Laparoscopy was born at the beginning of this century. A purely exploratory technique at first, it became an interventional surgical technique in the years 1970, under the impulse of gynaecologists. As long as the operator had to perform under direct vision and one-handed because his other hand was busy holding and directing the laparoscope, this new operating technique failed to win the digestive surgeons over. Things changed radically in the years 1985–1990 with the advent and popularization of miniaturized video cameras. Since then, we have enjoyed images of an excellent quality and real-time display on a television screen of a panoramic – or magnified view of the operative field. The camera/laparoscope unit being now held and handled by an assistant, the surgeon recovers the use of both hands and can easily perform with the necessary accuracy the maneuvers he is used to practising.
in open surgery, but on an inframillimetric scale. So, everything began between 1987 and 1990, not with the most straightforward procedure in abdominal surgery, namely appendectomy but, surprisingly enough, with a more complex one, cholecystectomy [1]. Everything went very quickly. In the history of surgery, few procedures have become so popular in such a short period of time [2, 3]. Although it was strongly and sometimes fiercely criticized in its early days because of a number of complications due to inexperienced operators whose enthusiasm verged on irresponsibility, laparoscopic surgery is now fully established. It has its place in the official surgical curriculum. Since 1992–1993, specialized surgeons have demonstrated that all the surgical procedures for the treatment of digestive disorders were feasible by laparoscopy. Only organ transplant remains outside its field of application. And yet a few recent cases of laparoscopic renal graft taking in live donors have been published. In addition to these ceaseless demonstrations of feasibility that make the success of our specialized congresses, a limited number of procedures have received the ‘gold standard’ label. The best example of all is undoubtedly laparoscopic cholecystectomy (LC). The scientific evaluation of all the other procedures is currently under way, and has reached various degrees of advancement. The data accumulated over 9 years of practice makes it possible to assess its results and to outline its future prospects.

**State of the Art 1998**

Because of the rapid evolution of laparoscopic surgery, due in part to the constant development of new instruments and new machines but also to the quick rate of publication of articles reporting new operative procedures and new modes of evaluation, a static inventory of what is currently possible would be of little interest. This is why we have chosen to present the state of the art under a dynamic form, thus allowing constant updating of each surgical procedure’s level of use.

**Classification Method**

The degree of achievement and level of use (LU) of a given laparoscopic procedure can be represented by a bell-shaped curve, where the X-axis represents time and the Y-axis represents the LU (fig. 1). The rising section of the curve corresponds to the phase of innovation and adjustment of the technique, which is first limited to the pioneers, then extends to the specialists, and eventually reaches the level of general surgeons. The curve’s apex corresponds to the maximum degree of use, or phase of generalization, where praise and criticism balance each other. At this stage, the various experiences accumulated reach a critical mass that allows precise scientific assessment. The indications can then be determined precisely according to the results obtained and to an assessment of the technical difficulties in learning the procedure. Then the curve begins to fall, which corresponds to readjustment according to objective criteria. The future of the procedure’s LU depends on the frequency of the disorder treated by it, and on the number of surgeons who are able to perform it. Three different curves can be distinguished.

Curve 1 corresponds to a procedure routinely performed by a majority of general surgeons for a very common disorder. It therefore becomes a public health problem which can only be solved by setting up a Consensus Conference involving representatives of all the medical specialities that are liable to treat the disorder in question. Once the operative procedure has been validated by the Consensus Conference, its LU leaves the bell-shaped curve to reach a plateau where it will stay until a new treatment appears and makes it drop to the zero level of obsolescence.

Curve 2 represents a lower level of use because the procedure is complex and/or applies to a moderately frequent disorder. Here again, a Consensus Conference is necessary to define the level of use that marks the beginning of the plateau. It will remain at the level of specialists.

Curve 3 corresponds to a procedure that is particularly complex and/or only applies to infrequent disorders. The level of use remains very low and is limited to the promoters and to a few specialists. It never becomes a public health problem and may gradually fall into disuse.

According to this evolution pattern, what are the degrees of involvement of the laparoscopic procedures in the various compartments of digestive pathology in 1998? We will discuss them organ by organ for nonmalignant disorders. The laparoscopic approach in oncological surgery will be treated in a separate chapter.

**Nonmalignant Disorders**

**Biliary Tract**

*Gallbladder Lithiasis and LC.* Despite its 10 years of age, LC is still the subject of an amazing number of publications. And yet its place is now perfectly well-defined...
after two Consensus Conferences have been held [4, 5]. Both reached the same conclusions, namely that ‘LC is currently the reference treatment for gallbladder lithiasis provided that it is performed by a surgeon who has received adequate training in this type of surgery’. LCs LU is the typical example of a No. 1 curve. It is now widely used by general surgeons in western Europe, so that very few patients still agree to undergo conventional open cholecystectomy in these countries.

Let us recall its main results: mortality 0–0.2%, conversion rate 2–7%, complication rate 3–6%, less than a quarter of which require secondary treatment by laparotomy [6]. The major problem remains CBD injury [7, 8], whose rate ranges from 0.1 to 0.8%, and is therefore slightly higher than that of similar complications in open cholecystectomy. Various studies have shown that the rate of CBD injury decreases as the surgeon’s experience increases [9], and above all as intraoperative exploration is performed more and more systematically either by cholangiography or, in the case of highly skilled teams, by ultrasonography.

The technique and indications for LC are now perfectly codified, all that is left to be done is to provide adequate training for all the surgeons. Let us only hope that as time goes by, there will be less and less uninteresting publications on the subject. It is nevertheless a fact that in the history of surgery, this procedure has become the landmark indicating the beginning of laparoscopic surgery. We will no doubt continue to hear about it for a long time, because it is now used to test all sorts of innovations involving instrumentation, robotics, telemedicine but also new modes of hospitalization such as ambulatory surgery.

Common Bile Duct Stones. No such consensus as has been reached about LC has yet been achieved in this matter. Since the very first laparoscopic cholecystectomies, the possible presence of silent stones in the CBD has haunted laparoscopic surgeons [10]. Two questions had to be answered: what type of preoperative assessment was to be performed in order to thoroughly check the contents of the CBD? If any stones were present, how could one remove them by laparoscopy?

Regarding the operative technique, an answer has been provided by the development of new instruments that can be handled through laparoscopic trocars (thin fiberscope with an operating channel, basket probe, electrohydraulic lithotriptor, pulsed laser). More and more surgeons are now able to perform all the different laparoscopic maneuvers, including cystic duct dilation, opening and closing of choledochotomies. Numerous personal series involving more than 100 cases are published daily, as well as controlled series comparing conventional surgery, endoscopic sphincterotomy and laparoscopic surgery [11–14].

Regarding preoperative assessment, a problem has been solved since ERCP with a diagnostic purpose is no longer performed in the centers equipped with the last generation of MRI equipment [15]. Despite the progress made in the predictive criteria of CBD stone presence, a number of cases remained borderline cases, which made it necessary to eventually perform either cholangiography by ERCP or echoendoscopy, both of which being highly invasive procedures. The first one often mingled diagnostic purpose and treatment. In fact, once the ERCP had been performed and the stones had been found, even if sphincterotomy was not the safest solution, it was performed in most cases. The advent of MRI cholangiography, a noninvasive procedure that does not require injection of contrast medium, has solved the problem. The choice between laparoscopic surgery, endoscopic sphincterotomy and conventional surgery can now be made thanks to a type of assessment that does not include any interventional procedure. We therefore have all the necessary elements to conduct controlled studies comparing the respective results of these treatments.

Up to now, the first studies have shown that the mortality and morbidity rates obtained with endoscopic sphincterotomy and laparoscopic surgery are very similar, the advantage of laparoscopy being that it allows removal of the lithiasic gallbladder during the same session. But it is still too early to reach definitive conclusions. The LU of laparoscopic management of CBD stones is still positioned on the rising section of the bell-shaped curve, at the specialist’s level. It is highly improbable that these techniques will ever spread to a great number of general surgeons. In fact, if one considers the epidemiology of CBD lithiasis, it is not certain that this method can be generalized at all. Indeed, associated CBD stones are only found in 10–12% of the cases of gallbladder lithiasis. Bearing in mind that a general surgeon performs 50–80 LCs each year, will he have enough CBD stones to remove to become proficient in the laparoscopic approach?

Biliary Bypass. Laparoscopic cholecystojejunosotomy, choledochoduodenostomy and Roux-en-Y hepatojunostomy for the palliative treatment of obstructions due to tumors have been published on. However, the publications are incomplete, and only involve short series of patients. There are no comparative studies of laparoscopic bypass procedures versus stenting either by ERCP or by transhepatic percutaneous puncture.
Fig. 1–3. Evolution of the level of use of the main procedures performed by the laparoscopic approach.
The Stomach

Gastroesophageal Reflux. Since the first cases of laparoscopic treatment of gastroesophageal reflux performed in the years 1991-1992 [16], this technique has continued to develop. In fact, the treatment of GER represents a perfect illustration of the objectives of minimal access surgery since it allows to perform a complex procedure for a functional disorder without damaging the abdominal wall. Since 1994, several series, individual [17-21], multicentric, nonrandomized or randomized [22], have been performed. All the procedures performed in open surgery have been adapted to the laparoscopic approach and the results show that the mortality and morbidity rates [23-25] are similar to those obtained in open surgery, perhaps even better. The low frequency of accidental spleen injury requiring splenectomy must be underlined. The conversion rate is less than 10%, decreases regularly as the operators gain experience, and often drops to 0%. On the other hand, it is too early yet for medium- or long-term results as few very series with a long follow-up have been published. The results are favorable in most of them. However, controversies persist [4], especially about the choice of a procedure. Basically, pressure collapse in the abdominal esophagus plus good motility of the thoracic esophagus require repair with a 360° Nissen or Nissen-Rossetti wrap, according to whether the short gastric vessels have been divided or not. If thoracic esophagus motility is poor, posterior hemifundoplication (Toupet’s procedure) is indicated [26-28]. Anterior hemifundoplication (Dor’s procedure) that was no longer performed by open surgery is indicated [26-28]. The LU of the laparoscopic approach except in case of contraindications can be drawn about these procedures since long-term follow-up and controlled series [47, 48] are not yet available.

Gastrostomy, Gastrectomy, Gastroplasty, Bariatric Surgery. All these operations are feasible by the laparoscopic approach. Laparoscopic gastrostomy is in competition with gastroscopy by the endoluminal endoscopic route [38]. Subtotal gastric resections are performed for benign disorders for the same indications as in conventional surgery [39-41]. The series are only small, owing to the less and less frequent indications due to the good results obtained with medical treatment. On the other hand, gastroplasty is used more and more frequently for the treatment of morbid obesity [42]. The population of obese people with a BMI over 30 is increasing in western countries. The creation of ‘small stomachs’ through gastric bypass [43] or gastric banding [44, 45] is more and more frequent. The first reports are favorable, however severe complications have been described [46]. No definitive conclusions can be drawn about these procedures today, all the vagotomy procedures described in open surgery have been performed by laparoscopy with total operative success. A few series about short-term results reported by western teams have been published [30-36]. The results are satisfactory. However, it is highly improbable that randomized comparative series about laparoscopic vagotomy versus medical treatment will be conducted, considering the perfect efficacy of the medical treatment, especially when Helicobacter pylori is the cause of the disorder [37]. The validation of vagotomy in the treatment of duodenal ulcer will perhaps be achieved by studies carried out in countries where the medical treatment is too costly to be used on a large scale over long periods of time. Regarding the LU curve, vagotomy remains in the hands of a few specialists, not because of its technical difficulty but because its indications are not frequent enough.

Upper Digestive Bleeding. Devascularization of the lower part of the esophagus and of the upper part of the stomach in the treatment of portal hypertension has been successfully performed by laparoscopy [49]. A few cases of a joint approach by laparoscopy and by endoluminal flexible endoscopy have been published on, which allows to associate local intragastric hemostasis with external ligation of the vessels. A transtestinal transparietal approach of the gastric cavity has also been published on [50], in which a laparoscope and two operative instruments are inserted in the stomach itself to stop the bleeding.

The Esophagus. The short subdiaphragmatic section of the esophagus is easier to reach and easier to handle by laparoscopy than by open surgery. The success obtained with fundoplication is such that more and more surgeons feel comfortable in this area. Cardiomyotomy for cardiospasm is often performed but this disorder is not a frequent one. Several short series with good short- and medium term results have been published. It seems probable that the conventional approach will be abandoned for the laparoscopic approach except in case of contraindication of a general order [51].

Regarding the thoracic section of the esophagus, all the procedures used in open surgery have been shown to be feasible by thoracoscopy [52]; wide extramucosal myotomy for achalasia [53] and dyskinesia [54], esophageal
diverticulum resection, tumorectomy for benign tumor, subtotal to total resection for cancer. However, surgical management of the thoracic esophagus is still the privilege of a few specialized teams.

**Colon and Rectum**

Laparoscopic surgery of the colon and rectum began in the years 1990–1991. The success obtained with LC encouraged surgeons to venture into major operations on these organs [55]. From a technical point of view, the latter are among the most difficult to perform because they require extensive dissection of large areas. For instance, total colectomy implies that the surgeon travels over the four quadrants of the abdomen. In addition, the specimen are voluminous and a minilaparotomy is eventually needed in order to remove them. Finally, the restoration of intestinal continuity implies that the surgeon has a good command of anastomosis techniques. After somewhat hesitant beginnings, with operative times that were twice as long as in conventional surgery, one can safely say that in 1998, most of the procedures performed in major colorectal surgery are technically perfect. However, they require the surgeon to have a perfect command of laparoscopy and are therefore reserved for the most experienced of them. This is an excellent illustration of how traditional technique and laparoscopic technique are closely interwoven. Any surgeon with a good training in open surgery may enter this restricted area without any additional risk for his patients, by judiciously combining the conventional and laparoscopic approaches. He begins with a laparoscopically-aided open colectomy, as the laparoscopic stage is limited to exploration then taking down of the left flexure for instance. The benefit for the patient is that the laparotomy will be shorter [56, 57]. As the surgeon gathers experience, the laparoscopic stage will grow longer while the laparotomic stage grows shorter and shorter until the laparotomy will be shorter [56, 57]. As the surgeon gathers experience, the laparoscopic stage will grow longer while the laparotomic stage grows shorter and shorter until the laparotomy will be shorter [56, 57].

**The Pancreas**

As early as 1992, a number of operations for lesions of the pancreas have been proved feasible. Since then short series and isolated cases have been regularly published on: external drainage of pseudocyst after acute pancreatitis [64], bypass between pseudocyst and jejunum in chronic pancreatitis. Elective resections are less frequent as they require a wide experience in the laparoscopic technique. However left pancreatectomy with or without splenectomy, for the exeresis of mucinous cystadenoma or spots of chronic pancreatitis. The very first laparoscopic duodenopancreatectomy was performed by the end of 1992 [65]. Since then, the same pioneer surgeon has reported another ten or so cases. This operation represents the extreme limit of the use of laparoscopy in digestive surgery. It is a typical example of an operation that will probably follow the No. 3 route on the LU curve.

**The Liver**

Major and minor hepatic resections, the treatment of congenital and parasitic cysts and the evacuation of intrahepatic collections should be discussed separately. Major formal hepatic resections are exclusively performed by a few pioneers. The only indisputable indications are nonmalignant tumors and these are rarely found. As for malignant tumors, they are involved in the controversy between laparoscopic surgery and oncological surgery that will be discussed later on. These major resections have benefited by the creation of ultrasonic scissors and of vascular clamps that can be inserted through trocars. Their LU still lingers at pioneer’s level in the innovation period. On the other hand a great number of articles have already been published about the deroofing and fenestration of
congenital liver cysts [66, 67]. This procedure is perfectly feasible in the hands of any surgeon with a good command of LC. A recent publication draws attention to the risks of accident linked to the use of cetremide as a parasiticide during laparoscopic management of hydatid cysts.

But a new indication of the laparoscopic approach is developing, with the more and more extensive use of cryosurgery for the destruction of hepatic tumors [68, 69], in particular disseminated metastases. The early results seem promising [70]. However the follow-up is too short to conclude that this type of treatment may have more than a palliative effect. It is particularly well-adapted in the treatment of secondary tumors of colorectal origin.

**Acute Abdominal Syndromes**

**Appendicitis.** Kurt Zemm, then professor of gynaecology in Kiehl, published in 1983 on the first case of appendectomy performed by the laparoscopic approach [71]. This earned him a severe condemnation by the German board of surgeons who could hardly tolerate a gynaecologist’s intrusion in their domain. As a consequence, the introduction of laparoscopy in digestive surgery was delayed, the time was not yet ripe. Paradoxically enough, one had to wait until the breakthrough of L.C for the majority of general surgeons to become interested in the laparoscopic approach of the most frequent intraabdominal disorder in the field of digestive emergencies. Since then, numerous series have been published, large series, personal series [72, 73], multicentric, retrospective [74, 75], randomized series [76–79], series about children [80, 81], about adults, with male [82] and female [83] subgroups. A Consensus Conference has been held on the subject. The results obtained with the laparoscopic approach of appendicitis are similar to those obtained in open surgery. Its main advantage lies in the fact that a precise diagnosis is always reached. This is particularly important for young women in whom one has to distinguish between appendicitis and gynaecological disorders. Moreover, in cases complicated with peritonitis, this route allows a minimally invasive approach (three 5- or 10-mm trocars), with complete checking and lavage of the peritoneal cavity and placement of the necessary drains. In case of difficulties in extracting a voluminous, suppurative or even necrotic appendix the laparoscopic approach allows to determine where exactly the laparotomy necessary for specimen extraction should be performed. On the LU curve (fig. 2), appendectomy has already reached its plateau at the level of the general surgeons. However, that plateau is well below that of LC. Several reasons may account for this. In most cases, the open technique provides a simple, quick and inexpensive solution without cosmetic damage, especially in male patients. In addition, the history of laparoscopic appendectomy has been marked by a number of dramatic complications due to accidents during trocar insertion. Undetected injuries in large vessels such as aortic or iliac vessels, have led to patient’s death or lower limb amputation. These intolerable mishaps are to be blamed on a handful of surgeons who imagined that anybody could become a laparoscopic surgeon without specific training but they have definitely brought discredit on the method.

Today, for those who practise laparoscopy every day, it seems absurd not to use it in all cases of acute appendicitis.

One last argument should succeed in convincing the most ardent supporters of open surgery: *appendectomy is the only procedure that can be converted from conventional surgery to laparoscopic surgery.* In fact, if a healthy appendix is discovered through a 15- to 20-mm McBurney incision, one can easily introduce an open laparoscopy trocar through this opening and complete the operation by laparoscopy. This will allow to thoroughly explore the whole abdominal cavity, to confirm the diagnosis and to treat the disorder thus discovered, provided it is compatible with laparoscopic treatment. This is also true if the micro McBurney incision reveals an infected appendix with diffuse peritonitis. Conversion into laparoscopy allows to assess the extent of the infection and to perform complete lavage and drainage of the greater abdominal cavity after addition of 2–3 additional trocars under visual control.

**Perforated Ulcer.** Numerous individual series have been published about emergency suturing of perforated ulcers [84, 85]. The satisfactory results obtained allow to recommend this type of operation.

**Acute Bowel Obstruction, Acute Pancreatitis, Bowel Infarction.** Although acute bowel obstruction was considered in the years 1989–90 as a contraindication to laparoscopy, more and more cases are now published on. Thanks to the technique of open laparoscopy, the peritoneal cavity is no longer blindly punctured, and the risks of bowel injury are therefore avoided [86, 87]. The advantages of laparoscopy are particularly obvious in cases of bowel obstruction due to strangulation by one single band. The procedure can be completed in 15 min by simple resection of the band. The patient is fully cured and can be discharged on the third postoperative day. In case of multiple adhesions, complete clearing can be achieved although it is a lengthy procedure.

More and more cases of abdominal emergencies managed laparoscopically are published in the literature. As
regards other abdominal emergencies, a few isolated cases have been reported. All the authors insist on the extremely interesting part played by laparoscopic exploration. Once a clear diagnosis has been reached it is either possible to continue the procedure laparoscopically (adhesioly-
sis, installation of external biliary drainage for acute pancreatitis, segmental bowel resection for bowel infarction) or laparoscopy cannot be continued, and conversion into laparotomy is necessary. Because of the extreme accuracy of laparoscopic diagnosis, the opening is always perfectly adapted to the lesion to treat. Although the idea has not yet received general approval, laparoscopy should altogether replace exploratory laparotomy. Let us recall that thanks to the ‘open laparoscopy’ technique, namely insertion of the first trocar under visual control through a microlaparotomy (10 mm long), even patients with heavy scarring due to previous open surgery can be explored laparoscopically [88, 89].

One single obstacle remains, a major one however, that prevents extensive use of laparoscopy in abdominal emergencies: the difficulty in having laparoscopic equipment and a laparoscopic surgical team available night and day.

Cancer and Laparoscopy

Malignant tumors located in all the various segments of the digestive tract including stomach [90], liver, biliary tract and pancreas have been successfully treated by the laparoscopic route. All these procedures have been proved to be feasible, with mortality and morbidity rates similar to those in open procedures. However, a controversy soon emerged upon observation of early recurrences (within 6 months) on trocar sites, and early break out of generalized peritoneal carcinomatosis. The alarm had already been raised when similar complications were reported after LC for gallbladder lithiasis, in which specimen examination showed malignant tumors to be present in the gallbladder [91, 92]. Considering the infrequent occurrence of these tumors, the cases reported were considered as purely anecdotal. Things changed when the number of surgeons capable of performing LC started to increase. Adenocarcinoma being the most frequent disorders of the colon and rectum, many colorectal surgeons made their first laparoscopic steps for this type of indication. As of the years 1991–1993, the reported cases of parietal grafts multiplied. A 2–6% rate of early recurrences on trocar sites was observed, which meant that the frequency of this complication was twice or three times as high as in conventional surgery [93]. This caused a great fright and some people demanded a moratorium on the use of laparoscopic surgery in colon cancer. Since 1994, the positive effect of this controversy has been that numerous studies have been conducted on the subject. Randomized prospective series comparing laparoscopic surgery and conventional surgery have multiplied among the most experienced teams [94, 95]. The conclusion is that the rate of parietal graft is equivalent in both types of surgery. Regarding the quality of the exeresis, its extent and the number of lymphnodes removed, everything is exactly the same in laparoscopic surgery and in conventional surgery. This is also true of patient’s survival and early metastasis recurrence. In order to achieve this, the rules of oncological surgery must be strictly observed in the laparoscopic technique, namely no direct handling of the tumor, initial control of the vascular pedicles, identical extent of the lymphnode- and tumor excises, and identical protection of the abdominal wall during removal of the operative specimen. Under these conditions, there is no valid reason why the principle of laparoscopic management of colorectal cancer should be given up [96]. Of course, the follow-up is not long enough so that the current randomized studies have not yet reached a conclusion. There is a dramatic lack of fundamental research work in general carcinology with regard to cancerous cell survival in the specific environment of laparoscopic surgery [97–99]. The latter is usually performed under CO2 insufflation. Recent research work suggests that the replacement of insufflation by the gasless technique would dramatically reduce neoplastic parietal grafts [100]. Other articles suggest that mechanical implantation due to the nonfixation of trocars could in certain cases, account for the frequent recurrences on the trocar sites. No definitive conclusion can yet be drawn, so that laparoscopic exeresis of malignant digestive tumors with a curative purpose should not be recommended for routine use except in controlled studies. On the other hand, exploratory laparoscopy and palliative interventional laparoscopy have already taken a major place in oncology. Exploration must follow strict rules, use few trocars, a 5 mm scope, and tumor handling should be reduced to a minimum with no direct contact with the tumor(s). Tumor staging is therefore incomplete as long as laparoscopy has not been performed [101–103]. A number of studies show that 15–20% of candidates for heavy surgery, whether gastric or pancreatic, are thus spared a laparotomy that would have been purely exploratory. We all know that laparotomy makes the hospital stay longer, the postoperative course less comfortable and is attended with potential specific complications that spoil the patient’s unfortunately short time of survival. The same arguments apply to laparoscopy for palliative surgery, resection and bypass. One of the best exam-
ples is gastroenterostomy for neoplastic stenosis of the duodenum.

We are now reaching the end of this dynamic presentation of the Current State of the Art in Laparoscopic Digestive Surgery. This new type of surgery also applies to many other fields that will be listed briefly. ‘A tout seigneur, tout honneur’, gynecologists who pioneered the use of laparoscopy continue to make considerable progress, to such extent that the most experienced teams now perform 80% of the procedures by this approach. Laparoscopic surgery allows to perform splenectomy for hematological disorders and extensive lymphnode picking for hemopathy. Orthopedic surgery, which already uses endoscopes routinely in arthroscopy, is beginning to use laparoscopy for the anterior and lateral surgical approaches of the spine. New spaces are being created daily for the laparoscope, the pre- and retroperitoneal spaces, subaponeurotic space, one of the best – and most controversial – examples being inguinal hernia repair. Vascular surgeons are beginning to use this approach in lumbar sympathectomy and for prosthetic replacement of the abdominal aorta and of the iliac arteries. Urologists use these new spaces for nephrectomy and endocrine surgeons for adrenalectomy and even parathyroidectomy and some subtotal thyroidectomies. Plastic surgeons are not far behind, who minimise scarring by using fine endoscopes that allow remote subcutaneous dissection and muscle plasty.

Interventional laparoscopy has invaded all the various compartments of surgery because it fits into the general evolution pattern of all treatments towards maximum efficacy with minimum adverse side effects.

Future Prospects

Although some people persist in depreciating it, nobody will now dare say as they said 10 years ago, that laparoscopy is but a short-lived fad. It has given sufficient proof of its efficacy to have now reached the point of no return. Two main trends of development emerge: the first, within everybody’s reach, is towards transformation of open surgery into laparoscopic surgery, through gradual adaptation of our instruments, the creation of and training in new operative procedures, while the second one is based on systematic integration of advanced technologies in operating techniques.

Gradual Adaptation

Laparoscopic surgery is now officially part of all the surgeons’ standard training curriculum. It is therefore everyone’s duty in his everyday’s practice to keep on trying to discover new improvements, new operative ‘tips’ that will make things easier. The best example is the progressive reduction of operative time as the surgeon’s experience increases. In some procedures such as cholecystectomy, the laparoscopic approach has become shorter than the open procedure as it is reduced to the biliary stage and saves the time normally devoted to opening and closing the abdominal wall, especially in obese patients. This quick performance has led anaesthesiologists to reconsider a number of contraindications to laparoscopic surgery. The most obvious example is that of ASA III patients who derive great benefit from the absence of postoperative abdominal scarring, provided that the operative time is short. These gradual improvements lead to periodically reconsider global patient management. A good illustration is the constant progress of ambulatory surgery in laparoscopic surgery [104–106].

Integration of Advanced Technologies

Without advanced technology, laparoscopic surgery would never have been born. It actually took off when it became possible to equip a laparoscope with a miniature videocamera which allowed to show live and in real-time on a TV screen, the gesture performed by the operator behind the undamaged opaque abdominal wall. And all of a sudden, the surgeon who used to operate one-handed, while his other hand was busy handling the laparoscope, was no longer a one-armed surgeon; his assistant, once a passive instrument-holder, was no longer blind, and all the visitors in the operating theatre or elsewhere, whether in the room next door or at the other end of the world, were able to follow an operation in process, whose credibility could no longer be challenged. This decisive turning-point was reached in the years 1988–1989. Coupled with computer science, this new imaging opens the way to a series of technological achievements whose developments, independent of the subject treated, are soaring up an almost vertical trajectory.

After 2D imaging, here comes 3D imaging. Following the example of the technologies used for radioactive product handling, one thought of using a remote-controlled robot operated by a surgeon [107]. This is the basic concept of ‘telepresence’ surgery. One of its advantages is the fact that the robot’s movements are incomparably more precise than those of a human hand. Some of the procedures can be controlled by a prerecorded computer programme, while the surgeon only intervenes in case of unexpected difficulties. This is already possible during preoperative assessment which, thanks to CT scan,
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laparoscopic surgery simulators. A few years from now, each training centre will no doubt possess one or several such simulators. They will also make it possible to altogether wipe out or at least considerably reduce the mediocre clinical results obtained at the beginning of the ‘learning curve’. A few years from now, each training centre will no doubt possess one or several such laparoscopic surgery simulators.

The most immediate implementation of these new technologies is their possible use for surgical training. Although abdominal viscera anatomy is quite difficult to reproduce by computer programming, surgical simulators similar to the flight simulators used for pilot training are already made available to surgeons in some surgical centres. In the near future, they will probably take the place of training on live animals. They will also make it possible to altogether wipe out or at least considerably reduce the mediocre clinical results obtained at the beginning of the ‘learning curve’. A few years from now, each training centre will no doubt possess one or several such laparoscopic surgery simulators.

The implementation of these major advances is no longer possible for the individual surgeon in his daily practice and environment. The integration of high technologies can only be achieved in institutes that possess not only huge money supplies but also an interdisciplinary staff of researchers including surgeons, physicists, computer-science engineers, etc. Their number is currently limited, and they are only found in those places where major financial resources are available. Neither our universities nor our hospitals taken individually, with their chronic financial difficulties, are capable of setting up such institutes. The solution lies in contracts that will bind together the great manufacturing firms, the universities, the hospitals, the private and state foundations. The mission of such institutes is twofold, as it includes research and training. In this extremely favorable environment, research must be conducted at all levels, both fundamental and applied.

The second aspect of their mission is didactic. These institutes will have to organize training sessions in advanced techniques and to serve as training centres for the future tutors who will dispense basic knowledge in nonspecialized institutions. Thanks to television medicine, the courses given by these specialized centres can already be broadcast to other hospital training centers. A new concept of education is being born.

Conclusion

Who could have imagined, back in 1985 that cholecystectomy, Nissen’s fundoplication, perforated ulcer suture, colectomy, splenectomy, adrenalectomy, partial hepatectomy, etc., could one day be performed routinely by laparoscopy. A real revolution has indeed taken place, which has profoundly changed the surgeon’s everyday practice, but also the appearance of operating theatres, now cluttered with highly sophisticated and costly new equipments. As of now, laparoscopic surgery is part of the basic training of every future surgeon in all medical schools. This represents a major problem for the public authorities and the health care system. On the one hand, the shorter postoperative course, the less important postoperative treatment, the quick return to physical or professional activity seem to reduce costs. On the other hand, the installation cost of the new equipments in the operating rooms causes a major increase in overall expenses. It is still too early to draw definitive conclusions about the cost-effectiveness of this new surgery as a great number of parameters are conditioned by the health and social system of each of the states considered. These problems will have to be studied and solved in close collaboration with economists. For the time being, the final results are still uncertain. Many more studies will have to be conducted, implementing modern evaluation methods, in order to make a selection and determine exactly where each new procedure stands with regard to traditional and laparoscopic techniques.

Laparoscopic surgery will no doubt remain in the history of surgery as the revolutionary episode that marked the end of the 20th century. It represents a major breakthrough that is just as important as the discovery of anaesthesia, asepsis, antibiotic treatment, extracorporeal circulation, operating microscopes and organ transplant. What will its future be like? No one can say for certain, but it will most probably fit into the general context of treatments with increased efficacy and reduced constraints. This is made possible by the more and more precise intraoperative means of investigation that allow to identify the increasingly smaller targets on which mechanical action will have to be exerted. In order to reach these sites, one has to be able to navigate inside the human body without ‘over-opening’ its external envelope. Laparoscopy makes this possible under direct vision. One can also navigate using X-rays, ultrasound or NMR [111]. Three specialties involving elements of a noninvasive or minimally invasive nature are brought together here: laparoscopic surgery, flexible endoscopy and interventional radi-
Adequate structures must be created right away for endoscopic surgeons and radiologists to be able to work together on the same patients, in the same rooms, and to combine their skills, their therapeutic indications and their implementation. Minimally invasive centres of treatment for digestive diseases must be created.

But navigation inside the human body implies image creation and exploitation. Images can be broadcast to other structures all over the world, thus allowing television-consultation, television medical training. Everyone will benefit by it, the patients because the various teams will be able to exchange documents and discuss them in real time, but also the students, who will see their professors at work, life-size and in real time. The most interesting moments will be recorded and used later for didactic purposes at a worldwide scale.

Tomorrow perhaps the navigators’ targets will have shrunk to cell or even molecule size. What will their professional life, their professional environment be like? Will they don special outfits to operate in a special room or will they work in their usual clothes in their usual office from which they will control the robot which unlike them, will be in physical contact with the patient? Let us hope that these ‘interventionists of the future’ will continue to be medicine doctors and will continue to follow the code of ethics that we all follow, which commands us to always put our patients’ interest first.

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