

Minimally Invasive Surgery

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ABSTRACT

The field of Minimally Invasive Surgery or Minimally Access Surgery (MAS) as it is commonly known has grown remarkably over the past two decades. MAS has a steep learning curve and unexpected complications with MAS are not infrequent unless approached with great caution. However it leads to a shorter hospital stay, less analgesic use, rapid return to school and a better cosmetic outcome. MAS in children started in India a decade ago, and has a great impact on the way we manage pediatric surgical problems today. This article is a brief description of most of the procedures that are being done with the help of MAS. In addition to these, new techniques, procedures and innovations are always ongoing in this fast developing field. MAS is being practiced in limited centers in our country with expanding experience and indications. Its use in children as the first option for early appendicitis, intrabdominal testis, gall stone disease and a few other conditions is now proven beyond doubt. There are other indications and areas of application of MAS which are continuously evolving and needs institutional audit and validation at every step before moving to the next phase. [Indian J Pediatr 2008; 75 (9) : 925-929] E-mail: dranirudhshah@gmail.com

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Pediatric minimally access surgery (MAS) has made remarkable progress over the past two decades. The use of MAS as a diagnostic tool in pediatrics dates back to the 1970's.¹ The initial resistance faced for MAS in children was due to the misconception that smaller patients have smaller incisions, their analgesic requirement is less and their recovery is speedy as compared to adults. Following the first laparoscopic cholecystectomy in an adult by Philip Mouret in 1987, the obvious extension of this technology to babies and children were delayed due to several reasons. The concerns for safety, pediatric operations being mainly reconstructive, acquisition of new skills, risk of unfortunate complications lead to a slow entry of this attractive new technology in the arena of pediatric MAS.²

In laparoscopic or thoracoscopic surgery, access is obtained using ports or valved tubular devices passed through the abdominal or chest wall. A measured amount of CO₂ is then pumped into the abdomen to a limited pressure. This helps open potential working space in the peritoneal cavity. A telescope attached to a camera is then passed through the port so that the procedure can be watched on a monitor after being processed by the camera

unit. Light from external xenon or halogen lamp source passes through a fiberoptic cable attached to the telescope to illuminate the working field. After the initial port is placed, additional ports are placed for instruments to carry out surgery. The number of accessory or working ports depends upon the type and complexity of the surgery.

MAS in acute abdomen

With a good history, clinical examination, relevant imaging and laboratory investigations, most causes of acute abdomen can be diagnosed without laparoscopy. However, in case of diagnostic dilemma, laparoscopy can be used as a diagnostic as well as a therapeutic intervention.

Role of diagnostic laparoscopy in acute abdominal pain: Diagnostic laparoscopy is most important when the possibility of acute appendicitis is raised. The diagnosis is often difficult in view of the doubtful history and clinical presentation. Laboratory investigations like total and differential leucocyte count and imaging like ultrasound and CT scan used widely are not reliable enough. Laparoscopy is diagnostic as well as can be a single therapeutic intervention in a child with question of appendicitis.

MAS in chronic abdominal Pain

Laparoscopy is only one of the many diagnostic tools in children with chronic abdominal pain. At no means

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TABLE 1. Present Procedures in a Variety of Areas in the Field of Pediatric Surgery**Basic Procedures - Indications**

1. Diagnostic Laparoscopy for acute abdomen and chronic recurrent abdominal pain
2. Cryptorchidism

Intermediate Procedures - Indications

1. Gastrointestinal bleeding - Meckel's diverticulum, Intussusception
2. Pathologies of the liver and biliary tree e.g. cholecystectomy, liver biopsy, cholangiography
3. Adhesiolysis
4. Splenectomy and Spleenic disorders
5. Trauma
6. Intractable Ascites
7. Intersex
8. Pyloric stenosis
9. Abdominal masses/cysts
10. Oncology
11. Hemias
12. Dysfunction of V-P Shunts or P-D catheters
13. Nephroureterectomy
14. Biopsies of a target organ
15. Empyema
16. Thoracic sympathectomy
17. Fundoplication for Gastro esophageal reflux

Advanced Laparoscopic Procedures-Indications

1. Primary pull through for Hirschsprung's disease
2. Laparoscopic pull through for Anorectal malformations
3. Pyeloplasty for PUJ Obstruction
4. Choledochal cysts
5. Diaphragmatic Hernia and eventration
6. Pulmonary lobectomies and sequestrectomies
7. Mediastinal node biopsy
8. Pericardial biopsy/Pericardiostomy
9. Repair of esophageal atresia

should laparoscopy replace a detailed history, careful clinical examination, selective additional imaging studies and laboratory investigations. Waldschmidt³ subjected almost 50% of his cases with chronic abdominal pain to laparoscopy and found pathology in more than 99% of them. Another important issue is evaluating the histology of mesenteric lymphadenopathy before starting therapy as such a step was omitted in the earlier years as laparotomy was too extensive a procedure to obtain sample of mesenteric node! In our experience, majority of the children started empirically on antituberculosis treatment did not have evidence on laparoscopic node biopsy. Post operative adhesions are also diagnosed on laparoscopy and may be managed, if they are not extensive.^{4,5}

Undescended testis

One third of the babies with undescended testis do not have the testis palpable in the groin. CT and MRI are frequently used, for the impalpable testis. It is now proven beyond doubt that laparoscopy is the best modality to diagnose, assess and even treat intrabdominal testis in either one or two stage depending on the

available length of testicular vessels or remove a dysplastic testis.^{6,7}

Gastrointestinal Diseases

Laparoscopy is being successfully used for diagnosis and treatment of massive gastrointestinal bleeding caused by a bleeding Meckel's diverticulum or intussusception. MAS has been used to reduce intussusceptions.⁸ A bleeding Meckel's diverticulum or diseased bowel segment can be diagnosed and dissected laparoscopically and delivered out through a small abdominal incision to perform an anastomosis outside the abdominal cavity.⁹ Resections for intestinal strictures or duplication cysts can also be accomplished with the help of MAS.

Biliary diseases

The use of laparoscopic cholangiography and liver biopsy may help in avoiding unnecessary exploration for this group of patients and arriving at a definite diagnosis in a case where diagnostic dilemma between biliary atresia and neonatal hepatitis persists.^{10, 11, 12} Laparoscopic cholecystectomy is a standard therapy in patients of all ages with gall stones. Advanced procedures like hepaticoportoenterostomy have also been reported from India.^{13, 14}

Abdominal Masses

MAS at present is not included in pediatric oncology protocols except for the Hodgkin's study HD96 in German speaking countries. There are several reports on laparoscopic staging of Hodgkin's and Non-Hodgkin's lymphoma.^{15, 16} Laparoscopy allows sampling of lymph nodes and liver biopsy along with oophorectomy in preparation for radiotherapy. Laparoscopy is an ideal tool when a biopsy is essential before therapy is started suspecting residual disease or recurrence. Laparoscopic adrenalectomy is feasible in selected patients for resection of virilizing tumors, pheochromocytomas and neuroblastomas.¹⁷

Splenectomy and Spleenic disorders

More than 85% of normal sized spleens removed laparoscopically are to treat hematological disorders.¹⁸ Laparoscopy saves the child from the morbidity of having a large painful incision. Laparoscopic splenectomy is not beneficial in children with hemoglobinopathies and huge spleens like thalassaemia major. Problems faced in retrieval of these huge spleens defy the advantages of MAS. In children with associated gall bladder disease, laparoscopic cholecystectomy may be added to the procedure. Spleenic cysts may be drained, enucleated or even excised depending on the anatomy.

Intersex disorders

Ambiguous genitalia pose a series of problems for the treating clinician. Even after a series of radiological and

serological studies there are doubts about the exact nature of the disease and hence the management options. Laparoscopy helps delineate the exact internal anatomy and also gives the advantage to perform a gonadal biopsy and also definitive surgery for removal of the inappropriate gonad or genitalia.¹⁹

Trauma

Blunt Abdominal Trauma: In cases of multiple injuries, decreased consciousness, persisting equivocal abdominal signs, diagnostic laparoscopy can help exclude an unstable abdominal injury such as bleeding liver injury, mesenteric tear and splenic laceration. A negative laparotomy in such circumstances unnecessarily adds morbidity in the already compromised child.²⁰ Laparoscopy however still lacks wide popularity in the diagnosis of blunt abdominal trauma.

Penetrating Trauma: Laparoscopy is an excellent diagnostic tool in looking for violation of peritoneum and diaphragmatic injuries in the case of penetrating trauma.²¹ Not every stab wound penetrates the abdominal wall or causes injury to the intra abdominal viscera. Laparoscopy can help identify whether the peritoneum has been penetrated. The key for success however is a stable patient, good equipment and an experienced surgeon.

Laparoscopy in Ascites

Ascites in children as it is in adults may be hepatic, renal, cardiac, pancreatic, gastro-intestinal, infectious, neoplastic or gynecological. It could also be secondary to a congenital or acquired lymphatic cause. Laparoscopy is rarely indicated in children with ascites. An exception may be lymphatic or chylous ascites where laparoscopy may be able to detect or even treat the leak. Intestinal lymphangiectasia can be very well diagnosed laparoscopically.²²

Inguinal hernias

In recent years few topics have raised as much controversy across the world as has the role of laparoscopy in the treatment of children with inguinal hernia. The main advantage of laparoscopy in inguinal hernia is evaluation for a contralateral patent processus vaginalis. The reported incidence of contralateral patency is about 40%. However, the incidence of later development of a symptomatic hernia after unilateral hernia repair is only 10 – 20%. Laparoscopic repair of hernia remains controversial, and has a distinctly higher recurrence rate. However laparoscopic evaluation of the contralateral groin is now practiced by 37% of pediatric surgeons, a six fold increase in over 12 years.²³

Hirschsprung's Disease

Laparoscopy has revolutionized the management of Hirschsprung's disease. Primary laparoscopic assisted endorectal pull through is the new standard treatment for

Hirschsprung's disease. Numerous authors have treated Hirschsprung's disease successfully by laparoscopy.²⁴⁻²⁷ Laparoscopic pull through can be performed in children even when if a diverting colostomy has been performed for enterocolitis.²⁸ The procedure gives good results, permits early postoperative feeding, early hospital discharge, and good cosmetic results. Laparoscopic

TABLE 2. Procedures in Pediatric Surgery Our experience (1998–2008)

Laparoscopy for Gastrointestinal Lesions	
Lap. Adhesiolysis	13
Lap. Hernia repair	760
Lap. Fundoplication	3
Lap. Achalasia Cardia	3
Lap. Assisted Meckel's diverticulectomy	20
Lap. Reduction of Intussusception	35
Lap. Pyloromyotomy	23
Lap. For Intestinal polyps	4
Lap. Ladd's procedure for Malrotation	5
Lap. Excision of Duplication cysts	10
Lap. Excision of Mesenteric cysts	6
Lap. Pull through for Hirschsprung's disease	76
Lap. Assisted Anorectoplasty for Anorectal malformation	10
Lap. Biopsy for Malignancy / Tuberculosis	17
Lap. Pseudo pancreatic Cyst drainage	5
Lap. For Enteric Perforation	4
Lap. Gastropexy for Gastric Volvulus	2
Lap. Rectopexy for Rectal Prolapse	1
Diagnostic Laparoscopy	268
Lap. appendicectomy	675
Lap. For Ascites	5
Lap. Para umbilical Hernia Repair	7
Laparoscopy for Genitourinary Lesions	
Lap. For Impalpable UDT	320
Lap. Nephroureterectomy	42
Lap. Hemi-nephrectomy	6
Lap. Pyelolithotomy	5
Lap. Adrenalectomy	4
Lap. Ureterolithotomy	7
Lap. Assisted Pyeloplasty	2
Lap. Ovarian Cystectomy	33
Lap. For Intersex Disorders	40
Lap. Gonadal biopsy / Gonadectomy	12
Lap. Cystolithotomy	2
Lap. For Renal Cyst	6
Lap. For varicoceles	4
Laparoscopy for Hepatobiliary Lesions	
Lap. Cholangiography + Liver Biopsy	55
Lap. Cholecystectomy	28
Lap. For excision of liver cysts / benign mass	4
Lap. Splenectomy	13
Video Assisted Thoracoscopic Surgery (VATS) for Lesions	
Empyema Thoracis	268
Mediastinal node biopsy	3
Pericardiostomy	2
Repair of Morgagni Diaphragmatic Hernia	4
Repair of Bochdalek Diaphragmatic Hernia	3
Eventration of Diaphragm	6
Sympathectomy	2
Pulmonary lobectomy / sequestrectomy	3
Total	2776

primary pull through saves the child from a colostomy and its related complications, which is an important factor for children in India. Long term results of the procedure are still under review.

Anorectal Malformations

MAS is now also being used for children with anorectal malformations, since its first use by Georgeson.²⁹ Lack of long-term follow-up precludes accurate assessment of the potential for fecal continence. However, short-term experience has been that this new method of pull-through for imperforate anus offers many advantages, including possibility of a primary pull through without colostomy, excellent visualization of the rectal fistula and surrounding structures, accurate placement of the bowel through the anatomic midline and levator sling, and minimally invasive abdominal and perineal wounds.

Video Assisted Thoracoscopic Surgery (VATS)

VATS in infants and children has also undergone a dramatic evolution from its infancy in the mid-1970s when limited procedures such as biopsy and pleural lysis, were pioneered by Rogers *et al* to the late 1990s when the most delicate of procedures, a tracheo-esophageal fistula repair was performed thoracoscopically for the first time in the world.³⁰ Thoracoscopic surgery offers several options in diagnosis and surgical treatment. Video-assisted thoracoscopic debridement and decortication has now become the primary mode of treatment for stage 1 and 2 empyema thoracis in children. Following a study of 1173 children with empyema, Gates RL and Li ST³¹ concluded that children treated with primary thoracoscopy had a shorter hospital stay, lower cost of treatment and less likelihood of therapeutic failure.

MAS in Urology

Retroperitoneal and Transperitoneal nephrectomy and nephroureterectomy may be performed for benign disease in children with minimal morbidity, improved cosmetic results, and a short hospital stay. It can also be used for treatment of simple renal cysts, removal of dysfunctional duplex renal moiety, stone removal and correction of pelviureteric junction obstructions. MAS for reconstructive urological procedures require a high level of expertise, has a steep learning curve, higher potential than open procedure for complication. Laparoscopy has shown to have a reliable role in the placement of peritoneal dialysis catheters in children.

COMPLICATIONS OF MAS

Complications in pediatric MAS are dreadful and at times fatal. It would therefore be very wise for an aspiring beginner to learn from others mistakes. Immediate identification and prompt treatment if required by

conversion to open approach saves post op morbidity and morality. In pediatric laparoscopy one must also keep in mind that irrespective of the indication of the procedure; exposure time of the surgery and extent of the pneumoperitoneum applied, most of the patients are comfortable and settled. Hence, sinister signs like pain, distention, ileus and fever should not be ignored until they grow into a morbid complication.

THE FUTURE

Robotic surgery is a new technology which may expand the variety of operations a surgeon can perform with minimally invasive techniques. Robotic surgery improves laparoscopic surgery through a more natural interface, tremor filtration, motion scaling, and additional degrees of freedom of the instruments. The high equipment and procedural cost however is restrictive for its use in India at present.

CONCLUSION

There is no doubt that paediatric MAS will continue to expand exponentially, in its indications and applications. MAS has been accepted as gold standard for many procedures like impalpable testis, cholecystectomy, appendicectomy, intersex, recurrent abdominal pain, early stage of empyemas etc. Hospital designs and theatre layout will change to accommodate this newer trend in surgery. MAS has opened a new, interesting and intriguing chapter in paediatric surgery. Proper training and dedicated surgical thinking can make the MAS safe.

Regular audit and clinical trial organized both at individual institutions and on multicentric level will be important to validate or challenge the presumed benefits of MAS in children.