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Resident autonomy in the operating room: Does gender matter?

Heather Hoops*, Aaron Heston, Elizabeth Dewey, Donn Spight, Karen Brasel, Laszlo Kiraly

Department of Surgery, Oregon Health & Science University, Portland, OR, USA

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ABSTRACT

Introduction: Previous data examining the effect of gender on surgical trainee autonomy is lacking. We hypothesized that female general surgery residents have less autonomy than males during laparoscopic cases.

Methods: We retrospectively reviewed factors associated with level of guidance needed during laparoscopic procedures as reported on intraoperative procedure feedback forms and on FLS tasks from one institution from 2013 to 2016. Data collected included resident and attending gender, level of guidance needed, PGY level, case characteristics, resident intraoperative performance, and skills lab FLS performance. Univariate and multivariate analyses were performed using a mixed-effects regression model.

Results: We analyzed data from 106 PGY1-PGY5 residents (51% Female) and 104 attendings (26% Female). Female resident gender was associated with more intraoperative guidance in univariate ($p = 0.019$) and multivariate analysis ($p = 0.034$). Technical performance between genders was similar.

Conclusions: This study demonstrated gender-based inequality in intraoperative autonomy even after controlling for technical performance, PGY level, and case factors.

Introduction

While the number of women entering general surgery residency has increased, it has not kept pace with the growing number of women entering medical school overall, and many other specialties are perceived as more accepting of female trainees.[1,2] After residency, female surgeons find disparities continue in the academic surgery community, as women occupy proportionately fewer leadership positions in academic surgery and are paid less than male peers.[3,4] Possible causes for gender-disparities in surgery include unequal mentorship opportunities and unconscious bias which may lead to differences in psychological well-being, burnout, and confidence levels among male and female residents.[5] These inequalities start within the training environment and continue throughout career advancement.[6–8]

There is also shared concern between residents and program directors that graduating general surgery residents are increasingly less prepared for independent practice.[9,10] The majority (80%) of general surgery residents choose to enter fellowship upon graduation, which may be partially due to a lack of confidence in readiness to enter independent general surgery practice.[11] Resident autonomy is critical to practice readiness, but there are many practical barriers to intraoperative autonomy, including attending, resident, and environmental factors. Attending factors cited include previous experience with a particular procedure, supervision requirements, and time/productivity goals.[12–14] Resident factors include case preparedness, technical skills, and previous time spent with an attending.[12,13,15,16] Environmental factors include case difficulty, other surgical trainees, and pressure from other members of the OR team.[15]

A recent study by Meyerson et al. demonstrated that resident gender may also play a role in intraoperative autonomy. Their study showed that male residents and fellows were granted more autonomy in the operating room compared to females during comparable cardiothoracic surgery cases.[17] To our knowledge no previous studies have evaluated the effect of gender on the intraoperative autonomy of general surgery residents during laparoscopic procedures. The objective of our study was to evaluate the effect of both resident and attending gender on intraoperative guidance during laparoscopic cases, using guidance as a surrogate for autonomy.[18]

Methods

To evaluate the effect of gender on intraoperative autonomy, we

* Corresponding author. Department of Surgery, Oregon Health & Science University, Mail Code L223 3181, SW Sam Jackson Park Rd, Portland, OR, 97238, USA.
E-mail address: hoops@ohsu.edu (H. Hoops).

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retrospectively reviewed two general surgery residency databases from a single institution over a three-year time period from July 2013 through June 2016. We sought to evaluate the effect of gender while controlling for resident technical performance and case factors known to affect intraoperative autonomy. We chose to evaluate laparoscopic cases only, as we could account for technical skill in both the simulation lab and intraoperative environment, potentially decreasing bias of utilizing measurement of technical skills from only one source of data. Additionally, the Accreditation Council for Graduate Medical Education (ACGME) divides laparoscopic cases into basic and complex laparoscopic cases allowing for us to control for procedure complexity in our analysis.[19]

Intraoperative performance data

Our institution utilizes Procedure Feedback Forms (PFF) to evaluate resident intraoperative performance.[20] These forms are resident initiated, with a section filled out by the resident and another by the faculty. All residents and faculty receive education on how to fill out the form, and the level of guidance is meant to be filled out by the faculty. All PFFs during the three-year study period for PGY1-PGY5 residents were reviewed, open cases were excluded. Data collected from these forms included resident and attending gender, procedure performed, case difficulty (straightforward, moderately difficult, very difficult), attending ratings of resident intraoperative performance, and attending perception of level of guidance needed (much, moderate, and little to none). On a continuous scale from one to three (with one needing improvement, two being satisfactory, and three being excellent), attendings evaluated resident intraoperative performance in five domains: medical knowledge, operative technique, operative knowledge, communication, and professionalism. Procedures were divided into basic and complex laparoscopic categories per ACGME case log guidelines, with basic procedures including laparoscopic cholecystectomies, laparoscopic appendectomies, and diagnostic laparoscopies and complex procedures comprising all other laparoscopic procedures.[19]

Laparoscopic skills lab data

During yearly laparoscopic skills labs running over four consecutive weeks, residents perform the five Fundamentals of Laparoscopic Surgery (FLS) tasks (Peg Transfer, Precision Cutting, Ligating Loop, Extracorporeal Suturing, Intracorporeal Suturing)[21] while being timed to simulate the FLS exam. Residents were given goals of PGY-specific benchmarks for each FLS task.[22] We analyzed the time to complete each FLS task adjusted for penalties for PGY1-PGY4 residents over the study period. For the purpose of this study, we also calculated a normalized McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) score,[23] which is a measure of overall FLS performance, equally incorporating performance on each of the five FLS tasks. There was no skills lab data for PGY5 residents, since PGY4 residents take the FLS exam during their 4th year.

Privacy

All resident and attending identifiers were removed by an independent data manager, assigning each resident an identification number. The key was kept in a password-protected folder only accessible by the data manager. This study was approved by our Institutional Review Board.

Statistical analysis

In order to account for dependency across multiple intraoperative evaluations per year, and data from residents across multiple PGY levels, level of guidance was fit to a multinomial mixed-effects regression model with unique identifiers for residents and attendings added to the model as random variables. The mixed-effects model utilized weighted each resident equally, using input variables on the procedure feedback forms and FLS tasks to predict level of guidance. First, a univariate analysis was performed, evaluating the effect of intraoperative performance on five domains (medical knowledge, operative technique, operative knowledge, communication, and professionalism), procedure complexity (basic or complex laparoscopic case), level of difficulty, resident gender, and attending gender. The univariate analysis was run for each PGY level separately, as well as using PGY level as a variable in the mixed-effects model, as some residents had procedure feedback form data across multiple years. Performance on FLS tasks between genders was compared using a Wilcoxon Rank Sum test, as there was only one timed evaluation of resident performance per year.

A multivariate analysis was performed using a mixed-effects regression model to evaluate the effect of an individual factor, while controlling for the effects of other factors. Variables added to the multivariate model included PGY level, case difficulty, procedure type (complex or basic), performance on FLS tasks, and attending ratings of resident intraoperative performance on domains of medical knowledge, operative technique, operative knowledge, communication, and professionalism. Test results for differences in guidance between unique resident-attending gender-pairs were adjusted for multiple comparisons. The significance level was set at $p < 0.05$.

Results

Univariate analysis

Data were collected from 908 procedure feedback forms, including data from 106 (54 female, 52 male) residents and 114 attendings (30 female, 84 male), with 179 unique resident-attending pairings. The number of PFFs per resident per year were similar between groups at all PGY levels as shown in Table 1. Mean numbers of PFFs evaluated per resident were lowest in PGY1 residents, with 3.0 and 1.8 forms for male and female residents, respectively ($p = 0.195$). Mean number of PFFs evaluated were highest for PGY3 residents, with 5.4 and 5.9 forms for male and females, respectively ($p = 0.382$).

Univariate analysis of PFF data was performed using a mixed-effects model in order to account for dependencies in data due to multiple evaluations of each resident and evaluations of residents across multiple years. Descriptive statistics are shown in Table 1. Resident intraoperative performance was similar between male and female residents in most categories. For PGY3 residents, males had significantly higher scores for operative technique than females ($p = 0.012$). For PGY4 residents, males had significantly higher scores for operative knowledge than female residents ($p = 0.044$). For procedure complexity, PGY3 female residents had a significantly higher percentage of complex laparoscopic cases evaluated compared to males ($p = 0.007$). Case difficulty was similar between groups at all PGY levels. Attending perception of intraoperative guidance needed was significantly higher for PGY3 females than PGY-matched males ($p = 0.012$). There was a trend toward attendings perceiving females as needing more guidance than PGY-matched males at the PGY2 ($p = 0.064$) and PGY4 levels ($p = 0.092$). Fig. 1 demonstrates level of guidance by PGY and gender.

Table 1
Descriptive statistics for procedure feedback form (PFF) Data by gender and post-graduate year (PGY).

	PGY = 1		PGY = 2		PGY = 3		PGY = 4		PGY = 5	
	Female (N = 20)	Male (N = 17)	Female (N = 27)	Male (N = 23)	Female (N = 22)	Male (N = 20)	Female (N = 22)	Male (N = 20)	Female (N = 21)	Male (N = 19)
Number of PFFs	35	52	129	135	127	104	114	72	70	70
PFFs per resident, mean (range)	1.8 (1–6)	3.0 (1–16)	4.8 (1–14)	6.2 (1–15)	5.9 (1–13)	5.4 (1–20)	5.4 (1–11)	4.0 (1–9)	3.3 (1–12)	3.7 (1–9)
Attending Ratings, mean (95% Confidence Interval)										
Medical Knowledge	2.5 (2.3, 2.8)	2.6 (2.4, 2.8)	2.8 (2.7, 2.9)	2.8 (2.7, 2.9)	2.9 (2.8, 3)	2.9 (2.9, 3)	2.9 (2.9, 3)	2.9 (2.8, 3)	3 (2.9, 3)	2.9 (2.8, 3)
Operative Technique	2 (1.8, 2.1)	2.2 (1.9, 2.4)	2.3 (2.2, 2.5)	2.4 (2.3, 2.6)	2.5 (2.4, 2.7)*	2.7 (2.6, 2.8)*	2.7 (2.5, 2.8)	2.9 (2.8, 2.9)	2.8 (2.7, 2.9)	2.8 (2.7, 2.9)
Operative Knowledge	2 (1.9, 2.2)	2.3 (2, 2.6)	2.5 (2.4, 2.6)	2.6 (2.5, 2.8)	2.7 (2.6, 2.8)	2.9 (2.8, 3)	2.8 (2.7, 2.9)*	2.9 (2.7, 3)*	2.8 (2.7, 2.9)	2.8 (2.6, 2.9)
Communication	2.7 (2.5, 2.9)	2.9 (2.8, 3)	2.9 (2.9, 3)	2.9 (2.8, 3)	2.9 (2.8, 3)	2.9 (2.9, 3)	2.9 (2.9, 3)	3 (2.9, 3)	2.9 (2.9, 3)	2.9 (2.8, 3)
Professionalism	2.9 (2.8, 3)	3 (3, 3)	3 (3, 3)	3 (3, 3)	3 (3, 3)	3 (2.9, 3)	3 (3, 3)	3 (3, 3)	3 (3, 3)	3 (3, 3)
Procedure Type, n (%)										
Basic	29 (83%)	34 (65%)	110 (85%)	114 (84%)	84 (66%)*	90 (87%)*	81 (71%)	55 (76%)	41 (59%)	39 (56%)
Complex	6 (17%)	18 (35%)	19 (15%)	21 (16%)	43 (34%)*	14 (13%)*	33 (29%)	17 (24%)	29 (41%)	31 (44%)
Difficulty of Procedure, n (%)										
Straightforward	22 (63%)	25 (49%)	68 (54%)	65 (49%)	50 (39%)	60 (58%)	51 (45%)	31 (44%)	25 (37%)	37 (54%)
Moderately difficult	9 (26%)	23 (45%)	45 (36%)	58 (44%)	61 (48%)	40 (38%)	49 (43%)	33 (46%)	34 (50%)	26 (38%)
Very difficult	4 (11%)	3 (6%)	12 (10%)	10 (8%)	16 (13%)	4 (4%)	14 (12%)	7 (10%)	9 (13%)	6 (9%)
Guidance Needed, n (%)										
Little to none	0 (0%)	3 (6%)	17 (13%)	25 (19%)	41 (32%)*	58 (56%)*	51 (45%)	47 (65%)	36 (54%)	38 (56%)
Moderate	15 (43%)	28 (54%)	93 (72%)	101 (75%)	70 (55%)*	43 (41%)*	55 (48%)	22 (31%)	27 (40%)	29 (43%)
Much	20 (57%)	21 (40%)	19 (15%)	9 (7%)	16 (13%)*	3 (3%)*	8 (7%)	3 (4%)	4 (6%)	1 (1%)

Note: N = 105 residents who submitted 908 total PFFs across five post-graduate years; residents submitted PFFs across multiple years. Parameters between male and female residents for each PGY level were evaluated using a univariate mixed-effects regression model. The "*" symbol denotes a statistically significant difference between groups.

When incorporating PGY level into the model, female gender was significantly associated with attending perception of more intraoperative guidance required ($p = 0.019$), as demonstrated in Table 3. Attending gender did not significantly affect resident level of guidance ($p = 0.956$). Attending-resident gender pairings (MM, MF, FM, FF), also did not significantly affect level of guidance ($p = 0.261$). Other factors that significantly affected level of guidance included medical knowledge ($p < 0.0001$), operative technique ($p < 0.0001$), operative knowledge ($p < 0.0001$), communication ($p < 0.0001$), PGY level ($p < 0.0001$), Procedure complexity ($p < 0.0001$), and case difficulty ($p < 0.0001$).

When comparing the performance of residents on FLS tasks, resident performance was similar between male and female residents, except on one task in the PGY4 group. At the PGY4 level, males performed the extracorporeal suturing exercise significantly faster than females ($p = 0.032$). Laparoscopic skills lab performance by PGY level and gender is shown in Table 2.

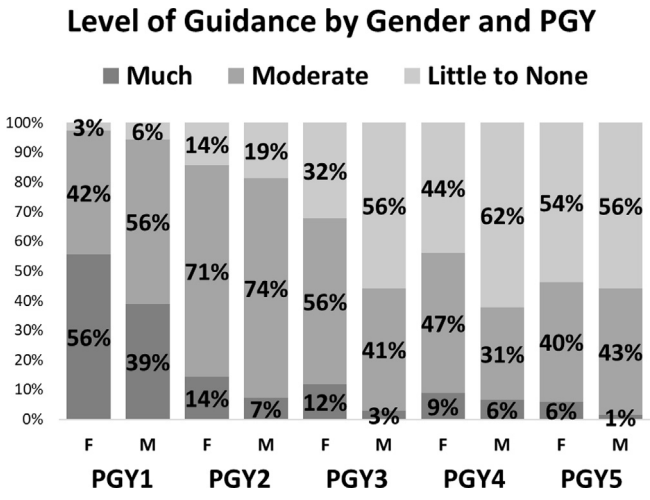

Fig. 1. Level of Intraoperative Guidance Needed by Gender and PGY Level.
Note: Percentages of all procedure feedback forms with levels of guidance as much moderate or little to none are listed by PGY level and by gender. Note that there is a trend toward female gender being associated with more guidance for PGY1 ($p = 0.591$), PGY2 ($p = 0.064$), and PGY4 ($p = 0.092$) levels. Females gender was associated with significantly more guidance at the PGY3 level ($p = 0.012$). Level of guidance needed was similar between genders at the PGY5 level.

Multivariate analysis

Female gender was significantly associated with attending perception of more guidance needed as compared to males after accounting for the effects of attending gender, PGY level, case difficulty, procedure complexity, intraoperative performance, and laparoscopic skills lab performance ($p = 0.034$). Other factors significantly associated with level of guidance included attending ratings of operative knowledge ($p < 0.0001$) and operative technique ($p = 0.002$), PGY level ($p < 0.0001$), procedure complexity ($p = 0.042$) and case difficulty ($p < 0.0001$). Results of the multivariate analysis are shown in Table 3.

Discussion

This study demonstrates significant gender-based differences in autonomy, with female residents receiving significantly less autonomy during laparoscopic procedures than male counterparts. Intraoperative autonomy is a complex issue, with attending, resident, and environmental factors all affecting the amount of guidance given to a resident during a case. Additionally, measuring intraoperative autonomy is complicated by difficulty determining whether guidance given during a case exceeds guidance need as well as by varying expectations for autonomy between residents and attendings.[24]

This study identified multiple factors that effect resident autonomy during laparoscopic procedures. Resident factors identified to affect guidance include gender, PGY level, technical skills (as measured by operative technique on PFFs), and knowledge of the steps of the case (as measured by operative knowledge on PFFs). Case factors identified to affect guidance include procedure complexity (basic vs complex laparoscopic procedures), and case difficulty (straightforward, moderately difficult, or very difficult). In

Table 2
Descriptive statistics fundamentals of laparoscopic skills (FLS) task performance by gender and post-graduate year (PGY).

	PGY1		PGY2		PGY3		PGY4	
	Female (N = 20)	Male (N = 17)	Female (N = 20)	Male (N = 20)	Female (N = 13)	Male (N = 11)	Female (N = 9)	Male (N = 10)
Laparoscopic Skills Lab FLS Tasks, mean *(95% confidence interval)*								
Normalized MISTELS Score	458 (466, 495)	451 (468, 481)	473 (497, 510)	478 (500, 513)	469 (500, 504)	490 (501, 522)	473 (487, 504)	489 (503, 516)
Peg Transfer (sec)	60 (77, 82)	57 (76, 86)	53 (63, 71)	52 (58, 66)	63 (66, 72)	55 (60, 74)	62 (67, 72)	51 (59, 74)
Precision Cutting (sec)	46 (63, 93)	50 (71, 106)	35 (48, 72)	40 (53, 73)	42 (55, 75)	40 (49, 62)	54 (60, 80)	49 (60, 72)
Ligating Loop (sec)	37 (42, 50)	38 (46, 55)	32 (40, 52)	32 (41, 52)	27 (38, 48)	32 (36, 42)	30 (33, 45)	29 (33, 36)
Extracorporeal Suture (sec)	86 (114, 128)	86 (106, 118)	71 (83, 101)	70 (81, 91)	82 (91, 106)*	70 (77, 86)*	81 (103, 107)	70 (80, 97)
Intracorporeal Suture (sec)	102 (130, 153)	102 (108, 142)	91 (95, 117)	74 (93, 108)	86 (91, 110)	70 (103, 115)	87 (104, 117)	70 (82, 97)

Note: Laparoscopic lab skills lab performance of male and females were compared for each PGY level using Wilcoxon Rank-Sum tests. The "*" symbol denotes a statistically significant difference between groups. No Laparoscopic Skills lab data exists for PGY5 residents, as residents take the FLS exam during their 4th year.

order to more accurately represent resident technical skill, we utilized both intraoperative and simulation-based measurements of technical skills. Performance on FLS tasks has been previously shown to correlate to intraoperative performance during laparoscopic procedures.[25]

Gender-based differences in autonomy were present even after accounting for intraoperative performance, laparoscopic skills lab performance, case factors, and PGY level on multivariate analysis. This is the first study, to our knowledge, that identifies gender-based disparities in autonomy among general surgery residents. However, the results of this study are consistent with previous work showing that female resident gender was significantly associated with less autonomy among surgical residents and fellows during cardiothoracic procedures.[17] It is imperative that gender-based disparities in autonomy are recognized and addressed in order to optimize training for all residents and to promote competency of all residents upon graduation.

One potential reason for gender-based disparity in autonomy is implicit bias which causes residents to be unconsciously judged differently based on their gender by both male and female attendings.[26] The basis for implicit bias is cultural norms for behavior and interpersonal interactions developed since childhood that do not differ systematically by gender.[26] The fact that attending gender and resident-attending gender pairings did not significantly affect resident autonomy supports the argument for implicit bias contributing to gender-based differences in autonomy.

Another potential reason for female residents having less autonomy than their male counterparts may be gender-based differences in confidence levels.[5,27] Previous studies have demonstrated that females report less confidence than males[28] and grade themselves more harshly than males.[29,30] Lack of confidence may be perceived as lack of competence by attending surgeons.[15]

Potential solutions to gender-based disparities in autonomy include faculty development with implicit bias training to increase awareness of bias and assessment training utilizing objective behavioral anchors to assess resident behaviors associated with readiness for entrustment.[13] For residents whose confidence lags behind competence, objective feedback and coaching may help optimize appropriate levels of guidance. However, confidence is not an exact surrogate for competence and there are pitfalls to self-evaluation.[31] Correlating self-reported and observed confidence levels with objective measures of performance may help residents

Table 3
Results from univariate and multivariate multinomial mixed-effects regression model evaluating effects of factors that influence guidance needed by residents in the operating room.

	Univariate		Multivariate	
	F-test	*p*-value	F-test	*p*-value
Attending Ratings				
Medical Knowledge	75.30	**<0.0001**	0.98	0.322
Operative Technique	158.92	**<0.0001**	10.32	**0.002**
Operative Knowledge	151.18	**<0.0001**	12.98	**<0.0001**
Communication	24.29	**<0.0001**	0.02	0.901
Professionalism	4.94	0.198	1.18	0.277
Post-Graduate Year				
PGY 2 compared to PGY 1	−4.12	**<0.0001**	−4.14	**<0.0001**
PGY 3 compared to PGY 1	−5.01	**<0.0001**	−4.71	**<0.0001**
PGY 4 compared to PGY 1	−6.18	**<0.0001**	−5.26	**<0.0001**
Procedure Type and Difficulty of Procedure				
Complex vs Basic procedure	−8.09	**<0.0001**	−2.04	**0.042**
Very Difficult vs Straightforward procedure	−7.16	**<0.0001**	4.84	**<0.0001**
Moderately Difficult vs Straightforward procedure	−3.47	**<0.0001**	5.15	**<0.0001**
Laparoscopic Lab Skills				
Normalized MISTELS Score	26.81	0.604	0.49	0.485
PEG Score (seconds)	11.63	0.365	1.18	0.279
Intracorporeal Score (seconds)	19.67	0.455	0.41	0.524
Pattern Score (seconds)	15.93	0.889	0.05	0.820
Endloop Score (seconds)	8.18	0.619	0.6	0.438
Extracorporeal Score (seconds)	19.43	0.371	0.45	0.503
Gender				
Resident	−2.35	**0.019**	4.56	**0.034**
Attending	0.06	0.956	0.01	0.916
Resident-Attending Pairing	1.34	0.261	2.97	0.086

NOTE: Significant p-values ($p < 0.05$) are in highlighted in bold.

calibrate their confidence to better match their competence level. Results of this study may be utilized to guide prospective evaluation of gender-based differences in autonomy across multiple institutions.

Limitations of this study include its retrospective, single-institution design, which may limit applicability to other institutions. However, the findings of this study are similar to the only previously published study[17] evaluating the effect of gender on surgical trainee autonomy using a different autonomy scale (Zwisch Scale),[18] implying more generalizability of the evidence identifying gender-based disparities in autonomy. This study may be subject to selection bias, as all evaluations are resident-initiated, and residents may choose cases in which they performed well. However, there is no evidence to suggest that the level of selection bias varied between genders. There may also be a Hawthorne effect, as attendings performed the evaluations in the presence of the resident. However, there is no evidence that this affected genders differently. Differences in gender may be due to resident cohort effect, but this was mitigated by three years of resident data and by controlling for performance factors in the multivariate analysis.

We chose to evaluate case factors by dividing laparoscopic case types into basic (which include laparoscopic cholecystectomy, laparoscopic appendectomy, and diagnostic laparoscopy), and complex (all other laparoscopic procedures), which may not adequately stratify the degree of difficulty between different laparoscopic procedures. However, the degree of difficulty for a case type (e.g. a straightforward vs very difficult laparoscopic cholecystectomy) was analyzed separately. Lastly, we were unable to assess resident confidence levels, which may affect gender-based differences in autonomy that we were unable to account for in our analysis.

Conclusions

Female resident gender was significantly associated with less intraoperative autonomy during laparoscopic procedures, even after controlling for resident technical skills, PGY level, and case factors. Further work is needed to identify causes for gender-based disparities in autonomy and to determine strategies that mitigate this bias in order to optimize training of all residents.

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