The integration of minimally invasive surgery in surgical practice in a Canadian setting: results from 2 consecutive province-wide practice surveys of general surgeons over a 5-year period

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Background: Although minimally invasive surgery (MIS) has been quickly embraced, the introduction of advanced procedures appears more complex. We assessed the evolution of MIS in the province of Quebec over a 5-year period to identify areas for improvement in the modern surgical era.

Methods: We developed, test-piloted and conducted a self-administered questionnaire among Quebec general surgeons in 2007 and 2012 to examine stated MIS practice, MIS training and barriers and facilitators to the use of MIS.

Results: Response rates were 51.3% (251 of 489) in 2007 and 31.3% (153 of 491) in 2012. A significant increase was observed for performance of most advanced MIS procedures, especially for colectomy for benign (66.0% v. 84.3%, $p < 0{,}001$) and malignant diseases (43.3% v. 77.8%, $p < 0{,}001$) and for rectal surgery for malignancy (21.0% v. 54.6%, $p < 0.001$). More surgeons practised 3 or more advanced MIS procedures in 2012 than in 2007 (82.3% v. 64.3%, $p < 0{,}001$). At multivariate analysis, the 2007 survey administration was associated with fewer surgeons practising advanced MIS (odds ratio 0.13, 95% confidence interval 0.06–0.29). In 2012, more respondents stated they gained their skills during residency ($p = 0.028$).

Conclusion: From 2007 to 2012 there was a significant increase in advanced MIS procedures practised by general surgeons in Québec. This technique appears well established in current surgical practice. The growing place of MIS in residency training seems to be a paramount part of this development. Results from this study could be used as a baseline for studies focusing on ways to further improve the MIS practice.

Contexte : Malgré l'adoption récente rapide de la chirurgie minimalement invasive (CMI), son utilisation pour les procédures complexes semble plus ardue. Afin d'identifier comment améliorer sa pratique, nous avons examiné l'utilisation de la CMI dans la province de Québec sur une période de 5 ans.

Méthodes : Nous avons développé, piloté, et distribué un questionnaire auto-administré aux chirurgiens généraux du Québec en 2007 et en 2012, afin d'examiner la pratique auto-rapportée de la CMI, la formation en CMI, et les barrières et facilitateurs à l'utilisation de la CMI.

Résultats : Le taux de réponse était de 51,3 % (251 sur 489) en 2007 et 31,3 % (153 sur 491) en 2012. L'utilisation de la majorité des procédures avancées de CMI a augmenté, particulièrement la colectomie pour maladie bénigne (66,0 % c. 84,3 %, $p < 0{,}001$) et maligne (43,3 % c. 77,8 %, $p < 0{,}001$), et la résection rectale pour cancer (21,0 % c. 54,6 %, $p < 0{,}001$). Plus de chirurgiens pratiquaient 3 procédures avancées de CMI ou plus en 2012 qu'en 2007 (82,3 % c. 64,3 %, $p < 0{,}001$). L'analyse multi-variée a indiqué que l'administration du questionnaire en 2007 était associée avec moins de chirurgiens pratiquant des procédures avancées de CMI (rapport de cote 0,13, intervalle de confiance à 95 % 0,05–0,29). En 2012, plus de répondants ont indiqué avoir obtenu leur expertise en CMI durant la résidence ($p = 0{,}028$).

Conclusion : De 2007 à 2012, la pratique de procédures avancées de CMI a augmenté significativement dans la province de Québec. L'approche minimalement invasive apparait solidement établie dans la pratique chirurgicale actuelle. La place grandissante de la CMI dans les programmes de résidence semble avoir été cruciale dans cet essor. Les résultats de cette étude peuvent maintenant servir à développer d'autres projets visant à améliorer encore davantage la pratique de la CMI.

Laparoscopic surgery has been one of the most important revolutions in surgery in the last century. The widespread use of this technique grew to be known as minimally invasive surgery (MIS). Many reports have now highlighted the benefits of the laparoscopic over the open approach for the treatment of a variety of conditions, mainly through a decrease in pain, blood loss, length of hospital stay and complications.[1,2]

Most surgeons quickly adopted laparoscopic cholecystectomy, but the introduction of major procedures can appear more complex. General surgeons in Canada have been able to follow the trend of the rising popularity of MIS to satisfy health services and increased public expectations, but the use of advanced MIS procedures has been variable.[3,4] The implementation of an MIS practice requires multiple conditions, such as technical skills and adapted tools. As these conditions vary among hospitals, the use of MIS may differ within a single health system. Moreover, the last few years have witnessed a quest for the least invasive procedure possible, with the advent of natural orifice transluminal endoscopic surgery (NOTES), single-port surgery or robotic surgery. Before considering widespread introduction of these latter techniques in current surgical practice, we need to better understand how previous developments have already been integrated.

To assess the current state of modern surgical practice, our aim was to describe the practice of MIS in the province of Quebec, the factors affecting it and its evolution over a 5-year timeframe. Therefore, in 2007 and 2012, we conducted practice surveys of Quebec general surgeons to determine self-reported MIS practice and training as well as the factors perceived to affect this surgical activity.

Methods

Sampling frame

The survey population was composed of Quebec's general surgeons working in both university-affiliated and community hospitals. In 2007 and 2012, postal or email addresses of potential respondents were obtained through the membership database of the Quebec Surgical Association (QSA), membership in which is mandatory. The final list included 489 potential respondents in 2007 and 491 in 2012.

Questionnaire development

The questionnaire was developed by a group of experts composed of academic surgeons specialized in MIS who identified important domains and specific issues within those domains, highlighting those most pertinent to MIS practice. We first generated items without restriction, grouped them into domains, and proceeded to item reduction in order to retain only the most relevant ones.[5] The questionnaire was designed using this final list of domains and items. The chosen domains were 1) parameters of surgical practice, 2) stated type of MIS practice, 3) MIS training, 4) barriers to MIS practice and 5) facilitators of MIS practice. Questions were constructed using closed answers. Advanced MIS procedures included all MIS procedures other than appendectomy, cholecystectomy and diagnostic laparoscopy. As both community and academic general surgeons in Quebec practise thoracic, endocrine or liver surgery, subspecialized procedures were included in this list. We used a 5-point Likert scale to assess the perceived importance of potential barriers and facilitators on an agree–disagree continuum. We test-piloted the original questionnaire by inviting 5 surgeons to complete it. These individuals were asked to provide feedback about the flow, the clarity and the ease of administration of the questionnaire. The questionnaire was reviewed accordingly.

Questionnaire administration

In 2007, the survey was self-administered in French in a written form. No incentive was offered to complete the questionnaire. Each potential respondent received a mailed invitation to complete the survey. Two reminders were sent over a 6-month period. An administrative assistant compiled the final database of completed questionnaires. No identifying information was included. In 2012, the survey was administered in a web-based format using SurveyMonkey, and email invitations were sent to all potential respondents. Reminders and compilation of data were done in a similar way as in 2007.

Data analysis

By aiming for a 60% response rate, we expected a precision of 5.7% in both 2007 and 2012. The precision for these surveys was 6.2% in 2007 and 7.9% in 2012.[5] We first performed descriptive analysis of completed questionnaires for both administration periods separately. Continuous data are expressed using means ± standard deviations (SDs) or medians and interquartile ranges (IQRs), as appropriate, and categorical data are reported as numbers and proportions. We conducted a univariate analysis to compare answers from respondents in 2007 and 2012, using a 2-sample t test, Fisher exact test or Pearson χ^2 test, as appropriate. We performed multivariate analysis using logistic regression to assess the variables associated with an advanced MIS practice (≥ 3 advanced MIS procedures). The year of survey administration as well as potential confounding variables were included in this model. Results are presented as odd ratios (ORs) with 95% confidence intervals (CIs). Data were considered to be significant at $p < 0.05$. Statistical analyses were conducted using XLSTAT version 2011.5 (Addinsoft SARL) for Microsoft Excel.

Results

In 2007, 251 (51.3%) of the general surgeons surveyed completed the questionnaire, whereas 153 (31.3%) completed it in 2012. There were 12 exclusions in 2007 (retired surgeons) and none in 2012 (Fig. 1).

Demographic characteristics and surgical practice parameters

Demographic data and surgical practice parameters of respondents are presented in Table 1. No significant difference was observed between the characteristics of respondents in 2007 and 2012, except that there were fewer respondents working in areas with a population of 50 000–500 000 individuals in 2007 (45,7% v. 57.9%, p = 0.020). Parameters of the surgical practice of respondents did not differ significantly between 2007 and 2012.

MIS practice characteristics

Table 2 presents MIS practice characteristics. Regarding basic MIS procedures, there was a significant increase in the number of surgeons practising laparoscopic appendectomies from 2007 to 2012 (82.3% v. 94%, p = 0.003). More surgeons reported always using an open technique for pneumoperitoneum establishment in 2012 (63.5% v. 76% p = 0.011). The 2012 survey showed an increased number of surgeons reporting the practice of 3 or more advanced MIS procedures (64.3% v. 82.3%, $p < 0.001$).

Details regarding the type of advanced MIS procedures performed are included in Table 2. The most commonly performed procedure reported in both surveys was colectomy for benign disease followed by the same surgery for malignancy. More surgeons reported practising these procedures in 2012 for both benign (66.%0 v. 84.3%, $p <$ 0.001) and malignant indications (43.3% v. 77.8%, $p <$ 0.001). The least often performed procedures at both time points were liver and lung resections.

MIS training

Perceptions of respondents on MIS training are reported in Table 3. From 2007 to 2012, the number of respondents stating that they gained their skills during residency (p = 0.028) or by self-training ($p < 0.001$) increased. In

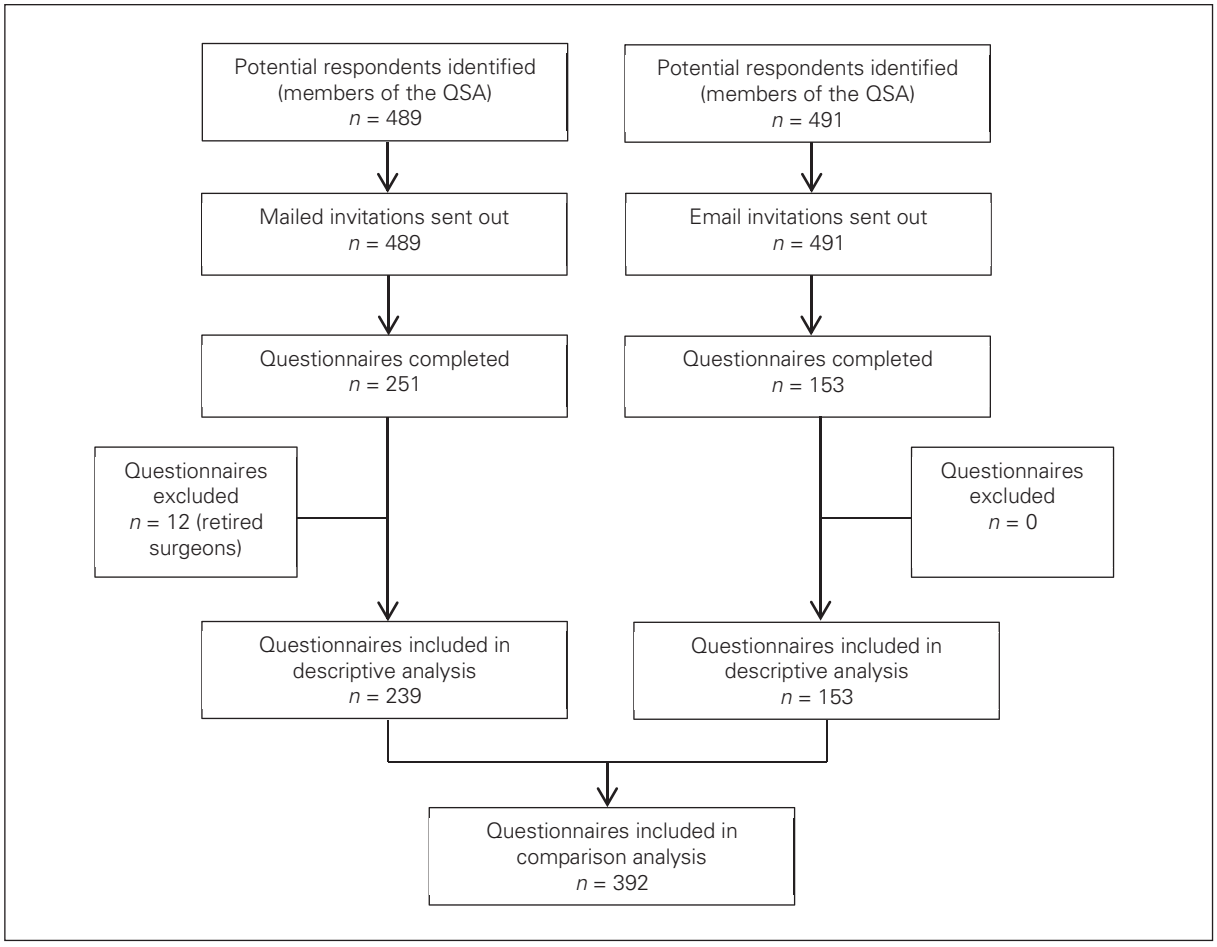

Fig. 1. Flow diagram of respondents. QSA = Québec Surgical Association.

both 2007 and 2012, most respondents perceived that the responsibility of MIS training lies with provincial surgical societies (92.0% in 2007 and 90.4% in 2012), national surgical societies (82.1% in 2007 and 91.7% in 2012) and universities (57.4% in 2007 and 62.5% in 2012).

Barriers and facilitators to MIS practice

Significant differences in barriers and facilitators to MIS practice were observed between 2007 and 2012. More respondents in 2012 disagreed or strongly disagreed that

Table 1. Comparison of respondents' demographics and practice characteristics between 2007 and 2012

Characteristic	2007 survey	2012 survey	*p* value
Age, mean ± SD yr	45.1 ± 10.6	43.7 ± 10	0.20
Male sex, no. (%)	141 (70.8)	106 (70.7)	0.97
Fellowship training, no. (%)	74 (31.1)	46 (30.7)	0.93
Surgical experience, mean ± SD yr	14.8 ± 10.7	13.5 ± 9.6	0.24
Community practice, no. (%)	114 (48.1)	85 (55.6)	0.15
Population, no. (%)			
< 50 000	54 (22.9)	26 (17.1)	0.17
50 000–500 000	108 (45.7)	88 (57.9)	0.02
> 500 000 individuals	74 (31.4)	38 (25)	0.18
Weekly operating time, mean ± SD d	1.4 ± 1.5	1.6 ± 1.3	0.32
Waiting time for malignant disease, mean ± SD wk	3.2 ± 2.0	3.7 ± 3.3	0.10
Waiting time for benign disease, mean ± SD wk	18 ± 31.2	17.3 ± 23.3	0.84

SD = standard deviation.

Table 2. Comparison of the characteristics of MIS practice between 2007 and 2012

Characteristic	2007 survey	2012 survey	*p* value
Basic MIS procedures performed, no. (%)			
Cholecystectomy	214 (90)	141 (94,0)	0.45
Diagnostic laparoscopy	214 (90)	145 (96,0)	0.09
Appendectomy	196 (82,3)	141 (94,0)	0.003
Technique used for pneumoperitoneum, no. (%)			
Always open (Hasson)	141 (63.5)	114 (76)	0.011
Always closed (Veress) or both	81 (36.5)	36 (24)	0.011
Number of advanced MIS procedures performed, no. (%)			
No advanced procedure	36 (15.1)	10 (6.5)	0.011
1–2 advanced procedures	49 (20.6)	17 (11.1)	0.013
≥ 3 advanced procedures	153 (64.3)	126 (82.3)	< 0.001
Type of advanced procedures performed, no. (%)			
Nissen fundoplication	90 (37.8)	75 (49)	0.029
Heller myotomy	52 (21.8)	51 (33.3)	0.012
Gastric resection	30 (12.6)	51 (33.3)	< 0.001
Liver resection	13 (5.46)	9 (5.9)	0.86
Biliary tract exploration	31 (13)	20 (13.1)	0.18
Distal pancreatectomy	21 (8.8)	27 (17.6)	0.009
Splenectomy	111 (46.6)	105 (68.6)	< 0.001
Adrenalectomy	60 (25.2)	50 (32.7)	0.109
Colectomy (benign disease)	157 (66)	129 (84.3)	< 0.001
Colectomy (malignant disease)	103 (43.3)	119 (77.8)	< 0.001
Rectal resection (benign disease)	87 (36.5)	97 (63.8)	< 0.001
Rectal resection (malignant disease)	50 (21)	83 (54.6)	< 0.001
Inguinal hernia repair	73 (30.7)	55 (36.2)	0.28
Ventral hernia repair	92 (38.7)	105 (68.6)	< 0.001
General video assisted thoracoscopy (pneumothorax or pleural effusion)	74 (31.1)	53 (34.6)	0.47
Video-assisted thoracoscopy for lung resection	33 (13.9)	16 (10.5)	0.32

MIS = minimally invasive surgery.

insufficient operative time ($p < 0.001$), lack of hospital resources ($p < 0.001$), lack of training opportunities ($p < 0.001$), lack of support from the hospital ($p < 0.001$) or insufficient remuneration ($p = 0.06$) were important barriers to MIS practice. In both surveys, most respondents did not believe that that the lack of scientific evidence or medicolegal issues were obstacles to the implementation of MIS (Table 4).

Multivariate analysis

On multivariate analysis, the 2007 survey administration was associated with significantly fewer surgeons reporting an advanced MIS practice (≥ 3 advanced MIS procedures; OR 0.13, 95% CI 0.06–0.29). Other variables associated with not practising advanced MIS were age (56–65 yr: OR 0.33, 95% CI 0.13–0.82; > 65 yr: OR 0.15, 95% CI 0.03–0.81), working in a community of fewer than 50 000 individuals (OR 0.4, 95% CI 0.19–0.83) and not performing MIS appendectomy (OR 0.04, 95% CI 0.01–0.10). The surgeons' experience (years in practice), community practice setting and the lack of fellowship training were not associated with the number of advanced procedures performed (Table 5).

Discussion

The benefits of MIS over open surgery are well established in terms of decreased postoperative pain, blood loss, length of hospital stay and complications,[1,2] and this technique is now part of modern general surgery practice; MIS even represents the standard of care in some cases.[6–9] The ability of general surgeons to learn and apply these new skills is paramount to keep up with the rapidly evolving field of general surgery. Our study illustrates the evolution of MIS practice in Quebec over a 5-year period 30 years after its introduction. We observed a significant increase in the number of advanced MIS procedures practised in the province from 2007 to 2012, with more surgeons performing 3 or more advanced techniques in 2012

Table 3. Comparison of respondents' perceptions regarding MIS training between 2007 and 2012

	Respondents, no. (%)					
Sources of MIS training, yr	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*p* value
During residency						
2012	24 (17,0)	8 (5.7)	3 (2.1)	44 (31.2)	62 (44.0)	
2007	49 (25.9)	16 (8.5)	8 (4.2)	63 (33.3)	53 (28)	0.028
Self-training						
2012	5 (3.5)	8 (5.6)	12 (8.3)	73 (50.7)	4 (31.9)	
2007	23 (10.9)	11 (5.2)	28 (13.3)	85 (40.5)	63 (30)	< 0.001
Help of colleagues						
2012	11 (7,9)	8 (5,7)	9 (6,5)	83 (59,7)	28 (20,1)	
2007	19 (9,3)	10 (4,9)	27 (13.2)	94 (45,8)	55 (26,8)	0.28
QSA CME seminars						
2012	30 (20.7)	13 (9.9)	19 (14.4)	50 (37.9)	20 (15.1)	
2007	58 (30.4)	21 (11)	24 (12.6)	59 (30.9)	29 (15.2)	0.54
MIS fellowship						
2012	61 (52.6)	12 (10.3)	21 (18.1)	14 (12.1)	8 (6.9)	
2007	100 (60.6)	8 (4.8)	18 (11)	19 (11.5)	20 (12.1)	0.09
Organizations responsible for MIS training						
University						
2012	2 (1.4)	3 (2.1)	7 (4.8)	70 (48.3)	63 (43.4)	0.09
2007	7 (3.8)	9 (4.9)	17 (9.2)	69 (37.5)	82 (44.6)	
QSA						
2012	1 (0.7)	2 (2.0)	10 (6.8)	87 (59.1)	46 (31.3)	0.045
2007	12 (6.5)	2 (1.1)	19 (10.3)	91 (49.8)	59 (42.2)	
CAGS						
2012	8 (5.9)	9 (6.6)	34 (25)	60 (44.1)	25 (18.4)	0.41
2007	20 (11.8)	10 (5.9)	42 (24.8)	63 (37.3)	34 (20.1)	

CAGS = Canadian Association of General Surgeons; CME = continued medical educatiuon; MIS = minimally invasive surgery; QSA = Québec Surgical Association

(64.3% v. 82.3%, $p < 0.001$). Colectomy for benign disease remained the most commonly performed MIS according to both surveys (66.0% in 2007 and 84.3% in 2012). Most respondents stated that they acquired their MIS skills during residency or by self-training. Major variables of surgical practice, including operating time and

Table 4. Comparison of respondents' perceptions barriers to MIS practice between 2007 and 2012

	Respondents, no. (%)					
Barriers to MIS practice, yr	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*p* value
Insufficient operating time						
2012	42 (29.2)	51 (35.4)	10 (6.9)	31 (21.5)	10 (6.9)	
2007	49 (22.6)	35 (16.1)	21 (9.7)	46 (21.2)	66 (30.4)	< 0.001
Lack of hospital resources						
2102	31 (21.7)	53 (37.1)	12 (9.1)	43 (30.1)	2 (2.1)	
2007	40 (18.4)	38 (17.5)	39 (18)	66 (30.4)	34 (15.7)	< 0.001
Lack of training opportunities						
2012	37 (26.1)	62 (43.7)	12 (9.9)	24 (16.9)	5 (3.5)	
2007	58 (27.7)	58 (27.7)	42 (20)	31 (14.8)	21 (10)	< 0.001
Lack of support from the hospital						
2012	41 (28.5)	59 (40.1)	19 (13.2)	23 (16)	2 (1.4)	
2007	48 (22.3)	51 (23.7)	46 (21.4)	41 (19.1)	29 (13.5)	< 0.001
Insufficient remuneration						
2012	43 (29.9)	42 (29.2)	23 (16)	30 (20.1)	6 (4.2)	
2007	61 (28.4)	31 (14.4)	48 (22.3)	44 (20.5)	21 (14.4)	0.006
Insufficient evidence-based data						
2012	55 (38.5)	57 (38.9)	17 (11.9)	14 (9.8)	0 (0)	
2007	71 (33.3)	68 (32)	43 (20.2)	26 (12.2)	5 (2.3)	0.05
Medicolegal issues						
2012	58 (41.11)	48 (34)	23 (16.3)	10 (7.1)	2 (1.4)	
2007	89 (42)	55 (26)	43 (20.2)	18 (8.5)	7 (3.3)	0.40

MIS = minimally invasive surgery.

Table 5. Mutlivariate regression of variables associated with advanced MIS practice (performance of 3 or more MIS procedures performed)*

Variable	Coefficient estimate	SD	OR† (95% CI)	p value‡
Intercept	3.77	0.75		< 0.001
2007 survey administration	–2.02	0.40	0.13 (0.06–0.29)	< 0.001
Female sex	–0.48	0.37	0.62 (0.3–1.27)	0.19
Surgeon age, yr				
< 35	0.53	0.53	1.70 (0.6–4.85)	0.32
46–55	0.30	0.46	1.35 (0.54–3.33)	0.52
56–65	–1.11	0.46	0.33 (0.13–0.82)	0.021
> 65	–1.88	0.85	0.15 (0.03–0.81)	0.030
> 10 years in practice	–0.31	0.42	0.73 (0.32–1.69)	0.46
No fellowship training	0.34	0.43	1.4 (0.6–3.28)	0.43
Population				
< 50 000	–0.93	0.38	0.4 (0.19–0.83)	0.011
> 500 000	0.63	0.47	1.88 (0.75–4.72)	0.18
Community practice	–0.47	0.43	0.62 (0.27–1.45)	0.27
Weekly operating time (days)	0.05	0.12	1.05 (0.84–1.32)	0.67
Open technique for pneumoperitoneum	–0.38	0.34	0.68 (0.35–1.34)	0.27
Not performing MI appendectomy	–3.2	0.46	0.04 (0.02–0.1)	< 0.001

CI = confidence interval; MI = minimally invasive; MIS = minimally invasive surgery; OR = odds ratio; SD = standard deviation.
*Number of advanced MIS procedures performed (< 2 v. ≥ 3) compared using logistic regression, Nagelkerke $R^2 = 0.453$.
†OR > 1 denotes increased practice of ≥ 3 MIS procedures; OR < 1 denotes decreased practice of ≥ 3 MIS procedures.
‡Wald χ^2 test.

hospital resources, were not perceived to be barriers to MIS practice, a trend that became more polarized in 2012.

When discussing the benefits of MIS for the treatment of various surgical conditions, the importance of surgical expertise in achieving these results is often highlighted: advanced MIS procedures are deemed beneficial if performed by experienced hands.[10] Our data show that the practice of basic and advanced MIS has significantly increased in Quebec in the last 5 years. Advanced MIS procedures that were once restricted to tertiary care settings have now widely spread. Multivariate analysis confirmed that the year of survey administration was significantly associated with an advanced MIS practice (OR 0.13 OR, $p < 0.001$) for the 2007 administration.

Appendectomy was one of the first procedures to be performed laparoscopically and is now one of the first laparoscopic techniques taught to general surgery residents. However, only 60.3% of general surgeons in Ontario performed minimally invasive (MI) appendectomies in 2004, as reported in a study from that province published in 2004.[4] Our survey had more encouraging results, with 94% of Quebec general surgeons practising MI appendectomy in 2012, which represents a significant increase over 2007 (82.3%, $p = 0.003$). In 2002–2003, a review of the practice of appendectomy in Quebec revealed that MIS was favoured in only 35% of cases of appendicitis.[11] The growing place of MIS in surgical practice may parallel this continued rising trend for MI appendectomy. Indeed, the Ontario survey observed that surgeons who practised MI appendectomy were more prone to do advanced MIS on univariate analysis (81.5% v. 39.1%, $p < 0.05$). Multivariate analysis from the present study revealed that not practising MI appendectomy was associated with a lower proportion of surgeons with an advanced MIS practice (OR 0.04, 95% CI 0.02–0.1). Poulin and colleagues[12] suggested that laparoscopic appendectomy is an interesting training procedure with which to transition toward laparoscopic colectomy. Ultimately, one may hypothesize that surgeons who do not practise MI appendectomy could be less comfortable with more advanced MI procedures.

The new generation of practising surgeons who have been trained in the MIS era may also contribute to the observed spread of advanced MIS procedures. Evolution over a few decades has allowed better integration of MIS not only in practice, but also in training with the development of new teaching tools and curricula.[13–16] In the United States, specific requirements for MIS training have even been added by the Accreditation Council for Graduate Medical Education Residency Review Committee, and the Fundamentals of Laparoscopic Surgery course is now mandatory for the American Board of Surgery.[17,18] Surveys of residents conducted in the early 2000s reported a perceived need for additional training in MIS both in Canada and in the United States.[19,20] In 2003, Canadian general surgery residents identified limited advanced case volume, limited opportunity in the operating room and lack of attending surgeon interest as factors with a negative impact on their MIS training.[19] With the evolution of the practice, this seems to have changed. In our survey, more respondents attributed their MIS training to residency ($p = 0.028$) in 2012 than in 2007. This reflects the adaptation of surgical training programs. Interestingly, universities were the last institution identified by respondents as being responsible for MIS training, which appear to contradict previously discussed findings. One hypothesis would be that with better MIS residency training, respondents feel that additional training for either maintenance of competence or acquisition of new skills then lies with surgical societies.

The practice of MIS relies on training but also on the available material resources and support, such as operating time or proper, up-to-date equipment. It takes time to build facilities and practice settings favouring adequate use of surgeons' skills, such as MIS. The 5-year lapse between our surveys seems to have allowed for these conditions to be united. Indeed, respondents did not identify significant institutional or clinical barriers to MIS practice. This was even more polarized in 2012, which may represent improvement in hospital resources. Interestingly, operating time was less of an issue in 2012 than in 2007. This could simply be related to a change in availability of operating time for general surgeons, but it could also represent a better use of this time by surgeons more efficient in MIS.

Other findings from our survey parallel the evolution of data in MIS and testify to the changing culture in this field. First, the number of surgeons who practise colorectal resections for malignancy has nearly doubled in 5 years. This is in keeping with the acceptance of the MIS approach as a safe oncological procedure for colonic malignancies and the growing evidence for laparoscopic treatment of rectal cancer.[21–23] Second, the number of MI inguinal hernia repairs performed did not differ between 2007 and 2012 (30.7% v. 36.2%, $p = 0.28$). Indeed, after being subject to great interest in the late 1990s and early 2000s, this technique lost popularity because of a reported higher rate of severe complications.[24,25] Third, we observed a significant difference in the preferred technique for pneumoperitoneum creation. More respondents reported always using an open technique in 2012 than 2007 (63.5% v. 76%, $p = 0.011$). Although this viewpoint has been challenged, the literature suggests that the open approach is superior to the closed entry technique because it is less likely to cause complications.[26–28] Our data are also in keeping with a survey of Canadian general surgeons reporting that more than 80% of them use the open technique.[29]

Limitations

The 51.3% and 31.3% response rates in 2007 and 2012 temper with the conclusions to be drawn from this survey. This represents an inherent challenge of survey studies, and is not out of the ordinary for a physician survey.[5] The difference in the number of responses in both administrations might be due to the change of the administration tool from a written form

to a web-based electronic platform. This renders the significant differences observed in the study more prone to the response bias inherent to survey studies. Indeed, surgeons with a greater interest or an established practice in MIS may have been keener to complete the questionnaire. Furthermore, this low response rate may also portend underpower issues, where lack of difference has to be interpreted with caution. We also acknowledge that our data represent stated intentions and perceptions of one's practice that may change with time and are not a perfect reflection of reality. Furthermore, questions addressed the number of surgeons performing MIS procedures but not the proportion of procedures actually performed using an MIS approach. Despite these limitations, we have collected interesting data about the evolution of MIS in Quebec. Beyond a snapshot of MIS practice, this study allows us to focus on the evolution of MIS in the modern surgical era.

Conclusion

We observed that from 2007 to 2012 there was a significant increase in the practice of advanced MIS procedures by general surgeons in Quebec. More surgeons have integrated MIS procedures in their practices, and this technique now appears well established in current surgical practice. The growing place of MIS in residency training seems to be a paramount part of this development over the last 5 years. Results from this survey could be used as a baseline for studies focusing on ways to further improve the existing MIS practice and examine the need for integrating newer technological advances in the current practice in relation with evidence-based data in the field.

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