patients. *Int J Crit Illn Inj Sci*. 2012; 2: 121–127.
29. Bhargava R, Hahn G, Hirsch W, Kim MJ, Mentzel HJ. Contrast-enhanced magnetic resonance imaging in pediatric patients: review and recommendations for current practice. *Magn Reson Insights*. 2013; 6: 95-111.
30. Holzki J. Recent advances in pediatric anesthesia. *Korean J Anesthesiol*. 2011; 60: 313-322.
31. Joshi PB, Kulkarni A. Current perspectives in robotic assisted pediatric surgery. *Apollo Medicine*. 2014; 11: 167-173.
32. Rees L, Shroff R, Hutchinson C, Fernando ON, Trompeter RS. Long-term outcome of paediatric renal transplantation: follow-up of 300 children from 1973 to 2000. *Nephron Clin Pract*. 2007; 105:c68-76.

33. Nadler EP, Youn HA, Ren CJ, Fielding GA. An update on 73 US obese pediatric patients treated with laparoscopic adjustable gastric banding: co-morbidity resolution and compliance data. *J Pediatr Surg.* 2008; 43:141-146.
34. Bezner SK, Hodgman EI, Diesen DL, Clayton JT, Minkes RK. Pediatric surgery on YouTube: is the truth out there? *J Pediatr Surg.* 2014; 49: 586-589.
35. Muensterer OJ, Lacher M, Zoeller C, Bronstein M, Kübler J. Google Glass in pediatric surgery: an exploratory study. *Int J Surg.* 2014; 12: 281-289.
36. Levitt MA, Pena A. Anorectal malformations. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 1286-1309.
37. Liu G, Yuan J, Geng J, Wang C, Li T. The treatment of high and intermediate anorectal malformations: one stage or three procedures? *J Pediatr Surg.* 2004; 39: 1466-1471.
38. Iwai N, Fumino S. Surgical treatment of anorectal malformations. *Surg Today.* 2013; 43:955-962.
39. Pinheiro PF, Simões e Silva AC, Pereira RM. Current knowledge on esophageal atresia. *World J Gastroenterol.* 2012; 18: 3662-3672.
40. Sharma AK, Shekhawat NS, Agrawal LD, Chaturvedi V, Kothari SK, et al. Esophageal atresia and tracheoesophageal fistula: a review of 25 years' experience. *Pediatr Surg Int.* 2000; 16: 478-482.
41. Al-Salem AH, Tayeb M, Khogair S, Roy A, Al-Jishi N, et al. Esophageal atresia with or without tracheoesophageal fistula: success and failure in 94 cases. *Ann Saudi Med.* 2006; 26:116-119.
42. Calisti A, Olivieri C, Coletta R, Briganti V, Oriolo L, et al. Jejunioleal atresia: factors affecting the outcome and long-term sequelae. *J Clin Neonatol.* 2012; 1: 38-41.
43. Bracho-Blanchet E, González-Chávez A, Dávila-Pérez R, Zalles Vidal C, Fernández-Portilla E, et al. Prognostic factors related to mortality in newborns with jejunioleal atresia. *Cir Cir.* 2012; 80: 345-351.
44. Stanger J, Mohajerani N, Skarsgard ED, Canadian Pediatric Surgery Network. Practice variation in gastroschisis: factors influencing closure technique. *J Pediatr Surg.* 2014; 49: 720-723.
45. Banyard D, Ramones T, Phillips SE, Leys CM, Rauth T. Method to our madness: an 18-year retrospective analysis on gastroschisis closure. *J Pediatr Surg.* 2010; 45: 579-584.
46. Ledbetter DJ. Gastroschisis and omphalocele. *Surg Clin North Am.* 2006; 86: 249-260.
47. Colvin J, Bower C, Dickinson JE, Sokol J. Outcomes of congenital diaphragmatic hernia: a population-based study in Western Australia. *Pediatrics.* 2005; 116: e356-363.
48. Tovar JA. Congenital diaphragmatic hernia. *Tovar Orphanet Journal of Rare Diseases.* 2012; 7:1.
49. Dahlheim M, Witsch M, Demirakca S, Lorenz C, Schaible T. Congenital diaphragmatic hernia--results of an ECMO-centre. *Klin Padiatr.* 2003; 215: 213-222.
50. Zani A, Eaton S, Puri P, Rintala R, Lukac M. International Survey on the Management of Necrotizing Enterocolitis. *Eur J Pediatr Surg.* 2014; .
51. Downard CD, Renaud E, St Peter SD, Abdullah F, Islam S, et al. Treatment of necrotizing enterocolitis: an American Pediatric Surgical Association Outcomes and Clinical Trials Committee systematic review. *J Pediatr Surg.* 2012; 47: 2111-2122.
52. Rao SC, Basani L, Simmer K, Samnakay N, Deshpande G. Peritoneal drainage versus laparotomy as initial surgical treatment for perforated necrotizing enterocolitis or spontaneous intestinal perforation in preterm low birth weight infants. *Cochrane Database Syst Rev.* 2011.
53. Kubiak R, Böhm-Sturm E, Svoboda D, Wessel LM. Comparison of long-term outcomes between open and laparoscopic Thal fundoplication in children. *J Pediatr Surg.* 2014; 49: 1069-1074.
54. Höllwarth ME. Gastroesophageal reflux disease. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 947-958.
55. Klein MD, Langenburg SE, Kabeer M, Lorincz A, Knight CG. Pediatric robotic surgery: lessons from a clinical experience. *J Laparoendosc Adv Surg Tech A.* 2007; 17: 265-271.
56. Hambræus M, Arnbjörnsson E, Anderberg M. A literature review of the outcomes after robot-assisted laparoscopic and conventional laparoscopic Nissen fundoplication for gastro-esophageal reflux disease in children. *Int J Med Robot.* 9:428-432.
57. Marinis A, Yiallourou A, Samanides L, Dafnios N, Anastasopoulos G. Intussusception of the bowel in adults: a review. *World J Gastroenterol.* 2009; 15: 407-411.

58. Ocal S, Cevik M, Boleken ME, Karakas E. A comparison of manual versus hydrostatic reduction in children with intussusception: single-center experience. *Afr J Paediatr Surg.* 2014; 11: 184-188.
59. Ghritlaharey RK, Budhwani KS, Shrivastava DK. Exploratory laparotomy for acute intestinal conditions in children: a review of 10 years of experience with 334 cases. *Afr J Paediatr Surg.* 2011; 8:62-69.
60. Wei CH, Fu YW, Wang NL, Du YC, Sheu JC. Laparoscopy versus open surgery for idiopathic intussusception in children. *Surg Endosc.* 2014.
61. Langer JC. Hirschsprung Disease. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 1265-1278.
62. Bai Y, Chen H, Hao J, Huang Y, Wang W. Long-term outcome and quality of life after the Swenson procedure for Hirschsprung's disease. *J Pediatr Surg.* 2002; 37: 639-642.
63. Chen Y, Nah SA, Laksmi NK, Ong CC, Chua JH, et al. Transanal endorectal pull-through versus transabdominal approach for Hirschsprung's disease: a systematic review and meta-analysis. *J Pediatr Surg.* 2013; 48:642-651.
64. Mathur MK, Aggarwal SK, Ratan SK, Sinha SK. Laparoscopic-assisted transanal pull-through for Hirschsprung's disease: comparison between partial and near total laparoscopic mobilization of rectum. *J Indian Assoc Pediatr Surg.* 2014; 19:70-75.
65. Gongopadhyay AN, Gopal SC, Gupta DK, Sinha CK, Dash, RN, et al. Management of pouch colon with anorectal malformation. *J Indian Assoc Pediatr Surg.* 1996; 1: 55-59.
66. Gupta DK, Sharma S. Congenital pouch colon - then and now. *J Indian Assoc Pediatr Surg.* 2007; 12: 5-12.
67. Ghritlaharey RK, Budhwani K S. Two-staged management for all types of congenital pouch colon. *Afr J Paediatr Surg.* 2013; 10: 17-23.
68. Wakhlu A, Wakhlu AK. Technique and long-term results of coloplasty for congenital short colon. *Pediatr Surg Int.* 2009; 25: 47-52.
69. Tannuri AC, Leal AJ, Velhote MC, Gonçalves ME, Tannuri U. Management of gallstone disease in children: a new protocol based on the experience of a single center. *J Pediatr Surg.* 2012; 47: 2033-2038.
70. Debray D, Franchi-Abella S, Irtan S, Girard M. Cholelithiasis in infants, children and adolescents. *Presse Med.* 2012; 41: 466-473.
71. Gonzales KD, Lee H. Choledochal cyst. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 1331-1339.
72. Visser BC, Suh I, Way LW, Kang SM. Congenital choledochal cysts in adults. *Arch Surg.* 2004; 139: 855-862.
73. Popova-Jovanovska R, Genadieva-Dimitrova M, Trajkovska M, Serafimoski V. Choledochal cysts: diagnosis and treatment. *Prilozi.* 2012; 33: 49-63.
74. Rai R, Jacobsen AS. Recent advances in minimal invasive surgery of children. *JIMSA.* 2014; 27: 101-107.
75. Alizai NK, Dawrant MJ, Najmaldin AS. Robot-assisted resection of choledochal cysts and hepaticojejunostomy in children. *Pediatr Surg Int.* 2014; 30: 291-294.
76. He XD, Wang L, Liu W, Liu Q, Qu Q. The risk of carcinogenesis in congenital choledochal cyst patients: an analysis of 214 cases. *Ann Hepatol.* 2014; 13: 819-826.
77. Cowles RA. The jaundiced infant: Biliary atresia. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 1321-1330.
78. Chan KW, Lee KH, Tsui SY, Wong YS, Pang KY. Laparoscopic versus open Kasai portoenterostomy in infant with biliary atresia: a retrospective review on the 5-year native liver survival. *Pediatr Surg Int.* 2012; 28: 1109-1113.
79. Bijl EJ, Bharwani KD, Houwen RH, de Man RA. The long-term outcome of the Kasai operation in patients with biliary atresia: a systematic review. *Neth J Med.* 2013; 71: 170-173.
80. Lima M, Gargano T, Ruggeri G, Manuele R, Gentili A. Clinical spectrum and management of congenital pulmonary cystic lesions. *Pediatr Med Chir.* 2008; 30: 79-88.
81. Koontz CS, Oliva V, Gow KW, Wulkan ML. Video-assisted thoracoscopic surgical excision of cystic lung disease in children. *J Pediatr Surg.* 2005; 40: 835-837.
82. Ghritlaharey RK, Budhwani KS, Shrivastava DK, Srivastava J. Tube thoracostomy: primary management option for empyema thoracis in children. *Afr J Paediatr Surg.* 2012; 9: 22-26.
83. Gates RL, Caniano DA, Hayes JR, Arca MJ. Does VATS provide optimal treatment of empyema in children? A systematic review. *J Pediatr Surg.* 2004; 39: 381-386.
84. Aydogdu O, Karakose A, Celik O, Atesci YZ. Recent management of urinary stone disease in a pediatric population. *World J Clin Pediatr.* 2014; 3: 1-5.

85. Salah MA, Holman E, Khan AM, Toth C. Percutaneous cystolithotomy for pediatric endemic bladder stone: experience with 155 cases from 2 developing countries. *J Pediatr Surg.* 2005; 40: 1628-1631.
86. Ozgür BC, Irkilata L, Ekici M, Hoscan MB, Sarici H. Pediatric extracorporeal shock wave lithotripsy: Multi-institutional results. *Urologia.* 2014.
87. Warren J, Pike JG, Leonard MP. Posterior urethral valves in Eastern Ontario - a 30 year perspective. *Can J Urol.* 2004; 11: 2210-2215.
88. Bhatnagar V, Agarwala S, Lal R, Mitra DK. Fulguration of posterior urethral valves using the Nd:YAG laser. *Pediatr Surg Int.* 2000; 16: 69-71.
89. Zubieta R, López PJ. Surgical technique for extravesical vesicoureteral neimplantation. *Arch Esp Urol.* 2008; 61:873-881.
90. Serkan Dogan H, Tekgul S. Laparoscopic correction of vesicoureteral reflux in children: review of the current literature. *Arch Esp Urol.* 2014; 67: 660-672.
91. Puri P, Kutasy B, Colhoun E, Hunziker M. Single center experience with endoscopic subureteral dextranomer/hyaluronic acid injection as first line treatment in 1,551 children with intermediate and high grade vesicoureteral reflux. *J Urol.* 2012; 188: 1485-1489.
92. Kirsch AJ, Arlen AM, Lackgren G. Current trends in dextranomer hyaluronic acid copolymer (Deflux) injection technique for endoscopic treatment of vesicoureteral reflux. *Urology.* 2014; 84: 462-468.
93. Bajpai M, Verma A, Panda SS. Endoscopic treatment of vesico-ureteral reflux: Experience of 99 ureteric moieties. *J Indian Assoc Pediatr Surg.* 2013; 18: 133-135.
94. Dangle PP, Shah A, Gundeti MS. Robot-assisted laparoscopic ureteric reimplantation: extravesical technique. *BJU Int.* 2014; 114: 630-632.
95. Reis LO, Ikari O, Zani EL, Moretti TB, Gugliotta A. Long-term results of Anderson-Hynes pyeloplasty in children: how long follow-up is necessary? *Eur J Pediatr Surg.* 2014.
96. Samarasekera D, Stein RJ. Robotic-assisted laparoscopic approaches to the ureter: Pyeloplasty and ureteral reimplantation. *Indian J Urol.* 2014; 30: 293-299.
97. Autorino R, Eden C, El-Ghoneimi A, Guazzoni G, Buffi N, et al. Robot-assisted and laparoscopic repair of ureteropelvic junction obstruction: a systematic review and meta-analysis. *Eur Urol.* 2014; 65:430-452.
98. Magee JC. Renal transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 617-629.
99. Polychronidis A, Laftsidis P, Bounovas A, Simopoulos C. Twenty years of laparoscopic cholecystectomy: Philippe Mouret--March 17, 1987. *JLS.* 2008; 12: 109-111.
100. Spaner SJ, Warnock GL. A brief history of endoscopy, laparoscopy, and laparoscopic surgery. *J Laparoendosc. Adv Surg Tech A.* 1997; 7: 369-373.
101. Vecchio R, MacFayden BV, Palazzo F. History of laparoscopic surgery. *Panminerva Med.* 2000; 42: 87-90.
102. Rockall TA, Demartines N. Laparoscopy in the era of enhanced recovery. *Best Pract Res Clin Gastroenterol.* 2014; 28: 133-142.
103. <http://emedicine.medscape.com/article/938198-overview>
104. te Velde EA, Bax NM, Tytgat SH, de Jong JR, Travassos DV. Minimally invasive pediatric surgery: Increasing implementation in daily practice and resident's training. *Surg Endosc.* 2008; 22: 163-166.
105. Liu KKW, Leung MWY. Current trends in minimal access surgery for neonates. *HK J Paediatr.* 2007; 12: 125-129.
106. Shah A. A decade of minimal access pediatric surgery in India. *J Indian Assoc Pediatr Surg.* 2008; 13: 123 - 124.
107. Parelkar SV, Oak SN, Bachani MK, Sanghvi BV, Gupta R. Minimal access surgery in newborns and small infants; five years experience. *J Minim Access Surg.* 2013; 9: 19-24.
108. Prasad A. Robotic surgery in India. *J Young Medical Researcher.* 2013; 1: 1-12.
109. Sinha CK, Haddad M. Robot-assisted surgery in children: current status. *J Robotic Surg.* 2008; 1: 243-246.
110. [http://en.wikipedia.org/wiki/Robotic\\_surgery](http://en.wikipedia.org/wiki/Robotic_surgery)
111. [http://en.wikipedia.org/wiki/Da\\_Vinci\\_Surgical\\_System](http://en.wikipedia.org/wiki/Da_Vinci_Surgical_System)
112. Kearns JT, Gundeti MS. Pediatric robotic urologic surgery-2014. *J Indian Assoc Pediatr Surg.* 2014; 19: 123-128.

113. Singh P, Dogra PN, Kumar R, Gupta NP, Nayak B. Outcomes of robot-assisted laparoscopic pyeloplasty in children: a single center experience. *J Endourol.* 2012; 26: 249-253.
114. Bansal D, Cost NG, Bean CM, Vanderbrink BA, Schulte M, et al. Infant robot-assisted laparoscopic upper urinary tract reconstructive surgery. *J Pediatr Urol* 2014.
115. Chowdhary SK, Kandpal DK, Agarwal D, Sibal A, Srivastava RN. Robotic augmentation ileocystoplasty with bilateral ureteric reimplantation in a young child with neuropathic bladder. *J Indian Assoc Pediatr Surg.* 2014; 19: 162-165.
116. [http://en.wikipedia.org/wiki/Joseph\\_Murray](http://en.wikipedia.org/wiki/Joseph_Murray)
117. <http://www.health.harvard.edu/blog/remembering-dr-joseph-murray-a-surgeon-who-changed-the-world-of-medicine-201211285590>
118. Adenwalla H S, Bhattacharya S. Dr. Joseph E. Murray. *Indian J Plast Surg.* 2012; 45: 596-597.
119. [http://en.wikipedia.org/wiki/E.\\_Donnall\\_Thomas](http://en.wikipedia.org/wiki/E._Donnall_Thomas)
120. [http://en.wikipedia.org/wiki/Thomas\\_Starzl](http://en.wikipedia.org/wiki/Thomas_Starzl)
121. Starzl TE. The co-development of liver and kidney transplantation (1955-1967). *Southeast Asian J Trop Med Public Health.* 2003; 34: 238-241.
122. [http://en.wikipedia.org/wiki/Mohammed\\_Rela](http://en.wikipedia.org/wiki/Mohammed_Rela)
123. [http://en.wikipedia.org/wiki/Arvinder\\_Singh\\_Soin](http://en.wikipedia.org/wiki/Arvinder_Singh_Soin)
124. Assadi F. Pediatric kidney transplantation: kids are different. *Iran J Kidney Dis.* 2013; 7: 429-431.
125. Saggi BH, Farmer DG, Busuttill RW. Liver transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 643-652.
126. Lao OB, Healey PJ, Perkins JD, Horslen S, Reyes JD, et al. Outcomes in children after intestinal transplant. *Pediatrics.* 2010; 125: e550-558.
127. Revillon Y, Chardot C. Pediatric intestinal transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 653-658.
128. Azeka E, Jatene M, Galas FR, Tanamati C, Penha J, et al. Heart transplantation in pediatric population and in adults with congenital heart disease: long-term follow-up, critical clinical analysis, and perspective for the future. *Transplant Proc.* 2014; 46: 1842-1844.
129. Fuller Stephanie MP, Spray TL. Heart transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 659-670.
130. Gandhi SK, Faro A, Huddleston CB. Pediatric lung transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 671-681.
131. Spahr JE, West SC. Heart-lung transplantation: pediatric indications and outcomes. *J Thorac Dis.* 2014; 6: 1129-1137.
132. Sutherland David ER, Gruessner AC, Hering BJ, Gruessner Rainer WG. Pancreas and islet cell transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 631-641.
133. Jalanko H, Pakarinen M. Combined liver and kidney transplantation in children. *Pediatr Nephrol.* 2014; 29: 805-814.
134. Reyes J, Murase N, Starzl TE. Principles of transplantation. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 605-615.
135. Starzl TE, Fung JJ. Themes of liver transplantation. *Hepatology.* 2010; 51: 1869-1884.
136. Holmes N, Harrison MR, Baskin LS. Fetal surgery for posterior urethral valves: long-term postnatal outcomes. *Pediatrics.* 2001; 108: E7.
137. [http://en.wikipedia.org/wiki/Michael\\_R.\\_Harrison](http://en.wikipedia.org/wiki/Michael_R._Harrison)
138. Smajdor A. Ethical challenges in fetal surgery. *J Med Ethics.* 2011; 37: 88-91.
139. <http://www.topmastersinhealthcare.com/20-most-innovative-pediatric-surgeons-alive-today>
140. Harrison MR. Fetal surgery. *West J Med.* 1993; 159: 341-349.
141. Lee H, Hirose S, Harrison MR. Prenatal diagnosis and fetal therapy. Coran AG, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, et al. (eds). In: *Pediatric Surgery.* Amsterdam: Elsevier. 2012; 77-88.
142. Jancelewicz T, Harrison MR. A history of fetal surgery. *Clin Perinatol.* 2009; 36: 227-236, vii.

143. Adzick NS. Fetal surgery for spina bifida: past, present, future. *Semin Pediatr Surg.* 2013; 22: 10-17.
144. Ville Y. Recent developments in fetal surgery: Technical, organizational and ethical considerations. *Bull Acad Natl Med.* 2008; 192: 1611-1621.
145. Deprest JA, Devlieger R, Srisupundit K, Beck V, Sandaite I. Fetal surgery is a clinical reality. *Semin Fetal Neonatal Med.* 2010; 15: 58-67.
146. Akkermans J, Peeters SH, Middeldorp JM, Klumper FJ, Lopriore E, et al. A world-wide survey on laser surgery for twin-twin transfusion syndrome. *Ultrasound Obstet Gynecol.* 2014.
147. Cunneen SA. Review of meta-analytic comparisons of bariatric surgery with a focus on laparoscopic adjustable gastric banding. *Surg Obes Relat Dis.* 2008; 4: S47-55.
148. Franco M, Sanz B, Otero L, Domínguez-Vila A, Caballero B. Prevention of childhood obesity in Spain: a focus on policies outside the health sector. *SESPAS report 2010. Gac Sanit.* 2010; 24: 49-55.
149. Kar SS, Dube R, Kar SS. Childhood obesity-an insight into preventive strategies. *Avicenna J Med.* 2014; 4: 88-93.
150. Zwintscher NP, Azarow KS, Horton JD, Newton CR, Martin MJ. The increasing incidence of adolescent bariatric surgery. *J Pediatr Surg.* 2013; 48: 2401-2407.
151. Sachdev P, Makaya T, Marven SS, Ackroyd R, Wales JK. Bariatric surgery in severely obese adolescents: a single-centre experience. *Arch Dis Child.* 2014; 99: 894-898.
152. Lugo-Vicente H. Internet resources and web pages for pediatric surgeons. *Semin Pediatr Surg.* 2000; 9: 11-18.
153. Hersh WR, Wallace JA, Patterson PK, Shapiro SE, Kraemer DF, et al. Telemedicine for the Medicare population: pediatric, obstetric, and clinician-indirect home interventions. *Evid Rep Technol Assess.* 2001; 24: 1-32.
154. <http://www.telegraph.co.uk/health/healthnews/10851116/First-operation-streamed-live-with-surgeon-wearing-Google-glass.html>
155. Gupta DK. Pediatric Surgery in India - A long way to go. *JK Science.* 1999; 1: 142-145.
156. Dorairajan T. Future of pediatric surgery. *J Ind Assoc Pediatr Surg.* 2002; 7: 115-116.
157. Chowdhary SK. Random thoughts on pediatric surgery. *J Ind Assoc Pediatr Surg.* 2008; 13: 47-48.
158. Pathak IC. Pediatric surgery in India: Then and now. *J Indian Assoc Pediatr Surg.* 2009; 14: 3-5.
159. Shah R. the past, the present, and the future of pediatric surgery in India. *J Indian Assoc Pediatr Surg.* 2015; 20: 2-7.
160. IAPS: Members Directory. 2014.
161. IAPS: Training centers. 2014.