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ORIGINAL ARTICLE

Surgical autonomy transfer in open and laparoscopic appendectomy: A study of mixed methods from the perspective of residents and supervisors

Transferencia de autonomía quirúrgica en apendicectomía abierta y laparoscópica: estudio de métodos mixtos desde la perspectiva de residentes y supervisores

Julián Senociain González[1], Luis Carlos Domínguez Torres[2]

[1] Physician, resident of General Surgery, Universidad de la Sabana, Chía, Colombia.
[2] Physician, specialist in General Surgery, Department of Surgery, Universidad de la Sabana, Chía, Colombia.

Abstract

Introduction. There is limited information on the appropriate development of surgical learning curves, with high levels of autonomy, in general surgery residents in Colombia. The objective of this study was to characterize the levels of autonomy for performing laparoscopic or open appendectomy in a specialization program, from the perspective of resident physicians and supervisors.

Methods. Study carried out in two phases. The first phase included the prospective collection of information on each procedure (open or laparoscopic appendectomy), performed between August 2015 and December 2018, in which 29 resident physicians participated. Each resident evaluated his/her function (surgeon, assistant), the level of supervision and the level of intraoperative autonomy using the Zwisch Scale (EZ). In the second phase (qualitative), a total of 15 general surgeons were interviewed who supervised the residents' practice with questions that sought to explain the quantitative findings.

Results. 1732 interventions were analyzed: 629 (36%) were performed open and 1103 (63%) were performed laparoscopically. 81.4% (n = 1411) of the procedures were performed in private hospitals. The global perception of autonomy reported by residents according to the Zwisch Scale had level A 28.9% (n = 500), level B 18.1% (n = 313), level C 30.4% (n = 526) and level D 22.7% (n = 393). 35.2% (n = 388) of laparoscopic appendectomies and 17.8% (n = 112) by open approach were performed with a level A, while 19.5% (n = 215) of laparoscopic appendectomies and 28.2% (n = 178) by open approach were performed with a level D. The explanation of the quantitative findings was the frequency of open appendectomies in public hospitals, aspects related to the transfer of autonomy to the resident and progressive increase in the level of advanced autonomy between 2015-2018.

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Correspondence: Julián Senociain González. Universidad de La Sabana, Puente del Común Campus, Km. 7, Autopista Norte de Bogotá, Chia, Colombia. Phone: 3105758791. Email: senosiain88@gmail.com
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Discussion. A higher level of autonomy was found in performing open appendectomy compared with the laparoscopic approach, and levels of autonomy were higher in public hospitals. The explanation for these findings was related to the clinical and professional context of the residents.

Keywords: Zwisch scale; autonomy; supervision; medical education; health postgraduate programs; general surgery.

Resumen

Introducción. Existe información limitada sobre el desarrollo apropiado de curvas quirúrgicas de aprendizaje, con altos niveles de autonomía, en residentes de cirugía general en Colombia. El objetivo de este estudio fue caracterizar los niveles de autonomía, para la realización de apendicectomía laparoscópica o abierta en un programa de especialización, desde la perspectiva de medicos residentes y supervisores.

Métodos. Estudio de métodos mixtos que se realizó en dos fases. La primera fase incluyó la recolección prospectiva de la información de cada procedimiento (apendicectomía abierta o laparoscópica), realizado entre agosto de 2015 y diciembre de 2018, en la que participaron 29 médicos residentes. Cada residente evaluó su función (cirujano, ayudante), el nivel de supervisión y el nivel de autonomía intraoperatoria mediante la Escala de Zwisch (EZ). En la segunda fase (cualitativa), se realizaron entrevistas a un total de 15 cirujanos generales que supervisaron la práctica de los residentes con preguntas que buscaban explicar los hallazgos cuantitativos.

Resultados. Se analizaron 1732 intervenciones: 629 (36 %) se realizaron por vía abierta y 1103 (63 %) por vía laparoscópica. El 81,4 % (n=1411) de los procedimientos fueron realizados en hospitales privados. La percepción global de autonomía reportada por los residentes de acuerdo con la Escala de Zwisch tuvo nivel A 28,9 % (n=500), nivel B 18,1 % (n=313), nivel C 30,4 % (n=526) y nivel D 22,7 % (n=393). El 35,2 % (n=388) de apendicectomías laparoscópicas y el 17,8 % (n=112) por vía abierta fueron realizadas con un nivel A, mientras el 19,5 % (n=215) de apendicectomías laparoscópicas y el 28,2 % (n=178) por vía abierta fueron realizadas con un nivel D. La explicación dada de los hallazgos cuantitativos fue la frecuencia de apendicectomías abiertas en hospitales públicos, aspectosrelacionados con la transferencia de autonomía hacia el residente y el aumento progresivo en el nivel de autonomía avanzada entre 2015-2018.

Discusión. Se encontró un mayor nivel de autonomía en la realización de apendicectomía por vía abierta comparada con la vía laparoscópica, y los niveles de autonomía fueron mayores en hospitales públicos. La explicación a estos hallazgos estuvo relacionada con el contexto clínico y professional de los residentes.

Palabras clave: Escala de Zwisch; autonomía; supervisión; educación médica; programas de postgrado; cirugía general.

Introduction

Surgeons who supervise the practice of residents must balance patient safety, efficiency of the operating rooms and the need of learning of the surgical procedures to provide progressive autonomy to the resident[1]. In programs of specialization continuous evaluation of autonomy and supervision surgical through milestones educational is required, in agreement with the level of the residency and the expected learning results, with the goal to create future surgeons competent to operate, independently and safely, in their professional practice[2].

Often these determinations of progress are made from the perspective of professors and surgeons in charge, through assessments (Objective Structured Assessment of Technical Skills), perception of surgical autonomy and achievement of training milestones, among others. Nevertheless, making the resident to

improve the performance, is essential to share a similar perception to the technical ability and autonomy. The self-perception of surgical autonomy is important because justifies the need of the surgical training, improvement in the learning curve, strengthens their self-confidence and influences the management of operative volume by exposure in medical practice[3,4].

Although the autonomy of the resident is imperative, appropriate supervision by the surgeon is crucial to not affect the proper clinical treatment of the patient[5]. Previous studies have shown that there are individual factors related to the surgeon (level of comfort, experience, competency and role of leadership) and to the context (security of the patient, case and timing), that influence in the determinations of surgeons achieving to transmit to residents[1–3]. However, the precise mechanisms by which surgeons transfer autonomy to the resident even require exploration can help to identify the strategies to improve the quality of the surgical training, from the relationship of the residents with their supervisor[6].

The autonomy to carry out specific procedures that are frequent and vary according to the level of risky complications, become important at the moment in which the future surgeons have to face without the supervision of a tutor. Appendectomy is one of these procedures. It is expected that the residents develop appropriate learning curves with a high level of autonomy to perform a procedure that represents the treatment of choice for the more prevalent surgical entity in patients with abdominal pain seen in the emergency department[7].

Appendectomy offers an opportunity to master basic skills, necessary before performing more complex interventions[8], as the dynamics occur during the process of transfer of autonomy, along with the operative training. However, the information about the surgical transference of autonomy in appendectomy is limited and offers research opportunities in contexts of high real opportunities to practice. The present study aims to improve the knowledge and experience about this topic and to provide information from the perspective of residents and supervisors, on the levels of operative autonomy for the performance of laparoscopic and open appendectomy in a program of specialization in general surgery.

Methods

This is a sequential mixed methods study. The first phase is quantitative through the prospective cross-sectional analysis of residents of the Program of Specialization in General Surgery from the Universidad de la Sabana (Colombia), who recorded levels of autonomy and intraoperative supervision in different surgical procedures. The second phase is qualitative, and aims to explain the quantitative results from the perspective of the supervisors (surgeons).

One of the expected learning outcomes of the program consists of knowledge and the dexterity to dominate the laparoscopic and open appendectomy techniques, in different types of patients and contexts of specialized attention. This process takes place during four years of training and it is framed in an educational ethics and cost-conscious fashion, which final objective is to guarantee performance trusted by the new surgeon within their scope of labor.

Quantitative phase

The information collection was carried out between August 2015 and December 2018. In this phase 29 residents participated (16 men, 29 ± 3.6 years, 13 women, 28 ± 2.7 years). Regarding the year of residence, they were distributed as follows: 17 first-year (58.6%) residents, three second-year (10.3%), three third-year (10.3%), and six fourth-year (20.6%).

At the end of each procedure (open or laparoscopic appendectomy), each resident evaluated his/her role (surgeon, assistant) and the level of supervision and intraoperative autonomy through the Zwisch scale (EZ), arranged in a mobile application. The scale allows to qualify four levels through answers Likert-like[9]. Level A corresponds to «demonstrate and explain», where

the supervisor in charge performs the procedure, demonstrate and explain to the resident the main steps. Level B corresponds to «active help», where the supervisor actively guides the resident in the critical points of the process and the resident completes it. Level C is «passive help», where the resident commands the procedure, while the supervisor provides passive assistance and intervenes when considers necessary, and level D that corresponds to «supervision only», where the resident carries out the procedure independently with the aid of assistants from lower level (other residents), and the supervisor does not participate directly.

In this phase the following outcomes were evaluated:

1. Distribution of appendectomies according to approach, level of residence, type of hospital and year of completion.
2. Distribution of autonomy in laparoscopic and open appendectomy according to level of residency.
3. Distribution of autonomy in laparoscopic and open appendectomy according to type of institution (public or private).
4. Distribution of the perception of autonomy in laparoscopic and open appendectomy according to the year of realization.

In the statistical analysis, the categorical variables are presented as percentages and ranges, and the continuous variables are shown as mean and standard deviation. Some continuous variables were categorized. In these analysis the level of significance was $p < 0.05$ the software used was R-3.5.2.

Qualitative phase

To explain the main quantitative findings 15 electronic formats of open response were sent to general surgeons who supervise the practice of residents (men: 86.6%). Average age of participants was 43.9 years (30-60 years). The 46% of responders work in public hospitals and 54% in private hospitals. Years of teaching experience varied from 1 to 25 years with an average of 10.5 years. About the method used to collect the information was an electronic format with open questions sent to selected surgeons via e-mail (annex 1).

Once all the responses were collected, were independently analyzed by each of the main researchers until saturation of the information was identified, agreement on its content and need to include new information. The texts were analyzed by thematic analysis, a qualitative method that allows identifying, analyzing and reporting the more important data patterns[10].

Results

Quantitative phase

1. Distribution of appendectomies according to approach, level of residence, type of hospital and year of completion.

Between 2015 and 2018, 1849 appendectomies were performed. Of those 117 cases were excluded (86 without complete information and 31 in which the appendectomy was not the main procedure); 1732 cases were analyzed: 36% (n = 629) were performed open and 63% (n = 1103) laparoscopic; 81.4% (n = 1411) of the procedures were performed in private hospitals. The distribution of the procedures were in accordance with the level of residency, hospital and year of completion and can be found in table 1.

2. Distribution of autonomy in laparoscopic and open appendectomy according to level of residency.

The global perception of reported autonomy by residents according to the Zwisch scale was: level A = 28.9% (n = 500); level B = 18.1% (n = 313); level C = 30.4% (n = 526) and level D = 22.7% (n = 393) ($p = 0.000$); 35.2% (n = 388) of laparoscopic appendectomies and 17.8% of the open (n = 112) were performed with a level A; 19.5% (n = 215) of laparoscopic appendectomies and 28.2% of open (n = 178) were carried out with a level D of autonomy. The distribution of levels of autonomy

Annex 1. Electronic format of open questions for the surgeons selected for the study.

This is a study that aims to measure the autonomy of general surgery residents in open and laparoscopic appendectomy procedures. The level of autonomy is based on the Zwich scale, which is divided into 4 levels where A is the level of least autonomy and D is the one with the highest autonomy.

For the data analysis, it was decided the use a quantitative and a qualitative phases that explain quantitative findings.

The questions are listed below:

1. What elements do you think favor or diminish autonomy in residents of general surgery?
2. In this study, we found that even though laparoscopic appendectomy is the procedure more frequently compared with the open technique, the level of autonomy of the residents is always lower in the laparoscopic technique. Why do you think the residents have more autonomy to perform open appendectomy than laparoscopic?
3. The findings of this study were a progressive increase in the number of appendectomies by laparoscopy going from 139 in 2015 to 383 in 2018. However, this trend is constant in private hospitals but not in public hospitals where the open appendectomy continues being the main trend. What do you believe could be the explanation of this phenomenon?
4. In our results, we showed that there is a higher level of autonomy in performing appendectomies by the residents progressively from 2015. Why do you think the level of autonomy for the advanced residents in the performance of appendectomies has changed and increased over time?

according to the surgical approach (open or laparoscopic) are shown in table 2. In agreement to the year of residency, it was observed that in first year 79% (n = 395) of the procedures were performed with a level A, and 1.3% (n = 5) with a level D. In contrast, in the fourth year procedures were mainly performed with a level D (54.5%) and only 2% with a level A (p = 0.000) (Figure 1).

3. Distribution of autonomy in open and laparoscopic appendectomy according to the type of institution (public or private).

The level of autonomy of residents in public institutions was distributed as follows: level A = 33.9% (n = 479), level B = 20.1% (n = 284), level C = 26.7% (n = 378), and level D = 19.4% (n = 270). In terms of the level of autonomy in private institutions the proportions found were: 6.5% (n = 21), 9.03% (n = 29), 46.1% (n = 148), and 38.3% (n = 123) for the levels A, B, C and D, respectively.

Table 1. Distribution of appendectomies depending on the approach, the level of training, the type of hospital and the year of completion.

Distribution of appendectomies	N: 1732
Type of appendectomy (%)	
Open	629 (36,3)
Laparoscopic	1103 (63,7)
Level (%)	
I year	615 (35,6)
II year	376 (21,7)
III year	386 (22,2)
IV year	355 (20,5)
Hospital (%)	
Private	1411 (81,5)
Public	321 (18,5)
Year (%)	
2015	208 (12,0)
2016	470 (27,1)
2017	557 (32,1)
2018	497 (28,8)

In this way, statistically difference was found (p = 0.000) towards greater autonomy in procedures performed in public institutions (Figure 2).

4. Distribution of the perception of autonomy in open or laparoscopic appendectomy according to the year of realization.

An increase in the level of autonomy was observed (level D) when performing appendectomies compared to the year of performance, finding that for year 2015 the level of autonomy D was 12.4% when compared to 40.7% for year 2018. Likewise, the level of autonomy C went from 9.4% to 28.4% (p = 0.000) between the years 2015 and

Table 2. Distribution of appendectomies according to the resident's perception of autonomy.

Perception of the autonomy during the procedure (Zwisch scale)	Appendectomy		Total (n=1732) n (%)
	Open (n=629) n (%)	Laparoscopic (n=1103) n (%)	
A. The professor describes and shows the surgical technique. You attend and ask.	112 (17,8)	388 (35,2)	500 (28,8)
B. You perform the procedure under the verbal and physical guidance of the professor.	113 (18)	200 (18,1)	313 (18,1)
C. You have the initiative and are the leader in the procedure. The professor assists, optimizes the exposure and follow his/her instructions.	226 (35,9)	300 (27,2)	526 (30,4)
D. You complete the procedure only with the teacher as companion, you have the responsibility to direct and expose the assistant without experience.	178 (28,2)	215 (19,5)	393 (22,7)

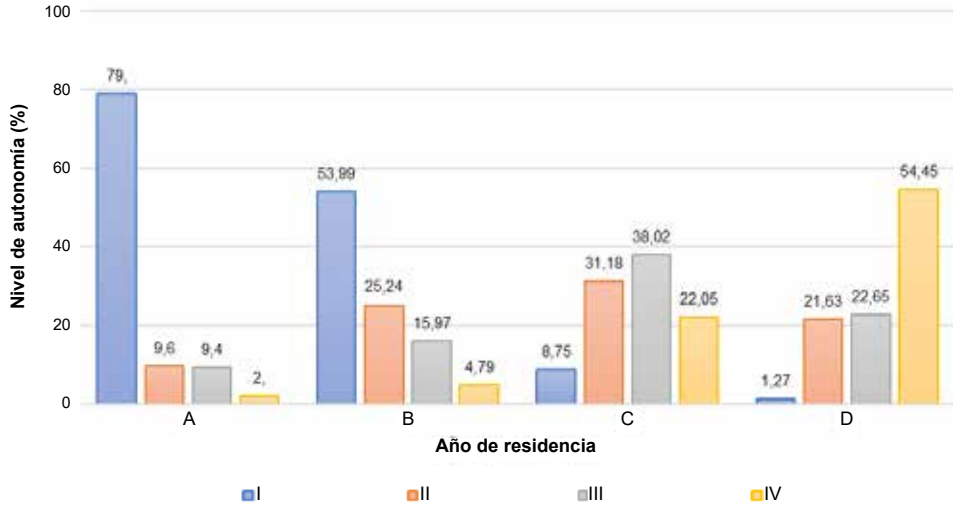

Figure 1. Distribution of appendectomies according to the resident's perception of autonomy compared to year of residence (%).

2018. As to progression of the level of autonomy A through the years, the values were 17% (n = 70), 30.5% (n = 126), 25.2% (n = 104), 23.7% (n = 98), and 3.4% (n = 14) for years 2015 to 2019, respectively. For the level of autonomy B, these values were 9.5% (n = 24), 35.8% (n = 75), 31.5% (n = 66), 31.5% (n = 17.7), and 3.3% (n = 7), respectively (Figure 3).

Qualitative phase

Supervisors explained four main quantitative findings:

a. Higher frequency of open appendectomies in public hospitals, and higher frequency of laparoscopic appendectomies in private hospitals.

Lower use of the laparoscopic approach in public hospitals was explained by the perception of higher cost associated with the procedure, lower frequency of contracting with the insurance companies, refusal of authorization of institutional procedures and limited availability of equipment and resources. Regarding a supervisor (woman with three years of experience) in a public hospital mentioned:

> *"It may be due to a higher cost, at least from the immediate point of view during the procedure, additionally the lower availability of towers or laparoscopic equipment for various surgical services increases the possibilities to generally perform open surgery."*

In contrast, the participants mentioned that in private hospitals more laparoscopic appendectomies were performed because the institutions have the instruments and the necessary agreements to practice this type of procedures, without major limitations of administrative order.

b. Aspects related to the transfer of progressive autonomy towards the resident according to the level of training (regardless of type of appendectomy).

Knowledge, skill and competence of the resident in view of the pathology, and the knowledge of the surgical technique, were the main themes highlighted by participants to transfer autonomy to the resident. These aspects were important for developing trust between the supervisor and the resident. Others aspects mentioned were attitude, interest and proven responsibility by the

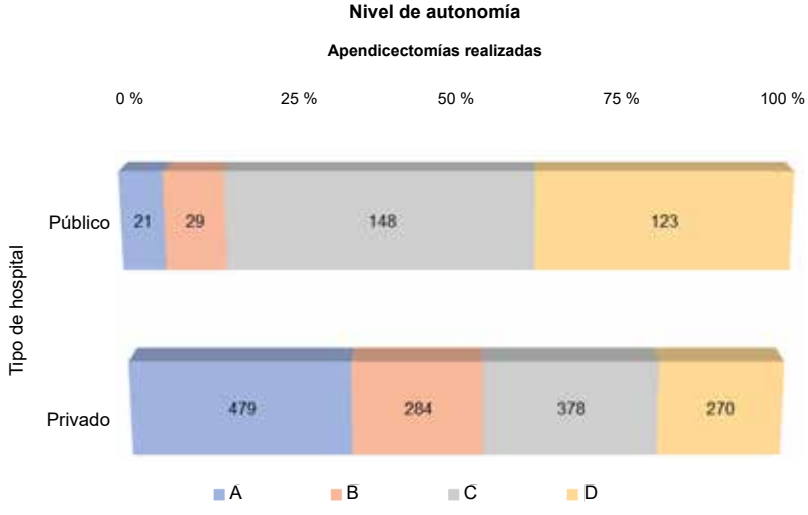

Figure 2. Distribution of appendectomies according to the resident's perception of autonomy compared to the type of hospital of rotation.

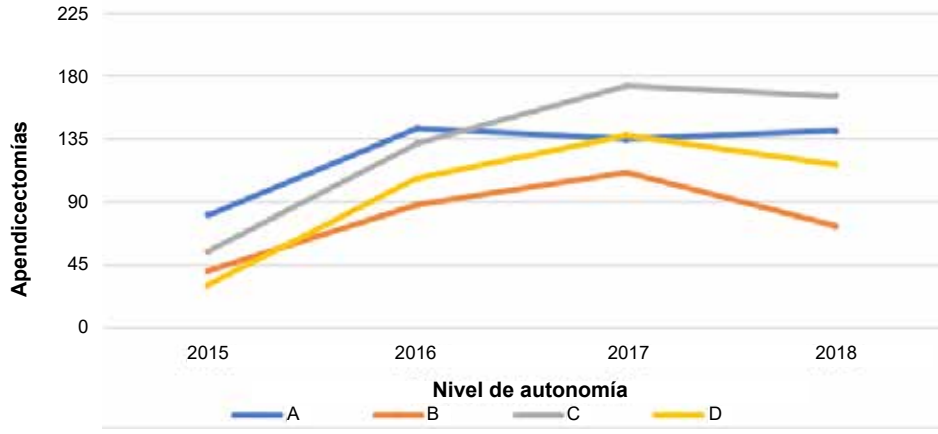

Figure 3. Distribution of appendectomies according to the resident's perception of autonomy compared to the year of performance.

resident and the complexity of the process they faced. To that, one of the participants (man, public hospital, two years of experience) mentioned:

> *"In my teaching activity, I base my actions in Vygotsky's theory whose central axis is the called zone of proximal development, which means that the student is able to learn by itself up to a point, where needs the teacher's help. Therefore, autonomy of the resident goes as far as he asks for help or even when I as a companion of this process I see that they do not have the skills to develop a certain procedure. I can divide the facts in two; the first depends on the resident, their intellectual level and abilities. And the second depends on the professor experience, as much as a surgeon as well as a teacher and the knowledge of the process of the resident."*

c. Greater transfer of autonomy towards resident in open appendectomy compared with laparoscopic appendectomy.

Participants agreed that the laparoscopic approach is of greater technical complexity, therefore, requires greater knowledge and competence. Also, in their perception is a technique whose introduction in the institutions of the country has been recent and requires, thus, a better learning curve for surgeons and residents. Participants mentioned that besides the laparoscopic technique could also be associated with greater complications compared to the open technique. In their perception, these aspects limit the transfer of autonomy towards the resident.

> *"Open appendectomy has been for long time the procedure of residents even from the first year, not the laparoscopic one; I think that a determining factor is that some instructors have learned that technique recently and is not their area of higher comfort, which make it more difficult to give up those cases."* (Woman, public hospital, three years of experience).

On the other hand, professors perceive that the open technique is less complex and more familiar to them, which allows transferring greater autonomy for the resident in this procedure.

> *"Due to its lower complexity, open appendectomy requires fewer skills and there is a low probability of missed iatrogenic injuries, therefore, the resident performs it according to their consideration under surveillance."* (Male, public hospital, 12 years of experience).

d) Progressive increase in the level of advanced autonomy (level D) between 2015 and 2018.

The increase in the transfer of autonomy at advanced levels was mainly explained by the

growing trust between surgeons and residents, higher commitment from the surgeon in his/her role as a teacher, and for the acquisition of more experience on part of the surgeons, which favored an appropriate training curve in laparoscopic surgery.

> *"It is because the instructors have already fulfilled a training curve that gives them security compared to the autonomy given to the resident."* (Man, public hospital, 10 years of experience).

> *"There is a greater commitment of the surgeon in his/her role as a teacher and is reflected by greater autonomy at the residents' practice sites."* (Man, private hospital, 26 years of experience).

Discussion

The objective of this study was to characterize the levels of perception of autonomy in the operating room in the performance of laparoscopic or open appendectomy, from the perspective of the residents of general surgery. Main findings showed that, in this Program, the appendectomies were mostly via laparoscopic. Nevertheless, the level of autonomy was less respect to the open approach. According to the supervisors, these findings could be explained because of the complexity of the laparoscopic approach that, consequently, demands higher knowledge and competence. These findings are similar to the one found by Castrillón *et al.*[8], who described an increasing trend of laparoscopic use in appendectomies and exposing to this process in more stages early in the residency. Further, they found that with training and adequate supervision, surgeons in training could achieve a satisfactory level of competence of these procedures without increasing the number of complications[11,12].

Another important finding was that most laparoscopic procedures were performed in private hospitals. "This is due to the increase in costs associated with the use of laparoscopy, the type of recruitment and the lack of authorization by insurers, as well as limited availability of equipment and resources in public hospitals", according to the respondents explanation. Nevertheless, it was found that in public hospitals, the residents' autonomy was greater than in the private institutions, in agreement with a qualitative study reported in Mexico[13], with the highest degree of autonomy of residents in public institutions, and at the same time offer important challenges of limitation of resources[12,14,15].

With respect to the elements that favored autonomy in residents, we found consistency with some factors described in other studies, such as the expertise of the resident that is usually related to years of training received, performance of the resident during the development of the case, the surgical difficulty during the procedure, and the factors related to the supervisor in the transfer of autonomy toward the resident[1,16-18]. Regarding the first group of factors, in this study we found that indeed during the 3rd and 4th year of residency, the instructors provide higher degree of autonomy to residents, in agreement with Hauer and cols.[19] with better clinical reasoning, better surgical skills and overall more experience in the operating room[2].

Additionally, according to the study by Williams *et al.*[20], which included 7297 evaluations of autonomy, 424 instructors, 487 residents and 14 residency programs, the second factor which can be summarized in the overall performance perceived by the supervising surgeon, represents the most important factor in the transfer of autonomy, which is consistent with the findings of the qualitative results obtained by the authors, whit a clear trend of this factor found as determinant in the transfer of autonomy. The difficulty of the case is the third factor to consider and has been previously studied finding a correlation between the level of autonomy of the resident and the difficulty of the case, as well as some critical steps of the procedure[16,21]. Finally, it has been considered as a determining factor in this transfer process the behavior of the supervising surgeon during the teaching process of a resident, and it has even been proposed that said behavior is influenced by previous aspects of the instructor, the experience measured in years and even their cultural believes[20,21].

Within the strengths of this study, it represents a possibility to evaluate the features of the process of transfer of autonomy towards residents of general surgery in Colombia. Therefore, the possibility to analyze the current situation and propose strategies that allow standardization with minimum requirements for a resident graduation in General Surgery, as has been proposed in United States by the program "General Surgery Milestones"[22]. Regarding the limitations, it is necessary to recognize that this study was carried out in a single training center and evaluated a single surgical procedure, which requires future research to scale the analysis performed.

Considering the arguments found in this document, opportunities are open for both aspects, clinical and investigative practice. One of the options of the clinical application is the implementation of the system from planning, preoperative instruction, intraoperative teaching and subsequent feedback, which allows a more homogeneous follow-up in terms of learning process and transfer of autonomy to the resident[4]. Regarding research opportunities, the validation of the hypotheses presented is considered necessary through studies that include other programs of surgery in the country, such as the use of technological tools as web or mobile applications for the registry and maintenance of information as a product of the process of transfer of autonomy.

Conclusions

The process of transfer of autonomy towards general surgery residents in appendectomy have multiple factors that influence the speed on how a level of adequate sufficiency is achieved, and the various analysis to be taken to consider the time to take decisions for planning the pedagogical strategies in these programs of residency. Based on this, research on this topic should be continued with the goal to improve the educational process as well as the outcomes in the surgical practice.

Compliance with ethical standards

Informed consent: This study was endorsed by the Health Research Committee of the Universidad de la Sabana and was approved by the Institutional Ethics Committee. According to resolution 8430 of 1993 this study is considered Risk free.

Conflicts of interest: The authors declare no conflicts of interest.

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