Original Article

Biliary Surgery During Residency: A Nationwide Study

Cirurgia Biliar Durante o Internato: Um Estudo a Nível Nacional

Filipa Dias Mendes[1#*], Mauro Sousa[2#], Sofia Silva[3#]

1. Surgery Department, Unidade Local de Saúde Cova da Beira, Covilhã, Portugal
2. Surgery Department, Unidade Local de Saúde Lisboa Norte, Lisboa, Portugal
3. Surgery Department, Unidade Local de Saúde Baixo Vouga, Aveiro, Portugal

\# On behalf of Comissão de Internos de Cirurgia Geral 2021-2023

Corresponding Author/Autor Correspondente:
Filipa Dias Mendes [filipa_mendes2@hotmail.com]
Praça da Comunidade Lusíada Bloco 10, 2º Direito 4610-115 Felgueiras

https:/doi.org/10.34635/rpc.1071

ABSTRACT

Introduction: Biliary surgeries present a challenge in general surgery training. Increased exposure to laparoscopic techniques, coupled with a decline in experience with open procedures and more complex biliary interventions, has become a point of concern for general surgery residency programs. The objectives of this article are to assess the biliary surgery experience of general surgery residents across Portugal, compare it with the training in other Western countries, and evaluate differences between the curricula of residents trained in central hospitals and those in district hospitals.

Methods: An analysis was conducted using data from an online questionnaire administered to general surgery residents in Portugal in 2023.

Results: Out of 93 residents with more than one year of experience, 63 were in their final three years of residency (68%). The majority were from district hospitals (61, 66%). While 88 residents had assisted in an open cholecystectomy, only 63 (72%) had performed one, with most being in their final years of training. Only 28 residents (32%) felt confident in performing this procedure. 88 residents had performed a laparoscopic cholecystectomy, 59 (67%) completed more than 20, including two residents in their second year (R2Y). Fifty-seven residents had converted a laparoscopic cholecystectomy, and 8 were unable to complete the surgery. In cases requiring conversion, most residents employed a "fundus-first" technique. When faced with a challenging laparoscopic case, 10 residents (11%) would choose to convert, while 60 (64%) preferred performing a laparoscopic subtotal cholecystectomy, and 23 (25%) favored the laparoscopic "fundus-first" approach. Thirty-four residents had performed intraoperative cholangiograms, with

Received/Recebido: 05/10/2024 **Accepted/Aceite:** 11/10/2024 **Published online/Publicado online:** 31/01/2025 **Published/Publicado:**

32 (94%) doing so selectively. Seventeen residents had performed biliary tree exploration, and 9 had performed a biliodigestive anastomosis. All respondents agreed on the need for further training in biliary surgery.
Conclusion: There is widespread concern about the lack of experience with cholangiography and bile duct exploration, highlighting the need for practical training tools to improve residents' proficiency in these critical areas.

Keywords: Biliary Tract Surgical Procedures; Cholangiography; Cholecystectomy, Laparoscopic/education; Clinical Competence; Curriculum; Education, Medical, Graduate; Internship and Residency

RESUMO

Introdução: As cirurgias biliares representam um desafio no treino da cirurgia geral. O aumento da exposição a intervenções laparoscópicas, aliado ao declínio na prática de procedimentos abertos e à crescente realização de intervenções biliares mais complexas, tornaram-se um foco de preocupação para os programas de internato em cirurgia geral. Os objetivos deste artigo são avaliar a experiência em cirurgia biliar dos internos de cirurgia geral em Portugal, compará-la com a formação noutros países ocidentais e avaliar as diferenças entre os currículos dos internos formados em hospitais centrais e os dos hospitais distritais.
Métodos : Foi realizada uma análise a partir de dados de um questionário online aplicado a internos de formação específica de cirurgia geral em Portugal em 2023.
Resultados: Dos 93 internos com mais de um ano de experiência, 63 estavam nos últimos três anos de residência (68%). A maioria era proveniente de hospitais distritais (61, 66%). Embora 88 internos tenham assistido a uma colecistectomia aberta, apenas 63 (72%) a realizaram, sendo a maioria nos últimos anos de formação. Apenas 28 internos (32%) se sentiram confortáveis na realização deste procedimento. 88 internos realizaram colecistectomias laparoscópicas, 59 (67%) completaram mais de 20, incluindo dois internos no segundo ano (R2Y). 57 internos converteram uma colecistectomia laparoscópica e 8 não conseguiram concluir a cirurgia. Nos casos que exigiam conversão, a maioria dos internos empregava uma técnica de "fundo primeiro". Quando confrontados com um caso laparoscópico desafiador, 10 internos (11%) optariam pela conversão, enquanto 60 (64%) prefeririam realizar uma colecistectomia subtotal laparoscópica e 23 (25%) prefeririam a abordagem laparoscópica "fundo primeiro". Trinta e quatro internos realizaram colangiografias intraoperatórias, sendo que 32 (94%) o fizeram de forma seletiva. Dezassete internos realizaram exploração das vias biliares e 9 realizaram anastomose biliodigestiva. Todos os entrevistados concordaram com a necessidade de treinamento adicional em cirurgia biliar.
Discussão: A experiência dos internos em cirurgia biliar é predominantemente limitada à colecistectomia laparoscópica, uma vez que procedimentos biliares mais complexos raramente são realizados por eles, refletindo tendências em outros países. Os internos dos hospitais centrais geralmente têm mais exposição a cirurgias abertas, começam a operar mais cedo e tendem a estar mais confiantes com o procedimento em comparação com os seus homólogos dos hospitais distritais, no entanto, no último ano, a diferença diminui. No que diz respeito à colecistectomia laparoscópica, os internos dos hospitais centrais alcançaram volumes cirúrgicos mais elevados mais cedo do que os dos hospitais distritais (particularmente no segundo e terceiro anos), mas os internos dos hospitais distritais recuperam nos últimos anos. As taxas de conversão foram mais elevadas nos hospitais centrais durante o quarto e quinto anos (R4Y e R5Y), enquanto os hospitais distritais apresentaram taxas mais elevadas durante o segundo e sexto anos (R2Y e R6Y). Esta disparidade pode ser atribuída à exposição precoce a procedimentos complexos. Existe uma preocupação generalizada sobre a falta de experiência com colangiografia e exploração das vias biliares, destacando a necessidade de ferramentas práticas de formação para melhorar a proficiência dos internos nestas áreas críticas.

Palavras-chave: Colangiografia; Colecistectomia Laparoscópica/educação; Competência Clínica; Currículo; Educação de Pós-Graduação em Medicina; Internato e Residência; Procedimentos Cirúrgicos do Trato Biliar

INTRODUCTION

One of the enduring challenges faced by general surgery residents is the diminishing trust in traditional open cholecystectomies. The shift towards minimally invasive techniques and the decline in open procedures have resulted in reduced exposure and curricular opportunities.[1]

The first open cholecystectomy was performed by Langebuch in 1882, followed by the first laparoscopic cholecystectomy a century later.[2,3] The robotic era began in 1995, enhancing surgical capabilities for both simple and complex procedures.[4,5] Recently, artificial intelligence has emerged as a valuable tool in surgery, aiding in standardizing procedures and addressing intra-operative uncertainties.[6-10]

While open surgery is more invasive and associated with greater post-operative discomfort, it offers surgeons clearer anatomy and a more intuitive three-dimensional view, leading to a quicker learning curve compared to laparoscopic techniques. Laparoscopic surgery, on the other hand, poses challenges such as two-dimensional imaging and ergonomic difficulties, which can prolong the learning curve.[11]

The most severe complications in cholecystectomy are prevalent in the initial thirty cases performed by a surgeon. Moore *et al* found that while laparoscopic cholecystectomy is relatively straightforward to learn, autonomy should only be granted after overcoming the initial learning curve.[12] Hopper *et al* identified four phases of the learning curve: the initial training phase, gradual improvement with experience, a plateau of performance, and eventual decline due to age-related factors.[13]

Richardson *et al* suggested that achieving proficiency in laparoscopic cholecystectomy requires approximately three years of practice. This learning process had phases: a slow beginning with a high risk of conversion and increased incidence of biliary tract injuries, a steep acceleration in which there was a fast procedure learning terminating in proficiency, followed by some technical improvements and a plateau, after which there was no improvement (Fig. 1). There is a controversial number of laparoscopic procedures to become proficient: it varies between 20 and 200 surgeries.[13,14]

There are several methods available to enhance surgical skills, including online and free programs such as fundamentals of laparoscopic surgery with 13 steps and self-evaluation with well-defined criteria,[15] regular practices using simulators, viewing videos of surgical procedures, studying surgical techniques through textbooks, and receiving supervised, hands-on training.[16-18]

This article aims to assess biliary surgery experience among general surgery residents in Portugal, compare this experience with that of residents in Western countries, and examine differences in the training curricula between central hospitals and district hospitals.

METHODS

This study utilized an online questionnaire distributed to all general surgery residents in Portugal in February 2023 (Table 1). The general surgery residency program spans six years and does not include subspecialization, irrespective of the residents' interests. Out of an estimated 413 residents, a total of 95 completed the survey, yielding a response rate of approximately 23%.

An observational analysis of the collected responses was conducted, and the results were systematically described. The survey included a combination of quantitative and qualitative questions designed to assess residents' experiences and training in biliary surgery.

To contextualize and compare these findings with existing literature, a comprehensive bibliographic review was performed, focusing on publications from 2015 to 2022. Relevant studies were identified through searches conducted on PubMed and Google Scholar, employing search terms including "general surgery residents," "biliary surgery," "training," and "experience." The abstracts of the retrieved articles were reviewed, and the most pertinent studies were selected for inclusion in this analysis.

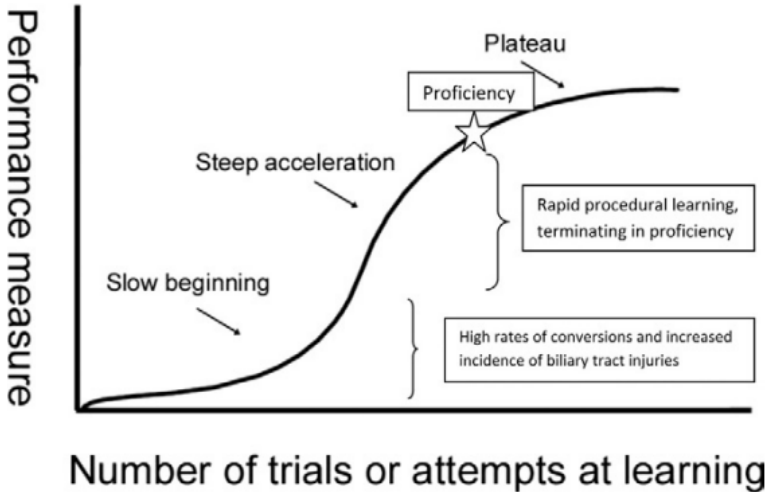

Figure 1. Model of learning curve of laparoscopic cholecystectomy (Richardson MD, *et al*[14])

Table 1. Online questionnaire made to surgical residents.

Question	Possible Answers
Residence year	1, 2, 3, 4, 5, 6
Formation hospital	Central District Portuguese Oncology Institute (POI)
Did you help any open cholecystectomy?	Yes No
Did you perform any open cholecystectomy as surgeon?	Yes No
How many open cholecystectomies have you performed as surgeon?	0 1-5 5-10 10-20 20-30 >30
Do you feel comfortable performing an open cholecystectomy?	Yes No
How many laparoscopic cholecystectomies have you performed as surgeon?	0 1-5 5-10 10-20 20-30 >30
How many cholecystectomies did you convert?	0 1-5 5-10 10-20 >20
In converted cholecystectomies, what would be the approach strategy?	Critical view of safety Fundus first
In what situations did you convert? (select all those who fit your experience)	Bleeding Difficulty obtaining critical view of safety. Adhesions Mirizzi syndrome Need for biliary tree exploration. Biliary iatrogenic lesion All the previous ones
In a difficult-to-approach gallbladder surgery where you don't get the critical view of safety, what do you do first?	Laparoscopic subtotal cholecystectomy Laparoscopic fundus first Conversion
Do you have experience in performing intraoperative cholangiography?	Yes No
In what situations do you perform intraoperative cholangiography?	Always Selective cases Never
Have you ever seen any biliary tract exploration surgery?	Yes No
Have you ever performed any biliary tract exploration surgery?	Yes No
Do you feel comfortable performing biliary tract exploration surgery?	Yes No
Have you performed any biliodigestive anastomosis?	Yes No
If yes, with laparoscopic approach?	Yes, laparoscopic. No, open
Do you consider important to provide a practical course for residents to standardize the performance of these procedures?	Yes No

RESULTS

1. POPULATION

Ninety-five residents responded to the questionnaire: two were in their first year (R1Y), fourteen in their second year (R2Y), sixteen in their third year (R3Y), nineteen in their fourth year (R4Y), twenty-four in their fifth year (R5Y), and twenty in their sixth year (R6Y) (Fig. 2). Due to the complexity of the procedures and their lack of experience, the first-year residents were excluded from the analysis.

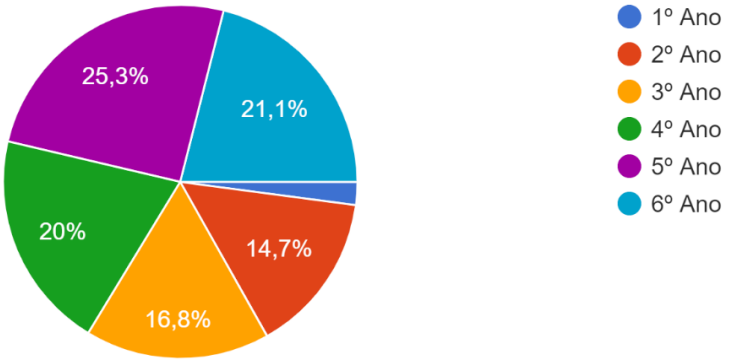

Figure 2. Characterization of the sample of surgical residents that have responded to the online query (without excluding the first-year residents).

After excluding R1Y residents, there were 63 participants from the last three years of residency, representing 68% of our population (R2Y: 15%, R3Y: 17%, R4Y: 20%, R5Y: 26%, R6Y: 22%).

Most responses came from district hospital residents (61 respondents, 66%), where specialization is lower and fewer complex surgeries are performed. Central hospitals, which handle more complex procedures, accounted for 31 respondents (33%). Additionally, one resident from a Portuguese Oncologic Institute (POI), a hospital dedicated solely to oncology patients, participated in the survey (1%) (Fig. 3).

2. OPEN CHOLECYSTECTOMY

Out of the 93 residents with more than one year of experience, 88 had assisted in at least one open cholecystectomy (95%). All residents from the last three years participated in such procedures.

Among those who had assisted, 63 residents had performed at least one open cholecystectomy as surgeon (72%), while 25 had not had the opportunity to operate (28%). None of the five residents who had not assisted with any of these procedures had performed one: two were from R2Y and three were from R3Y.

Overall, 68% of the sample had performed an open cholecystectomy, with the majority being from the last three years of residency.

Only one resident of the second year (R2Y) performed an open cholecystectomy, in a central hospital. With less than five surgeries he did not feel comfortable operating without guidance; seven residents of the third year (R3Y) also performed less than five open cholecystectomies, three of them came from central hospitals and four of them came from district hospitals, and, except for one central hospital resident, none of the rest felt comfortable with this procedure.

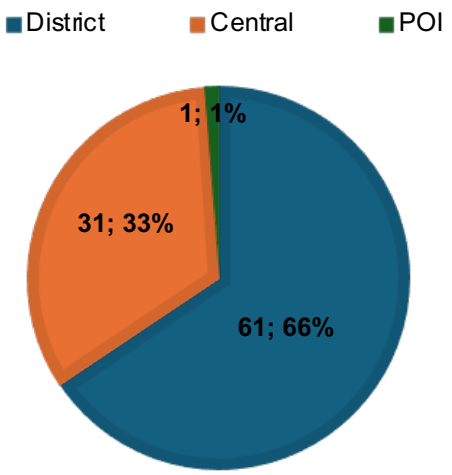

Figure 3. Hospital of formation according to the answers to this questionnaire. Sixty-one were from district hospitals, 31 were from central hospitals and one were from the Portuguese Oncologic Institute.

Fifteen residents of the fourth year (R4Y) performed open cholecystectomies. Thirteen performed less than five, six of them came from central hospitals and seven of them came from district hospitals – despite having the same interval of open procedures, three central hospital residents and only one from the district hospital felt capable of performing the surgery by their own – and two residents from the central hospital who performed between five to ten cholecystectomies, both felt comfortable with the practice.

Twenty-one residents of the fifth year (R5Y) performed open cholecystectomies, fifteen of them performed less than five, one resident from an oncological institute felt comfortable with the procedure, four from central hospitals who did not feel confident, ten from district hospitals, three of them fell comfortable on doing it by their owns. Three residents performed between five and ten surgeries, all from district hospitals, but only two were capable of doing so without guidance. Three residents performed between ten and twenty surgeries, two of whom were from central hospitals, and all expressed comfort with the procedure.

Nineteen R6Y residents performed open cholecystectomies, but their case numbers were relatively low. Thirteen district hospital residents performed less than five surgeries, with seven feeling comfortable. Two residents, one from a district and one from central hospitals performed between five and 10 surgeries, and only the district one felt comfortable with it; two residents from district hospitals performed between 10 and 20 surgeries and both felt comfortable. One resident from a central hospital performed between 20 and 30 surgeries and expressed confidence, and one from a district hospital had performed more than 30 and felt comfortable operating.

Among those who had performed open cholecystectomies, 49 residents (78%) had completed between one and five. Seven residents (11%) had performed between five and 10, and five residents (8%) had completed between 10 and 20. Only two residents (3%), both from R6Y, had performed more than 20 open cholecystectomies (as it is shown in Table 2).

Despite these figures, 33% of the sample (30 residents) had not performed any open cholecystectomy. Eight of these were from the last three years of residency: one from R6Y (central hospital), three from R5Y (two from district hospitals, one from a central hospital), and four from R4Y (three from district hospitals, one from a central hospital).

3. LAPAROSCOPIC CHOLECYSTECTOMY

Of the 93 residents, five had never performed a laparoscopic cholecystectomy: four were R2Y (one from a central hospital, three from district hospitals), and one was an R3Y from a central hospital.

Ten residents had performed between one and five surgeries: three were R3Y (one from a central hospital, two from district hospitals) and seven were R2Y (three from central hospitals and four from district hospitals). Six residents had performed between five and ten surgeries: one was an R4Y from a central hospital, three were R3Y (one from a central hospital and two from district hospitals), and two were R2Y from district hospitals. Thirteen residents had performed between ten and twenty surgeries: one R2Y from a central hospital, six R3Y (two from central hospitals and four from district hospitals), four R4Y (one from a central hospital and three from district hospitals), and two R5Y (one from the Portuguese Oncologic Institute and one from a district hospital).

Fifty-nine residents performed more than 20 laparoscopic cholecystectomies (67%). Thirteen residents had performed between 20 and 30 surgeries: two were R3Y from central hospitals, five were R4Y (two from central hospitals and three from district hospitals), and six were R5Y (two from central

Table 2. Number of open cholecystectomies by year of residence.

Year of residency	Number of open cholecystectomies						
	0	1-5	5-10	10-20	20-30	>30	Total
R2Y	13	1	-	-	-	-	14
R3Y	9	7	-	-	-	-	16
R4Y	4	13	2	-	-	-	19
R5Y	3	15	3	3	-	-	24
R6Y	1	13	2	2	1	1	20
Total	30	49	6	4	1	1	92

RxY – year of residence.

Table 3. Number of laparoscopic cholecystectomies performed as surgeon by year of residence.

Year of residency	Number of laparoscopic cholecystectomies						
	0	1-5	5-10	10-20	20-30	>30	Total
R2Y	4	7	2	1	-	-	14
R3Y	1	3	3	6	2	1	16
R4Y	-	-	1	4	5	9	19
R5Y	-	-	-	2	6	16	24
R6Y	-	-	-	-	-	20	20
total	5	10	6	13	13	46	93

hospitals and four from district hospitals). Forty-six residents had performed more than 30 surgeries, sixteen of them were R5Y (five from central hospitals and 11 from district hospitals), twenty were R6Y (three from central hospitals and 17 from district hospitals) and one was R3Y (from a district hospital). The remaining nine residents that performed more than thirty laparoscopic cholecystectomies were R4Y, five from central and four from district hospitals (Table 3).

When comparing R2Y and R3Y residents from central and district hospitals, 20% of R2Y from central hospitals had not performed a laparoscopic cholecystectomy (1/5), compared to 33% from district hospitals (3/9). Among R3Y residents, 14% from central hospitals (1/7) had not performed any. All district hospital residents from R3Y had performed at least one laparoscopic cholecystectomy.

Looking at R2Y and R3Y together, the most common number of surgeries for central hospital residents was between one and five (33%), with 42% having performed more than ten surgeries (5/12) and 58% fewer than ten (7/12). For district hospital residents, while the mode was also one to five surgeries, 72% had performed fewer than ten (13/18), compared to 28% who had performed more (5/18).

Among R4Y residents, all from central hospitals had performed more than five surgeries, and all from district hospitals had performed more than ten. Furthermore, 55% of R4Y from central hospitals (5/9) and 40% from district hospitals (4/10) had performed more than 30 surgeries.

For residents in their final two years, all from central hospitals had performed more than 20 surgeries, while 97% from district hospitals had done the same (one R5Y had performed between ten and twenty surgeries). All chief residents (R6Y) had performed more than 30 laparoscopic cholecystectomies. Among R5Y residents, the majority had performed more than 30 surgeries—72% from central hospitals (5/7) and 69% from district hospitals (11/16).

4. CONVERSION

Out of the 88 residents who had previously performed laparoscopic cholecystectomies, 31 never had to convert a procedure, 51 converted less than five surgeries, and six converted between five and 10.

Among those who never converted a surgery, four were R5Y and five were R6Y (mostly from district hospitals), seven were R4Y, nine were R3Y and six were R2Y.

Of those who converted fewer than 5 surgeries, eight had no experience as surgeons in open procedures: four were R2Y, two were R4Y and two were R5Y.

The remaining residents who converted fewer than five surgeries had varying levels of experience, as shown in Table 4. Four had performed fewer than five surgeries (3 R2Y, 1 R3Y), four had performed between 5 and 10 surgeries (1 R2Y, 2 R3Y, 1 R4Y), five had performed between 10 and 20 (2 R3Y, 2 R4Y, 1 R5Y), eight had performed between 20 and 30 (4 R4Y, 4 R5Y), and the majority had performed more than 30 surgeries (1 R3Y, 5 R4Y, 12 R5Y, 12 R6Y).

The six residents who had converted between 5 and 10 surgeries had each performed more than 20 laparoscopic cholecystectomies as the primary surgeon, and all were R5Y or R6Y.

Among R2Y residents from district hospitals, the conversion rate was 75% for those who had performed less than five surgeries (3/4), and 50% for those who had performed more than five (1/2), compared to no conversions among R2Y from central hospitals. These R2Y used "fundus first" and the critical view of safety in equal proportions (2:2) as their preferred open surgery approach. The only R2Y with more than 10 surgeries did not need to convert any.

For R3Y residents from central hospitals, 50% of those who had performed less than 10 surgeries had to convert (1/2),

Table 4. Correlation between the number of converted cholecystectomies and the volume of surgeries in each resident year. The total number related to all the residents that had at least one laparoscopic surgery.

	Converted	0					< 5					5-10		Total
	Surgical Volume	1-5	5-10	10-20	20-30	>30	1-5	5-10	10-20	20-30	>30	20-30	>30	
Year of residence	R2Y	4	1	1	-	-	3	1	-	-	-	-	-	10
	R3Y	2	1	4	2	-	1	2	2	-	1	-	-	15
	R4Y	-	-	2	1	4	-	1	2	4	5	-	-	19
	R5Y	-	-	1	1	2	-	-	1	4	12	1	2	24
	R6Y	-	-	-	-	5	-	-	-	-	12	-	3	20
		6	2	8	4	11	4	4	5	8	30	1	5	88

while only 25% of those who had performed more than 10 surgeries converted (1/4), with "fundus first" being their preferred strategy. Among R3Y from district hospitals, the conversion rate was 50% for those with fewer than 10 surgeries (2/4) and 40% for those with 10 or more (2/5). Excluding one resident who had performed more than 30 surgeries, the conversion rate dropped to 25% (1/4). Regarding their favorite open surgery approach, 75% preferred a critical view of safety against 25% who preferred "fundus first" (3/4 *vs* ¼).

For R4Y residents, the conversion rate was 77% in central hospitals and 50% in district hospitals (7/9 and 5/10, respectively), with "fundus first" being the preferred approach in 9 cases (5 out of seven residents from central and 4 out of five district hospitals). All of these residents converted fewer than 5 surgeries.

Among R5Y residents, all from central hospitals had converted at least one surgery, while 75% of those from district hospitals had done so, all with more than 20 surgeries. The preferred approach in central hospitals was "fundus first," whereas district hospitals favored the critical view of safety.

For R6Y residents, 66% from central hospitals (2/3) and 76% from district hospitals (13/17) had converted surgeries. Among district hospital residents, "fundus first" was the elected approach. Among central hospital residents, they used "fundus first" and the critical view of safety in equal proportions.

Overall, "fundus first" was the preferred approach for converted surgeries, chosen by the majority of residents from both district hospitals (21 out of 38) and central hospitals (12 out of 18) (Table 5).

The most common reason for conversion was difficulty achieving the critical view of safety (47 responses). Adhesions and bleeding were the second most common reasons (19 and 17 responses, respectively). Four residents converted to explore the biliary tree, and six converted due to iatrogenic biliary injury. Mirizzi syndrome was cited in two cases.

5. DIFFICULT CASE SCENARIO

When faced with a challenging laparoscopic case, ten residents would opt to convert, 23 would perform a laparoscopic subtotal cholecystectomy, and 60 would attempt a laparoscopic "fundus first" approach (11%, 25% and 82%, respectively).

Among residents in the last three years, fourteen R6Y, fourteen R5Y and fourteen R4Y would prefer to perform a laparoscopic "fundus first" than converting. Four R6Y, seven R5Y and five R4Y would prefer to perform a laparoscopic subtotal cholecystectomy rather than converting the surgery.

6. BILIARY TREE PROCEDURES

Fifty-nine residents did not consider themselves experienced in performing intraoperative cholangiography, including nine R6Y (eight from district hospitals and one from a central hospital), fourteen R5Y (ten from district hospitals and four from central hospitals), and eleven R4Y (seven from district hospitals

Table 5. First choice approach to a converted cholecystectomy.

Approach	R2	R3	R4	R5	R6	Total
Fundus First	10	8	12	11	13	54
Critical View of Safety	4	8	7	13	7	39
Total	14	16	19	24	20	93

and four from central hospitals). The remaining twenty-five residents were R2Y and R3Y.

Among the thirty-four residents who felt experienced in intraoperative cholangiography, most were in the last three years of training: two R2Y from central hospitals, three R3Y (two from district and one from central hospitals), eight R4Y (three from the district and five from central hospitals, with one performing it routinely), ten R5Y (six from the district, three from central hospitals, and one from an oncologic institute, with only one district hospital resident performing it routinely), and eleven R6Y (nine from district and two from central hospitals). Most of these residents performed the procedure only in selective cases.

Although they did not consider themselves experienced in performing intraoperative cholangiography, seven residents performed bile duct explorations during their training: four by open approach (one R5Y and two R4Y from central hospitals and one R6Y from a district hospital) and three laparoscopically (one R4Y and one R6Y from a district hospital and one R5Y from a central hospital).

Of the sixty-six residents who witnessed a biliary tree exploration, only seventeen performed the procedure: one R3Y, four R4Y, four R5Y, and eight R6Y. Eight of these residents were from central hospitals (three R4Y, three R5Y, and two R6Y), while nine were from district hospitals (one R3Y, one R4Y, one R5Y, and six R6Y). Only six felt comfortable performing the procedure.

Among R6Y residents, five had never seen or performed a biliary tree exploration, four of whom were from district hospitals. In R5Y, five residents had never seen or performed this procedure, all from district hospitals. Additionally, six R4Y residents reported never having seen or performed biliary tree exploration, five of whom were from district hospitals.

Only nine residents performed a biliodigestive anastomosis: four were R6Y from district hospitals, two R5Y from central hospitals, two R4Y from central hospitals, and one R3Y from a central hospital. Only one R6Y performed it laparoscopically.

7. FORMATION

All residents agreed on the importance of providing a practical course to standardize the performance of these procedures.

DISCUSSION

The estimated number of general surgery residents in Portugal at the time of the questionnaire was 413, with 72 in their first year. Out of these, 95 residents responded to the online survey, excluding two first-year residents, resulting in a final sample of 92, or 27% of the eligible residents.

The sample was nearly evenly distributed across residency years, except for the first year, and consisted of 61 residents from district hospitals, 31 from central hospitals, and one from a Portuguese oncological institute. This distribution closely mirrors the actual placement of residents across hospitals, making the sample reasonably representative of the overall population.

Ninety-five percent of residents had assisted at least one open cholecystectomy, with all R4Y to R6Y residents having this experience. Among those who assisted, 72% performed the procedure as a surgeon, while 28% had not, including eight senior residents (one R6Y, three R5Y, and four R4Y; five were from district hospitals). The majority of those performing open surgeries (78%) had completed between one and five cases, while only 3% had performed more than 20 surgeries, all of whom were R6Y. A total of 11% of residents performed between five and 10 surgeries, while 8% performed between 10 and 20 surgeries. Five young residents never assisted with an open approach.

When comparing hospital types, central hospital residents performed more open cholecystectomies earlier in their training. Central hospital R4Y residents were more likely to feel confident performing the surgery independently, despite having similar procedure counts as district hospital residents. By R5Y and R6Y, central hospital residents had gained more confidence due to greater surgical volume.

Residents from central hospitals generally have more exposure to open surgeries, which could explain why they start operating earlier, and tend to be more confident with the procedure compared to their counterparts from district hospitals. This difference in exposure and confidence highlights a disparity in surgical training between the two types of hospitals. However, by the final year, the gap narrows, with a small number of residents performing higher volumes of surgeries and feeling confident in their skills. All residents felt capable of performing the surgery by their own after performing ≥ 10 open surgeries.

Five residents (R2Y and R3Y) had never performed a laparoscopic cholecystectomy, due to limited early exposure, corresponding to 20% of all R2Y from central hospitals, 33% of all R2Y from district hospitals and 14% of all R3Y from central hospitals. Residents from both hospital types had similar early experiences, but a higher proportion of central hospital

residents performed more than 10 surgeries compared to district hospital residents (42% *vs* 28%). A higher percentage of central hospital R4Y residents performed more than 30 surgeries (55%) compared to district hospital R4Y residents (40%).

Residents from central hospitals generally achieved higher surgical volumes earlier in their training, especially between R2Y and R4Y. However, district hospital residents caught up in the later years, with both groups reaching similar levels of proficiency in laparoscopic cholecystectomy by the end of their residency as most R5Y and all R6Y residents, regardless of hospital type, had performed more than 30 laparoscopic cholecystectomies.

It is also reasonable to state that If 20 laparoscopic cholecystectomies were considered the threshold for proficiency, 67% of the sample would be deemed proficient.

Among the 88 residents who performed laparoscopic cholecystectomies, 31 never converted to open surgery, 51 converted fewer than five cases, and six converted more than five Nine R5Y and R6Y never converted a surgery, most of them from district hospitals. This could be explained by the shift of the surgical teams to minimally invasive procedures, having more confidence and more technical skills to handle difficulties by laparoscopy and, therefore, avoiding conversion to open approach.[1,20,21]

Those who had no experience with on open approach and had to convert did not end the procedure as surgeons (four were R2Y, two were R4Y and two were R5Y). Those who converted more than five surgeries had more than 20 laparoscopic cholecystectomies performed as surgeons, all of them R5Y and R6Y. Among residents, the "fundus first" approach is preferred (60%, 21 from district hospitals, 13 from central hospitals) compared to the critical view of safety (40%, 18 from district hospitals, four from central hospitals and one from POI). However, a critical view of safety is preferred among district hospital R5Y residents.

The conversion rate was higher among R4Y and R5Y residents in central hospitals, likely due to earlier exposure to more complex cases, with rates decreasing as they gained experience. In district hospitals, conversion rates were higher among R2Y and R6Y residents. This could suggest that younger residents in district hospitals, while still progressing along the learning curve, may have caused some biliary tract injuries, consistent with findings in the literature.[12] Additionally, R6Y residents likely encountered more challenging cases in their final year, contributing to the higher conversion rate.

The main reasons for conversion were difficulty in achieving the critical view of safety, adhesions, and bleeding, which aligns with findings from other research.[21,22]

When faced with a challenging laparoscopic case, 11% of the residents would convert to an open approach, 25% would perform a laparoscopic subtotal cholecystectomy and 82% would try a laparoscopic "fundus first". Most R4Y-R6Y would do a "fundus first" or a subtotal cholecystectomy. This could be explained by the decreased experience in the open approach and the improvement of the laparoscopic technique for residents, leading to less need for conversion, opting for other strategies, such as "fundus first" dissection, which more senior residents already mastered.[1,21,22]

A significant portion of residents (59) did not feel experienced in performing intraoperative cholangiography. Among the thirty-four residents who felt experienced in intraoperative cholangiography, most were in the last three years of training. Most of these residents performed the procedure only in selective cases.

Of the 66 residents who witnessed a biliary tree exploration, only 17 performed the procedure, and only six felt comfortable performing it independently. This limited exposure was more pronounced among district hospital residents.

Among R6Y residents, five had never seen or performed a biliary tree exploration, four of whom were from district hospitals. Among R5Y, five residents had never seen or performed this procedure, all from district hospitals. Additionally, six R4Y residents reported never having seen or performed biliary tree exploration, five of whom were from district hospitals.

9% of our population performed a biliodigestive anastomosis: four were R6Y from district hospitals, two R5Y from central hospitals, two R4Y from central hospitals, and one R3Y from a central hospital. Only one R6Y performed it laparoscopically. This suggests a lack of hands-on experience in biliary surgery, an issue observed in other countries as well.

Overall, residents' experience in biliary surgery is primarily focused on laparoscopic cholecystectomies, while exposure to more complex biliary tree procedures remains limited for most, which aligns with existing literature.[23] This discrepancy is particularly pronounced among residents from district hospitals. It is concerning that some senior residents have never encountered a biliary tree exploration. Will they be solely reliant on endoscopic procedures to manage synchronous common bile duct stones? What about intrahepatic stones?

When it comes to less commonly performed procedures, residents from central hospitals generally have greater exposure and experience. While central hospital residents initially have an advantage in terms of surgical volume, this advantage diminishes in the later years of training. This suggests that as residents progress, their overall experience and training become more balanced, though those in central hospitals may benefit from earlier and more varied experiences. According to the literature, district hospital residents typically have higher surgical volumes, but this issue seems to diverge, as specific training for biliary tree procedures is more often found in central hospitals.[23]

All residents agreed on the importance of standardized practical training, which could be addressed through cadaver simulations, liver transplant curricula, and advanced mentorship programs.[1,24] Training courses, robotic simulation, and more structured exposure to complex biliary procedures, like intraoperative cholangiography and biliary tree explorations, should be considered to enhance practical surgical education.[15-18,20,25]

ETHICAL DISCLOSURES

Conflicts of Interest: The authors have no conflicts of interest to declare.
Financing Support: This work has not received any contribution, grant or scholarship
Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.
Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2013).
Provenance and Peer Review: Not commissioned; externally peer reviewed.

RESPONSABILIDADES ÉTICAS

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.
Fontes de Financiamento: Não existiram fontes externas de financiamento para a realização deste artigo.
Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.
Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pela Comissão de Ética responsável e de acordo com a Declaração de Helsínquia revista em 2013 e da Associação Médica Mundial.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

CONTRIBUTORSHIP STATEMENT

FDM, MS and SS: Conceptualization, formal analysis, investigation, methodology, writing of the original draft, project administration, supervision, validation, visualization, article writing, review and editing.
All authors approved the final version to be published.

DECLARAÇÃO DE CONTRIBUIÇÃO

FDM, MS e SS: Conceptualização, análise formal, investigação, metodologia, redação do artigo original, administração do projeto, supervisão, validação, visualização, escrita do artigo, revisão e edição.
Todos os autores aprovaram a versão final a ser publicada.

REFERENCES

1. Riccardi M, Dughayli M, Baidoun F. Open Cholecystectomy for the New Learner-Obstacles and Challenges. JSLS. 2021;25:e2021.00026. doi: 10.4293/JSLS.2021.00026.
2. Morgenstern L. Carl Langenbuch and the first cholecystectomy. Surg Endosc. 1992;6:113–4.
3. Polychronidis A, Laftsidis P, Bounovas A, Simopoulos C. Twenty years of laparoscopic cholecystectomy: Philippe Mouret--March 17, 1987. JSLS. 2008;12:109–11.
4. Zaman JA, Singh TP. The emerging role for robotics in cholecystectomy: the dawn of a new era? Hepatobiliary Surg Nutr. 2018;7:21–8. doi: 10.21037/hbsn.2017.03.01.
5. Kadakia N, Malek K, Lee SK, Lee EJ, Burruss S, Srikureja D, et al. Impact of Robotic Surgery on Residency Training for Herniorrhaphy and Cholecystectomy. Am Surg. 2020;86:1318–23. doi: 10.1177/0003134820964430.
6. Shinozuka K, Turuda S, Fujinaga A, Nakanuma H, Kawamura M, Matsunobu Y, et al. Artificial intelligence software available for medical devices: surgical phase recognition in laparoscopic cholecystectomy. Surg Endosc. 2022;36:7444–52. doi: 10.1007/s00464-022-09160-7.
7. Vedula SS, Ghazi A, Collins JW, Pugh C, Stefanidis D, Meireles O, et al. Artificial Intelligence Methods and Artificial Intelligence--Enabled Metrics for Surgical Education: A Multidisciplinary Consensus. J Am Coll Surg. 2022;234:1181–92. doi: 10.1097/XCS.0000000000000190.
8. Morris MX, Fiocco D, Caneva T, Yiapanis P, Orgill DP. Current and future applications of artificial intelligence in surgery: implications for clinical practice and research. Front Surg. 2024;11:1393898. doi: 10.3389/fsurg.2024.1393898.
9. Madani A, Namazi B, Altieri MS, Hashimoto DA, Rivera AM, Pucher PH, et al. Artificial intelligence for intraoperative guidance: using semantic segmentation to identify surgical anatomy during laparoscopic cholecystectomy. Ann Surg. 2022;276:363–9. doi: 10.1097/SLA.0000000000004594.
10. Golany T, Aides A, Freedman D, Rabani N, Liu Y, Rivlin E, et al. Artificial intelligence for phase recognition in complex laparoscopic cholecystectomy. Surg Endosc. 2022;36:9215–23. doi: 10.1007/s00464-022-09405-5.
11. Ballantyne GH. The pitfalls of laparoscopic surgery: challenges for robotics and telerobotic surgery. Surg Laparosc Endosc Percutan Tech. 2002;12:1–5. doi: 10.1097/00129689-200202000-00001.
12. The Southern Surgeons Club, Moore MJ, Bennett CL. The learning curve for laparoscopic cholecystectomy. Am J Surg. 1995;170:55–9.
13. Hernandez J, Ross S, Morton C, McFarlin K, Dahal S, Golkar F, et al. The Learning Curve of Laparoendoscopic Single-Site (LESS) Cholecystectomy: Definable, Short, and Safe. J Am Coll Surg. 2010;211:652–7. doi: 10.1016/j.jamcollsurg.2010.07.008.
14. Richardson MC, Bell G, Fullarton GM. Incidence and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. West of Scotland Laparoscopic Cholecystectomy Audit Group. Br J Surg. 1996;83:1356–60.
15. Cullinan DR, Schill MR, DeClue A, Salles A, Wise PE, Awad MM. Fundamentals of Laparoscopic Surgery: Not Only for Senior Residents. J Surg Educ. 2017;74:e51–4. doi: 10.1016/j.jsurg.2017.07.017.
16. Thomaschewski M, Kist M, Zimmermann M, Benecke C, Kalff JC, Krüger CM, et al. Conception and prospective multicentric validation of a Robotic Surgery Training Curriculum (RoSTraC) for surgical residents: from simulation via laboratory training to integration into the operation room. J Robot Surg. 2024;18:53. doi: 10.1007/s11701-023-01813-6.
17. Chan KM, Hsu J Te, Yeh CN, Yeh T Sen, Lee WC, Lien HY. Application of mentorship program for another aspect of surgical residency training: The importance of academia in surgical training. Medicine. 2021;100:e26939. doi: 10.1097/MD.0000000000026939.
18. Binkley J, Bukoski AD, Doty J, Crane M, Barnes SL, Quick JA. Surgical Simulation: Markers of Proficiency. J Surg Educ. 2019;76:234–41.
19. Cortez AR, Winer LK, Katsaros GD, Kassam AF, Shah SA, Diwan TS, et al. Resident operative experience in hepatopancreatobiliary surgery: exposing the divide. J Gastrointest Surg. 2020;24:796-803. doi: 10.1007/s11605-019-04226-9.
20. Daee SS, Flynn JC, Jacobs MJ, Mittal VK. Analysis and implications of changing hepatopancreatobiliary (HPB) case loads in general surgery residency training for HPB surgery accreditation. HPB. 2013;15:1010--5. doi: 10.1111/hpb.12088.
21. Ledezma Dominguez J, Tariq N, Martins RS, Jawad G, Fisher AD, Maqbool B. Bailout surgery for difficult gallbladders: surgical approach and outcomes. Am Surg. 2024;90:1324–9. doi: 10.1177/00031348241227186.
22. Ravendran K, Elmoraly A, Kagiosi E, Henry CS, Joseph JM, Kam C. Converting from laparoscopic cholecystectomy to open cholecystectomy: a systematic review of its advantages and reasoning. Cureus. 2024;16:e64694. doi: 10.7759/cureus.64694.
23. Punnen S, Taheri S, Chen L, Scott T, Karimuddin A. Comparing resident operative volumes for routine general surgery cases at academic, urban community, and rural training sites. Can J Surg. 2024;67:E273–4. doi: 10.1503/cjs.005323.
24. Chung RS, Wojtasik L, Pham Q, Chari V, Chen P. The decline of training in open biliary surgery: effect on the residents' attitude toward bile duct surgery. Surg Endosc. 2003;17:338–40; discussion 341. doi: 10.1007/s00464-002-8621-4.
25. Sirinek KR, Willis R, Schwesinger WH. Who will be able to perform open biliary surgery in 2025? J Am Coll Surg. 2016223:110–5. doi: 10.1016/j.jamcollsurg.2016.02.019.