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GROUNDWORK

Are 2 Years Enough? Exploring Technical Skills Acquisition Among General Surgery Residents in Brazil

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ABSTRACT

Phenomenon: Recent studies have shown that up to 40% of the General Surgery (GS) residents are not confident with their surgical skills. There is concern that residents are at risk of receiving inadequate training due to the low number of operations they perform. In Brazil, although all GS residents receive by law the Board Certification at the end of their programs, the assessment of their technical skills is not mandatory in Medical Residency programs' training. Consequently, our concern was that current GS medical residency format might be insufficient to create competent and autonomous general surgery residents after 2 years of regular training. Hence, the aim was to assess GS residents' surgical skills in their final months of training to evaluate the present format of GS residency programs in Brazil. *Approach*: Trained surgical faculty members directly observed 11 operations of varying difficulty performed by 2nd-year regular GS residents and by 4th-year residents in the optional Advanced Program in General Surgery. Participants were located at 3 university and 3 nonuniversity hospitals in Rio de Janeiro and Sao Paulo (Brazil's largest cities). Surgical skills were assessed using an internally developed observation checklist reviewed by subject matter experts. *Findings*: Sixty residents (46 regular 2nd-year trainees and 14 advanced 4th-year trainees) were assessed on performing 499 operations. Only 10 residents (17%), all advanced 4th-year residents, satisfactorily performed all operations and were considered eligible for the Board Certification. Even after excluding the 2 operations of greatest difficulty, only 24 regular 2nd-year residents (52%) satisfactorily performed the other 9 operations. Residents from hospitals with open Emergency Departments performed better than those from hospitals without Emergency Departments. *Insights*: The results of this pilot study suggest that residents with 2 years of training are not prepared for independent high-level surgical practice. The current formatting of regular GS residency programs in Brazil (2 years) may be insufficient to train experts in general surgery.

KEYWORDS
general surgery; residency; technical skills assessment; training

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Background

In the last two decades, concerns for patient safety, new technologies, public dissatisfaction about care provided, legal aspects related to training, and even the professional expectations of residents have driven changes in surgeon development toward competency-based training.[1,2] Medical Residency (MR) is widely accepted worldwide as one of the best forms of training after graduation. General Surgery (GS) residency training in Brazil differs from training in other countries like the United States, Canada, and the United Kingdom, both in the whole duration and in its mandatory rotations. Training in GS in Brazil is divided into two programs: First, GS residents must complete a 24-month MR in GS (GSMR), which includes 11 one-month mandatory rotations in related areas, with a workload of 2,880 hours per year and 60 hours per week, including a 24-hour on call at Emergency Departments.[3] Residents from hospitals without open Emergency Departments do not attend outpatients' surgical emergencies, including trauma but do attend inpatients' surgical urgencies/emergencies. It is defined that the 1st-year residents (PGY-1) should perform at least 24 operations of low difficulty and that 2nd-year residents (PGY-2) perform 48 operations of medium/high difficulty.[3] Second, GS residents may complete an optional MR Advanced Program (GSMR-AP), with an additional 24 months' duration and compulsory rotations, with the prerequisite of the regular GSMR. There is, however, no requirement of any surgical technical skills assessment in either residency program.[3] Furthermore, by law, at the end of any regular MR program in Brazil, including the GSMR, all residents receive the

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Board Certification without any further obligatory examination,[3] even if not adequately prepared for the autonomous practice of surgery.

The training of general surgeons has been a concern worldwide. In the United States, with a 5-year GS program, 38% of residents do not feel confident to act independently after finishing their residency programs,[4] and only 40% were considered by their coordinators to be capable of partially operating unattended on a case of great difficulty.[5] Most important, U.S. residents are being exposed to a relatively small number of operations, insufficient for proper technical training.[6,7] In Brazil, with a training period of 2 years, these problems are potentially more serious,[8] and an assessment of technical competence during training should be mandatory. Historically, assessment has been limited in general to cognitive areas and does not specifically evaluate technical skills.[9,10] Some psychomotor evaluation tests have been used, such as the Objective Structured Assessment of Technical Skill[11] or the Global Rating Scale,[12] as well as some more sophisticated methods such as training laboratories, virtual reality, motion analysis systems, and analysis of operations recorded on video, among others. Nevertheless, all have potential drawbacks, such as difficulty in application, being far from the actual operation, and being costly and impractical to implement on a large scale.[9,10] The evaluation of resident performance in the operating room is desirable, and many instruments have been proposed.[10,13] However, most of them still require validation, reliability, and applicability to be implemented.[10,13]

The aim of this study was to evaluate the surgical technical skills in the operating room of GS residents at the end of their MR programs in university hospitals (UH) and nonuniversity ones (NUH) in two major Brazilian cities. To do this, we applied a technical skills assessment instrument developed in-house to meet our need for large-scale practical assessment. Our hypothesis was that the current regular GSMR formatting in Brazil, with only 2 years of training, might be insufficient to create GS specialists able to perform their activities with competence and autonomy.

Methods

Trainees

We evaluated 60 residents, 46 in the 2nd year of regular GSMR programs and 14 in the GSMR-AP in six hospitals: five in Rio de Janeiro and one in Sao Paulo; three from universities (UH; 33 residents) and three nonuniversity-affiliated (NUH; 27 residents); three with open Emergency Departments (36 residents) and three without them (24 residents). The evaluation was conducted in the last 2 months of their GS programs in 2013 and 2014. All assessed residents agreed to participate and signed an informed consent form, and the Research Ethics Committee of School of Medicine and University Hospital had previously approved the study protocol (No. 115.032; October 4, 2012).

Evaluators

Both GSMR and GSMR-AP preceptors were chosen to conduct the residents' evaluation. All evaluators had the GS Board Certification title. There were 20 evaluators, two to four per hospital; each evaluator assessed a median of three residents on 25 operations. The evaluators from Rio de Janeiro (five hospitals, 16 evaluators) were trained personally, and the evaluators from São Paulo (four evaluators) were trained by video-conference and phone calls. They were trained as to what should be assessed and were instructed not to identify the operation as an assessment, not to be in the operative field with the resident (i.e., the evaluators were not the attending surgeons during the operations), not to interact with the evaluated resident, and to fulfill the assessment form during the operation. Hence, the evaluators were in the operating room, but they did not participate in the operation itself; they just observed the resident's performance and filled the assessment form during the procedure. All completed forms were personally received by one investigator (EGS), except those from São Paulo, which were received by e-mail. There was no interevaluator reliability testing because of practical reasons: We opted to assess the greatest number of operations as possible with only one evaluator per operation instead of having two evaluators per operation, which would have allowed testing interevaluator reliability but at the cost of assessing fewer operations. Evaluators were not blinded as to which resident they were assessing (i.e., they knew the residents they were evaluating), but the residents were blinded as to being assessed or not in that particular procedure. Similar to the assessed residents, all evaluators also agreed to participate and signed an informed consent form.

Assessment materials and procedure

We used an in-house developed assessment tool (Table 1) that was previously reviewed[14] by full and emeritus members of the Brazilian College of Surgeons (BCS), all board certified in General Surgery. This tool contains a set of 11 increasingly difficult operations, with four questions for each operation.

Table 1. The surgical skills assessment instrument.

Low-difficulty operations
Inguinal Herniorrhaphy
a. Correctly identifies the structures corresponding to the inguinal ligament, conjoint tendon, inguinal triangle?
b. Properly identifies the anatomical relations with the femoral vessels?
c. Properly handles the hernia sac?
d. Properly fixes the mesh?
Gastrostomy
a. Properly incises the abdominal wall for gastrostomy?
b. Choose a suitable gastric segment for positioning of the catheter?
c. Properly fixes the catheter to the stomach?
d. Properly fixes the catheter to the abdominal wall?
Incisional Herniorrhaphy
a. Properly prepares the aponeurosis for fixing the mesh?
b. Properly fixes the screen? (adequate distance from the aponeurotic edges, adequate distance between stitches)
c. Properly handles the contents of the hernia sac?
d. Properly handles the hernia sac?(resection of excess, base ligation, possibility of use of the excess for abdominal cavity insulation)
Medium-difficulty operations
Colostomy
a. Chooses the correct abdominal wall spot for colostomy positioning?
b. Exercises caution not to let the colon in tension?
c. Incises the colon in proper extension?
d. Adequately performs the lateral colostomy? (early maturation)[a]
Enterectomy
a. Properly uses linear staplers for suture of small bowel resection?
b. Properly uses intestinal clamps?
c. Properly performs manual entero-enteric anastomosis?
d. Observes the care required for the success of the anastomosis. (angles' stitches, vascularization, tension on suture line)
Laparoscopic cholecystectomy
a. Performs the first puncture with the necessary care?
b. Recognizes the anatomical repairs for surgical safety? (dissection along the gallbladder, Calot's triangle exposure, exposure of junction of cystic duct and choledocus)
c. Properly dissects the gallbladder pedicle (cystic duct, choledocus, cystic artery)
d. Uses cautery with the required caution? (low current, away from the main biliary tree area)
Biliodigestive derivation with jejunum
a. Appropriately chooses the bowel segment for anastomosis? (proper distance to excluded loop)
b. Properly incises biliary tree and bowel loop?
c. Properly performs the anastomosis? (no tension)
d. Appropriately positions the cavity drain?
Partial gastrectomy
a. Recognizes stomach's vascular pedicles? (left gastric and celiac trunk; right gastric, left and right gastroepiploic, short vessels)
b. Recognize stomach's anatomical divisions?
c. Adequately performs vascular ligatures? (type suture, type of ligature)
d. Adequately performs the reconstruction of transit? (Roux-en-Y, B I or B II, submucosal hemostasis, equal distance from the edges).
Partial colectomy
a. Recognizes anatomical landmarks and vascular pedicle of segment to be resected.
b. Adequately performs vascular ligatures?
c. Properly uses linear and circular staplers?
d. Adequately performs anastomosis for the reconstruction of the transit? (repairs in the angles, extramucosal suture, mesenterium position, absence of tension)
High-difficulty operations
Simple hepatectomy
a. Correctly recognizes the liver vascularization landmarks?
b. Adequately performs digitoclasia, ligatures and resection?
c. Recognizes the intrahepatic ducts and ligates them separately?
d. Adequately uses the different methods for hemostasis? (monopolar current, ultrasonic, argon scalpel, biological glues, etc.)
Distal pancreatectomy
a. Properly recognizes and dissects planes for access to the pancreas?
b. Properly identifies splenic artery and vein?
c. Adequately performs parenchymal suture?
d. Adequately treats the pancreatic duct?

[a]The unique revised item following experts' review.

One hundred GS experts of the BCS from all Brazilian states (hence nationwide) sent the tool for review. We sought their agreement on whether (a) the 11 operations featured were of increasing grades of difficulty and were the essential ones that a general surgeon must perform proficiently and (b) the four assessment questions for each operation could demonstrate proficiency in performing that operation. Internal validity was assessed by the Cronbach alpha test applied to the experts' answers (agree/disagree) within each operation. Only one item (the fourth item of Colostomy—Table 1) was revised following the experts' validation because of disagreement. All operations had Cronbach's $\alpha \geq 0.7$, confirming that it represents general agreement among experts that each operation's set of assessment criteria adequately represent proficiency.[14] The increasing grades of operation difficulty were also validated by the BCS experts. We chose this tool because it was simple to use in the operation room, with only four questions with a yes/no answer for each operation, contrary to other assessment tools designed to measure surgical skills in the operating room,[11,12,15,16] which are much more complex with several items evaluating different aspects of surgical competence. We intended to design a simple assessment tool capable of being used in a daily routine, as the mini–Clinical Examination Exercise is being used for internal medicine residents' assessment.

The assessment tool had a closed-answer fashion, with four response options: yes, no, NA (not assessed; when it was not possible to say whether the resident knew or could not perform the operation because during the evaluation period he or she was not assigned to that procedure), and NP (not performed; when the assessor was informed that residents did not perform such operation because it was considered beyond their technical skills). When an operation was evaluated as NP, the resident was considered not able to do it, whereas when rated NA, the data were excluded from the assessment of that particular resident because that resident did not perform this specific operation during the evaluating period. Chosen operations were considered by experts as the minimum a surgeon must handle, so as to be considered a Board Certified surgeon. The pass criterion was based on each operation separately. To be considered capable of performing an operation, the resident should know how to conduct at least three of its four main steps, and to aspire to the Board Certification, he or she should be able to perform all 11 operations. In an alternative analysis, we excluded the two most difficult procedures (hepatectomy and pancreatectomy)

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from the evaluation of the overall judged proficiency. The 2-month observation period permitted evaluators to assess one instance of the 11 operations targeted for assessment, although not all assessed residents performed all the 11 operations.

Data analysis

Statistical analyses included descriptive analysis of individual item yes/no response frequencies, proportion of residents considered proficient in each operation, and proportion of residents considered able to obtain Board Certification. We used the Fisher's exact test to carry out bivariate comparisons between the performance of regular GSMR residents and GSMR-AP ones, as well as between residents from UH and NUH and from hospitals with or without open Emergency Departments. All statistical analyses were performed by the software Statistical Analysis System, Version 6.11 (SAS Institute, Inc., Cary, NC, USA).

Results

Observed operations

In total, 499 operations were assessed, and evaluated residents performed a median of nine operations (range = 4–11) during the 2-month evaluation period. Only 13 residents, all in GSMR-AP programs, were assessed in all 11 operations. Table 2 shows the judged proficiency to perform each of the 11 operations by all of the evaluated residents stratified by years of training. These data are presented graphically in Figure 1.

Low- to medium-difficulty operations

Eighty-eight percent of residents were rated as able to perform the low-difficulty operations. All GSMR-AP residents could perform them, compared to 83% of regular GSMR residents, although this difference was not significant (Fisher's exact test: $N = 60$, $df = 1$, p range = 0.17–0.99). However, for the operations of medium difficulty (e.g., biliodigestive derivations), the overall proportion of residents judged-proficient dropped to 66%, with significant differences between residents from GSMR and GSMR-AP programs (Fisher's exact test: $N = 60$, $df = 1$, $p = .042$).

High-difficulty operations

Only 70% of the GSMR-AP residents (17% of all residents) were rated as proficient in the most difficult operations. Using the criterion of proficiency on all 11 surgeries, only 10 residents (17%) would be considered eligible for Board Certification, all from GSMR-AP. When disregarding the two most difficult operations (hepatectomy and pancreatectomy), we found that only slightly more than half (52%) of regular GS residents would be able to receive the Board Certification.

Institutional differences

Table 3 shows comparative data between residents from UH and NUH, and from hospitals with and without open Emergency Departments, for each of the 11 operations. In general, the NUH residents were more frequently rated as proficient in operations of low–medium difficulty (Fisher's exact test: $N = 60$, $df = 1$, $p = .001$, for biliodigestive derivations), whereas the UH residents were more frequently rated proficient in the most difficult operations (Fisher's exact test: $N = 60$, $df = 1$, $p < .001$, for both operations). When considering the total judged proficiency in the 11 conducted operations, the UH had a higher proportion of residents able to receive the Board Certification (30% vs. 0% of NUH residents; Fisher's exact test: $N = 60$, $df = 1$, $p < .001$); however, when disregarding the two most difficult operations, the picture is reversed and NUH residents had a higher frequency of overall judged proficiency (82% vs. 46% of UH residents; Fisher's exact test: $N = 60$, $df = 1$, $p = .007$). On the other hand, residents from hospitals with open Emergency Departments had higher frequency of judged proficiency in virtually all operations, except herniorrhaphy, enterectomy, and cholecystectomy (Fisher's exact test: $N = 60$, $df = 1$, ps ranging from $< .001$ to .07). This was also demonstrated in the overall judged proficiency in performing the 11 proposed procedures (Fisher's exact test: $N = 60$, $df = 1$, $p = .004$) and when excluding the two most difficulty of them (Fisher's exact test: $N = 60$, $df = 1$, $p < .001$).

Discussion

Main findings

This pilot study evaluated the technical performance of 60 GS residents in regular and advanced stages of training. Direct observations of 11 variously difficult operations were evaluated by residency program directors using an assessment developed in-house[14] for practical reasons. It showed that none of the residents of the regular GSMR programs (2 years of training) reached adequate levels of judged proficiency and therefore were

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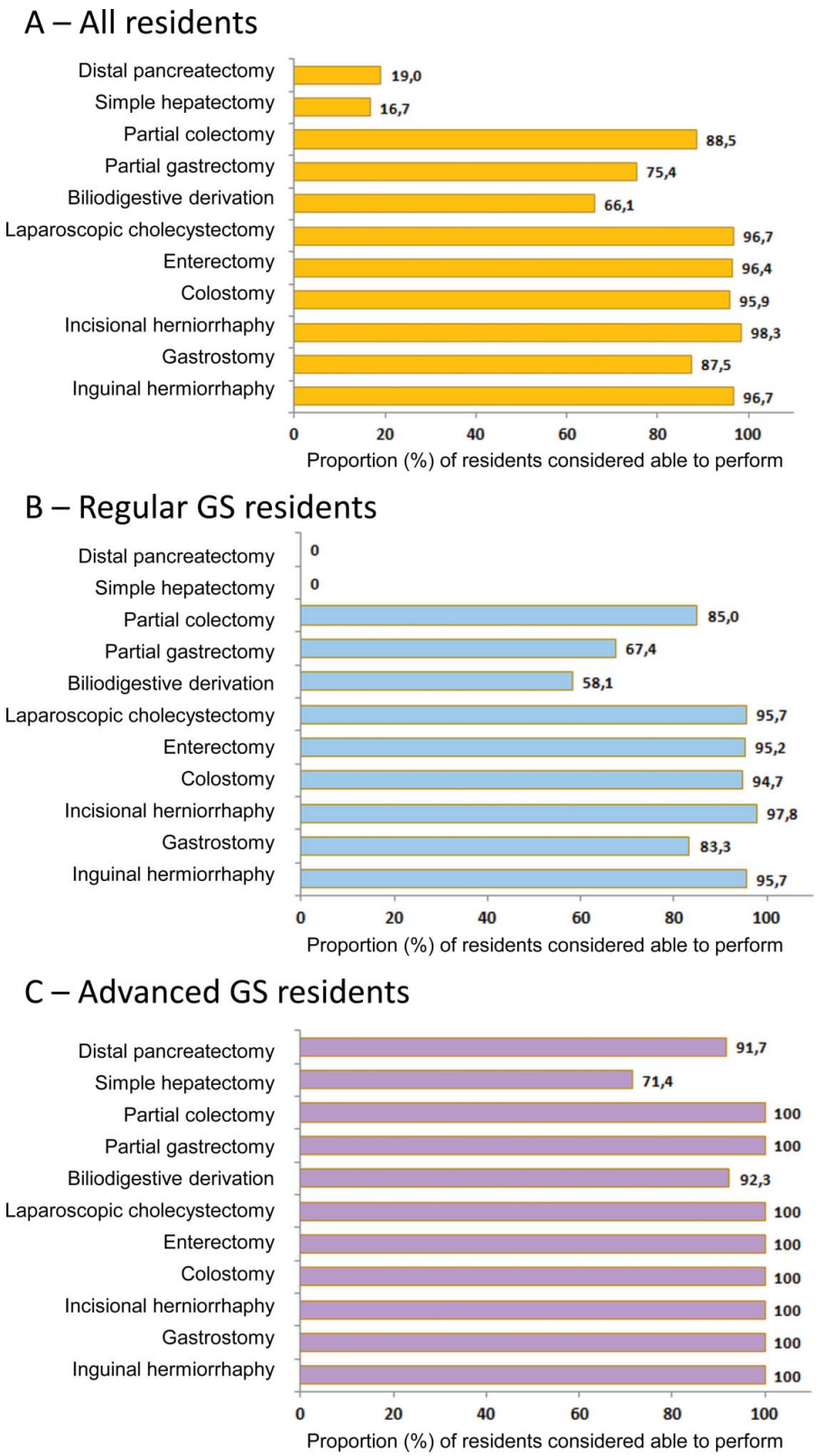

Figure 1. Graphic representation of the proportion of all residents (panel A), regular General Surgery (GS) residents (2 years of training) (panel B), and advanced General Surgery (GS) residents (4 years of training) (panel C), considered able to perform each operation.

deemed unable for autonomous daily practice of GS and were not considered eligible to obtain the Board Certification. However, 70% of GSMR-AP residents (4 years) had satisfactory judged proficiency in carrying out the 11 operations considered essential and were considered eligible to obtain the Board Certification. This suggests

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Table 2. Proficiency (able or unable) to perform each one of the 11 operations of all evaluated residents and divided according to participation in regular (2 years) or advanced (4 years) General Surgery residency programs.

Operation	Able/Unable to Perform	All Residents		GSMR Residents		GSMR-AP Residents		
		n	%	*n*	%	*n*	%	*p*[a]
Inguinal herniorrhaphy	Able	58	96.7	44	95.7	14	100	.99
	Unable	2	3.3	2	4.3	0	0	
Gastrostomy	Able	49	87.5	35	83.3	14	100	.17
	Unable	7	12.5	7	16.7	0	0	
Incisional hernia	Able	58	98.3	44	97.8	14	100	.99
	Unable	1	1.7	1	2.2	0	0	
Colostomy	Able	47	95.9	36	94.7	11	100	.99
	Unable	2	4.1	2	5.3	0	0	
Enterectomy	Able	54	96.4	40	95.2	14	100	.99
	Unable	2	3.6	2	4.8	0	0	
Laparoscopic cholecystectomy	Able	58	96.7	44	95.7	14	100	.99
	Unable	2	3.3	2	4.3	0	0	
Biliodigestive derivation	Able	37	66.1	25	58.1	12	92.3	.042
	Unable	19	33.9	18	41.9	1	7.7	
Partial gastrectomy	Able	43	75.4	29	67.4	14	100	.013
	Unable	14	24.6	14	32.6	0	0	
Partial colectomy	Able	46	88.5	34	85.0	12	100	.32
	Unable	6	11.5	6	15.0	0	0	
Simple hepatectomy	Able	10	16.7	0	0	10	71.4	< .001
	Unable	50	83.3	46	100	4	28.6	
Distal pancreatectomy	Able	11	19.0	0	0	11	91.7	< .001
	Unable	47	81.0	46	100	1	8.3	
All operations	Able	10	16.7	0	0	10	71.4	< .001
	Unable	50	83.3	46	100	4	28.6	
All operations, except hepatectomy and pancreatectomy	Able	37	61.7	24	52.2	13	92.9	.006
	Unable	23	38.3	22	47.8	1	7.1	

Note. Operations were organized in order of increasing difficulty (less difficult on top). GSMR = regular General Surgery medical residency program (2 years); GSMR-AP = General Surgery medical residency advanced program (4 years).
[a]The *p* values refer to Fisher's exact test with 1 degree of freedom.

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that the 2-year regular GSMR may not be enough to form a competent general surgeon. In addition, this study showed the importance of a functioning Emergency Department for the acquisition of surgical skills but that hospital affiliation with a university was less relevant.

Evaluating surgical proficiency

Surgery is a mainly practical specialty, and its technical skill acquisition and development are initially acquired through observation and then by hands-on experience in the operating room.[17] Despite significant advances in simulation and skills laboratory technologies, the operating room remains the fundamental learning environment for surgical residents.[18] The exact number of operations necessary for the acquisition of expert status is unknown, and it is possibly variable among residents.[6] However, at the end of the training program it is expected that residents shall be competent in carrying out operations and be able to establish themselves as autonomous professionals.[19]

Surgical proficiency evaluation has generally been based on written and oral cognitive examinations and on the subjective opinion of a consultant staff, mostly from the program coordinator, in unsystematic observations, far from the time of the procedures and therefore fraught with biases.[20] Some indirect parameters, such as the duration of the procedure and hospital stay, economy of motion, and the occurrence of postoperative complications, have been used in studies as performance measures. However, such measures are not in fact able to assess the surgeon's surgical skill, as patients have different characteristics, patients may be hospitalized for prolonged clinical complications, and an operation performed in a short time is not always well done;[21] hence, these parameters are thus inadequate technical skill indicators. Some proposed assessment tools of surgical skills in the operating room are targeted to evaluate general surgical procedures (care with the tissues, knot tying, knowledge of the instruments, sutures to be used),[13,22] or general trainee's independence,[16,18] but not surgical skill in specific operations, which was the main focus of the evaluation instrument used in this study. Moreover, these tools are generally complex, with several items evaluating different aspects of surgical competence.[11,12,15,16,23,24] An advantage of our instrument is that it is simple to apply by staff members from the program facility and the answers are of closed ended. Therefore, it reduces the potential subjectivity inherent to general questionnaires of open answers.

Table 3. Residents' proficiency (able or unable) to perform each of the 11 operations, according to residence programs in university or nonuniversity hospitals, and in hospitals with or without open emergency departments.

Operation	Able/Unable to Perform	UH		NUH			With EMERG		Without EMERG		
		n	%	*n*	%	*p*[a]	*n*	%	*n*	%	*p*[a]
Inguinal herniorrhaphy	Able	31	93.9	27	100	.50	35	97.2	23	95.8	.99
	Unable	2	6.1	0	0		1	2.8	1	4.2	
Gastrostomy	Able	23	79.3	26	96.3	.10	36	100	13	65.0	< .001
	Unable	6	20.7	1	3.7		0	0	7	35.0	
Incisional hernia	Able	32	100	26	96.3	.46	36	100	22	95.7	.39
	Unable	0	0	1	3.7		0	0	1	4.3	
Colostomy	Able	22	95.7	25	96.2	.99	36	100	11	84.6	.066
	Unable	1	4.3	1	3.8		0	0	2	15.4	
Enterectomy	Able	28	93.3	26	100	.49	36	100	18	90.0	.12
	Unable	2	6.7	0	0		0	0	2	10.0	
Laparoscopic cholecystectomy	Able	31	93.9	27	100	.50	36	100	22	91.7	.16
	Unable	2	6.1	0	0		0	0	2	8.3	
Biliodigestive derivation	Able	13	44.8	24	88.9	.001	33	91.7	4	20.0	< .001
	Unable	16	55.2	3	11.1		3	8.3	16	80.0	
Partial gastrectomy	Able	21	70.0	22	81.5	.37	34	94.4	9	42.9	< .001
	Unable	9	30.0	5	18.5		2	5.6	12	57.1	
Partial colectomy	Able	21	84.0	25	92.6	.41	36	100	10	62.5	< .001
	Unable	4	16.0	2	7.4		0	0	6	37.5	
Simple hepatectomy	Able	10	30.3	0	0	.001	10	27.8	0	0	.004
	Unable	23	69.7	27	100		26	72.2	24	100	
Distal pancreatectomy	Able	11	35.5	0	0	< .001	11	30.6	0	0	.004
	Unable	20	64.5	27	100		25	69.4	22	100	
All operations	Able	10	30.3	0	0	.001	10	27.8	0	0	.004
	Unable	23	69.7	27	100		26	72.2	24	100	
All operations, except hepatectomy and pancreatectomy	Able	15	45.5	22	81.5	.007	31	86.1	6	25.0	< .001
	Unable	18	54.5	5	18.5		5	13.9	18	75.0	

[a]The *p* values refer to Fisher's exact test with 1 degree of freedom. UH = university hospitals; NUH = nonuniversity hospitals; EMERG = Emergency Department.

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Contextual factors

This study demonstrated a difference in judged technical proficiency between 2nd-year (PGY-2) and 4th-year (PGY-4) residents, particularly regarding operations of medium/high difficulty, which supports the construct validity of the assessment tool used.[13] The training time is the most important variable, as longer training allows residents to be exposed to a larger number of cases, required for the acquisition of manual dexterity. On the other hand, this study showed no significant differences in judged proficiency between UH and NUH residents, except for the two most difficult operations, which is explained by the fact that only UHs have GSMR-AP programs, and for the biliodigestive derivation operation, this favoring NUH residents. When we consider judged proficiency in the evaluated operations, excluding the two most difficult, we observed a higher frequency of proficiency of NUH residents (82% judged proficient in NUH vs. 46% in UH). This fact was also described in the United States and may be due to the greater number of residents in UH with consequent lower number of operations performed by each resident.[6] Notably, this study showed the importance of rotation in the open emergency of teaching hospitals for GS residents' training. Residents from hospitals with open Emergency Departments had a higher frequency of judged proficiency than those from hospitals without it, probably due to greater exposure of residents to surgical contexts different from those of elective procedures.

Study limitations

This study has limitations that warrant discussion. First, despite that the GSMR is nationally standardized, Brazil is a country of continental dimensions with unique regional characteristics and different development and economic situations, which makes the complete execution of the residency program, and consequently its assessment, difficult. The states in which we conducted the study are in Brazil's southeast, the most economically developed region, and the chosen hospitals were the largest ones, so the findings may not be generalized to other Brazilian regions.

Second, another limitation was the number and type of operations chosen for evaluation. Although some studies have suggested that only one to four procedures might be enough for evaluation of technical proficiency,[15,22,24] the American Board of Surgery and the Association of Program Directors in Surgery in the

United States prepared a list of 121 procedures that should be considered essential in the competence of a general surgeon.[6] For this study we chose the operations that take place on a day-to-day basis of a GS practice, and these have been validated by the BCS's experts.[14]

Third, the lack of validation of our assessment instrument is probably the main limitation of our study. Moreover, the fact that only one evaluator appraised each procedure is a limitation, as we cannot assess the instrument's interobserver reliability, a fundamental step in the complete validation of an assessment tool.[13] Also, we did not evaluate interevaluator reliability after training, and other psychometric analyses of the assessment tool were not performed, except the previous experts' review. Otherwise, one resident was assessed during different operations by different evaluators, and a single evaluator assessed different residents, hence diluting a possible effect of different evaluators' assessment due to excessive rigor or indulgence.[15–17,22] Furthermore, all evaluators have been trained and clearly informed about what the investigator wanted for each question of the operations.

Fourth, we assumed that all residents had started at the same zero level of technical ability; however, the lack of information on the prior operative experience of assessed residents may be considered a potential bias.

Fifth, the rather small sample size (60 residents), although evaluated during the performance of 499 operations, is a clear limitation, and our findings should be confirmed by larger studies, preferably from other Brazilian cities. Also, the fact that residents were assessed only once for each operation is a limitation, because case specificity makes it difficult to judge general proficiency based on a single observation.

Finally, we focused our study on surgical technical skill acquisition, but trainees may need other nontechnical skills to be considered truly proficient (e.g., interpersonal and teamwork skills and professional self-development), so this study provides only a partial, though important, picture of general surgical competence.

Conclusions

The results of this pilot study suggest that in Brazil, the surgical experience of the residents at the end of their regular GSMR programs (2 years) did not reach adequate levels for the autonomous exercise of daily surgical practice, whereas most residents from GSMR-AP programs (4 years) can be considered competent and able to receive the Board Certification. The current formatting of the regular GSMR program in Brazil seems insufficient to form an independent and autonomous specialist in General Surgery. There is need of change in the curriculum and assessment methods of GSMR programs in Brazil.

Acknowledgments

EGS designed the surgical skill assessment tool, validated it among expert surgeons from the Brazilian College of Surgeons, trained the evaluators who applied the assessment tool to residents in operating rooms, collected the whole data, and drafted the manuscript. GFS analyzed the data, contributed with intellectual content, coordinated, and helped to draft the manuscript. Both authors designed the whole study and read and approved the final manuscript.

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