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Neonatal laparoscopy

ALP NUMANOGLU, M.B. CH.B., F.C.S. (S.A.)
ANGUS ALEXANDER, M.B. CH.B., F.C.S. (S.A.) (CERT. PAED. SURG.)
Department of Paediatric Surgery, Red Cross War Memorial Children's Hospital and University of Cape Town

Summary

Until recently minimally invasive surgery was not performed in neonates. This was because of their small size and distinct physiological characteristics. Since the introduction of fine laparoscopic instruments, improvements in the surgical technique and a better understanding of the unique anaesthetic requirements of laparoscopy, more complex operations have been performed.

While certain operations such as laparoscopic pyloromyotomy have become routine in many centres, others require significant infrastructure and experience. Advantages of minimally invasive surgery seen in older children and adults, such as shortened hospital stay and less pain, also apply to neonates.

There is no doubt that minimally invasive surgery for neonates is still in its infancy. For many neonatal conditions requiring surgery, the benefits of minimally invasive surgery have yet to be established with well-designed studies.

Paediatric surgeons were slow to start using minimally invasive techniques, but today they are well established in many centres. As a result of this interest in minimally invasive surgery (MIS), the type of surgery has evolved from simple diagnostic procedures to more complex operations.[1] A good example of this development is minimally invasive neonatal surgery, which is evolving rapidly on the back of a better understanding of the neonatal physiological response to MIS together with refined surgical techniques, miniaturised instruments, and equipment designed specifically for the needs of the neonate.[2] Today both laparoscopic and thoracoscopic procedures are performed routinely on neonates. There have been many reports of premature babies weighing less than 1 000 g undergoing successful MIS procedures.

Metabolic considerations

Neonates have distinct physiological and anatomical characteristics that potentially increase the risk of surgical complications.

Smaller airways and large dead space may result in decreased gas exchange and increased end-tidal CO_2 (ET CO_2). The peritoneal absorption surface per unit of weight is higher in neonates. Neonates have less fat and thinner vessel walls, allowing for rapid diffusion of CO_2. Raised ET CO_2 may expose neonates to risk of acidosis and alteration of cerebral circulation.[2] The impact of hypercarbia on the neonatal brain appears to be benign provided respiratory acidosis is avoided, but the possible immediate and long-term effects of raised ET CO_2 on these patients still require further research.

Insufflation pressures should be kept as low as possible and are best kept below 8 mmHg to avoid haemodynamic instability.[3] This is particularly important as neonatal myocardium has low compliance, is sensitive to intravascular pressure changes, is incapable of increasing stroke volume, and is therefore reliant on an increased heart rate to maintain cardiac output.[2]

Hypothermia is a significant concern in particularly long operations. In addition to prolonged exposure and environmental elements, use of cold and dry gas contributes to hypothermia. Gas leak from port sites should be avoided to minimise continuous cold gas flow from insufflators through the peritoneum.

In neonates low body temperature, high variations of ET CO_2, need for vascular expansion and major modification in the oxygen inspiratory fraction or peak inspiratory pressure (PIP) at the start of insufflations were found to predict the risk of insufflation-related incidents.[2] External warming and attention to detail will minimise hypothermia-related complications.

At present the majority of MIS for neonates is performed in only a few centres in South Africa. As national experience is gained and appropriate instrumentation becomes available we will see more and more centres using MIS in neonates. The indications are increasing daily, and although most babies will benefit from this technique, there are still many operations for which MIS is not yet indicated, acceptable or appropriate. Biliary atresia is such a case, where laparoscopic porto-enterostomy hastens the need for liver transplantation when compared with the standard open Kasai procedures.

Necrotising enterocolitis

The use of MIS for diagnostic purposes has proved very helpful in diagnosing those infants who require bowel resection or have a visceral perforation as a result of necrotising enterocolitis.[4] The addition of systemic fluorescein dye during laparoscopy is a novel technique that has been very helpful in identifying areas of bowel that are not perfused and thereby helping to establish or exclude the diagnosis of transmural necrosis (unpublished data from Red Cross War Memorial Children's Hospital, 2010).

Pyloromyotomy

The use of MIS to perform pyloromyotomy has generated extensive debate. The development of surgical skills together with smaller ports and pyloric spreaders soon made this surgery attractive and easy to perform in an acceptable operative time. It also provided excellent exposure and minimal scarring. Paediatric surgeons with an interest in MIS soon discovered that pyloromyotomy is an ideal operation for gaining further expertise in laparoscopy in small babies.[5] Initially the advantages were thought to be purely cosmetic, but a recent randomised study confirmed slightly better outcomes with regard to time to full feeds and discharge from hospital.[6] Today laparoscopy has become the technique of choice in many centres.

Ovarian cysts

Extensive use of antenatal ultrasound has resulted in increased detection of asymptomatic ovarian cysts in neonates. It has been well documented that larger cysts (3 cm) have an increased incidence of torsion. In some cases ultrasound diagnosis of a cystic lesion is made, but its origin cannot be identified accurately. We have used laparoscopy to confirm diagnosis and help manage these cysts. Once the site of origin has been identified, the cyst is aspirated under direct vision and externalised through a small (1 cm) Pfannenstiel incision. The cyst can then be resected from the ovary.

Malrotation

Malrotation, with or without volvulus, is increasingly being treated with laparoscopic derotation.[7,8] These studies demonstrate that MIS is feasible but that enthusiasm should be restrained. There is an almost 20% re-operation rate owing to inability to correct malrotation at the initial laparoscopic operation, and a 25% conversion rate. These figures are in no way comparable to the open procedure.[8,9]

Outcome depends on identification and complete correction of the mesenteric abnormality, and unless this can be satisfactorily achieved, conversion to an open procedure must occur. Long-term outcome and comparison with open surgery still need to be established with randomised studies.

This potentially poor outcome highlights the dilemma that often plagues novel interventions. Can we ascribe the poor outcome to the learning curve, or is MIS simply not appropriate at present? Certainly good cosmesis, shorter hospital stays and less pain should not be pursued at the expense of outcomes.

Duodenal atresia

Rothenberg recently published his experience with laparoscopic duodeno-duodenostomies.[10] There were no postoperative leaks, no missed distal atresias and no short-term complications. Time to full feeds averaged 12 days. The duodenum could be Kocherised without difficulty, and the anastomosis was easily performed under the excellent magnification of laparoscopy. We have used laparoscopy in older children (fenestrated webs) with similar good results. Rothenberg's recommendation was to perform this operation only if the necessary skills, equipment and advanced laparoscopic instrumentation are available.[10]

Conclusion

Neonatal laparoscopy is increasingly being performed as experience and technology improve. The unique physiology and anatomical relations of the newborn pose a particular challenge to both anaesthetist and surgeon. Some indications such as pyloromyotomy are well established, but concerns remain about others, particularly biliary atresia. It is well accepted that the advantages seen in older children apply to neonates as well.

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