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Gallbladder Surgery, Choice of Technique: An Overview

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1. Introduction

The first cholecystectomy was performed by Langenbuch in 1882 (1), and the surgical approach changed very little in the next century. However, in the 1980s, reports began to appear that described the removal of the gallbladder through a 3-8 cm, muscle-sparing incision (small-incision cholecystectomy, or minicholecystectomy) (2-17). A few years later, laparoscopic cholecystectomy entered the scene (18, 19). These two minimally-invasive techniques have largely replaced the traditional open cholecystectomy, which used a 10 – 20 cm incision in elective gallbladder surgery (20). In 1993, a consensus conference at the National Institute of Health concluded that the experience of small-incision surgery or mini-laparotomy cholecystectomy was limited; and that laparoscopic cholecystectomy could be performed at a treatment cost that was equal to or slightly less than that of open cholecystectomy and offered substantial cost savings to the patient and society by reducing the time off work (21). The alternative to surgical removal of the gallbladder, lithotripsy combined with chemical dissolution of gallstones is restricted to single stone disease and runs a risk of stone recurrence (22, 23). However, it has been found to be associated with good long-term quality of life in selected patients (24).
The aim of this review is to discuss factors that influence the choice between cholecystectomy techniques, taking into account the applicability and cost of each technique.

2. Methods

We conducted a literature search, including a search of the Cochrane Library and PubMed (year 2010) with the keyword "cholecystectomy" and used the principles of evidence based medicine in the presentation of the findings (25-29).

3. Results and discussion

Cholelithiasis, the magnitude of the problem

The prevalence of cholelithiasis in European population is currently 10-15%, and it increases with age and female gender (30-33). Patients with cholelithiasis may be asymptomatic or symptomatic. Biliary colic is the only symptom specific to cholelithiasis (34). It is characterised by a high intensity, long duration pain located in the right upper abdominal quadrant; it can be referred, and often appears at night (35). Cholelithiasis may be

complicated by acute cholecystitis, common bile duct stones (with pancreatitis or jaundice), or fistula (32). Gallstone disease is the most common among all abdominal diseases that lead to hospital care in the Western world (36); recently, an increase of hospital admissions for gallstone disease has been observed in England (37). This has made gallstone disease a health care problem with considerable economic consequences; moreover, this problem will most likely increase with increases in population age (38). The annual direct cost in the United States has been estimated to be approximately six billion USD (39, 40). No randomised controlled trials have favoured operative treatment of asymptomatic patients with cholelithiasis (41). A wait-and-see management approach may also be adopted for symptomatic patients with uncomplicated disease (42), particularly those with atypical symptoms (43). With the introduction of the laparoscopic technique, the cholecystectomy incidence increased substantially (15 – 80%) in Europe (38, 44, 45), Canada (46), the United States (47, 48), and Saudi-Arabia (49).

Comments on cholecystectomy techniques

Details of the laparoscopic technique (Figure 1) are readily available to any trainee and will not be discussed here. Essential equipment for small-incision cholecystectomy include

Fig. 1. Laparoscopic cholecystectomy with trainee (right). Consultant surgeon and nurse closely follow the operation.

Harrington-type retractors, headlamps, and magnification loops (Figure 2) (14). Briefly, the incision is performed over the right rectus muscle, two to three fingers below the xiphoid process (Figure 3) (10, 14). The anterior and the posterior rectus sheath are divided. The

rectus muscle is left intact, but one or two cm may be divided medially. Intra-abdominal dissection is initiated at the triangle of Calot, although in patients with inflammation, a "fundus down" dissection may be advantageous. Before wound closure, a local anaesthetic agent is administered liberally in the rectus muscle compartment as well as subcutaneously. The rectus sheaths are sutured with non-absorbable suture and the subcutaneous layer with absorbable suture. When an extension of the incision must be performed in small-incision cholecystectomy, the incision is rarely extended lateral to the rectus muscle. Conversion from laparoscopic to open cholecystectomy typically requires a traditional 10 – 20 cm subcostal incision through the rectus muscle, the oblique muscles, and the transverse muscle, with the risk of causing denervation injury and subsequent incisional hernia.

Fig. 2. Headlights and x2.5 magnification loops are necessary for performing a safe small-incision cholecystectomy.

Minimally-invasive techniques and day-case surgery

Both small-incision cholecystectomy (6, 7, 14, 17, 50-52) and laparoscopic cholecystectomy (50, 52-56) are compatible with ambulatory surgery. A Cochrane review has considered laparoscopic day-case surgery safe and effective for selected patients with symptomatic cholelithiasis (57).

Randomised controlled trials that compared open cholecystectomy, small-incision cholecystectomy, and laparoscopic cholecystectomy

Cochrane reviews demonstrate that small-incision and laparoscopic cholecystectomy should be considered equivalent with respect to complications and recovery, but the small-incision

cholecystectomy requires a shorter operation time (58). However, trials with large numbers of patients are necessary to determine potential differences in serious adverse advents (59). Open cholecystectomy is associated with a longer hospital stay than the two minimally-invasive techniques (58). One randomised controlled trial concluded that small-incision cholecystectomy was also suitable for obese patients (17). Patient opinion of the cosmetic outcome of surgery did not differ significantly between small-incision and laparoscopic cholecystectomy one year after surgery (60). For both groups, the median value concerning patient views of the scar was 1 on a scale of 1 to 10, where 1= does not bother me at all, and 10=very disturbing. To judge the external validity of conclusions reached in randomised controlled trials, it is necessary to know outcomes for non-randomised patients treated at the units that participated in the trial. In one trial that compared the two minimally-invasive cholecystectomy techniques, the patients that received operations, but were excluded from the trials were older and tended to have more advanced disease (higher ASA-scores, more co-morbidities, more complications from gallstone disease) than the patients included in the trials (61).

Fig. 3. Place for small-incision cholecystectomy. The incision is 6 -7 cm long, located over the right rectus muscle, 2 – 3 fingers below the xiphoid process (to the right). The costal margins are indicated by dots.

Cholecystectomy techniques from a population based perspective

In Sweden, laparoscopy has been the predominant cholecystectomy technique since 1993 (Sandzén et al, unpublished). From 2000 through 2003, 28% of patients who underwent

cholecystectomy for benign, biliary diseases in Sweden had their operations completed as open procedures (62). Those patients showed a higher likelihood of having an acute admission and a complicated gallstone disease compared to patients that underwent laparoscopic cholecystectomy. They also had a higher mortality than expected, considering age and sex of the background population, both within 90 days of admission for cholecystectomy and 91-365 days postoperatively, indicating that these patients were sicker than the Swedish population in general. This suggested that efforts should be undertaken to reduce the surgical trauma in open biliary surgery (62). In the United States, 25% of all cholecystectomies were performed as open operations from 1998-2001, and 5-10% of laparoscopic cholecystectomies were converted to open operations (63). In Scotland, an audit reported that the open technique for gallbladder surgery was used in 11.4% of all cholecystectomies (4.0% primary and 7.4% converted laparoscopic) and concluded that also in the 2000s, open cholecystectomy is a common procedure with limited room in current trainee programs(64). Similar conclusions have been drawn from studies in the United States (65-67). Training programs for open cholecystectomy and common bile duct procedures have been considered necessary (68).

Population based studies have demonstrated that the incidence of bile duct injuries has increased after the introduction of laparoscopic cholecystectomy (69). In Sweden, there was a small to moderate long-term increase in the risk of bile duct injury after introduction of the laparoscopic technique compared to the prelaparoscopic era (70). This may be an underestimation of the real change, as the majority of bile duct injuries may be treated without reconstructive surgery today (71).

Cholecystectomy for complicated gallstone disease

The cholecystectomy technique should be chosen based on the particular type of gallstone complication in order to achieve smooth, early, definitive treatment. The complications include acute cholecystitis, common bile duct stones, and acute biliary pancreatitis.

For acute cholecystitis, an early randomised controlled trial showed that small-incision cholecystectomy was safe, reliable, and had advantages compared to traditional open cholecystectomy (72). Another randomised controlled trial found no clinically significant differences between traditional open cholecystectomy and laparoscopic cholecystectomy (73). Observational series have demonstrated that both small-incision (74) and laparoscopic cholecystectomy (75-79) are suitable for treating acute cholecystitis. According to meta-analyses, an early operation (open or laparoscopic) does not carry a higher risk of mortality or morbidity compared to delayed surgery, and therefore, should be the preferred treatment (80, 81). This is also applicable to older patients (81, 82). Laparoscopic cholecystectomy for acute cholecystitis, whether performed early or delayed, is associated with a higher conversion rate compared to elective cholecystectomy (81). In England, 40% of patients with acute gallbladder disease had an open operation (converted laparoscopic or traditional open cholecystectomy) (83). In Denmark, in 2004, 36% of cholecystectomies for acute cholecystitis were completed as open procedures (84). In Sweden, from 1995 through 1999, 68% of patients aged 70 years and older had open operations for acute cholecystitis (85).

Concomitant removal of common bile duct stones via choledochotomy can be successfully performed with open cholecystectomy (86), small-incision cholecystectomy (87), or laparoscopic cholecystectomy (88-90). According to a Cochrane review, choledochotomy is superior to endoscopic sphincterotomy for bile duct clearance in open gallbladder surgery. In contrast, laparoscopic choledochotomy and endoscopic sphincterotomy are equally

effective in the short term, although the latter alternative requires an increased number of procedures (91). In laparoscopic surgery, endoscopic sphincterotomy is the method preferred by most surgeons for common bile duct clearance (37, 66, 92). However, laparoscopic choledochotomy and trancystic common bile duct exploration (93) with concomitant cholecystectomy are achievable, effective alternatives. Long-term observational studies have shown that, following endoscopic sphincterotomy, there is a risk of infection, gallstone formation, pancreatitis (94-98), and biliary carcinoma (96). After endoscopic retrograde cholangiopancreatography (ERCP), a prerequisite for sphincterotomy, there is an increased risk for cancer in bile ducts, liver, and pancreas compared to the background population (99). A Cochrane review indicated that patients with gallbladder *in situ* should be offered a cholecystectomy following common bile duct stone removal, provided they are fit for surgery (100). An observational study recommended a cholecystectomy within one week of sphincterotomy (101). Further randomised controlled trials are necessary to assess the benefits and risks of T-tube versus primary closure after both open (102) and laparoscopic common bile duct exploration (103, 104).

In acute pancreatitis, an early etiological diagnosis (<48 h after admission) is recommended, and in mild and moderate acute pancreatitis of biliary origin, an early cholecystectomy is recommended (105-109). In acute biliary pancreatitis without cholangitis, early ERCP does not lead to a significant reduction of complications or mortality (110). Deviations from these recommendations are common (111-117). However, a recent audit demonstrated that it is possible to follow the guidelines for acute biliary pancreatitis with a low associated mortality (118). According to one randomised trial (119) and other observational studies, in acute biliary pancreatitis, an early cholecystectomy can shorten the hospital stay (120, 121) and reduce the risk for recurrent pancreatitis (122) compared to a delayed operation.

Health care costs

An early randomised controlled trial concluded that hospital costs were higher for small-incision cholecystectomy than for laparoscopic cholecystectomy (123); in one trial no significant difference was found between the two methods (124). However, in all other randomised controlled trials, health care costs were found to be lower for small-incision compared to laparoscopic cholecystectomy also when re-usable laparoscopic instruments were used (125-129). In a cost-minimising analysis, small-incision cholecystectomy appeared to be more cost-effective than laparoscopic cholecystectomy, both from hospital and societal perspectives (130). To our knowledge, no formal systematic review has compared the costs of small-incision cholecystectomy and laparoscopic cholecystectomy. However, in a recent overview of Cochrane reviews, it was concluded that small-incision cholecystectomy "seems to be less costly" (58). Observational studies have supported that view (14-16). In laparoscopic surgery, endoscopic sphincterotomy is associated with a longer hospital stay (131) and is more costly than choledochotomy (132, 133). Health care costs are ultimately determined by more factors than the surgical technique used. Factors that modify the response to surgical trauma, including the use of steroids, use of ondansetron, or liberal administration of fluid (134-141), advice to patients concerning pain medication and postoperative activity may affect convalescence, return to work, and finally, the societal cost for cholecystectomy (142). Long-term costs for cholecystectomy should include costs for repair of abdominal wall hernias following large, subcostal incisions (Figure 4). Finally, overall costs for surgical training should take into account the costs for two learning curves for laparoscopic trainees (laparoscopic cholecystectomy and open cholecystectomy in case of

conversion) versus one curve for minicholecystectomy trainees (small-incision cholecystectomy with extended incision when needed).

Medical ethics and cholecystectomy technique

Non-maleficence, beneficence, respect for autonomy, and justice are the cornerstones of principle-based medical ethics (143). Respect for autonomy involves providing evidence based information on the risks (including conversion/extended incision) and benefits of surgery in elective and emergency settings (144). Justice involves the fair distribution of resources among individuals in need of health care. External factors may affect the practice of justice (145). However, within the limits set by stakeholders, the health care system and the surgeon must always consider the cost-effectiveness of surgical care (146).

Fig. 4. Patient with a large abdominal wall hernia following subcostal incision in converted laparoscopic cholecystectomy.

4. Conclusions

Traditional open cholecystectomy is associated with a longer recovery than small-incision and laparoscopic cholecystectomy. To make a scientific evidence-based choice between small-incision cholecystectomy and laparoscopic cholecystectomy, surgeons and health care providers must scrutinize the evidence from randomised controlled trials and from defined populations, and they must consider the applicability of the techniques to their own setting. Conclusions reached may have a profound effect on costs and surgical training.

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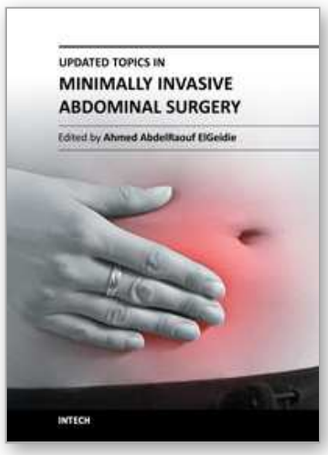

Updated Topics in Minimally Invasive Abdominal Surgery

Edited by Prof. Ahmed Elgeidie

ISBN 978-953-307-773-4
Hard cover, 246 pages
Publisher InTech
Published online 14, November, 2011
Published in print edition November, 2011

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How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

E. Nilsson, M. Öman, M.M. Haapamäki and C.B. Sandzén (2011). Gallbladder Surgery, Choice of Technique: An Overview, Updated Topics in Minimally Invasive Abdominal Surgery, Prof. Ahmed Elgeidie (Ed.), ISBN: 978-953-307-773-4, InTech, Available from: http://www.intechopen.com/books/updated-topics-in-minimally-invasive-abdominal-surgery/gallbladder-surgery-choice-of-technique-an-overview

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