

## **Ten Years of Maturation of Endoscopic Surgery in Children. Is the Wine Good?**

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**I** AM VERY HONORED that the BAPS leadership has invited me speak to you on the occasion of its 50th birthday. I would like to congratulate the organization for its achievements. I wish to toast BAPS, but which wine should we drink? What about a bottle of Endoscopic Surgery in Children?

### HISTORY

#### *The Hopkins Rod Lens System and the Link With Pediatric Surgery*

As this lecture is a Karl Storz lecture, there must be a relationship between him and endoscopic surgery in children. One of the major problems in endoscopic surgery in the past was to get a nice undistorted picture and to introduce enough light into the body. It was the British scientist, Hopkins, who invented the now classic Hopkins rod lens system.<sup>1</sup> This system has revolutionized image transmission and is still very much in use today. While many companies did not realize the great importance of Hopkins' invention, Karl Storz did, and he signed a license agreement with Hopkins. Moreover, Karl Storz combined the Hopkins lens system with cold light illumination through glass fibers. It is no wonder that Karl Storz has been called a beacon lighting the way on the path to minimal access surgery.<sup>2</sup>

Karl Storz did have a special relationship with pediatric surgery for many years. Already in the early 1970s, Stephen Gans and George Berci, both members of the University of California, had close contact with Karl Storz. Bronchoscopes with an external diameter of only 4 mm became available through which Hopkins rod lens systems could be used. At the same time, Karl Storz developed mini instruments for procedures like biopsy

taking.<sup>3</sup> By doing so, the Storz company got an enormous lead in endoscopy and in endoscopic surgery in children. Two pediatric surgeons have been very much on the frontline of the development of endoscopy in children: while Stephen Gans was active in the field of bronchoscopy and laparoscopy, Bradley Rodgers was and still is active in the field of thoracoscopy.<sup>3-5</sup>

Until the mid 1970s, most endoscopic surgical procedures were diagnostic. This is not surprising as the surgeon had to look with one eye through the telescope close to the patient, which was not ideal from an ergonomic point of view and also not from the point of view of sterility.

#### *Chip Video Cameras*

The real breakthrough in endoscopic surgery came when chip cameras became available, allowing for real-time video transmission of the endoscopic picture onto a TV screen.<sup>6</sup> From then on, the surgeon as well as his assistant had a binocular picture. Laparoscopic cholecystectomy was first described in 1989 by Dubois et al<sup>7</sup> and laparoscopic Nissen fundoplication in 1991 by Dalle-magne et al.<sup>8</sup>

#### *Endoscopic Surgery in Children*

*Pioneers.* While endoscopic surgery was embraced in general surgery at its initial glance, the breakthrough in endoscopic surgery in children lagged behind but recently has been catching. I would like to mention a few pioneers: Alain: pyloromyotomy,<sup>9</sup> Walschmidt,<sup>10</sup> Valla: appendectomy, retroperitoneal nephrectomy<sup>11,12</sup>; Montupet: appendectomy, nephrectomy, Toupet, inguinal hernia repair<sup>11-14</sup>; Holcomb: cholecystectomy and splenectomy<sup>15,16</sup>; Lobe: Nissen, Duhamel, and thoracoscopic correction of esophageal atresia<sup>17-19</sup>; Georgeson: pull-through for Hirschsprung's disease and for anorectal malformations<sup>20,21</sup>; Hock Lim Tan: dismembering pyloplasty<sup>22</sup>; Felix Schier: inguinal hernia repair<sup>23</sup>; Rothenberg: Nissen, thoracoscopic lobectomy, correction of esophageal atresia<sup>24-27</sup>; Yeung: urinary incontinence<sup>27</sup>; and Borzi: nephrectomy.<sup>28</sup> I consider the Utrecht group also as pioneers: Duhamel procedure, ovarian cysts, diaphragmatic hernia, Thal, malrotation, duodenal atresia, and esophageal atresia.<sup>29-35</sup>

*The Utrecht experience.* I became interested in endoscopic surgery because of our pediatric orthopedic

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surgeons asking me to approach the spinal column anteriorly. It often took me an hour or so, then our orthopedic surgeons removed a few discs and left me closing the wound, which took me another hour or so. I felt that there was a disbalance between the magnitude of the trauma of the exposure and the trauma of the operation itself. In 1991 we started in the laboratory to approach the spinal column in the pig thoroscopically.

A year later, we started endoscopic procedures at the children's hospital. That year, we did 23 endoscopic procedures: nonpalpable testis (4), gastrostomy (4), appendicitis (3), peritoneal dialysis catheter (2), intersex (2), liver biopsy (1), lymphoma (1), abdominal pain (1), duodenal stenosis (1), ovarian cyst (1), chylascitis (1), and chylothorax (1). The procedures were merely diagnostic, and the series contained no neonates.

In 1993, the number of procedures roughly doubled ( $n = 47$ ). In that year, we did our first appendectomy, pyloromyotomy, cholecystectomy, adhesiolysis for small bowel obstruction, anterior fundoplication of the stomach according to Thal, and thoracic epiphysiodesis.

By the end of 2002 we had performed 1,288 endoscopic surgical procedures. About 30% of the patients were less than 6 months old, and 13% were neonates. Now we do between 150 and 180 endoscopic surgical procedures per year.

The top 3 laparoscopic operations were pyloromyotomy, antireflux surgery according to Thal, and appendectomy. But a fair number of other operations have been performed. As far as thoracoscopic operations are concerned, by far the most common indication has been the thoracoscopic assisted operation according to Nuss. Our series of esophageal atresia with distal fistula is up to 25 cases now.

The relative number of diagnostic and therapeutic procedures has changed over the years. In the beginning, many cases of appendicitis were converted as soon as the diagnosis was established. Now, less than 10% of the procedures are diagnostic, and more than 90% are therapeutic. The conversion rate in 2002 was 5.6%.

To give you an idea as to how far we have come, I would like to share with you the following case. A boy was born July 7, 2001 with esophageal atresia and distal fistula. He also had an absent kidney and a nonpalpable testis as well as an inguinal hernia on the right. He underwent the following endoscopic surgical procedures: (1) a thoracoscopic correction of the esophageal atresia with distal fistula; (2) a Nissen fundoplication was performed as well as a step one Fowler Stephens I on the right intraabdominal testis; and (3) he received a thoracoscopic aortopexy as well as a laparoscopic Fowler Stephens II on the right testis, closure of the right sided inguinal hernia, and a laparoscopic-assisted resection of a diverticulum of Meckel. He is now doing very well without obvious scars. If all these operations would have

been done in a classic open fashion, the child would have looked much different.

*General experience.* Most of the operations in children that are classically done in an open way have been done using endoscopic surgical techniques. Even hepatoportojejunostomy for choledochal cyst<sup>37</sup> and biliary atresia<sup>38</sup> have been carried out as well as transvesical reimplantation of ureters.<sup>39</sup>

#### WHAT IS THE LEGITIMATION OF ENDOSCOPIC SURGERY IN GENERAL AND IN CHILDREN IN PARTICULAR, OR, IN OTHER WORDS, SHOULD THESE OPERATIONS BE DONE ENDOSCOPICALLY?

When Alice in Wonderland looked through the keyhole, she entered a fascinating yet frightful world. What about key hole surgery?

#### *The Traditional Hippocratic Ethos, Modern Parents, and their Children*

The traditional Hippocratic ethos provides for the background of the idea that the less invasive a procedure, the better.<sup>40</sup> But also modern parents do not like that scars are inflicted on their children, and each scar on a child is a scar on the soul of the parents. Often parents ask before the operation how long the incision is going to be. Not only the parents but the children themselves do not like scars. Even a slight touch of acne can cause severe problems. More and more children now have their childhood scars corrected when they are grown up. Bergmeier, looking at the long-term results after a Nissen fundoplication in childhood, found that 37.5% were not happy with the upper laparotomy scar.<sup>41</sup> In a family in which the mother and 2 daughters are affected with spherocytosis, the mother underwent an open cholecystectomy and splenectomy when she was young. The 2 daughters underwent laparoscopic splenectomy. The family was so happy with the cosmetic result that I got a pictures of all the bellies of the family!

#### *The Scientific Basis for Endoscopic Surgery*

There is more to it than Hippocrates and the feelings of the parents and the children. There is also a scientific basis for it. The relationship between the degree of operative trauma and the magnitude of the stress response as well as the degree of immunosuppression has been shown over and over again.<sup>42</sup> It leaves no doubt anymore that the stress response, as well as the changes in the inflammatory and antiinflammatory parameters, are less pronounced after laparoscopic surgery<sup>43,44</sup> when compared with the same procedure performed through a laparotomy. The clinical relevance of these results currently is not certain.

Any new method should be superior or at least equal

to the conventional technique.<sup>43</sup> Comprehensive technology assessment includes 4 steps that have been described by Jennett<sup>45</sup>: (1) feasibility and safety, (2) efficacy (benefit for the patient), (3) efficiency (benefit for the general population), (4) economic appraisal (does it save money).

But how do we measure this? There is no discussion that randomized controlled trials (RCT) are the golden standard to study these various steps, but such studies are difficult to perform, especially in surgery. In a recent study of all 760 abstracts that have been accepted for presentation by BAPS in the period between 1996 and 2000, only 9 abstracts regarded clinical randomized studies.<sup>46</sup> None mentioned the method of randomization. Only 4 studies had relevant end-points, and sample size in all was inadequate. Only one study has been published so far in the English-language literature. I looked in PubMed for a randomized trial comparing pyloromyotomy through a right upper quadrant transverse minilaparotomy and through a circumumbilical incision but could not find one. This is not an excuse for not doing randomized, controlled trials in endoscopic surgery. On the other hand, this does not mean that all endoscopic surgery in children is bad.

There are other levels of evidence than the evidence provided by good RCT (Table 1).

The European Association of Endoscopic Surgeons (EAES) holds regular Consensus Development Conferences, which consist of 9 steps<sup>48</sup>: (1) Identification of areas of uncertainty is made by majority voting by the scientific committee. (2) A dozen experts are invited. (3) A list of questions is sent to these anonymous experts. They are asked to look at the different steps of technology assessment. Arguments have to be based on literature search, taking into account the level of evidence of the articles used. (4) Preliminary statements are made, and the controversies are highlighted. (5) Personal contact between the panelists and the statements are reformulated. (6) Statements are presented at the EAES meeting. (7) New arguments are discussed. (8) The final

approval is typed. (9) The final approval is published in *Surgical Endoscopy*.

Such consensus conferences have been held on: laparoscopic appendectomy, hernia repair, cholecystectomy, antireflux surgery, treatment of common bile duct stones, and treatment of diverticular disease. These conferences were concluded in 1997 and updated by the chairman of the particular conference in 2000.

The conclusions of a number of these conferences are as follows: **Laparoscopic appendectomy** can be as safely performed as open appendectomy, gives less wound infection, results in a faster recovery, has reached the stage of effectiveness, is more costly in the hospital, but results in an earlier return to work. **Laparoscopic cholecystectomy** results in a discrete higher incidence of common bile duct injury, is superior to classic open cholecystectomy, but the superiority may be smaller when compared with cholecystectomy through minilaparotomy and has become the standard procedure in the community. **Laparoscopic treatment of gastroesophageal reflux** results in more complications during the first 20 cases and is advantageous for the patient in terms of less pain, shorter hospital stay, and earlier return to work. There are insufficient data to prove effectiveness and efficiency.

More recently, the results of a consensus development conference on pneumoperitoneum have been published.<sup>44</sup> I would like to summarize a number of conclusions:

1. Pneumoperitoneum versus lifting devices:  
Surgical handling and operative view is impaired in most procedures (grade A).  
Lifting devices have no advantage above pressures of 5 to 7 mm Hg (grade B).
2. Open versus Veress access:  
RCT have not enough sample size for definitive conclusions.
3. Cardiovascular effects at a pressure of 12 to 14 mm Hg:  
Not clinically relevant in ASA I and II patients.  
Invasive measurement of BP in ASA III and IV patients is strongly recommended.
4. Lung physiology and gas exchange:  
Pneumoperitoneum causes hypercapnia and respiratory acidosis. Monitoring of end-tidal CO<sub>2</sub> is mandatory (grade A). Minute ventilation should be increased to maintain normocapnia.  
Increased intraabdominal pressure and controlled hyperventilation reduce respiratory acidosis (grade A).  
Laparoscopic surgery preserves postoperative pulmonary function better (grade A)
5. Venous return:  
Head up position and increased intraabdominal

**Table 1. Levels of Evidence**

Recommendation Grade	Evidence Level	Possible Design Studies for Evaluation of Therapeutic Interventions
A	1a	Systematic review of RCT
	1b	Individual RCT
	1c	All or none case series
B	2a	Systematic review of cohort studies
	2b	Individual cohort study
	2c	Outcomes research
	3a	Systematic review of case control studies
C	3b	Individual case control study
	4	Case series
D	5	Expert opinion

Adapted from Sackett et al.<sup>47</sup>

pressure reduce independently venous return from the lower limbs (grade A).

The incidence of thromboembolic complications after pneumoperitoneum is not known.

6. Perfusion of intraabdominal organs:  
At a pressure of 12 to 14 mm Hg, liver and kidney perfusion is decreased (grade A).  
This is not clinically relevant in ASA I and II patients.
7. Stress response and immunologic parameters:  
Stress response and changes in inflammatory and antiinflammatory parameters are less pronounced after laparoscopic surgery (grade A) but the clinical relevance remains to be proven.
8. Peritonitis:  
Peritonitis is not a contraindication for pneumoperitoneum if adequate preoperative fluid loading and hemodynamic stability is achieved (grade B).  
Animal studies on bacteremia and endotoxemia are controversial.
9. Risk of tumor spread:  
There is no strong clinical evidence that pneumoperitoneum enhances tumor spread (grade D).  
Malignancy is not a contraindication for pneumoperitoneum (grade C).
10. Gas embolism:  
Gas embolism is rare. The true incidence is not known.
11. Choice of the insufflation pressure:  
Pressure should be set at the lowest possible pressure giving sufficient exposure (grade B).  
A pressure not exceeding 12 to 14 mm Hg is safe in the healthy patient (grade A).
12. Warming and humidification of insufflation gas:  
The clinical effects are minor in comparison with external heating devices (grade B).  
The influence on postoperative pain is contradictory (grade A).
13. Adhesions:  
Laparoscopic operations cause less adhesions (grade B)

What about evidence-based endoscopic surgery in children? There are few RCT regarding endoscopic surgery in children. Most of these RCT regard appendectomy.<sup>49-51</sup> The conclusion of a recent Cochrane Database Systematic Review on appendicitis including studies in children was as follows<sup>52</sup>: In those clinical settings in which surgical expertise and equipment are available and affordable, diagnostic laparoscopy and laparoscopic appendectomy (LA) (either in combination or separately) seem to have various advantages over open appendectomy (OA). Some of the clinical effects of LA, however, are small and of limited clinical relevance. In spite of the mediocre quality of the available research data, we

would generally recommend to use laparoscopy and LA in patients with suspected appendicitis unless laparoscopy itself is contraindicated or not feasible. In gangrenous or perforated cases, however, LA may possibly carry a higher risk of intraabdominal infections.

RCT regarding thoracoscopic procedures are even more scarce. Even for a relatively frequent condition such as pleural empyema, insufficient good studies are available to draw definite conclusions.<sup>53,54</sup>

The era of feasibility studies in endoscopic surgery has reached its end, even in pediatric surgery. For doing prospective randomized studies, a large volume of pathology usually is required, which is hard to achieve in pediatric surgery. Multicenter studies are an option, but the participating centers should have an equal level of expertise. Moreover, such studies are difficult to conduct logistically. What we can do currently is to do prospective nonrandomized studies, as we have been doing for several endoscopic surgical operations.

#### THE MAJOR IMPACT OF ENDOSCOPIC SURGERY ON MODERN SURGERY HAS BEEN THAT SURGEONS ARE NOW THINKING IN TERMS OF INVASIVENESS

As a result, open surgery has evolved as well, and there is a tendency to avoid large incisions. The smaller the exposure, the less stress response and the more difficult to prove that the endoscopic surgical variant is superior.<sup>55-59</sup>

#### TRAINING

It leaves no doubt that minimal access surgery in its broad sense is going to develop further. Pediatric surgeons should be able to provide our patients with the best available treatment options, including the endoscopic surgical approach. But how should we cope with the rapidly changing technology? This is especially true in pediatric surgery in which the volume load of more complicated pathology is limited.

Endoscopic surgical techniques will become easier with further technical development. Good 3-dimensional vision in endoscopic surgery already exists, eg, in the Da Vinci robot system, making the surgery easier. Unfortunately, the size of the actual scope prohibits its use in small children. The more we understand matters of ergonomics and the more we implicate these ergonomic principles into our surgery, the easier the surgery will be. But we should be aware that technology waits for no one and that new technology has the potential to replace established organizations such as corporations, businesses, and professions.<sup>60</sup>

Now, how do we become proficient in endoscopic surgery? Training in a skills laboratory will become standard in the surgical curriculum of a trainee. There are simple systems, such as simple trainers, in which skills

can be learned on inanimate material. At the children's hospital in Utrecht, for example, we will not allow our trainees to do live endoscopic surgical operations unless they have proven in the trainer that they are able to exert elegantly endoscopic stitching and knotting. Virtual reality systems have become available for practicing different tasks of different levels of complexity.<sup>61,62</sup> It is a matter of time before specific operations can be learned on such systems. A great advantage of these systems is that performance is measurable. This means that standards to be reached can be set. The positive effects of laboratory-based skills curriculum on laparoscopic proficiency has been proven in a randomized trial.<sup>63</sup>

Another major effect of the introduction of endoscopic surgery is that surgical skills are important. From studies, it appears that some individuals are better than others in acquiring endoscopic surgical skills, and this raises the question as to standards for selection of surgical trainees.<sup>64-66</sup>

Mentoring in the clinic will still play an important role in the training. It was recently shown that an intensive mentorship system decreases the learning curve in laparoscopic radical prostatectomy.<sup>67</sup> How many specific operations a trainee should have been performed under guidance before proficiency is reached, is difficult to answer. From the literature, it appears that the numbers given are not based on evidence.<sup>68</sup> Especially in complex

procedures, investigators have a tendency to exaggerate, eg., the learning curve for laparoscopic Roux en Y gastric bypass has been stated to be 100 cases.<sup>69</sup> Clinical training should start by doing simple high-volume cases, eg, appendectomy, pyloromyotomy. Depending on the total load of endoscopic surgical cases of the department, the trainee will gain experience in a number of procedures at the same time. Once a department of pediatric surgery has embraced endoscopic surgery, the impact on the total thoracic and abdominal surgical activities of the department will be enormous as we showed already in 1998.<sup>70</sup> Whenever a child in Utrecht needs a thoracotomy or laparotomy for a new indication, we will always discuss whether such an operation should be done endoscopically.

Mister chairman, ladies and gentleman, when Alice in Wonderland looked through the keyhole again at the end of the film but now from inside to the outside, she saw that she had fallen asleep under a tree and that she had been dreaming. The difference with endoscopic surgery is that endoscopic surgery is reality.

Do I still toast BAPS on their 50th anniversary with a bottle of Endoscopic Surgery in Children? I am positive, but I would like to choose the domain and the castle where the bottle is coming from, I would like to know the year when the cultivation started, and, above, all, I would like to have a taste first.

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