Editorial

PEDIATRIC LAPAROSCOPY CURRENT STATE AND FUTURE

"Minimally invasive surgery" is normally taken to mean laparoscopic surgery. Often the steps of the operation are identical to the conventional open procedure, only the access is different. The term "minimal invasive" thus may be misleading, because it basically still remains surgery. Laparoscopic surgery has become widely accepted especially since 1989. Minimal invasive surgery did not originate from the university hospitals—in contrast, they warned of uncritical euphoria. Pediatric surgeons, traditionally used to minimal techniques, remained even more reserved.

Fourteen different indications are listed and briefly discussed below for gastrointestinal laparoscopic (or thoracoscopic) surgery in children. Some are theoretical, some have already been performed, only a few will remain as having routine application.

Leakage from the Thoracic Duct

The thoracic duct runs between the vertebra] column and the posterior aspect of the esophagus. Exposure of the thoracic duct using a thoracoscope would save a child a thoractomy. The indication is rare, however. The technique has, as far as we are aware, has never been used in children. Closure of a large lymph vessel is difficult either by open procedures or via a laparoscope. This technique will never become widely used.

Esophageal Atresia

In the standard operation, the thorax is opened in the 5th intercostal space, the atretic esophagus being exposed either through the pleural cavity or extrapleurally. Although the ribs are preserved, deformities of the thorax and scoliosis are frequently observed as late sequelae. Esophageal atresia should be operable thoracoscopically with the instruments currently available but it has not been tried yet. Even a country of the size of India would probably expect no more than 2500 children with esophageal atresia per year. Since a thoracoscopical repair of an esophageal atresia will technically be even more demanding than an open procedure, thoracoscopic access will never become the procedure of choice.

Esophageal Achalasia

The incidence of esophageal achalasia is extremely rare in children. Thoracoscopic myotomy could become an accepted procedure because thoracotomy causes considerable trauma. The instruments are already available and could be used in the future.

Fundoplication

In pediatric surgery, fundoplications are often performed in neurologically disabled children with associated chest wall deformities. Access to the hiatus may thus be difficult. When using a laparoscope this difficulty does not exist. Furthermore, postoperative recovery is quicker and analgesic requirements reduced. In addition possible fewer intra-abdominal adhesions develop.

Laparoscopic fundoplications are estimated to be performed in 80-100 children(l). However, technically, the procedure is more difficult than in adults. Hundreds of adult patients have been operated upon by laparoscopic fundoplication—in one Belgian

hospital almost 300 in a single year(2,3). The operation takes longer than the open procedure. Statistical evaluations of the safety, morbidity and mortality of the procedure in children are not yet available.

In general, all laparoscopic procedures requiring intra- abdominal suturing appear less safe than "open" techniques. Vessel ligatures or bowel anastomoses can be more easily achieved directly by hand, without interpositioning of a long metal instrument. Knot tying is restricted in the limited intra-abdominal space in children. Still, laparoscopic fundoplication is feasible in children. It may become a procedure of the future, especially in older children with extensively deformed chest walls.

Gastrostomy

Gastrostomies are rare in pediatric surgery but when required, a percutaneous endoscopic gastrostomy is performed. Occasionally, laparoscopic assistance may be necessary for localization. This combination of gastroscopy and laparoscopy is unlikely to gain wide acceptance.

Pyloromyotomy

Pyloromyotomies for infantile pyloric hypertrophy are performed 20-30 times per year in an average Western pediatric surgical department. The usual technique involves a transverse right upper quadrant incision of 4 cm length. It takes around 15 minutes and is associated with practically no complications. Laparoscopic pyloromyotomies have been performed in roughly 80 children worldwide(4). Initially, unnoticed perforations of the bowel wall occurred resulting in laparotomies. Operating time for laparoscopic pyloromyotomies should not far exceed that required for an open procedure but the procedure is not easy. Postoperatively, there is little difference between the open and laparoscopic procedures. Normally, three 0.5 cm puncture scars result from insertion of the trocars in the umbilicus and the left and right upper abdomen. It remains open and the cosmetic result is more favorable. Advocates of laparoscopic pyloromyotomy emphasize the cosmetic aspect. If cosmetic results are important (which may be the case 20 years later) we would recommend the technique as described by Tan and Bianchi(5). It involves an umbilical incision which is carried cranially dividing the fascia in the midline. This allows access to the pylorus and leaves virtually no scar. Therefore, the technique is superior to laparoscopy surgically, cosmetically and economically. Laparoscopic pyloromyotomy is unlikely to become the technique of choice in the future. Evaluation of Cholestasis

Frequently, biliary atresia cannot be excluded pre-operatively and conventional investigative techniques take a long time. Laparoscopy can speed up the process. The liver, the gallbladder and the extrahepatic bile ducts are easily visible. Cholangiography and biopsies under direct view can also be performed. If biliary atresia is encountered, laparoscopy can immediately be converted to laparotomy and a hepatoporto-enterostomy performed without delay. We estimate that at least 100 laparoscopies were undertaken to differentiate cholestasis in neonates(6). Unexplained cholestasis in newborns represents a good indication for laparoscopy since other diagnostic techniques are complicated by a large margin of error. In the future, however, with increasing resolution of ultrasound scans this is likely to become less frequent.

Cholescystectomy

In adults, laparoscopic cholecystectomy

has opened the road for "minimal invasive surgery". At least 30,000 cases have been published(T). In children, cholecystectomies are much less frequent. Fewer than 100 cholecystectomies have been reported laparoscopically worldwide(8-10). Controlled studies about the mortality and morbidity of the procedure in children are thus not available. In adults bile duct complications are more frequent in laparoscopic than in open procedures(2). This rate is likely to be higher in children due to lack of practice;-a single pediatric surgeon would never accumulate extensive experience with laparoscopic cholecystectomy. Postoperative recovery would be likely to be smoother after laparoscopy than after laparotomy. We believe that in the future laparoscopic cholecystectomy will be the method of choice in children.

Splenectomy

Laparoscopic splenectomies have not as far as we are aware been performed in children, in adults, however, approximately 70 cases have been reported(ll,12). In about 10% of cases, a conversion to an open technique became necessary due to uncontrollable bleeding. It appears difficult to capture the devascularized and mobilized organ in a plastic sac. Most authors had to enlarge the umbilical incision, crushed the organ and removed the fragments through the umbilical access. Pediatric surgeons would be less likely to remove such a large organ via a minimal access route. Technically, the operation is tedious and demanding because of the bleeding risk. Laparoscopic splenectomy is not likely to become the method of choice in pediatric surgery.

Nephrectomy

We are aware of 6 laparoscopic nephrectomies in children performed by Tan in Melbourne. Possibly, 100 nephrectomies have been performed laparoscopically so far in adults(13). The laparoscopic approach is time-consuming, it crosses the peritoneum and requires extensive tissue dissection (although not discernable from outside). The conventional lumbar approach, in contrast, leaves the peritoneum intact, leaves a comparably limited scar with seemingly acceptable postoperative pain and can be accomplished in 30 minutes by an experienced surgeon. Therefore, we would at present recommend the conventional approach for nephrectomy in children.

Meckel's Diverticulum

Most Meckel's diverticula are encountered during appendectomies. At least 20 Meckel's diverticula were excised laparoscopically in children worldwide, usually using staplers(14). When found during laparoscopy it appears logical to remove the diverticulum using the same technique. Technically, this extension of the procedure is not too difficult. In the near future angular staplers with smaller diameters can be expected, rendering laparoscopic diverticulectomy a routine method. Preoperatively, known Meckel's diverticula require a different approach. They may be associated with congenital ligaments and cysts originating from the bottom of the umbilicus. A primary blind trocar approach through the umbilicus can be risky. Still, these cases can and have been treated laparoscopically(14). It is unlikely to develop into the procedure of choice as the combined length of all trocar incisions can, in a child, approximate the length of a single conventional incision.

Appendectomy

Laparoscopic appendectomies have been reported more than 2000 times in children(15,16). Our own experiences with 194 laparoscopic appendectomies in children

demonstrate the general risks of laparoscopy in children. The indications were often so called "chronic" but also acute and even perforated appendicitis. Recovery was quicker and children required less analgesia. The cosmetic result is normally very good and the intra-abdominal view is excellent; an advantage immediately impressing even sceptics. Complications have been as follows: *(i)* Simultaneous trocar perforation of the aorta and the vena cava with consequent mass transfusion, subsequent relaparotomy and wound infection; (*ii*) A similar perforation of an iliac artery also with mass transfusion; and *(iii)* Two stump insufficiencies leading to peritonitis and relaparotomy (laparoscopic appendectomies usually limit themselves to a simple stump ligature and do not use purse-string sutures). In the beginning of our series, two laparoscopies were converted to laparotomies due to minor bleeding. In an older child - overweight and on the oral contraceptive pill - a deep pelvic vein thrombosis occurred soon after laparoscopy. Epigastric vessels have been injured twice with a trocar, bleeding was controlled in both instances by slightly ^enlarging the trocar incision. One child noted a transient hypoesthesia along the right thigh probably originating from a lesion to the nervus cutaneous femoris.

Nonetheless, laparoscopic appendectomy is technically not difficult once learnt. The advantages are: much better view, diagnostic superiority, quicker recovery and shortened hospital stay. The disadvantages are: increased risk, especially by the trocars, expensive equipment and a sophisticated technique. There is practically no difference in anesthetic time compared to open appendectomies. All stages, acute and perforated, can be treated. Some retrocecally located appendices are easier laparoscopically than with the open access. Perforated appendices or abscesses covered by omentum are as equally complicated as with the open approach.

Laparoscopic appendectomy is likely to become a widely used alternative technique. In Western countries appendectomies are often performed for rather vague medical reasons. Under these circumstances laparoscopy may become the method of choice due to its additional diagnostic appeal. Conventional appendectomy will continue to exist as in small children the small incision compares with that of the trocars.

Staging in Malignancy

The classic "staging laparotomy" has not yet been converted to "staging laparoscopy" in children. Technically, staging laparoscopy would pose no problem. Possibly, artificial ascites would make it technically easier. Bowel loops would swim and the mesentery would be easier to examine. The risk would be low. Trig diagnostic potential of laparoscopy is one of its strong points. Often during staging, the spleen and its hilus are only inspected; it is only removed when there is obvious involvement. If splenectomy becomes necessary, laparoscopy could easily be converted to laparotomy. As soon as laparoscopic staging has entered therapeutic protocols, the procedure could become a permanent part of surgical practice.

Varicocele

Laparoscopic varicocelectomies have been performed in at least 200 adults and 100 children(17). Aside from the complications attributable to the specific access technique, the risk is low. There are no long term results available from children and very limited ones from adults. The results are comparable to those obtained with the conventional Ivanissevich or Palomo tech-

niques. Further, long term follow up is necessary. If the instruments currently available improve, which is likely, laparoscopic varix ligation could become a valuable alternative technique.

Undescended Testis

In about **1%** of cases an undescended testis **is** located too high to be mobilized down into the scrotum via an inguinal incision. Alternative techniques (free transplant, two stages, Fowler-Stephens technique) all carry the risk of testicular atrophy.

We have shown in 7 children that after preliminary transaction of the internal vessels by laparoscopy, the gubernaculum leads the testis down to the internal ring. Additionally the testis can be placed laparoscopically near the internal ring. A regular inguinal orchidopexy 6 weeks later was possible without undue tension(18,19). The procedure has been repeated by other institutions in 20 cases. Certainly, a number of testicular atrophies have to be expected, although we have not seen it yet. We believe, however, that the results of this technique are superior to transplantation. Laparoscopic varix ligation is likely to enter pediatric surgical practice as an alternative technique.

Large Bowel Resection

Laparoscopic resection of the sigmoid colon as in Hirschsprung's disease has not yet been undertaken. In adults, roughly 250 colon resections have been performed(20). The incisions for a conventional large bowel resection are usually so small that there is little difference with the trocar incisions required for laparoscopy. Furthermore, the staplers available at present are too clumsy for the small pelvis of a little child. The anterior resections commonly performed in Germany for Hirschsprung's disease rely on a very deep anastomosis. With the instruments currently available this would be very difficult to achieve. Diihamers or Soave's techniques are probably better suited for a combined laparoscopic/perineal approach. We doubt that laparoscopic large bowel resections in children will be a technique of the future.

Conclusion

We believe that "minimal invasive surgery" will never be as popular in children as compared to adult surgery. Routine incisions are obviously much larger in adults than in children. In contrast, in children the trocars can leave more extensive and ugly scars than the limited incision by an experienced pediatric surgeon. The scars grow proportionally with the child, as with any scar acquired in childhood.

The term "minimal invasive surgery" is incorrect, "minor access surgery" would be more correct as intra-abdominally the same trauma is possible and could be greater. "Minimal access" techniques are best suited when "internally" limited intervention is expected.

Laparoscopy could support conventional procedures; from a traditional incision for appendectomy, the gall bladder, spleen or the gonads cannot be seen, laparoscopy could provide additional information. In addition, the advantage of quicker recovery is more pronounced in adults than in children. Our experience is that 2 to 3 days can be gained at most. In staging operations the present treatment protocols do not include laparoscopy. Laparoscopy is a product of the wealthy Western World. Its tendency to use disposable material makes it virtually impractible for the Third World.

In summary, how should pediatricians and parents be advised? At present, there is

only one laparoscopic operation reasonably well established, laparoscopic appendectomy. All other procedures are still experimental.

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