

Which Cholecystectomy Technique Would Surgeons Prefer on Themselves?

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Background: As the minimally invasive surgery revolution approaches 30 years, many techniques are now available for cholecystectomy: open, conventional laparoscopy, mini-laparoscopy, single incision, robotic, and natural orifice. Although much has been published about patient preferences regarding these techniques, less is known about surgeon perceptions and preferences. The aim of this study was to survey attending and trainee surgeons about which cholecystectomy technique they would prefer for themselves and what factors determine their decision.

Methods: Attending fellow and resident surgeons globally completed a Google Forms online questionnaire that was posted in 3 closed groups for surgeons on Facebook and WhatsApp.

Results: The online questionnaire was completed by 600 surgeons (453 attending surgeons and 147 residents/fellows). Most respondents were male individuals (87.6% of attending surgeons, 78.2% of trainee surgeons). The most common age range of respondents was 31 to 40 years. Surgeon response was global, with especially good representation from North American, Asian, and European physicians. When conventional laparoscopy, mini-laparoscopy, and robotic surgery were the options offered for cholecystectomy, 58.5% of trainees and 45.7% of surgeons chose conventional laparoscopy. When asked if they would consider a single-incision or natural orifice transluminal endoscopic surgery approach, 91.5% answered no. When asked which technique they would prefer if hypothetically all techniques were equally safe, about three-fourths chose either conventional laparoscopy (46%) or mini-laparoscopy (27%). When asked to rank which factors they considered most important in choosing a surgical technique, surgeon experience (52%) and safety of the procedure (45%) were the 2 most important factors.

Conclusions: When an international sample of 600 attending and trainee surgeons were asked about undergoing a cholecystectomy on themselves, most chose either conventional laparoscopy or mini-laparoscopy as their preferred access technique. Single-incision and natural orifice transluminal endoscopic surgery approaches were unpopular. Surgeons ranked the experience of the operating surgeon and safety of the procedure as the most important factors guiding their decision.

Key Words: Minimally invasive surgery, cholecystectomy, surgical approach, laparoscopic cholecystectomy, mini-laparoscopy

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Minimally invasive surgery reduces incision size, postoperative pain, and recovery time compared with open surgery.¹ There are now multiple minimal access approaches available for cholecystectomy: conventional laparoscopy, mini-laparoscopy (MINI), single-incision laparoscopic surgery (SILS), robotic surgery, and natural orifice transluminal endoscopic surgery (NOTES).² Most studies comparing these approaches address feasibility, safety, efficacy, and cost. Fewer studies explore patient preferences and factors affecting surgical choice. We previously published a study exploring medical student preferences about cholecystectomy.³ The aim of this study was to survey a broad sample of attending and trainee surgeons about which minimally invasive technique they would prefer for cholecystectomy on themselves and what factors determine their decision.

METHODS

A 17-item online questionnaire was posted in 3 closed groups for surgeons on Facebook and WhatsApp. These 3 closed groups allowed sampling of surgeons specializing in laparoscopy (Mini Friends), robotic surgery (Robotic Surgery Collaboration), and general/hernia surgery (International Hernia Collaboration). This study did not involve human subject research or protected health information, and institutional review board approval was not required. The online questionnaire addressed hypothetical scenarios wherein the participants were being submitted to an elective cholecystectomy under various circumstances (Table 1). Data were collected, submitted to a biostatistician for analysis, and analyzed using the R Project Statistical Computing software version 3.3.1 (www.r-project.org). Statistical analysis was descriptive. Continuous variables were resumed with position and dispersion measures, and categorical variables with the distribution of frequencies. To analyze the relationship between variables, χ^2 and F tests were used, each one in its appropriate situation. The level of significance used was 5% and the confidence, to the confidence intervals, 95%.

RESULTS

The online survey was completed by 600 surgeons. There were 453 attending surgeons and 147 fellows and residents (Table 2). Most of the surgeons were male individuals, including 397 (88%) of the attending surgeons and 115 (78%) of the trainee surgeons. Respondents represented all ages and stages of a surgical career. The majority were in the first 10 years of surgical practice (52.3%) or in training (24.5%). Of those still in training,

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TABLE 1. 17-Item Questionnaire Completed by the Residents/Fellows and Surgeons

- 1 What is your gender?
- 2 What is your age?
- 3 In which country do you do your surgery residency?/In which country do you work as a surgeon?
- 4 What is your year in residency?/For how long have you been working as a surgeon (after residency)?
- 5 Would you undergo an open cholecystectomy if minimally invasive techniques were available?
- 6 Would you consider NOTES or SILS cholecystectomy on yourself, even though they are newer procedures with less well-established safety profiles?
- 7 If all cholecystectomy techniques (open, laparoscopic, MINI, robotic, SILS, NOTES) were equally safe, which one would you choose?
- 8 If only the minimally invasive techniques were offered to you (laparoscopic, MINI, robotic, SILS, and NOTES), which one would you choose?
- 9 If your only options were the NOTES approaches, which NOTES route would you choose—transgastric, transvaginal, or transrectal?
- 10 If only SILS, MINI, and robotic approaches were offered to you, which one would you choose?
- 11 Only if you chose Robotic surgery, which approach would you choose?
- 12 If only conventional laparoscopy, robotic surgery, or MINI were offered, which one would you choose?
- 13 What factor would you consider the most important when choosing the surgical technique?
 - Safety of the procedure
 - Experience of the surgeon
 - Early recovery
 - Cosmesis
 - Postoperative pain
 - Cost
 - Other
- 14 Which of the following factors would you consider the second more important when choosing the surgical technique?
- 15 If your first choice of an MIS approach was not available, what would be your second choice?
- 16 If only conventional laparoscopy, SILS, and robotic surgery were available, which one would you choose?
- 17 If all techniques were equally safe, which would be your second choice?

MINI indicates mini-laparoscopy; MIS, minimally invasive surgery; NOTES, natural orifice transluminal endoscopic surgery; SILS, single-incision laparoscopic surgery.

most were late in their training (48% fellows, 47% senior residents) (Table 2). Respondents represented a diverse global distribution, with North America (43%), Asia (20%), and Europe (18%) being the most represented regions (Table 3).

TABLE 2. Sociodemographic Characteristics of the Residents/Fellows and Surgeons

Demographic Characteristic	n (%)	
	Residents/Fellows	Surgeons
Sex		
Male	115 (78.2)	397 (87.6)
Female	32 (21.8)	56 (12.4)
Total	147	453
Age (y)		
21-30	46 (31.3)	8 (1.7)
31-40	76 (51.7)	177 (39.0)
41-50	17 (11.5)	152 (33.5)
51-60	7 (4.7)	84 (18.5)
> 60	1 (0.6)	32 (7.0)
Year in residency		
1st year	2 (1.4)	
2nd year	6 (4.1)	
3rd year	22 (14.9)	
4th year	20 (13.6)	
5th year	16 (10.8)	
6th year	11 (7.5)	
Fellowship	70 (47.6)	
Working as a surgeon (after residency)		
5 y		139 (30.6)
6-10 y		98 (21.6)
11-15 y		62 (13.6)
16-20 y		67 (14.7)
21-25 y		32 (7.0)
26-30 y		29 (6.4)
> 30 y		26 (5.7)

One question asked was: “If all cholecystectomy techniques (open, laparoscopic, MINI, robotic, SILS, and NOTES) were equally safe, which one would you choose?” To this question, 52.4% of residents/fellows and 43.9% of surgeons chose conventional laparoscopy (Table 4). The second most preferred choice was mini-laparoscopy, selected by 21.1% of residents/fellows and 28.5% of attending surgeons.

Another question asked was “If only the minimally invasive techniques were offered to you (laparoscopic, MINI, robotic, SILS, and NOTES), which one would you choose?” To this question, 60.5% of trainee surgeons and 46.1% of surgeons answered conventional laparoscopy (Table 5).

Respondents were probed a bit further regarding their preferences, by offering them fewer choices. When asked “if only conventional laparoscopy, robotic surgery, or MINI were offered, which one would you choose,” 58.5% of residents/fellows and 45.7% of surgeons opted for conventional laparoscopy (Table 6). When offered conventional

TABLE 3. Sociodemographic Characteristics of the Residents/Fellows and Surgeons

Continent	n (%)	
	Residents/Fellows	Surgeons
North America	63 (43)	253 (56.2)
South America	10 (6.8)	57 (12.6)
Africa	9 (6.1)	9 (2)
Europe	27 (18)	52 (11.5)
Central America	4 (2.7)	8 (1.7)
Asia	29 (20)	63 (13.9)
Oceania	5 (3.4)	8 (1.7)
Not answered	0 (0)	3 (0.7)
Total	147 (100)	450 (100)

Bold values denote the most important factors.

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TABLE 4. Preferred Surgical Technique for Cholecystectomy

Preferred Technique	n (%)	
	Residents/Fellows	Surgeons
Mini-laparoscopy	31 (21.1)	129 (28.5)
Conventional laparoscopy	77 (52.4)	199 (43.9)
Robotic surgery	16 (10.8)	86 (19)
Single-incision laparoscopy	13 (8.8)	19 (4.2)
NOTES	10 (6.8)	20 (4.4)
Open surgery	0 (0)	0 (0)
Total	147	453

Bold values denote the most important factors.

Pearson $\chi^2 = 14.0426$; $Pr = 0.007$.

NOTES indicates natural orifice transluminal endoscopic surgery.

laparoscopy, SILS, and robotic surgery, conventional laparoscopy was again selected by 74.2% of surgical trainees and 71.3% of surgeons (Table 7).

Respondents were also asked, "What factor would you consider the most important when choosing the surgical technique?" (Table 8). For attending surgeons, the experience of the surgeon was considered the most important factor (54.8%), followed by the safety of the procedure (43.5%). For residents and fellows, those 2 priorities were reversed, with the safety of the procedure as the most important factor (53.1%) followed by surgeon experience (42.9%).

In our previous study, which surveyed 111 medical students, MINI was the preferred technique. In the current study, conventional laparoscopy was preferred. A post hoc multinomial analysis of the data was therefore performed to see if there might be a correlation between surgeon career status (resident, fellow, and attending) and preference for a mini-laparoscopic procedure. The dependent variable was the technique, and the explicative variable was the experience of the professional (in years) (Table 9). The "coefficient" column shows the coefficients to each technique in relation to mini-laparoscopy. The column " $P > |z|$ " is the P -value for the significance of the surgeon experience to technique. The column "SE" means the standard error of the estimate and is a measure of the accuracy of estimates. The interpretation of the coefficient (-0.0320528) is that for each year of seniority as a surgeon, the chance of selecting the conventional laparoscopy instead of mini-laparoscopy decreases by ~3%. We observed a similar correlation between mini-laparoscopy and robotic surgery. For each year as a surgeon, the chance of choosing robotic surgery instead of mini-laparoscopy decreases ~4% (-0.0396437).

TABLE 5. Preferred Minimally Invasive Surgical Technique for Cholecystectomy

Preferred Technique	n (%)	
	Residents/Fellows	Surgeons
Mini-laparoscopy	27 (18.3)	134 (29.5)
Conventional laparoscopy	89 (60.5)	209 (46.1)
Robotic surgery	18 (12.2)	92 (20.3)
Single-incision laparoscopy	9 (6.1)	11 (2.4)
NOTES	4 (2.7)	7 (1.5)
Total	147	453

Bold values denote the most important factors.

Pearson's $\chi^2 = 19.1566$; $Pr = 0.001$.

NOTES indicates natural orifice transluminal endoscopic surgery.

TABLE 6. Preferred Surgical Technique for Cholecystectomy if Laparoscopy, Robotic, and MINI were Offered

Preferred Technique	n (%)	
	Residents/Fellows	Surgeons
MINI	37 (25.2)	148 (32.7)
Conventional laparoscopy	86 (58.5)	207 (45.7)
Robotic surgery	24 (16.3)	98 (21.6)
Total	147	453

Bold values denote the most important factors.

Pearson $\chi^2 = 7.2909$; $Pr = 0.026$

MINI indicates mini-laparoscopy.

DISCUSSION

Over the last 3 decades, as minimally invasive surgery has become routine, and as options for approach have expanded, some debate has naturally occurred regarding the comparisons of techniques. NOTES, single-incision laparoscopy, robotic surgery, and mini-laparoscopy have surfaced as alternative options to what is now a well-established procedure, conventional multiport laparoscopic cholecystectomy.⁴

Most studies comparing these approaches address feasibility, safety, efficacy, and cost.⁵⁻⁷ Fewer studies explore patient preferences and factors affecting surgical choice. To our knowledge, only one other study queried healthcare professionals about all currently available approaches.^{3,8-13} This study also reached a large number of participants (600) by implementing electronic tools and social media.¹⁴

Rao et al⁸ looked at preferences regarding SILS. Participants ($n = 750$) were asked about their preferred technique for appendectomy, and the single-incision approach was preferred. A limitation of this study was that mini-laparoscopy or robotic surgery was not offered as option. Rao et al⁸ attributed the preference for SILS over conventional laparoscopy to the concept of virtually scarless surgery, without the use of natural orifices.

Several investigators addressed preferences and perceptions regarding NOTES. Sulz et al⁹ offered 140 patients elective cholecystectomy through conventional laparoscopy or NOTES (transgastric and transvaginal). Transgastric NOTES cholecystectomy was not popular. For female individuals, transvaginal (rigid, hybrid) cholecystectomy had similar popularity to conventional laparoscopy.⁹ Teoh et al¹⁰ found that many Asian/Chinese patients preferred NOTES, mainly for cosmetic reasons. For those patients who chose conventional laparoscopy over NOTES, they

TABLE 7. Preferred Surgical Technique for Cholecystectomy if Laparoscopy, Robotic, and SILS were Available

Preferred Technique	n (%)	
	Residents/Fellows	Surgeons
SILS	11 (7.4)	15 (3.3)
Conventional laparoscopy	109 (74.2)	323 (71.3)
Robotic surgery	27 (18.4)	115 (25.4)
Total	147	453

Bold values denote the most important factors.

Pearson $\chi^2 = 6.8926$; $Pr = 0.032$

SILS indicates single-incision laparoscopic surgery.

TABLE 8. Response to the Question: “What Factor Would You Consider the Most Important When Choosing the Surgical Technique?”

	n (%)							
	Procedure Safety	Surgeon Experience	Early Recovery	Cosmetics	Postop Pain	Cost	Others	Total
Residents/fellows	78 (53.1)	63 (42.9)	2 (1.3)	1 (0.6)	2 (1.3)	1 (0.6)	0 (0)	147
Surgeons	197 (43.5)	248 (54.8)	3 (0.7)	0 (0)	3 (0.6)	0 (0)	2 (0.4)	453
Total								

Bold values denote the most important factors.
 Pearson $\chi^2 = 13,3569$; $P = 0.064$.

reported perceptions that NOTES was too new, it was too dangerous, it had no apparent advantage over the gold-standard technique, and they also did not like the idea of specimen removal through their mouth or rectum. Swanson et al¹¹ surveyed 192 patients about their preferences for conventional laparoscopic or NOTES cholecystectomy, and 56% chose NOTES. Safety, pain, and recovery time were ranked as more important than cosmesis, cost, or length of hospital stay. Patients still had concerns about increased risk, surgeon inexperience, and cost. Hagen et al¹⁵ surveyed 292 participants and found a decreasing desire for scarless surgery as risk increased. Interestingly, younger patients were less satisfied with scars but they were also less inclined to accept higher surgical risk.

Bucher et al¹³ surveyed only female individuals (n = 300), regarding conventional laparoscopy, transvaginal NOTES, and SILS. If all techniques were considered equally safe, then 87% preferred SILS. The female respondents were attracted to SILS and NOTES because of perceptions of improved cosmesis and lower pain. However, 96% of them were worried about transvaginal access causing postoperative dyspareunia, decreased sensibility during intercourse, and the need for short-term abstinence from intercourse.

Almost all of the above studies failed to include mini-laparoscopy as one of the access choices. Mini-laparoscopy has been around for > 20 years, and recent advances in MINI instrumentation are significant.¹⁶⁻²¹ Yet, its penetrance remains limited and somewhat regional. Ironically, in our prior study with Brazilian medical students, mini-laparoscopy was their preferred choice.³ In the present study, conventional laparoscopy was the preferred technique by all groups (surgeons, fellows, and residents). It is interesting though that, in the multinomial analysis comparing practicing surgeons to surgical trainees, more experienced surgeons were more willing to choose mini-laparoscopy. It is well accepted that the introduction and acceptance of new technologies and techniques is a complex and often slow process.²² It is also possible that unfamiliarity with mini-laparoscopy and/or lack

of newer and better MINI instrumentation in many regions may be contributing to these findings.

This study expands upon our previous work in which the same survey questions were answered by 111 Brazilian medical students,³ where there was a difference in the survey methodology: before answering the 17-item questionnaire, the medical students watched a 5-minute video that provided them with some baseline knowledge about the procedures and the published risks and benefits of each technique. For the current study of practicing surgeons and surgeons in training, we wanted to understand their existing perceptions, without any potential bias that might be induced by (or perceived to be induced by) such a video, so no video was shown.

For both the prior study with medical students and the current study with trainee/attending surgeons, the authors selected cholecystectomy as the hypothetical operation because of the familiarity of most people with this procedure as laparoscopic cholecystectomy is one of the most common surgeries performed annually. It is also a procedure with which most medical students, residents, and fellows are quite familiar.

Strengths of the current study include a large number of respondents (n = 600), the global draw of the respondents, broad sampling of open/laparoscopic/robotic surgeons, representation of surgeons from all stages of a surgical career, and the offering of all contemporary surgical techniques. A limitation of this study is that participants were not queried more about their individual daily practices or workplace/social resources, and the form was submitted to a population connected through online education platforms.

CONCLUSIONS

When an international sample of 600 attending and trainee surgeons were asked about undergoing a cholecystectomy on themselves, most chose either conventional laparoscopy or mini-laparoscopy as their preferred access technique. More experienced surgeons were slightly more inclined to choose mini-laparoscopy over either conventional

TABLE 9. Multinomial Model Analysis With Dependent Variable (Chosen Technique) and Explicative Variable (Years Experience)—Surgeons

Technique Chosen for Analysis: Mini-Laparoscopy	Coefficient	SE	z	P > z	95% CI
Conventional laparoscopy	-0.0320528	0.011542	-2.78	0.005	-0.0546748 to -0.0094309
Robotic surgery	-0.0396437	0.0149072	-2.66	0.008	-0.688613 to -0.0104261
Single-incision laparoscopy	-0.0365041	0.0266737	-1.37	0.171	0.0887836-0.0157754
NOTES*	-0.0365041	0.0266737	-1.37	0.171	-0.0887836 to 0.0157754
Open surgery	-0.0211578	0.0246345	-0.86	0.390	< 0.0694406-0.0271249
Others	-0.0187776	0.1027569	-0.18	0.855	-0.2201773 to 0.1826222

*Denote the most important factor.
 CI indicates confidence interval; NOTES, natural orifice transluminal endoscopic surgery.

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laparoscopy or robotic surgery. Single-incision and NOTES approaches were not popular. Both practicing surgeons and surgical trainees ranked experience of the operating surgeon and safety of the procedure as the 2 most important factors guiding their decision.

REFERENCES

- Rao PP, Rao PP, Bhagwat S. Single-incision laparoscopic surgery—current status and controversies. *J Minim Access Surg*. 2011;7:6–16.
- Noguera JF, Cuadrado A. NOTES, MANOS, SILS and other new laparoendoscopic techniques. *World J Gastrointest Endosc*. 2012;4:212–217.
- Carvalho GL, Lima DL, Shaddock PP, et al. Which cholecystectomy do medical students prefer? *JSLs*. 2019;23:e2018.00086.
- Gaillard M, Tranchart H, Lainas P, et al. New minimally invasive approaches for cholecystectomy: review of literature. *World J Gastrointest Surg*. 2015;7:243–248.
- Gurusamy KS, Vaughan J, Rossi M, et al. Fewer-than-four ports versus four ports for laparoscopic cholecystectomy. *Cochrane Database Syst Rev*. 2014;CD007109.
- Arezzo A, Scozzari G, Famiglietti F, et al. Is single-incision laparoscopic cholecystectomy safe? Results of a systematic review and meta-analysis. *Surg Endosc*. 2013;27:2293–2304.
- Borchert DH, Federlein M, Fritze-Büttner F, et al. Post-operative pain after transvaginal cholecystectomy: single-center, double-blind, randomized controlled trial. *Surg Endosc*. 2014;28:1886–1894.
- Rao A, Kynaston J, MacDonald ER, et al. Patient preferences for surgical techniques: should we invest in new approaches? *Surg Endosc*. 2010;24:3016–3025.
- Sulz MC, Zerz A, Sagmeister M, et al. Perception of preference and risk-taking in laparoscopy, transgastric, and rigid-hybrid transvaginal NOTES for cholecystectomy. *Swiss Med Wkly*. 2013;143:w13888.
- Teoh AYB, Ng EKW, Chock A, et al. Asian-Chinese patient perceptions of natural orifice transluminal endoscopic surgery cholecystectomy. *Dig Endosc*. 2014;26:458–466.
- Swanstrom LL, Volckmann E, Hungness E, et al. Patient attitudes and expectations regarding natural orifice transluminal endoscopic surgery. *Surg Endosc*. 2009;23:1519–1525.
- Hey J, Roberts KJ, Morris-Stiff GJ, et al. Patient views through the keyhole: new perspectives on single-incision vs. multiport laparoscopic cholecystectomy. *HPB (Oxford)*. 2012;14:242–246.
- Bucher P, Ostermann S, Pugin F, et al. Female population perception of conventional laparoscopy, transumbilical LESS, and transvaginal NOTES for cholecystectomy. *Surg Endosc*. 2011;25:2308–2315.
- Lima DL, Cordeiro RN, Carvalho GL, et al. The influence of social media in minimally invasive surgery education: how surgeons exchange experience and knowledge in these platforms. *J Minim Access Surg*. 2019;15:275–276.
- Hagen ME, Wagner OJ, Christen D, et al. Cosmetic issues of abdominal surgery: results of an enquiry into possible grounds for a natural orifice transluminal endoscopic surgery (NOTES) approach. *Endoscopy*. 2008;40:581–583.
- Cavazzola LT, de Carvalho GL, Silva JSN. Who should decide the best minimally invasive approach? Should we listen to our patients? *Surg Endosc*. 2011;25:1351–1352.
- Firme WA, Carvalho GL, Lima DL, et al. Low friction mini-laparoscopy outperforms regular 5-mm and 3-mm instruments for precise tasks. *JSLs*. 2015;19:e2015.00067.
- Redan JA, Humphries AR, Farmer B, et al. Big operations using mini instruments: the evolution of mini laparoscopy in the surgical realm. *Surg Technol Int XXVII*. 2015:19–30.
- Shaddock PP, Moreno Paquentin E, Carvalho GL, et al. Mini-laparoscopy: instruments and economics. *Surg Technol Int XXVII*. 2015:59–64.
- Carvalho G, Redan JA, Shaddock PP. Morphing into Mini. *Surg Technol Int*. 2015;27:15.
- Carvalho GL, Paquentin EM, Redan JA, et al. The science behind mini-laparoscopic cholecystectomy. *Surg Technol Int*. 2016;29:93–98.
- Strong VE, Forde KA, MacFadyen BV, et al. Ethical considerations regarding the implementation of new technologies and techniques in surgery. *Surg Endosc*. 2014;28:2272–2276.