A Comparison of Open and Laparoscopic Cholecystectomy done by a Surgeon in Training

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ABSTRACT

Laparoscopic cholecystectomy has virtually replaced conventional open cholecystectomy as the gold standard for symptomatic cholelithiasis. The laparoscopic approach brings numerous advantages at the expense of higher complication rates, especially in training facilities. This comparative 18-month review examines the outcomes of 52 cholecystectomies performed by a single surgical resident at the University Hospital of the West Indies – a teaching hospital in Jamaica. The advantages of laparoscopic cholecystectomy have been demonstrated and it has been found to be safe and effective in this training facility.

Comparación de Colecistectomías Abiertas y Laparoscópicas Realizadas por un Cirujano Durante su Adiestramiento

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RESUMEN

La colecistectomía laparoscópica ha reemplazado virtualmente la colecistectomía abierta convencional, siendo ahora la norma de oro para la colelitiasis sintomática. El abordaje laparoscópico trae consigo numerosas ventajas a expensas de tasas de complicación más altas, sobre todo en las instalaciones de adiestramiento. Este estudio comparativo realizado a lo largo 18 meses, examina los resultados de 52 colecistectomías realizadas por un residente de cirugía del Hospital Universitario de West Indies – un hospital docente de Jamaica. Las ventajas de la colecistectomía laparoscópica han quedado demostradas, y el tratamiento ha probado ser seguro y efectivo en esta instalación docente.

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INTRODUCTION

The first reports of Laparoscopic Cholecystectomy (LC) in medical literature originated simultaneously from France (1) and the United States of America (USA) (2). The first recorded LC in Jamaica was performed in 1993 (3). Since its introduction, LC is considered the gold standard operation for symptomatic cholelithiasis (4).

Several trials have demonstrated the advantages of the laparoscopic approach including reduced postoperative pain, recovery time and duration of hospitalization (5–13). Patients usually return to normal activity within a week of LC and find it aesthetically gratifying. These advantages have led to a patient-driven demand for LC (5, 11, 12).

With the increasing popularity of LC, the surgical community became concerned about the increase in complications that was even more pronounced with less surgical experience and training (12, 14). Once the learning curve has been overcome, the incidence of complications from LC reduces, but still remains higher than with open cholecystectomy (OC) (12, 15–18). This study attempts to examine the outcome of operations performed by a surgeon in training to determine the safety and feasibility of LC at the University Hospital of the West Indies (UHWI) in Jamaica.

SUBJECTS AND METHODS

Data were retrospectively analyzed over the 18-month period from October 2003 to April 2004 by chart analysis of 26 patients who had LC performed by a single resident surgeon (SC) at UHWI. Comparisons were made with a group of 26 matched patients who had OC performed by the same surgeon.

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At the UHWI, resident surgeons were taught OC and LC by consultant staff. During the initial learning phase, surgical consultants supervised all procedures intra-operatively. Once subjectively deemed competent by consultant staff, the surgical residents were allowed to perform both forms of cholecystectomy without intra-operative supervision by consultant staff. Mitchell (3) previously described the modified LC technique used at UHWI.

Patients were offered cholecystectomy based on previous documented history of symptomatic cholelithiasis, cholecystitis or pancreatitis. All patients selected for elective cholecystectomy were offered the laparoscopic approach as an alternative to OC. The final decision was patient-based and was largely influenced by the longer waiting times and increased costs accompanying LC. Patients who required emergency operations were not offered LC because the laparoscopic equipment was unavailable for emergency use.

Patients with suspected choledocholithiasis were subjected to pre-operative endoscopic retrograde cholangiopancreaticography (ERCP) before LC, as laparoscopic cholangiography and common duct exploration were unavailable during the study period. Intra-operative cholangiography (IOC) was available for elective OC.

Prophylactic antibiotics were administered at induction before OC but were not routinely utilized for LC. The final decision for prophylaxis was individualized, but was influenced by recent evidence suggesting that prophylaxis is unnecessary for routine uncomplicated LC (43–48).

Immediately after cholecystectomy, nasogastric tubes were removed and patients fed a normal diet. Parenteral opioid analgesia (pethidine) was administered on demand postoperatively. Patients were discharged once diet was tolerated, and were followed-up in the outpatient clinic. The operative time, complications, analgesic requirements and hospital stay were recorded.

After obtaining informed verbal consent, telephone interviews were performed to determine subjective outcome and detect late complications. Patients were questioned regarding the presence of complications, their choice of approach and subjective satisfaction with the cholecystectomy experience.

Statistical differences between the groups were determined by Pearson's chi squared test and the 1-sided Fisher's exact test. A p value < 0.05 was considered statistically significant. All statistical calculations were performed using Stata® software version 8 (Stata corporation, College Station, Texas, USA).

RESULTS

Over this time period, LC was attempted in 26 patients at UHWI. There were 23 females and 3 males with an overall female to male ratio of 8:1. The ages ranged from 13 to 69 years with males being an average 9 years younger. The indications for cholecystectomy are outlined in Table 1.

Table 1: Indications for cholecystectomy n (%)

Indications for Cholecystectomy	Laparoscopic (n = 24)	Open (n = 28)	Conversions
Chronic cholecystitis	18 (69.2%)	8 (3.1%)	1 (50%)
Biliary colic	2 (7.7%)	6 (23.1%)	–
Acute cholecystitis – emergent	1 (3.8%)	4 (15.4%)	–
Acute cholecystitis – urgent < 6 week	2 (7.7%)	1 (3.8%)	1 (50%)
Acute cholecystitis – 6 week interval	3 (11.5%)	1 (3.8%)	–
Gallstone pancreatitis	0	7 (26.9%)	–

In two males (7.7%), the procedure was converted to conventional OC due to dense adhesions that precluded clear anatomic definition of structures in Calot's triangle. Neither patient had previous abdominal surgery and neither was obese. The first patient was a 58-year-old man with a four-month history of chronic cholecystitis. At OC, a 2 cm stone was found lodged at Hartmann's pouch and had to be removed transmurally to facilitate antegrade cholecystectomy. The second patient was a 13-year-old male with sickle cell disease who had recovered from an attack of acute cholecystitis 30 days prior. Admission ultrasound revealed a thick-walled distended gallbladder with multiple stones. Multiple common duct stones were removed by sphincterotomy and basket retrieval at ERCP two weeks prior to LC. At conversion, cholecystectomy was technically difficult due to extensive adhesions and enlarged peri-portal nodes.

In the remaining 24 patients, LC was successful with an average operating time of 83 minutes for LC as the only procedure. Complications are detailed in Table 2. After LC there was no mortality but one (4%) minor complication and one (4%) major complication occurred in a patient who developed pneumonia. There was no bile duct injury (BDI) after LC.

Table 2: Complications after cholecystectomy n (%)

Complication	Laparoscopic (n = 24)	Open (n = 28)
Haemorrhage	1 (4.2%)	2 (7.1%)
Wound infection	0	1 (3.6%)
Overall minor morbidity	1 (4.2%)	3 (10.7%)
Pneumonia	1 (4.2%)	1 (3.6%)
Pulmonary embolism	0	1 (3.6%)
Adhesive obstruction	0	1 (3.6%)
Bile duct injury	0	1 (3.6%)
Overall major morbidity	1 (4.2%)	4 (14.3%)
Mortality	0	1 (3.6%)

After two conversions, 28 patients had OC. The average operating time was 81 minutes when OC was the only procedure performed. Comparing operating time for patients having IOC (108 minutes) and OC only (81 minutes) revealed that IOC required an average of 27 minutes additional operating time.

Postoperative complications are outlined in Table 2. There was one death after OC in a 39-year-old woman with sickle cell trait who succumbed to a massive pulmonary embolus on the first postoperative day despite chemoprophylaxis. There was one bile duct injury (BDI) after OC in a 14-year-old male who initially presented with gallstone pancreatitis. He became symptomatic of a bile leak one week after OC and was investigated with ERCP that revealed spillage of bile in the region of the cystic duct – common duct junction. At exploratory laparotomy, a 50% lateral wall transection of the distal common hepatic duct was noted and was repaired by a Roux-en-Y hepatico-jejunostomy. Overall, there were three (11%) minor complications and four (14%) major complications seen after OC.

All 28 patients having OC were administered prophylactic antibiotics and one (3.5%) patient developed a wound infection. Only 5/24 (3.7%) patients having LC were administered antibiotics and no wound infections were noted.

The average analgesic dosage administered on demand was used as an index of postoperative pain. The average dosage of pethidine administered was lower after LC (205 mg) than OC (387 mg).

Overall, the average duration of hospitalization was twice as long after OC (1.6 days) than after LC (0.8 days). Same day discharge was possible in 10 (42%) patients having LC and 7 (25%) patients having OC. Patients were discharged from hospital within 24 hours in 22 (92%) patients after LC and 16 (57%) patients after OC. The duration of hospitalization was greater than 24 hours in two (8%) patients after LC compared to 12 (43%) patients who had OC.

On average, the interval between presentation to the surgical service and operation was longer for patients who had LC (116 days) than OC (43 days).

Telephone interviews were successful in 19 (73%) patients who had LC and in 21 (81%) who had OC. All the patients cited aesthetics as the primary reason to choose the laparoscopic approach and 10 (53%) also cited quicker recovery as an additional reason. Patients opted for OC because of financial constraints in seven (33%) cases, long intervals to scheduled LC in three (14%) and unavailability of timely ERCP in seven (33%) cases. In four (19%) patients with unsettled cholecystitis, LC was not offered because it was unavailable on an emergency basis. Cholecystectomy was described as a "pleasant experience" by 18 (95%) patients who had LC and 15 (71%) patients who had OC. Only one patient who had BDI during OC was "disappointed" with cholecystectomy.

DISCUSSION

Since its introduction two decades ago, LC has become one of the most common general surgical operations performed (5, 11, 12). Several well-designed prospective randomized trials, together encompassing more than 1800 cholecystectomies, have demonstrated the superiority of LC over mini-OC (6, 7, 9, 10, 13).

Generally, LC has a higher operating theatre cost than conventional OC (12). In a four-year prospective study, Champault (19) implemented subtle procedural changes in 112 LCs and demonstrated cost reductions from €560 to €330 without compromising patient care or outcome. The LC technique at UHWI has similarly been modified by the use of a single video monitor and re-usable instruments (3). In this developing country, Mitchell (3) reported that the cost of LC ($3 050 US) was $550 US more expensive than OC. But, LC brings lower overall costs by savings in postoperative management from reduced hospitalization, analgesic requirements and time lost from work (12, 19).

Recently, there has been a trend toward outpatient LC. A 10 year meta-analysis of 2119 operations across 16 studies demonstrated the safety of ambulatory LC with 0.5% morbidity, 4.9% unplanned admissions and 1.8% re-admissions (20). With proven safety and greater cost containment, ambulatory LC has become an even more attractive option. In this study, ambulatory cholecystectomy was possible after 42% LCs and 25% OCs.

As more experience is accrued and expertise builds, the classic contraindications to LC are being abandoned and more difficult cases are being attempted. In this series, more patients scheduled for LC had chronic cholecystitis (69%) than any other indication. Conversely, only 3% of patients scheduled for OC had chronic cholecystitis.

Acute inflammation was once considered a contraindication due to anticipated technical difficulties from tissue friability, oedema and haemorrhage. But, several studies have demonstrated that LC for acute cholecystitis is feasible and safe (17, 21–27). In the present study, patients with unsettled acute cholecystitis who required emergent cholecystectomy were more often scheduled for OC (80%) than LC (20%). And, 50% of patients that settled with conservative management were offered interval LC at six weeks. This is not in keeping with recent evidence proving the safety of emergent LC. In fact, many authorities have recommended that the traditional recommendations for interval LC be abandoned (22, 25–27). Over two years, Lo (25) prospectively randomized 99 patients with acute cholecystitis to LC and recommended emergency LC within 72 hours of onset. Although technically demanding, emergency LC was associated with significantly lower conversion rates (11% *vs* 23%), complications (13% *vs* 29%), hospitalization and overall recuperation periods. In a further trial, Lai (27) prospectively randomized 104 patients with acute cholecystitis to early or interval LC and noted that LC, as early as 24 hours, did not increase complication or conversion rates. At UHWI, LC was offered largely on an elective basis and equipment was generally unavailable for emergency use, accounting for the small number of LCs done on an emergency basis in this study (17%).

Gallstone pancreatitis was also considered a contraindication in earlier series. In this era, many patients were subjected to OC in the same admission to eliminate the possibility of recurrent severe attacks (28). Laparoscopic cholecystectomy is safe when performed during the index admission for mild and moderate gallstone pancreatitis (29–34). There is evidence from several prospective randomized trials to prove that urgent ERCP within 72 hours of disease onset improves outcome in patients with severe gallstone pancreatitis (36–38). Similar to the scenario with OC, it is advised that LC be delayed for several weeks after the patient has settled from a severe attack (11). In this study, all patients with gallstone pancreatitis had OC because they were reluctant to delay operation until the tentatively scheduled dates for ERCP. This reflects institutional limitations at UHWI where, only five years since its introduction, ERCP is only performed on an elective basis at a rate of three cases per month (39). Despite this, gallstone pancreatitis was the indication for 13% of all ERCPs at UHWI, although it was not available for any case of severe disease within 72 hours (39).

Today, the only absolute contraindication to LC is gall bladder carcinoma but relative contraindications include acute cholangitis, portal hypertension, pregnancy and major bleeding diatheses (12, 15). The list of contraindications is still in evolution and depends upon the expertise of the surgical team (12, 15).

The 7.7% conversion rate in this series is greater than the 2–5% acceptable conversion rates for larger series (5, 12). This is expected in an early series due to the learning curve effect. At UHWI, Mitchell (3) reported 6% conversions during the first 100 LCs performed. But, seven years and 281 LCs later, the conversion rates fell to 3.6%, illustrating the learning curve effect (40). Similarly, the high conversion rate for residents performing LC is expected to reduce as they garner more experience.

Generally, conversion rates are higher in complicated cases. In a three-year meta-analysis across 84 studies, Krahenbuhl (17) reported greater conversions (20%) with 2207 LCs for acute cholecystitis compared to 9904 LCs without acute inflammation (7%). In the present series, there was one conversion occurring in a patient who had urgent LC 30 days after an acute attack. Overall, patients having LC for acute cholecystitis had 17% conversions compared to 4% for all other indications.

Other general factors that may herald a difficult operation with increased conversion or complication rates include older age, male gender, long symptomatic intervals and greater number of acute attacks before LC (18, 22, 41). In the present series, all conversions occurred in males, and one patient was 58 years of age. Local factors making dissection of Calot's triangle technically difficult include active inflammation, dense adhesions, peri-portal obesity, portal lymphadenopathy and bleeding (41, 14). Dense adhesions were present in both cases converted and portal lymphadenopathy was a contributory factor in one patient. Neither peri-portal obesity nor bleeding was associated with conversion in this study.

In the index series, the average operating time for LC (83 minutes) was comparable to other modern series (8, 3, 42, 5). Although operating time was longer than that for OC (81 minutes), the difference was not significant. The other benefits of LC reported in the literature were seen in this study, including reduced pain and analgesic requirements. Convalescence periods were significantly reduced after LC with more patients recovering sufficiently to allow discharge within 24 hours after LC (92% *vs* 57%). Quicker recovery also allowed more patients to have same day discharge (41% *vs* 25%) and halved the overall duration of hospitalization (0.8 *vs* 1.6 days) after LC. Due to the small study size, statistical significance could not be demonstrated but these results are consistent with the trends in current medical literature.

Many large studies have shown that these advantages come at the expense of greater complication rates (8, 12, 11, 15–17). Mortality rates after LC range from 0.02–0.07% (8, 12). Mortality in this study was lower after LC (0 *vs* 3.6%). The only death occurred after OC from a massive pulmonary embolus despite thrombo-prophylaxis.

There was a trend toward reduced postoperative complications after LC (8.3% *vs* 25%), but statistical significance could not be demonstrated with the small study size. The complication rates after LC is higher than the accepted complication rates ranging from 2–6% in modern literature (5, 8, 11, 12). But our results compare favourably to other early series (42). At UHWI, Mitchell (3) demonstrated a reduction in complication rates from 12% during the first 100 LCs to 2.2% after 640 cases.

Minor complications were commoner after OC (11%) than LC (4%) but statistical significance could not be demonstrated. Notably, 3.6% of patients developed wound infections after OC despite prophylactic antibiotics at induction in all cases. On the other hand, antibiotic prophylaxis was administered only in complex LC cases (21%) without any wound infections. This is in keeping with recent evidence that antibiotic prophylaxis is not necessary to prevent wound infection after LC. Five prospective randomized trials have consistently shown no benefit from antibiotic prophylaxis with LC (43–47). Ghnaniem (48) performed a meta-analysis of these five trials and demonstrated that 528 patients who received prophylaxis had no difference in wound infections (1.5%) compared to 371 patients who had prophylaxis omitted (2.1%).

Major complications tended to be commoner after OC (14% *vs* 4%), although this did not achieve statistical significance limited by the small sample size in this early case series. This is higher than the 1–2% acceptable major morbidity rates for LC reported in international literature (16, 12). But early series report similar figures ranging from 4% (42) to 6% (8). Pulmonary complications were twice as common after OC – a pattern previously described by Strasberg (14) who also reported less cardiac sequelae.

The incidence of BDI is higher after LC, occurring in 0.04–0.07% cases (11, 12, 14, 15). But in the present study the only BDI occurred during OC. Again, this finding must be taken in context of the small sample size.

Greater surgeon experience is protective against BDIs that tend to occur during the learning curve in smaller and earlier case series. The Southern Surgeon's Club (16) prospective analysis of 1518 LCs showed that as surgical experience increased beyond 13 cases, BDI reduced from 2.2% to 0.1%. Krahenbuhl (17) demonstrated a similar effect after the first 50 cases. Flum (18) also noted that BDI was more likely to be caused by surgeons who had performed less than 20 LCs (35% *vs* 25%). It is expected, then, that BDI is commoner when residents perform cholecystectomy. In this study, the injury was noted during the 25^{th} OC performed, although it would have been expected to be commoner during LC.

Greater surgeon training is also protective. Flum (18) noted that injuries were significantly more common during cholecystectomies performed by younger surgeons who were not board certified and were more recent graduates from medical school. Surgical residents fit this profile and the 3.6% incidence of BDI is testimony to this. But, the incidence of injury is expected to reduce with enrolment in an effective teaching programme. Mitchell (40) demonstrated the efficacy of the training programme at UHWI. Compared to other institutions, less BDI occurred at UHWI (0.36%) where more LCs are performed by residents than in all other hospitals across Jamaica (1.4%).

Routine IOC has been purported as a procedure that could reduce the prevalence of BDI by acting as an "operative roadmap" to detect unsuspected aberrant anatomy or by early detection of injuries. Three large retrospective studies together encompassing 1 596 472 cholecystectomies have shown 50–76% increased risk of BDI when IOC was not employed (18, 49, 50). But, this was not the case in this study.

Opponents argue that the mere activity of performing IOC by encircling and clipping a duct could incite damage if it is not the Cystic duct (51). But, advocates refute that injury is then recognized early, limiting its severity. (49, 50). A frequent argument is that routine IOC incurs significant cost and operating time. At UHWI, it was estimated that IOC during LC increased operating time by 49 minutes at an average cost of US$375 (3). In the present study, IOC during OC required 27 additional minutes operating time. On the other hand, the treatment of BDI is quite expensive with estimates in the literature ranging from US$13 612 to US$300 000. Flum (49) retrospectively applied population based data to decision analysis models developed specifically to compare routine IOC from a financial aspect. Routine IOC theoretically could save US$87 143 per BDI avoided – a financially significant value. Nevertheless, BDIs are not totally abolished with IOC. This was the case in our study where, despite IOC, injury was neither avoided nor detected early. In the current practice of cholecystectomy, the standard is to perform selective IOC for suspected choledocholithiasis or unclear anatomy (51, 52).

Reports that routine IOC detects retained stones in 10% of patients undergoing OC (52) has been used as its justification. In a prospective randomized trial of 275 LCs, Nies (53) reported that routine IOC detected unsuspected choledocholithiasis in 2.1% cases with 0.7% false positivity. After one year, patients randomized to LC without IOC had 1.4% retained stones, of which only 1 (0.7%) case was symptomatic of pancreatitis. Routine IOC could not be justified solely to prevent 0.7% symptomatic choledocholithiasis at significantly greater cost and operating time (53). Collins (54) prospectively studied 962 LCs over 11 years and reported that routine IOC had 61% false positivity in predicting unsuspected choledocholithiasis (2.3%). Expectant management of retained stones for six weeks was advocated, as 35% of these patients would have spontaneous asymptomatic stone clearance and the remaining 65% patients all remained asymptomatic to six weeks. Patients with proven retained stones can be managed selectively by ERCP with sphincterotomy and stone retrieval (53, 54).

In this study, five patients with gallstone pancreatitis had IOC that was normal in all cases. And, three patients with suspected choledocholithiasis were investigated with pre-operative ERCP that was normal in two (66%) cases. One patient with gallstone pancreatitis and a normal pre-operative ERCP initially accepted LC, but later opted for OC due to financial constraints. Choledocholithiasis was confirmed in one (33%) patient with sickle cell disease who had sphincterotomy and successful basket retrieval.

The average time between presentation and ERCP was 28 weeks. It was interesting that this interval prompted the choice against LC in 33% of patients overall and 71% of patients with gallstone pancreatitis. The long interval between presentation and LC (116 days) prompted the choice for OC in 14% cases. LC is more expensive than OC and even with cost subsidization at the UHWI, financial constraint was cited as a reason to select OC in 33% cases. The cost must be recovered in order to continue offering LC but increased available operating time for LC and ERCP and making equipment available for emergency use can increase LC utilization. These small changes in hospital policy would allow 77% more patients to enjoy the proven benefits of LC. Although this is a small retrospective study, it has demonstrated that there are similar benefits accompanying LC in this developing country. Surgical residents are performing LC with acceptable complication rates for an early series and with 95% patient satisfaction. Small changes in hospital policy would allow up to 77% of patients to enjoy these benefits at this institution.

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REFERENCES

1. Dubois F, Icard P, Berthelot G, Levard H. Coelioscopic cholecystectomy: Preliminary report of 36 cases. Ann Surg 1990; **211:** 60–2.
2. Reddick EJ, Olsen DO. Laparoscopic laser cholecystectomy. A comparison with mini-laparotomy cholecystectomy. Surg Endosc 1989; **3:** 131–3.
3. Mitchell DIG, DuQuesnay DR, McCartney T, Bhoorasingh P. Laparoscopic cholecystectomy in Jamaica. West Indian Med J 1996; **45:** 85–8.
4. Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW. Laparoscopic cholecystectomy. The new 'gold standard?' Arch Surg 1992; **27:** 917–23.
5. Talamini M, Gadacz T. Laparoscopic approach to cholecystectomy. Advances in Surgery 1992; **25:** 1–21.
6. Barkun JS, Barkun AN, Sampalis JS, Fried G, Taylor B, Wexler MJ et al. Randomised controlled trial of laparoscopic versus mini-cholecystectomy. The McGill Gallstone Treatment Group. Lancet 1992; **340:** 1116–9.
7. Kunz R, Orth K, Vogel J, Steinacker J, Meitinger A, Bruckner U et al. Laparoscopic cholecystectomy versus mini-laparotomy cholecystectomy. Results of a prospective, randomized study. Chirurg 1992; **63:** 291–5.
8. Soper NJ, Flye MW, Brunt LM, Stockmann PT, Sicard GA, Picus D et al. Diagnosis and management of biliary complications of laparoscopic cholecystectomy. Am J Surg 1993; **165:** 663–9.
9. McMahon AJ, Russell IT, Baxter JN, Ross S, Anderson JR, Morran CG et al. Laparoscopic versus mini-laparotomy cholecystectomy: a randomised trial. Lancet 1994; **343:** 135–8.
10. McGinn FP, Miles AJ, Uglow M, Ozmen M, Terzi C, Humby M. Randomized trial of laparoscopic cholecystectomy and mini-cholecystectomy. Br J Surg 1995; **82:** 1374–7.
11. Strasberg S, Hertl M, Soper N. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg 1995; **180:** 101–25.
12. Gadacz TR. Update on laparoscopic cholecystectomy, including a clinical pathway. Surg Clin North Amer 2000; **80:** 1127–49.
13. Ros A, Gustafsson L, Krook H, Nordgren CE, Thorell A, Wallin G et al. Laparoscopic cholecystectomy versus mini-laparotomy cholecystectomy: a prospective, randomized, single-blind study. Ann Surg 2001; **234:** 741–9.
14. Strasberg SM. Laparoscopic biliary surgery. Gastroenterol Clin North Amer 1999; **28:** 117–32.
15. Csendes A, Navarrete C, Burdiles P, Yarmuch J. Treatment of common bile duct injuries during laparoscopic cholecystectomy: endoscopic and surgical management. World J Surg 2001; **25:** 1346–51.
16. The Southern Surgeon's Club. A prospective analysis of 1518 laparoscopic cholecystectomies. N Engl J Med 1991; **324:** 1073–7.
17. Krahenbuhl L, Sclabas G, Wente M, Schafer M, Schlumpf R, Buchler M. Incidence, risk factors and prevention of biliary tract injuries during laparoscopic cholecystectomy in Switzerland. World J Surg 2001; **25:** 1325–30.
18. Flum DR, Dellinger EP, Cheadle A, Chan L, Koepsell T. Intraoperative cholangiography and risk of common bile duct injury during cholecystectomy. J Am Med Assoc 2003; **289:** 1639–44.
19. Champault A, Vons C, Dagher I, Amerlinck S, Franco D. Low cost laparoscopic cholecystectomy. Br J Surg 2002; **89:** 1602–7.
20. Lau H, Brooks DC. Contemporary outcomes of ambulatory laparoscopic cholecystectomy in a major teaching hospital. World J Surg 2002; **26:** 1117–21.
21. Rattner DW, Ferguson C, Warshaw AL. Factors associated with successful laparoscopic cholecystectomy for acute cholecystitis. Ann Surg 1993; **217:** 233–7.
22. Eldar S, Sabo E, Nash E, Abrahamson J, Matter I. Laparoscopic cholecystectomy for acute cholecystitis. Prospective trial. World J Surg 1997; **21:** 540–5.
23. Lujan JA, Parrilla P, Robles R, Marin P, Torralba JA, Garcia-Allyon J. Laparoscopic cholecystectomy vs. open cholecystectomy in the treatment of acute cholecystitis: a prospective study. Arch Surg 1998; **133:** 173–5.
24. Kiviluoto T, Siren J, Luukonen P, Kivilaakso E. Randomized trial of laparoscopic versus open cholecystectomy for acute and gangrenous cholecystitis. Lancet 1998; **351:** 321–6.
25. Lo CM, Lai EC, Fan ST, Liu CL, Wong J. Laparoscopic cholecystectomy for acute cholecystitis in the elderly. World J Surg 1996; **20:** 983–6.
26. Navez B, Mutter D, Russier Y, Vix M, Jamali F, Lipski D, et al. Safety of laparoscopic approach for acute cholecystitis: retrospective study of 609 cases. World J Surg 2001; **25:** 1352–6.
27. Lai PBS, Kwong KH, Leung KL, Kwok SPY, Chan ACW, Chung SCS et al. Randomized trial of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. Br J Surg 1998; **85:** 764–7.
28. Kelly TR, Wagner DS. Gallstone pancreatitis: A prospective randomized trial of timing of surgery. Surgery 1998; **104:** 600–5.
29. Rhodes M, Armstrong CP, Longstaff A, Cawthorn S. Laparoscopic cholecystectomy with endoscopic retrograde cholangiopancreatography for acute gallstone pancreatitis. Br J Surg 1993; **80:** 247–50.
30. Soper NJ, Brunt LM, Callery MP, Edmundowicz SA, Aliperti G. Role of laparoscopic cholecystectomy in management of acute gallstone pancreatitis. Am J Surg 1994; **167:** 42–9.
31. Tang E, Stain SC, Tang G, Froes E, Berne TV. Timing of laparoscopic surgery in gallstone pancreatitis. Arch Surg 1995; **130:** 496–9.
32. Tate JJ, Lau WY, Li AK. Laparoscopic cholecystectomy for biliary pancreatitis. Br J Surg 1994; **81:** 720–2.
33. Bulkin AJ, Tebyani N, Dorazio RA. Gallstone pancreatitis in the era of laparoscopic cholecystectomy. Am Surg 1997; **63:** 900–6.
34. de Virgilio C, Verbin C, Chang L, Linder S, Stabile BE, Klein S. Gallstone pancreatitis: the role of pre-operative endoscopic retrograde cholangiopancreaticography. Arch Surg 1994; **129:** 909–12.
35. Neoptolemos JP, Carr-Locke DL, London NJ, Bailey IA, James D, Fossard DP. Controlled trial of urgent ERCP and sphincterotomy versus conservative treatment for acute pancreatitis due to gallstones. Lancet 1988; **2:** 979–83.
36. Folsch UR, Nitsche R, Ludtke R, Hilgers RA, Creutz-Feldt W. Early ERCP and Papillotomy compared with conservative treatment for acute biliary pancreatitis. The German Study Group on Acute Biliary Pancreatitis. N Engl J Med 1997; **336:** 237–42.
37. Nowak A, Nowakwska-Dulawa E, Marek T, Rybicka J. Final results of the prospective randomized study on endoscopic sphincterotomy versus conventional management in acute biliary pancreatitis. Gastroenterol 1995; 108: A380 (abstract).
38. Fan ST, Lai EC, Mok FP, Lo CM, Zheng SS, Wong J. Early treatment of acute biliary pancreatitis by endoscopic papillotomy. N Engl J Med 1993; **328:** 228–32.
39. Plummer JM, Arthurs M, McDonald AH, Mitchell DIG, McFarlane ME, Newnham MS et al. Endoscopic Retrograde Cholangiopancreatography use at the University Hospital of the West Indies. West Indian Med J 2004; **53:** 234–7.
40. Mitchell DIG. Unpublished data presented at the Association of Surgeons of Jamaica Conference. Pegasus Hotel. Kingston Jamaica. 2001.
41. Ahrendt S, Pitt, HA. Surgical therapy of iatrogenic lesions of the biliary tract. World J Surg 2001; **25:** 1360–5.
42. Peters JH, Ellison EC, Innes JT, Liss JL, Nichols KE, Lomano JM, et al. Safety and efficacy of laparoscopic cholecystectomy: A prospective analysis of 100 initial patients. Ann Surg 1991; **213:** 3–12.
43. Dobay KJ, Freier DT, Albear P. The absent role of prophylactic antibiotics in low risk patients undergoing laparoscopic cholecystectomy. Am Surg 1999; **65:** 226–8.
44. Higgins A, London J, Charland S, Ratzer E, Clark J, Haun W, et al. Prophylactic antibiotics for elective laparoscopic cholecystectomy: are they necessary? Arch Surg 1999; **134:** 611–3.
45. Illig KA, Schmidt E, Cavanaugh J, Krusch D, Sax HC. Are prophylactic antibiotics required for elective laparoscopic cholecystectomy? J Am Coll Surg 1997; **184:** 353–6.
46. Mahatharadol V. A re-evaluation of antibiotic prophylaxis in laparoscopic cholecystectomy: randomized controlled trial. J Med Assoc Thai 2001; **84:** 105–8.
47. Tocchi A, Lepre L, Costa G, Liotta G, Mazzoni G, Maggiolini F. The need for antibiotic prophylaxis in elective laparoscopic

cholecystectomy: a prospective randomized study. Arch Surg 2000; 135: 67–70.
48. Al-Ghnaniem R, Benjamin IS, Patel AG. Meta-analysis suggests antibiotic prophylaxis is not warranted in low-risk patients undergoing laparoscopic cholecystectomy. Br J Surg 2003; **90:** 365–6.
49. Flum DR, Flowers C, Veenstra DL, A cost-effectiveness analysis of intraoperative cholangiography in the prevention of bile duct injury during laparoscopic cholecystectomy. J Am Coll Surg 2003; **196:** 358–93.
50. Fletcher DR, Hobbs MS, Tan P, Valinsky LJ, Hockey RL, Pikora TJ et al. Complications of cholecystectomy: risks of the laparoscopic approach and protective effects of operative cholangiography 1999: a population based study. Ann Surg 1999; **229:** 449–57.
51. Talamini MA. Routine vs. Selective intraoperative cholangiography during cholecystectomy. J Am Med Assoc 2003; **289:** 1691–3.
52. Barkun AN, Barkun JS, Fried GM, Ghitulescu G, Steinmetz O, Pham C, et al. Useful predictors of bile duct stones in patients undergoing laparoscopic cholecystectomy. Ann Surg 1993; **220:** 32–7.
53. Nies C, Baucknecht F, Groth C, Clerici T, Bartsch D, Lange J, et al. Intraoperative cholangiography as a routine method? A prospective, controlled, randomized study. Chirurg 1997; **68:** 892–7.
54. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC. A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: natural history of choledocholithiasis revisited. Ann Surg 2004; **239:** 28–33.