Original Article

Negotiating the Curve of Laparoscopic Hepatopancreaticobiliary Procedures (Basic to Advanced) at a Tertiary Rural Teaching Institute

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Abstract

Background: We present here our experience of laparoscopic hepatopancreaticobiliary (HPB) surgeries at our rural institute and the hurdles we faced overcoming the various challenges. **Aims and Objectives:** The objectives of this study were to assess the feasibility, successful completion, operative time, conversions/requirement of assistance, duration of hospital stay, and postoperative complications on the HPB procedures performed laparoscopically in our surgical unit; and to help young surgeons for smooth navigation through their laparoscopic career. **Materials and Methods:** All the patients admitted under our unit over the past 9 years for elective HPB surgeries operated by a single surgeon were included in this study. **Results:** Total 1304 basic laparoscopic biliary procedures were successfully completed laparoscopically. After getting well versed with the standard procedure, we switched over to difficult cases involving densely adhered gallbladder, frozen Calot's, Mirizzi's syndrome, use of intraoperative cholangiogram, and take down of cholecystoduodenal fistulas. Next step in evolution was doing laparoscopic common bile duct exploration and biliary procedures with decreased number of ports. Five hundred and sixty-eight procedures were advanced HPB surgeries. With time, we also started performing a variety of complex advanced laparoscopic procedures such as cystogastrostomy, hepaticojejunostomy, choledochoduodenostomy, and pancreaticojejunostomy. All these procedures have been discussed with respect to operative duration, conversion rates, blood loss, hospital stay, and complication rates in the initial and later parts of the learning curves and further compared with previous standard large case studies on specific surgeries. **Conclusion:** Several hurdles are met in a new institute, that too, a rural one. The present discussion will help the budding surgeons to identify their deficiencies and chart a way forward in a systematic scientific manner.

Keywords: *Hepatopancreaticobiliary surgery, laparoscopy, learning curve, minimally invasive surgery, residency training, rural center*

Introduction

Laparoscopic surgery has become an indispensable part of almost all surgical specialties due to its obvious advantages that include less pain, rapid recovery, shorter hospital stay, less wound complications, and better cosmesis. The past 30 years have shown an evolution of minimally invasive (laparoscopic) surgery to such an extent that in suitably trained hands, most of general surgical procedures can be safely undertaken laparoscopically. This development has been expedited by technological innovations and the enthusiasm of surgeons worldwide who have devoted their valuable time and proficiency developing their laparoscopic prowesses. In the present era, every surgeon wants to master this art of laparoscopic surgery as quickly as possible. However, everyone has to go through a "learning curve" for all surgical procedures whether basic or advanced. Diagnostic laparoscopies, laparoscopic cholecystectomy, and appendectomy are often the initial laparoscopic procedures one starts with, and then they move on to advanced procedures. We share our experience of 9 years of performing various laparoscopic hepatopancreaticobiliary (HPB) procedures.

The aims of the present study were to assess the following parameters on the HPB procedures performed laparoscopically – feasibility, successful completion, operative time, conversions or requirement of assistance, duration of hospital stay, postoperative complications, and hurdles in learning. The final objective was to make a learning ladder to chart a way forward for new and upcoming laparoscopic tertiary teaching institutes

How to cite this article: Kaushal-Deep SM, Singh V, Mani R, Gupta P, Lodi M. Negotiating the curve of laparoscopic hepatopancreaticobiliary procedures (basic to advanced) at a tertiary rural teaching institute. Int J App Basic Med Res 2018;8:237-43.

Received: 26 November, 2017.
Accepted: 25 May, 2018.

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Access this article online

Website: www.ijabmr.org

DOI: 10.4103/ijabmr.IJABMR_399_17

Quick Response Code:

to reduce learning time and properly plan upgradation of laparoscopic skills. This can guide and serve as a benchmark for budding surgeons who want to pursue career in laparoscopy more specifically in HPB surgery.

Materials and Methods

This is a retrospective analysis of a prospectively collected 9-year data of laparoscopic procedures. All the patients admitted under our general surgical unit at a postgraduate teaching institute for elective HPB surgeries were included in the study. Ours is a rural tertiary institute setup by an act passed by the government in the State Legislative Assembly 12 years back. All patients were aged between 11 and 75 years and operated by a single general laparoscopic surgeon having formal laparoscopic training. Various elective laparoscopic HPB (L-HPB) procedures were performed in standard way under adequate anesthesia after proper convincing and informed consent. The current study was approved by the institute's ethics committee and was conducted in accordance with guidelines of "Good Clinical Practice" and the "Declaration of Helsinki." Statistical analysis, wherever required, was done using Microsoft® Excel 2013.

Results

The operating surgeon performed a total of 2523 laparoscopic procedures during this period of 9 years out of which 1897 were L-HPB procedures which are the part of our current discussion. Figure 1 shows the flowchart of included patients. The male-to-female ratio of operated patients was approximately 1:5. All procedures involving the common bile duct (CBD), liver, and pancreas with or without usage of gastro-duodeno-jejunal entity were considered advanced L-HPB (AL-HPB) procedures.

Basic laparoscopic biliary (BL-B) procedures constituted ≈70% (1329/1897) of all L-HPB surgeries. BL-B surgeries performed included diagnostic laparoscopies for dilemmatic HPB pathologies; and standard four-port laparoscopic cholecystectomy including cases of empyema of gallbladder (GB), mucocele of GB, and moderately dense omental and bowel adhesions with GB. Rest ≈30% (568/1897) were AL-HPB surgeries. These included difficult laparoscopic cholecystectomies (frozen Calot's cases with difficult abnormal anatomy, Mirizzi's syndrome, and cholecystoduodenal fistulas), reduced port cholecystectomies (three-incision, two-incision, and single-incision laparoscopic cholecystectomy [SILC]), laparoscopic cholecystectomy with choledocholithotomy, and laparoscopic cystogastrostomy/cystojejunostomy. The AL-HPB procedures were further considered complex (CAL-HPB) if they involved mobilizing retroperitoneal structures (duodenum and pancreas) and/or multiple anastomoses. Nine CAL-HPB performed by the surgeon included three laparoscopic hepaticojejunostomy, five laparoscopic CBD exploration with choledochoduodenostomy, and one laparoscopic lateral pancreaticojejunostomy (modified Puestow procedure). Figure 2 shows the breakup of various BL-B, AL-HPB, and CAL-HPB procedures.

Conversions/requirement of rescue ports

Figure 3 shows a comparative analysis of conversion/requirement of rescue port rates for various procedures during different parts of our learning curve. The initial period has been defined in our study as the first half of the learning curve of that particular procedure and current period includes the procedures done during the second half of learning curve. A total number of BL-B done over 9 years were 1329 out of which 1304 BL-B procedures were successfully completed laparoscopically. During our initial part of learning curve (2008 to mid-2013), our conversion rate to open procedure in BL-B procedures was approximately 5%. This has fallen drastically to the current rate of 0.8%. The rate of requirement of rescue ports in

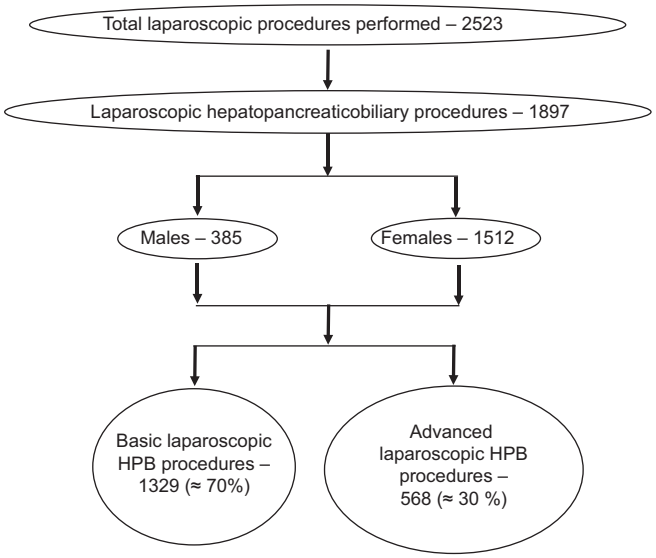

Figure 1: Data of various laparoscopic hepatopancreaticobiliary procedures

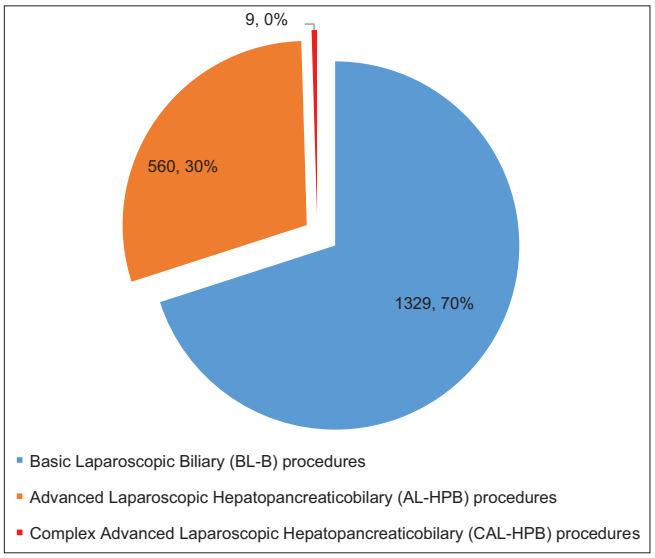

Figure 2: Data breakup of laparoscopic hepatopancreaticobiliary procedures

BL-B was initially approximately 1.5%. Our overall rate of requirement of rescue port in such procedures is 0.2%. Five hundred and sixty-eight procedures are AL-HPB surgeries, out of which 522 procedures are reduced port laparoscopic cholecystectomy (RPLC). The cases done with three-port and two-port laparoscopic techniques marked our transition period in the process of acquiring necessary know-how and technique required to perform SILC. Five hundred and twelve RPLCs were completed laparoscopically and only 10 cases were converted into open procedures (overall conversion rate of 2%). The rate of requirement of rescue ports has been expectedly relatively higher in RPLC (2.8%). All the CAL-HPB procedures (9) done till now have been done successfully without any conversions to open technique, though at times, rescue ports were required for retraction and/or ergonomics. Our overall conversion rate for all L-HPB procedures is 1.8% (35/1897).

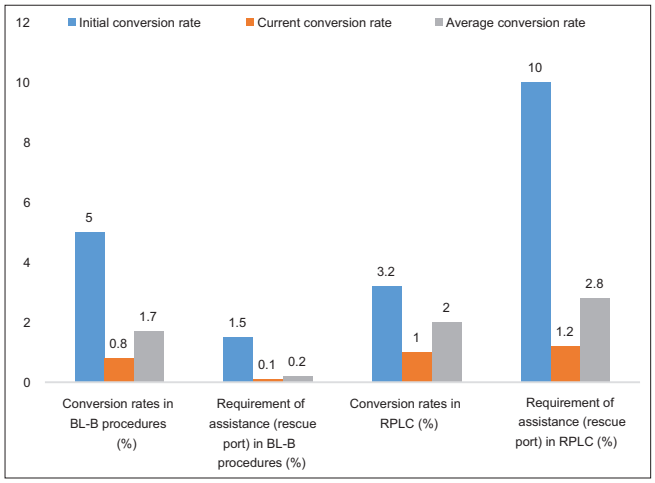

Figure 3: Conversions/requirement of rescue port rates

Operative time

The mean operative time, hospital stay, and blood loss during various procedures have been summarized in Table 1. As is the usual scenario with learning curve, the mean operative time was longer initially for all the procedures but now has been reduced significantly as is evident by the mean operative duration depicted in Table 1.

Major intraoperative and postoperative complications

Figure 4 shows the various complications which we met in our experience. The complication rates during the initial part of our learning curve were in the range of 5%–7% in various procedures. These rates fell to 1%–3% in the latter half of the learning as depicted in Table 2 ($P < 0.05$). No 30-day in-hospital mortality occurred during this duration. Iatrogenic perforation of GB during any L-HPB procedure has not been considered as complication as all such cases were managed by proper lavage and careful collection of spilled stones.

Discussion

This study highlights our experience over the past 9 years, which is a high-volume postgraduate teaching tertiary rural institute. The spectrum of L-HPB procedures performed is wide, ranging from basic to advanced HPB procedures. Table 2 shows a comparative analysis of our experience as compared to previously done standard long-term studies/meta-analyses on respective procedures.

Intraoperative parameters

Intraoperative parameters which have been described in Table 2 include operative time, blood loss, and hospital stay. The analysis of data with other studies from

Table 1: Data of successfully completed laparoscopic hepatopancreaticobiliary procedures

Procedure	Number of patients	Mean operative time (min)	Mean blood loss (ml)	Mean hospital stay (days)
BL-B surgeries				
Conventional laparoscopic cholecystectomy	1304	24 (15-123)	10	1.8 (0.6-26)
AL-HPB surgeries				
Reduced port (three-port and two-port) laparoscopic cholecystectomy	286	48 (28-140)	20	1.9 (0.9-5)
SILC	226	38 (21-131)	10	1.5 (0.5-5)
Laparoscopic cholecystectomy with choledocholithotomy	27	121 (109-156)	25	5.6 (5-8)
Laparoscopic cystogastrostomy and cystojejunostomy	9	97 (84-130)	90	5.8 (5-9)
Laparoscopic de-roofing of hepatic cyst	1	67	20	7
CAL-HPB surgeries				
Laparoscopic hepaticojejunostomy	3	240 (206-274)	100	9 (8-10)
Laparoscopic common bile duct exploration with choledochoduodenostomy	5	130 (102-141)	120	6.5 (5-8)
Laparoscopic lateral pancreaticojejunostomy (modified Puestow procedure)	1	350	120	10

BL-B: Basic laparoscopic biliary; AL-HPB: Advanced laparoscopic hepatopancreaticobiliary; CAL-HPB: Complex advanced laparoscopic hepatopancreaticobiliary; SILC: Single-incision laparoscopic cholecystectomy; RPLC - Reduced port laparoscopic cholecystectomy

Table 2: Comparative analysis of our experience as compared to previous standard long-term studies

Procedure	Authors and type of study	Mean operative time (min)	Mean blood loss (ml)	Conversion to open surgery rate (%)	Requirement of additional/ rescue ports rate (%)	Mean hospital stay (days)	Postoperative complication/ morbidity rate (%)
Conventional laparoscopic cholecystectomy	Our experience	24	10	1.7	0.2	1.8	2.8
	Meta-analysis Arezzo *et al*.[1]	47.2	NA	2.4	NA	2.16	6.3
	Meta-analysis Pisanu *et al*.[2]	45.8	NA	0.7	NA	2.2	9.8
Reduced port (three- and two-port) laparoscopic cholecystectomy	Our experience	48	20	2.0	2.8	1.9	4.0
SILC	Our experience	38	10	0	2.7	1.5	3.4
	Meta-analysis Arezzo *et al*.[1]	58.1	NA	1.2	NA	2.13	9.2
	Meta-analysis Pisanu *et al*.[2]	63	NA	0.43	NA	2.0	13.1
Laparoscopic cholecystectomy with choledocholithotomy (choledochotomy approach)	Our experience	121	25	1.1	0.8	5.6	7
	Quaresima *et al*.[3]	191	NA	11	NA	7	6
	Darkahi *et al*.[4]	194	NA	4	NA	4.8	4
Laparoscopic cystogastrostomy and cystojejunostomy	Our experience	97	90	0	11	5.8	0
	Palanivelu *et al*.[5]	89.3	69.3	NA	NA	5.6	6.1
Laparoscopic de-roofing of hepatic cyst	Our experience	67	20	0	0	7	0
	Palanivelu *et al*.[6]	60-110	Minimal	0	NA	3-5	42 (recurrence)
Laparoscopic hepaticojejunostomy (for biliary stricture only)	Our experience	240 (206-274)	100	0	0	9	0
	Chowbey *et al*.[7]	268 (270-350)	149	10	NA	4.9	22.2
	Cuendis-Velázquez *et al*.[8]	240 (120-585)	200 (50-1100)	3.4	0	8 (4-15)	17.2
Laparoscopic common bile duct exploration with choledochoduodenostomy	Our experience	130 (102-141)	120	0	0	6.5	20
	Chander *et al*.[9]	156.3	143.3 (50-500)	0	0	6.4	3.7
Laparoscopic lateral pancreaticojejunostomy (modified Puestow procedure) (no additional procedure)	Our experience	350	120	0	0	10	0
	Tantia *et al*.[10]	277	NA	23.5	0	5.2 (4-9)	11.8
	Palanivelu *et al*.[11]	178.5 (113-225)	NA	0	0	5 (4-7)	8.3

NA: Not Available; SILC: Single-incision laparoscopic cholecystectomy

Table 2 shows that for laparoscopic cholecystectomy (whether standard four-port or SILC) and laparoscopic choledocholithotomy, we have come a long way in terms of operative time compared to various studies and meta-analyses.[1-11] Major intraoperative complication rates are in general less than the previous data in BL-B procedures as compared to described literature. Data for blood loss are not available for most of the previous studies and hence a comparison cannot be done. For other AL-HPB procedures, we also appear to be at par with the described literature with regards to mean operative time, mean blood loss, and hospitalization time. There is a definite scope of improvement in AL-HPB procedures with special reference to CAL-HPB due to limited experience in these cases. We have only done a single complex pancreatic surgery, hence the more operative time in laparoscopic lateral pancreaticojejunostomy. Laparoscopic pancreatic surgery is gaining increasing recognition in recent times despite its highly complex nature and longer learning curve compared with surgeries for other abdominal viscera.

Conversions

Conversions of laparoscopic approach to open approach or use of rescue port in reduced port procedures were mainly due to lack of experience and non-availability of expert opinion. During the initial phase of learning,

dense adhesions with difficulty in proper delineation of Calot's triangle, anomalous anatomy, lack of requisite instrument at times, patients' safety, and lack of requisite skills such as intracorporeal suturing also contributed to conversions. We have a lower conversion rate as compared to the described literature as is evident from Table 2. During the recent 5 years, we feel more comfortable in going for the laparoscopic approach even in difficult cases, and this has drastically reduced our conversion rate without any effect on complication rate as complication rate has reduced proportionately with conversion rates.

Major intraoperative and postoperative complications

Most of the intraoperative complications in laparoscopic surgery stem from misperception or what is referred to as "visual perceptual illusion" and less commonly it is technique related.[12] Our overall complication rates were generally less than and in other cases comparable to various previous studies/meta-analyses and have been shown in Figure 4 and further tabulated in Table 2. The complication rates during the latter part of learning reduced by >50%.

Hurdles in learning and operative procedures

There are several factors which affected slope of our learning curve in this relatively new tertiary rural institute. This included lack of supervision and opinion of a senior/mentor during the initial phase of learning; huge load of patients leading to time constraints to complete all cases in limited timings; lack of will power and determination on part of operating surgeon (initially) and other members of operative team including residents and OT assistants; lack of awareness and willingness among patients, operation theater (OT) staff and anesthetists (time-to-time); lack of exposure of OT assistants to various laparoscopic surgeries; and increased wear and tear of instruments due to lack of knowledge and training of OT staff. The last factor has been curbed largely with time with the increased experience of permanently posted OT staff who understand the needs of the operating surgeon in a better way.

'Learning Curve' versus 'Learning Steps' and the 'Learning Ladder

The learning time for laparoscopic cholecystectomy in adults ranges from 10 to 75 procedures.[13] Chang *et al*.[14] showed that the duration of the operation correlates negatively with the experience of the operating surgeon. As mentioned earlier, every surgeon has to go through a phase of learning for basic as well as advanced surgeries. Some steps may be smaller and some may be big leaps. These big and small "learning steps" make your "learning ladder" as we have depicted ours in Figure 5. We think that the term 'learning curve' is a misnomer in the sense that it implies a state of stasis at the peak. It may be true for a single procedure but doesn't imply the overall capability of the surgeon. As learning and skill upgradation is a constant process for surgeons, what we assume is that we undergo 'learning steps'. Some steps are smaller, some are big leaps. Big leaps are the result of surgeons burning desire to try something new after proper training, their desire to innovate, a voracity to leave a mark, a constant devotion to work and last not the least, the passion for the surgical speciality of laparoscopy. This leads to a constant improvement in the surgical skills, if the surgeon is truly dedicated. These big and small 'learning steps' make your 'learning ladder' as we have depicted ours in Figure 5. There are no limits for anyone's 'learning ladder'.

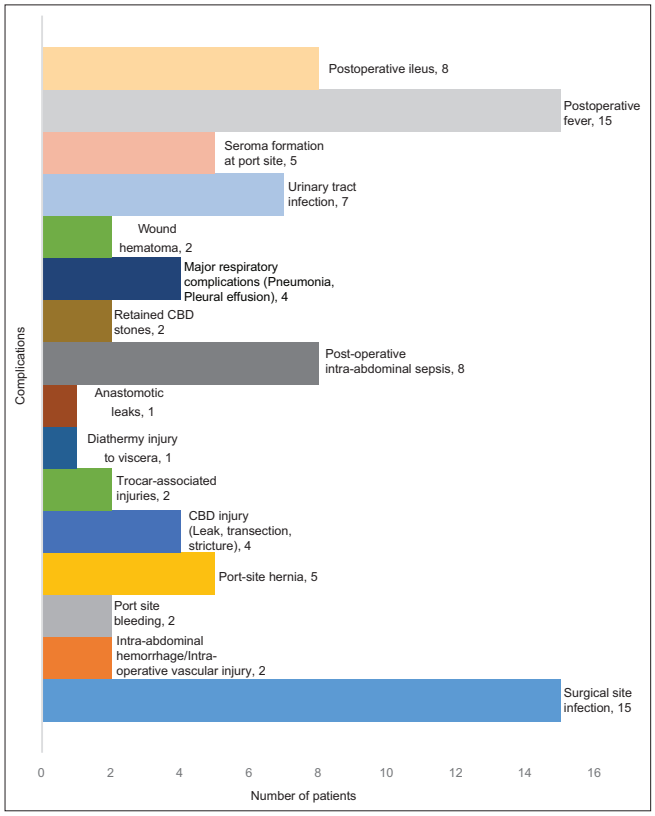

Figure 4: Complications

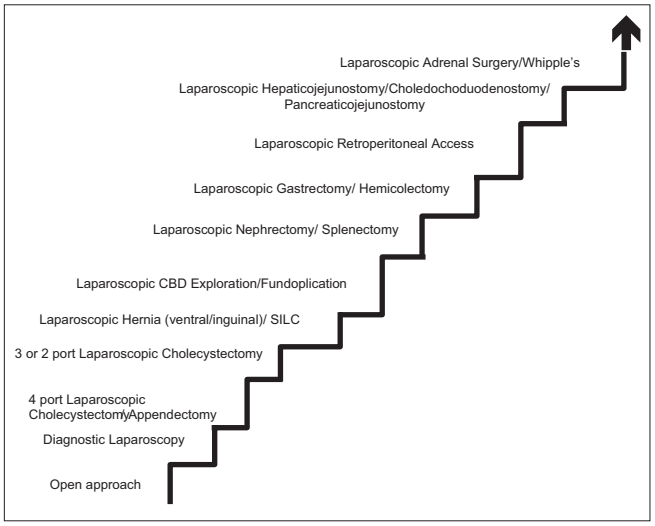

Figure 5: Our learning ladder

Lessons learned

Mode of Learning and Various Techniques Employed for Learning

Surgical training and learning starts from the very first day of your surgical postings. Authors' interest in laparoscopy was the result of the thesis topic allotted to him related to laparoscopy which was 'Laparoscopic Intervention in Non-acute Intestinal Pathologies' under one of the pioneers of laparoscopy that is Professor Rajiv Sinha. Further interest was cultivated by the beautifully written lines in Fischer's Mastery of Surgery and Mastery of Endoscopic and Laparoscopic Surgery by Swanstrom and Soper. During the senior residency, the author got to learn from and assist the front-runners in laparoscopy like Professor Jagdish Chandra, Professor Pawanindra Lal and Professor P. N. Agrawal. During the same period, the author had the grace to visit several laparoscopic teaching institutes in India and abroad. This made the author familiar with the basics of laparoscopy, laparoscopic suturing and knotting, handling of laparoscopic instruments and stapling devices.

Author joined as Assistant Professor in general surgery in this relatively new rural institute soon after completing his senior residency. The institute had a variety of newly procured and cutting-edge laparoscopic instruments at that time as it was in government's priority list. Due to the relatively few faculty members in the department and a good patient load in the hospital, there was a lot of exposure in a variety of cases. This was both a boon (lots of hands-on) as well a hindrance (lack of expert opinion). Thus, as depicted in our learning ladder previously, we first started with diagnostic laparoscopies and simple laparoscopic cholecystectomies. We then moved to increasingly complex procedures. Dr C. Palanivelu would need special mention here as his enthusiasm in laparoscopy, his optimistic and powerful inspiration in laparoscopic techniques and innovations were particularly motivating. His videos in laparoscopy available online, various lecture videos and reputed articles authored by him further expedited learning of the author.

Author actively participated in various laparoscopic workshops and conferences across India. Various technical know-how presented in the conferences, live operative sessions, discussions by the Masters of laparoscopy were very fruitful. It was through these sessions that the author came in touch with many current pioneers of laparoscopy where the author discussed with them the various problems he faced. The author also developed an indigenous laparoscopic trainer on which he used to practice for hours the various laparoscopic skills requiring expertise in various cases. This particularly boosted the hand-eye co-ordination, speed and dexterity of the author and led him to win the second prize in annual laparoscopic skills shootout competition 'Top Gun' conducted by Society of Laparoscopic Surgeons in Los Angeles USA in 2011. The author has currently many technical innovations presented at various conferences which are a result of the thirst to excel in the field of laparoscopy. Author is currently mentoring various thesis candidates and actively involved in laparoscopic training".

We need to develop a team approach for better results. Books are the ships that prepare us to chart the unknown seas. Reading and understanding the books thoroughly is the first step in learning. Proper training in basics of laparoscopy and courses for advanced laparoscopic procedures should be done from recognized and learned bodies. At the start of your laparoscopic career, careful selection of cases is very important as completing case by laparoscopic approach only even if it is time taking, gives a lot of confidence boost to the operating surgeon. However, initially, one should remain liberal with asking for a seniors help or asking for opinion of colleague/seniors and conversion to open approach. These should not be deemed as failures as patient safety should always be given due priority. Observerships at premier institutes also help in brushing up the fine details and learning new procedures. Attending national and international conferences on regular basis is a vital part of imbibing current knowledge. Educational video resources in the form of video articles in online journals, subscription to laparoscopy-dedicated websites, and finally, re-watching your own recorded difficult cases are a boon.

Conclusion

Several hurdles are met in a new institute, that too, a rural one. We have sailed through the rough patches keeping ourselves at par with the laparoscopic world. Laparoscopic surgery is here to stay. Learning and mastering the art of laparoscopic surgery is the need of hour. Finally, what led us to share our learning curve was that we did not come across any similar study or discussion during our review of literature especially from the point of view of young surgeons. Thus, this study has the potential to become a benchmark for budding surgeons who want to pursue career in laparoscopy, more specifically HPB surgery.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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