

Laparoscopy Complications in Neonates and Small Infants

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Abstract: Laparoscopy in pediatric surgical practice has become a reality, and many sophisticated procedures are nowadays being performed by it, this article tries to focus on the laparoscopy among neonates and small infants and to answer the question how safe is the MAS in this group of patients. Few important studies were revised carefully figuring out the complications specific to laparoscopy, their rate and underlying causes.

Keywords: Complications, laparoscopy, MAS, neonates, infants.

INTRODUCTION

Minimal access surgery though, first described as early as 1973, it was mainly used for diagnostic purposes. Historically, pediatric surgeons were slow to get used to minimal access surgery (MAS) techniques compared with the adult surgical community. The reasons behind those debates and hesitations were many and could be summarized into:

PATIENTS FACTORS

Physiological Issues

The physiologic response to pneumoperitoneum in children is more obvious than in adults. Peritoneal insufflation with carbon dioxide was discovered to be a cause of hypercarbia, acidemia, and decreased oxygenation in the pediatric piglet model. Pneumoperitoneum-induced hypothermia was a major concern also.

Anatomical Issues

Laparoscopy in children requires special care. The abdominal cavity (in relation to surface area) in infants and children is less than that of adults. The abdominal wall in children is very elastic compared to that in adults which increases the difficulty of port incision.

Anesthesia for MAS in Neonates

MAS in neonates makes new challenges for the pediatric anesthetists who should establish how to maintain one lung ventilation (in thoracoscopy), keep infant warm against cold insufflation with cold CO₂, avoid hypercarbia and abdominal

distention and many other tasks that need knowledge, skills and special training.

TECHNICAL FACTORS

Differences in size and physiology have required a number of technological modifications to apply MAS techniques to this population. Minimal access surgery in infants has additional ergonomic problems compared with that of adult patients.¹² The small endoscope needs to be positioned at a short distance from the target thus limiting the field of view. The surface available for insertion of working instruments and the internal operative workspace for maneuvering of these instruments are limited, so the tips of instruments can move out of vision field easily and could cause inadvertent injuries. However, special care must be taken when using smaller-sized instruments while doing surgical tasks. Tremors and imprecise movements will be exaggerated because the small extracorporeal hand movement will be translated into relatively larger one because of the longer intracorporeal shaft length in comparison to extracorporeal part, and the magnification of the operative field.¹² In addition, the risk of puncture by inadvertent movements or damage by excessive grasping forces is higher due to the small surface area of the tip of fine instruments.

PRACTICAL FACTORS

Lack of infrastructures.

Lack of formal training programs in MAS. Many of pediatric surgeons—who were well established in the art of open surgery—were terrified of the long learning curve of the new technology and unenthusiastic to apply to newborn babies and children.⁸ All these factors made pediatric surgeons worry about the complications that might happen. But nowadays, there are increasing numbers of complex MAS procedures in infants, including thoracoscopic esophageal atresia repair, laparoscopic duodenoduodenostomy and laparoscopic porto-enterostomy for biliary atresia some of which involve anastomosis in small neonates weighing less than 1.5 kg.¹²

The usual procedures done in neonates and small infants by laparoscopy are:

Diagnostic Laparoscopy

1. Diagnostic gold standard for impalpable testes
2. Liver biopsy
3. Direct cholangiography
4. Lower GI bleeding
5. Intersexual anomalies
6. Recurrent abdominal pain
7. Blunt/sharp abdominal trauma
8. Seromuscular bowel biopsy

Therapeutic Laparoscopy

1. Orchidopexy for intra-abdominal testes
2. Cholecystectomy.
3. Anti-reflux surgery (Nissen, Thal) fundoplication
4. Resection of benign ovarian tumors
5. Pyloromyotomy
6. Gonadectomy for dysgenetic gonads
7. Small bowel resection
8. Lap-assisted pull through for Hirschsprung's disease
9. Lap-assisted pull through for anorectal malformations
10. Nephrectomy for non-functioning kidney
11. Partial nephrectomy for duplex system
12. Adrenalectomy
13. Varicocelelectomy
14. Appendectomy
15. V-P shunt placement
16. Uncomplicated liver cysts
17. Splenectomy for minimal or moderate splenomegaly
18. Meckel's diverticulum

As a summary minimal access surgery (MAS) in neonates and small infants carries a significant consideration. The tolerance of these small babies and the assumed physiological effect of MAS, in addition to the required anesthetic and surgical skills, have made it difficult to perform such procedures in many international centers. The present article tries to answer the important question; laparoscopic surgery in neonates and small infants is it safe?

Aim of the Article

To evaluate the complications of minimal access surgery in neonates and small infants.

Material and Method

A literature search was performed using Medline, the search engine Google, springer link and highwire press. The following search terms were used: laparoscopy, minimal access surgery, neonates, infants, complications. Selected papers were screened for further references. Criteria for selection of literature were methods of analysis (statistical or non-statistical), and the institution where the study was done (Specialized institution for pediatric laparoscopic surgery, well known centers)

RESULTS

The search gave a wide range of scientific material, but only Seven studies were chosen as a final result of the search (the most important and recent ones according to the above mentioned selection criteria), revised, presented in summary and to be discussed later.

Multicentric Assessment of the Safety of Neonatal Video Surgery

Nicolas Kalfa, 1 Hossein Allal et al Surg Endosc (2007) 21: 303–308

218 neonates (mean age, 16 days; weight, 3,386 g) from seven European university hospitals were included in a retrospective study. In 42 cases minor and major complications occurred (19.2%). In 16 cases, the complications were due to surgical incidents, and in 26 cases, they were related to poor tolerance of the pneumoperitoneum or pneumothorax (anesthetic incidents). The overall rate of conversion to open surgery was 15%.

Complications of Laparoscopic Surgery in Neonates and Small Infants

Iwanaka, H. Uchida, H. Kawashima, A. Nishi, S. Kudou, R. Satake Journal of Pediatric Surgery, Volume 39.

Total number of 585 children underwent laparoscopic surgery during the study period. The children were classified into three groups according to the body weight:

154 infants weighing less than 5 kg (group S), most common procedure was pyloromyotomy. Complications were observed in 9.7%.

96 infants weighing less than 10 kg (group M), most common procedure was Nissen fundoplication, Complications were observed in 15.6%.

335 children weighing more than 10 kg (group L), most common procedure was appendectomy, complications were observed in 9.6%.

The rate of visceral injuries (GIT and other organs) was significantly higher in group S (5.2%) than in the other groups M (3.1%) and L (1.2%).

Minimal Access Surgery of Pediatric Inguinal Hernias: A Review

Ramanathan, Saranga Bharathi, Manu Arora Vasudevan Baskaran Surg Endosc

Collection of data of studies included 22 surgeons from different countries resulted in total of 3580 cases of congenital inguinal hernias which give 4776 hernias (unilateral and bilateral) within age ranging from 4 days up to 18 years. No any significant

increase in any specific complications among the younger age group was noticed.

Laparoscopic Inguinal Hernia Repair in Children: The Early Learning Curve of the Trainer and Trainees

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45 patients were included in the study with ages ranged from 4 weeks to 4 years. About 37 of those children were aged less than 1 year. 8 were more than 1 year. The median age was 4 months. All of them underwent laparoscopic inguinal hernia repair. There were no intraoperative complications, and no patient required conversion to an open procedure. There has been no presentation with recurrent inguinal hernia following early follow-up.

Outcomes after Laparoscopic Surgery in Neonates with Hypoplastic Heart Left Heart Syndrome

*Journal of Pediatric Surgery, Volume 42, Issue 6
Pages 1118 - 21, B Slater, S Rangel, C Ramamoorthy
C Abrajano, C Albanese*

12 patients with HLHS underwent a total of 13 surgeries during the study period (8 combined Nissen fundoplication and gastrostomy tubes, 3 isolated gastrostomy tubes, 1 Ladd procedure, and 1 combined Nissen fundoplication and gastrocutaneous fistula closure). Perioperative complications (which are not specific for laparoscopy) were observed in 6 patients (3 gastrostomy tube site infections, 1 small bowel obstruction, 1 postoperative sepsis, and 1 urinary tract infection). There was no mortality in this series.

Tolerance of Laparoscopy and Thoracoscopy in Neonates

Nicolas Kalfa, Hossein Allal

The study included 49 neonates (mean age: 11 days; weight: 3285 g) underwent 50 Laparoscopy procedures (Laparoscopy and Thoracoscopy). No surgical incidents were noted. Ten anesthetic incidents occurred (20%), 3 of which required temporary or definitive cessation of insufflation (O_2 saturation < 70%). Systolic arterial pressure decreased in 20% of the cases, but was controlled easily by vascular expansion. Temperature loss (mean postoperative temperature: 35.6°C) was proportional to the duration of insufflation (Core temperature was <36°C in 50% of the patients and <34.5°C in 12%. For 1 infant, the hypothermia (33.6°C) was complicated by an episode of bradycardia).

Laparoscopic Urinary Tract Surgery in Infants Weighing 6 kg or Less: Perioperative Considerations and Comparison to Open Surgery

Neheman A, Noh PH, Brenn R, González R

Retrospective nonrandomized chart review: comparison between 17 infants weighing 6 kg or less in whom laparoscopic urinary tract surgery was done and a weight matched group of 18 patients in whom open urinary tract surgery was performed. Surgical complications occurred in 1 patient (6%) from the laparoscopic group and 2 patients (11%) from the open group. No anesthesia complications were recorded.

DISCUSSION

Laparoscopy in small children requires special care, because of its high potentiality to develop complications. These complications can be divided into two categories:

Nonspecific laparoscopic complications; those might occur in any laparoscopic procedure and are further classified into:

Those specifically attributable to the insufflation of gas into a body cavity (physiological). Those due to specific instruments used to carry out the laparoscopic procedure and are not unique to the kind of surgery but common for the procedure in general like Veress needle insertion, trocar placement¹⁶ (surgical). **Specific complications** which might occur for certain procedure in particular like injury to iliac vessels in inguinal hernia repair, injury to vagus nerve in fundoplication etc.

Unique aspects of neonatal physiology makes dealing with them is not merely as if they are small models of adult persons, and in MAS specially the element of insufflation has important effect on their cardiovascular system Changes in cardiovascular function during laparoscopy are affected by insufflation pressure, intravascular volume, patient position and anesthetic agents¹⁶ This was observed clearly in **study 1**. There was no mortality but a significant morbidity (19.2%) including both surgical (7.5%) and anesthetic incidents (12%). The anaesthetic incidents occurred during insufflations includes decrease oxygen saturation, transient hypotension, hypercapnia, hypothermia and metabolic acidosis. It was possible to correct these complications in 42% by ventilatory adjustments, intravenous fluids and external warming. But insufflations had to be temporarily (35%) or definitively (23%) stopped, and conversion to open surgery was done in the latter. The risk factors for an insufflation-related incident were young age, low body temperature, thoracic insufflation, high pressure and flow of insufflation, and length of surgery (if the operation lasts > 100 min the complication rate increases).

The abdominal surface/cavity ratio in neonates and small children is less than that of adults. The abdominal wall in children is very flexible compared with adults. Special attention

is also needed in trocar placement to prevent intra-abdominal injuries.¹¹ Therefore, minimally invasive surgery in small children and infants requires high skills and special training and in **study no 2** the results took in consideration the surgical complications in the first place without focusing on the physiological complications due to insufflation and anesthesia. These complications are attributed to the size of working space and skills of the surgeon. It was observed that the rate of visceral injuries (GIT and other organs) was significantly higher in smaller infants, and the probable causes are: (1) limited surgical field because of small telescope and fewer ports and incomplete preoperative bowel preparation to get rid of intestinal gases, (2) Sharp tip of instruments, (3) thin and fragile gastrointestinal walls, (4) poor opportunity for learning and practicing these procedures.¹ In **study 3** the percentage of complications in general was unremarkable but the vascular complications (Although small in number) have the potential to assume threatening proportions, i.e. the complications might be qualitative rather than quantitative. However, the MAS in inguinal hernia have the advantage of detection and repair of subclinical contralateral defect without need for another access.⁵ Also postoperative pain, operation time (especially for bilateral cases), recovery, and cosmetic results are additional advantages, and this goes with the results of **study no. 4** where the conclusion is (Laparoscopic inguinal hernia repair in children is safe, with minimal complications). Operative time decreases with increase in surgeons' experience.⁶ And the results of the previous two studies (3 and 4) may be because this procedure is relatively easier, short-timed and common; so surgeons are familiar with it. **Study 5** was included because assessment of laparoscopic procedures needs to be done also in complicated cases. The results are in favor of application of MAS on this category of infants, but (a multidisciplinary approach, including availability of a skilled and experienced anesthesia team, is believed to be vital to get optimum outcomes in these critically ill children).⁴ In the **study no. 6** focus was again on the evaluation of the respiratory, hemodynamic, and thermic effects of video-surgery (MAS) on newborn babies (in the first month of life) and to determine the risk factors associated with pre- and postoperative complications.³

This study figures out the neonatal high sensitivity to insufflation as the main limiting factor in MAS.

Risk Factors

Low body temperature, high variations of end-tidal pressure of CO₂, high oxygen or vascular expansion requirement at the beginning of insufflation.

The length of surgery. More than 100 minutes of insufflation. Thoracoscopy (The neonates were more sensitive to thoracoscopy than laparoscopy).

Patients' age and weight were not determining factors for insufflation tolerance.³

Study no. 7 includes small group of cases and its results are in favor of MAS.

CONCLUSION

Despite the very rapid growth of MAS in children in the past few years, its application in neonates should not be considered as a direct alternative of techniques used in older children.⁹ Because of the much reduced working room and the potential effects of carbon dioxide insufflation (pneumoperitoneum and pneumothorax) on an immature cardiopulmonary system of the newly born baby, neonatal MAS is rendered more difficult. It is technically demanding and needs good selection of optimum instruments size and in infants it has extra ergonomic problems compared with that of adult patients. Adequate training is essential to gain enough skills and experience to face the challenging new, more advanced procedures integrated in this field to achieve less operative time and more safety to the patients. Relatively few studies reporting the complications of MAS were published, and most of those supporting the feasibility and safety of applying laparoscopy in the first month of life are case reports or short clinical series,² (knowledge of risk factors and alarming signs of incidents may help to improve the tolerance of this technique during the neonatal age).

In the other hand laparoscopy in pediatric surgical practice has become a reality and looking at its advantages.^{11,14}

1. Less postoperative pain
2. Better cosmetic results

Shorter hospital stay

Early return to normal activities including feeding, bowel movements, and work/school

Performance of surgery in deep cavities of small children like the hiatus and the pelvis with good illumination and magnification

Reduced wound complications

Early discharge from the hospital can decrease the hospital bill.

Makes it worthy to devote the time and effort to improve its advantages and broaden its usage scope based on sound scientific fundamentals.

As a summary, more efforts should be made to study and publish the effects and results of MAS among neonates and small infants to weigh them against the well-established traditional ways of open surgery, but (at the present time Laparoscopy should be considered an additional tool, with specific indications, in hands of a surgeon who has the sound principles of child surgery and capable of managing the complications independently, at the time of need. It is important that the operating surgeon knows how to select the cases that benefit from this new technology.

“We are made wise not by recollection of our past but for our responsibility for our future”

George Bernard Shaw

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