# The Impact of Resident Postgraduate Year Involvement in Body-Contouring and Breast Reduction Procedures

## *A Comprehensive Analysis of 9638 Patients*

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**Background:** Given the rising popularity in body-contouring procedures (BCPs) in the United States, it is important to assess the currently unknown association between resident involvement and postoperative complications. As such, the aim of this study was to evaluate the impact of resident involvement on outcomes in BCPs using a large national database.

**Methods:** A retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program database was performed (2006–2012) to identify patients undergoing BCPs, using relevant *Current Procedural Terminology* codes. Outcome measures included postoperative complications, hospital length of stay, and operation time.

Multivariate regression models were used to assess the impact of resident involvement and resident experience on outcomes.

**Results:** A total of 9638 cases were identified, of which 3311 involved resident participation.

Resident involvement was associated with significantly higher rates of complications (7.8% vs 4.4%; $P = 0.003$) and longer operation times (180.7 vs 171.9 minutes; $P = 0.005$). For each year increase of resident postgraduate year, there was a significant decrease in odds of complications (odds ratio, 0.906; $P = 0.013$) and operative time (−2.7 minutes; $P = 0.001$).

**Conclusions:** Resident involvement in BCPs was associated with an increased rate of overall complications in a large, national database. However, the clinical significance of these outcomes may be debated. Increased postgraduate year experience as a surgical resident was inversely associated with overall complications. Guided resident autonomy and earlier exposure to BCPs could lead to an optimization of clinical outcomes and resident education.

**Key Words:** body contouring, resident involvement, patient outcomes, National Surgical Quality Improvement Program

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Over the past decade, there has been a continuing rise in the number of body-contouring procedures (BCPs) performed in the United States. According to the American Society of Plastic Surgeons, there has been a respective 107% and 4284% increase in abdominoplasties and lower body lift procedures performed in the United States between 2000 and 2017.[1] This increase has been greatly influenced by the increasing numbers of massive weight loss patients.[2] This includes patients who have undergone bariatric surgery procedures, but also patients with anatomical deformities related to pregnancy, aging, or weight reduction from dieting and exercise.[2] The American Society for Metabolic and Bariatric Surgery has reported a 36% increase in bariatric procedures from 2011 to 2016, with a total of 216,000 performed in 2016.[3–5]

Fueled by the obesity epidemic, BCPs are likely to continue to increase in popularity. However, an evaluation on the impact of resident involvement regarding postgraduate year level on BCP outcomes has not yet been examined. This may be especially important given the varying exposure and comfort with performing aesthetic procedures reported by residents and the noted high complication rates of BCP procedures.[6] Prior studies have evaluated the impact of resident involvement on procedures across multiple surgical specialties, such as urology,[7] general surgery,[8–13] orthopedic surgery,[14] and plastic surgery.[15–19] These studies have reported varying patient outcomes with respect to resident involvement.[8–19] The aesthetic surgery experience of residents may be variable due to the high demanding nature of patients seeking aesthetic surgery and the limited aesthetic surgery volume at academic medical centers.[6,20–23] Physicians at teaching hospitals are often faced with the struggle to reconcile their own fiduciary commitment to patients with the potentially increased risk of complications associated with resident surgical involvement.[24]

As such, the aim of this study was to investigate the influence of postgraduate year level resident involvement on outcomes in BCPs using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP).

## METHODS

Institutional review board approval was not required for this study. We performed a retrospective analysis of the 2006 to 2012 ACS-NSQIP registry to identify all patients who underwent BCPs. This database includes deidentified information from the ACS-NSQIP database and prospectively collects data for patients undergoing surgical procedures for a 30-day period. The data collection process has been described extensively and is provided by the program.[25] Data include demographic information, laboratory values, operative procedures and details, and surgical outcomes (including complications). The data were collected by trained clinical reviewers based on standard definitions. Operational definitions for each of the variables used in this study can be found in the ACS-NSQIP user guide.[26]

### Patient Identification

Patients aged 18 years or older who underwent BCPs were identified using the following *Current Procedural Technology* (*CPT*) codes: 15830, 15832–15839, 15847, 15876–15879, 19316, and 19318. An overview of *CPT* codes, description, and corresponding frequencies of surgical procedures is shown in Table 1. We filtered patients by surgical specialty and selected those who were operated upon by plastic surgeons. There were no restrictions placed on patient comorbidity or American Society of Anesthesiologists (ASA) physical classification status, as our aim was to obtain a comprehensive understanding of the patient population who underwent these procedures.

Of the patients identified, we selected cases that were coded to reflect resident involvement in the operation and those that did not by

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**TABLE 1.** *CPT* Codes

| *CPT* Code | Procedure | Frequency |
|---|---|---|
| 15830 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); abdomen, infraumbilical panniculectomy | 2507 |
| 15832 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); thigh | 51 |
| 15833 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); leg | 8 |
| 15834 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); hip | 55 |
| 15835 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); buttock | 60 |
| 15836 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); arm | 100 |
| 15837 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); forearm or hand | 5 |
| 15838 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); submental fat pad | 2 |
| 15839 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); other area | 116 |
| 15847 | Excision, excessive skin, and subcutaneous tissue (includes lipectomy); abdomen (eg, abdominoplasty; including umbilical transposition and fascial plication) | 1706 |
| 15876 | Suction-assisted lipectomy; head and neck | 53 |
| 15877 | Suction-assisted lipectomy; trunk | 1515 |
| 15878 | Suction-assisted lipectomy; upper extremity | 112 |
| 15879 | Suction-assisted lipectomy; lower extremity | 283 |
| 19316 | Mastopexy | 1790 |
| 19318 | Reduction mammaplasty | 5283 |

using the "ATTEND" variable. If a resident was involved in the procedure, we further classified for level of training by analyzing postgraduate year using the "PGY" variable. In addition, we stratified cases with resident involvement into 2 groups: PGY1–3 and PGY4+.

## Patient Characteristics

To adjust for risk factors in statistical analyses, we extracted patient demographics, preexisting comorbidities, prior surgeries (within 30 days before BCP), ASA classification, and the number of concurrent procedures. Patient demographics included sex, age, body mass index (BMI; kg/m$^2$), race, inpatient/outpatient care status, smoking, alcohol use, radiotherapy, chemotherapy, and steroid use. The following preexisting comorbidities were extracted: bleeding disorders, cardiovascular comorbidities, diabetes mellitus, hypertension, neurologic comorbidities, renal/hepatic comorbidities, and respiratory comorbidities.

## Outcomes

The ACS-NSQIP collects perioperative morbidity data for patients within 30 days of their respective index operation. Our primary outcomes were postoperative complications. Our secondary outcomes were hospital length of stay and operation time. Postoperative complications were classified as surgical wound, infectious, thromboembolic, cardiovascular, neurologic, renal, respiratory, bleeding requiring transfusion, and death. Surgical wound complications were categorized into (1) superficial incisional surgical site infection, (2) deep incisional surgical site infection, (3) organ space surgical site infection, and (4) wound disruption. Infectious complications were categorized as either sepsis or septic shock. Thromboembolic complications were categorized into pulmonary embolism and deep vein thrombosis.

## Statistical Analysis

For univariate analysis on categorical and continuous variables, the $\chi^2$ and *t* tests were used, respectively. Multivariate regression analyses were performed to assess the effect of resident involvement and resident experience (based on postgraduate year) on postoperative complication rates, operation time, and length of stay. In our multivariate models, we corrected for BMI, sex, age, inpatient care status, race, alcohol, smoking, comorbidities, ASA classification, and number of concurrent BCPs. All statistical analyses used SPSS version 25 (IBM Corp, Armonk, NY). A *P* less than 0.05 was considered significant for all analyses.

# RESULTS

After querying the ACS-NSQIP database (2006–2012), we identified 54,661 patients who underwent BCPs. After selecting cases from plastic surgeons and removing cases from which it was not possible to determine if a resident was or was not involved, we obtained a total of 9638 cases. Of these cases, 6327 were performed by an attending only and 3311 were performed with resident involvement. Cases performed by an attending had a mean age of 45.5 ± 13.3 and a mean BMI of 30.6 ± 7.1. The remaining 3311 patients operated on with resident involvement had a mean age of 46.2 ± 13.2 and a mean BMI of 31.0 ± 7.3. Study characteristics are described in Table 2. There were significant differences in sex, age, BMI, race, ratio of inpatient/outpatient care, alcohol use, preexisting comorbidities (cardiovascular, diabetes, renal/hepatic, respiratory), and ASA classification between cases performed by attending only and cases with resident involvement.

Univariate analyses of surgical outcomes between "attending only" cases and "resident involvement" cases are shown in Table 3. The surgical outcomes for the multivariate analysis after adjustment for covariates are also shown in Table 3. We found a significantly higher rate of overall complications (7.8% vs 44%; $P = 0.003$) and increased operation time (180.7 ± 91.3 vs 171.9 ± 82.9; $P = 0.005$) in cases with resident involvement compared with cases without resident involvement.

Table 4 shows the impact of resident postgraduate year experience on surgical outcomes. There was a significant decrease in odds of overall complications (odds ratio, 0.906; $P = 0.013$) and thromboembolic complications (odds ratio, 0.780; $P = 0.022$) per year increase of PGY level. In addition, there was a significant decrease in operation time (−2.7 minutes; $P = 0.001$) and a significant increase in length of stay (0.1 days; $P = 0.031$) per year increase of PGY level.

After comparing surgical outcomes between residents with different levels of surgical training (Table 5), we found a significantly lower rate of overall complications (6.6% vs 9.9%; $P = 0.049$) and

**TABLE 2.** Patient Demographics and Comorbidities

| Variable | Attending Only (n = 6327) | Resident Involved (n = 3311) | *P* |
|---|---|---|---|
| Women | 6132 (97.1%) | 3158 (95.8%) | **0.001** |
| Age, y | 45.5 ± 13.3 | 46.2 ± 13.2 | **0.011** |
| BMI | 30.6 ± 7.1 | 31.0 ± 7.3 | **0.004** |
| % BMI ≥ 35 | 1356 (21.7%) | 715 (21.8%) | 0.857 |
| Race | | | **<0.001** |
| White | 3392 (73.0%) | 1783 (74.2%) | |
| Black | 686 (14.8%) | 400 (16.7%) | |
| Other | 569 (12.2%) | 219 (9.1%) | |
| Inpatient care | 1121 (17.7%) | 1057 (31.9%) | **<0.001** |
| Smoking | 698 (11.0%) | 357 (10.8%) | 0.709 |
| Alcohol | 60 (1.0%) | 18 (0.5%) | **0.036** |
| Radiotherapy | 8 (0.1%) | 6 (0.2%) | 0.501 |
| Chemotherapy | 59 (0.9%) | 30 (0.9%) | 0.901 |
| Steroid use | 58 (0.9%) | 41 (1.2%) | 0.137 |
| Prior surgery < 30 days | 15 (0.2%) | 5 (0.2%) | 0.376 |
| Comorbidities | | | |
| Bleeding disorder | 44 (0.7%) | 31 (0.9%) | 0.201 |
| Cardiovascular | 101 (1.6%) | 32 (0.9%) | **0.012** |
| Diabetes | 306 (4.8%) | 230 (6.9%) | **<0.001** |
| Hypertension | 1445 (22.8%) | 798 (24.1%) | 0.164 |
| Neurologic | 78 (1.2%) | 43 (1.3%) | 0.779 |
| Renal/hepatic | 3 (0.0%) | 14 (0.4%) | **<0.001** |
| Respiratory | 162 (2.6%) | 111 (3.4%) | **0.026** |
| ASA classification | | | **<0.001** |
| I | 1520 (24.1%) | 671 (20.3%) | |
| II | 4003 (63.4%) | 2045 (61.8%) | |
| III | 769 (12.2%) | 576 (17.4%) | |
| IV | 24 (0.4%) | 18 (0.5%) | |
| ASA III or IV | 793 (12.6%) | 594 (17.9%) | **<0.001** |
| Concurrent BCPs | 1.70 ± 1.05 | 1.74 ± 1.02 | 0.106 |

Bold values statistically significant ($P \leq 0.05$)

thromboembolic complications (0.6% vs 1.0%; $P = 0.018$) in cases with PGY4+ versus PGY1–3 resident involvement. Involvement of PGY4+ residents was associated with significantly lower operation time (minutes, 180.2 ± 92.6 vs 181.5 ± 90.0; $P = 0.002$) and increased length of stay (days, 1.7 ± 13.9 vs 0.9 ± 2.1; $P = 0.014$).

## DISCUSSION

Resident involvement in operative procedures at academic medical centers is a requisite for surgical training. The effect of resident involvement on surgical outcomes has been discussed in previous studies and across different surgical specialties,[8–14] including plastic surgery. However, studies are comparatively limited in this field.[15–19] The majority of existing literature found no differences for procedures with resident involvement compared with those without, in regards to overall morbidity and mortality. This would suggest that resident involvement has no significant impact on patient safety. Previous literature has examined common risk factors, complications, and readmission rates associated with BCP. To our knowledge, the effect of resident involvement on BCP outcomes regarding postgraduate level training remains unexamined.[27,28] In our study, we assessed the impact of resident involvement and PGY level experience on postoperative outcomes for BCP using a large, national database. Our findings suggest that resident involvement is associated with increased surgical morbidity, thromboembolic events, and longer operation time, compared with procedures without resident involvement. With respect to resident experience, our study shows a significant decrease in surgical morbidity, thromboembolic events, and operative time per progressive PGY year.

### Complications

There was a significantly increased risk of surgical complications, specifically superficial surgical site infections in cases with resident involvement. This is consistent with existing literature supporting infections as one of the most common wound complications in BCP.[28–32] However, our findings do not align with that of previous literature regarding resident participation, as most studies report a similar surgical complication rate between the 2 groups.[8,9,16–18] In fact, studies describing resident involvement and an increased risk of surgical complications note the reported increased rates of minor surgical morbidity in the resident group as clinically irrelevant.[11–14] Fischer et al[19] found an added risk of surgical morbidity in breast reduction surgery with resident involvement, albeit with an absolute risk of 1.4%. The comparatively increased number of surgical complications in cases with resident involvement is likely multifactorial in origin. Raval et al[33] proposed several factors that might affect perioperative and postoperative outcomes, such as increased intraoperative technical issues with resident involvement, unmeasured case-mix differences between procedures involving residents and those with no resident involvement, and increased vigilance of residents to report complications encountered perioperatively and postoperatively, resulting in reporting bias.

Our study findings support that resident participation was associated with a significantly longer operative time, albeit minimal with an average difference of 8.8 minutes between the groups. Several studies have corroborated this finding.[8–19] It would be logical to expect that cases involving residents may have a longer duration. Attending physicians allocate time for resident surgical education. In addition, surgical trainees have comparatively less surgical experience and may take longer to assist in procedures. Residents are also more involved in complex cases, as evidenced in prior studies, adding to the didactic qualities of these particular cases, which may lead to an increase in operation time. A prolonged operative time could have also contributed to our findings of higher surgical complications in residents versus nonresident involvement cases. Studies have shown increased operation time to be a risk factor for surgical site infection.[34–36] A study by Vieira et al[37] found that patients undergoing BCP with increasing operating times were more likely to be readmitted, with each additional hour conferring a 20% increased risk.

There were significantly more thromboembolic events in the resident group compared with the attending only group (0.7% vs 0.4%; $P = 0.04$), although this significance was not seen when stratified for pulmonary embolism and deep venous thrombosis. The absolute difference of 0.3% does raise questions about its clinical significance. This is an unfavorable complication to see in elective procedures, particularly due to its association with increased morbidity, and even mortality. An extended operative time is thought to contribute to thromboembolic events, due to longer exposure to anesthetics, a lower body temperature, and long inactivity as a result of bedridden recovery, which could facilitate blood stasis and coagulation.[38] In contrast, Hatef et al[39] concluded operation time (295.3 ± 88.8 minutes vs 255.1 ± 106 minutes) not to be a risk factor for venous thromboembolisms in body-contouring surgery, although it did approach statistical significance ($P = 0.11$). This is probably due to the number of patients (n = 347) included in the study. Wes et al[27] performed a study assessing thromboembolic events in BCP and found significant heterogeneity in patient chemoprophylaxis. Unfortunately, our database did not include information regarding this variable, precluding any analysis on the effect of prophylaxis and its influence on operative outcome.

**TABLE 3.** Univariate and Multivariate Analysis of Surgical Outcomes

| Variable | Attending Only (n = 6327) | Resident Involved (n = 3311) | *P* | Adjusted *P** |
|---|---|---|---|---|
| All complications | 279 (4.4%) | 258 (7.8%) | **<0.001** | **0.003** |
| Surgical | 211 (3.3%) | 183 (5.5%) | **<0.001** | **0.019** |
| Superficial incisional SSI | 142 (2.2%) | 135 (4.1%) | **<0.001** | **0.026** |
| Deep incisional SSI | 29 (0.5%) | 28 (0.8%) | **0.019** | 0.090 |
| Organ space SSI | 7 (0.1%) | 4 (0.1%) | 0.888 | 0.601 |
| Wound disruption | 40 (0.6%) | 23 (0.7%) | 0.718 | 0.946 |
| Infectious | 12 (0.2%) | 17 (0.5%) | **0.006** | 0.359 |
| Sepsis | 11 (0.2%) | 16 (0.5%) | **0.006** | 0.363 |
| Septic shock | 2 (0.0%) | 1 (0.0%) | 1.000 | 0.976 |
| Thromboembolic | 24 (0.4%) | 23 (0.7%) | **0.035** | **0.042** |
| Pulmonary embolism | 18 (0.3%) | 13 (0.4%) | 0.373 | 0.152 |
| Deep vein thrombosis | 9 (0.1%) | 12 (0.4%) | **0.028** | 0.073 |
| Cardiovascular | 0 (0.0%) | 3 (0.1%) | **0.041** | 0.945 |
| Neurologic | 0 (0.0%) | 2 (0.1%) | 0.118 | 0.977 |
| Renal | 14 (0.2%) | 15 (0.5%) | **0.049** | 0.631 |
| Respiratory | 12 (0.2%) | 2 (0.1%) | 0.160 | 0.060 |
| Bleeding requiring transfusion | 32 (0.5%) | 47 (1.4%) | **<0.001** | 0.116 |
| Death | 2 (0.0%) | — | | |
| Operative time, min | 171.9 ± 82.9 | 180.7 ± 91.3 | **<0.001** | **0.005** |
| Length of stay, d | 0.7 ± 2.2 | 1.4 ± 11.0 | **0.001** | 0.180 |

*Adjusted for BMI, sex, age, inpatient care status, race, alcohol use, smoking, comorbidities, ASA classification, and number of concurrent BCPs.
SSI indicates surgical site infection.

## Resident Experience

We found a significant decrease in odds of overall complications, thromboembolic events, operative time, and an increase in length of stay, per yearly PGY progression. When comparing our findings with existing literature, we find studies showing no difference in PGY levels,[10,17] studies concurring with our results,[9,19] and studies contradicting our results.[11–13] The different outcomes in these studies can be ascribed to the various surgical procedures highlighted in the studies and possible case-mix differences per PGY year. Our study suggests that an increase in resident training leads to better results in outcomes. Therefore, guided autonomy at an early stage of resident training may be beneficial to accelerate the learning curve, while also maintaining satisfactory outcomes. An increase in length of stay per yearly PGY progression, as seen in our study, may be due to the fact that more experienced residents may be more involved in higher risk or more complex cases. Consequently, these patients may stay longer in the hospital for recovery.

Resident experience and comfort in performing aesthetic surgery procedures is important due to the continuing rise of these procedures in the coming years. Rohrich et al[40] predict a doubling of cosmetic surgery demand for at least the next 2 generations. Massive weight loss procedures and facial aesthetic surgery are predicted to be among the procedures with the highest patient demand in the coming years. Training in cosmetic surgery is also challenging due to the lack of patient volume or staff support to train residents.[6,20,21] Cosmetic surgery procedures usually take place in an outpatient clinic setting and not in (academic) teaching hospitals. The risk of not training residents might also affect the safety of the patients.[41] A survey study performed by McNichols et al[41] showed low comfort levels and confidence among plastic surgery residents in performing body-contouring surgery and thus suggested increasing emphasis on BCPs in the resident curriculum.

To increase resident confidence in performing body-contouring surgery, certain recommendations have been proposed. McNichols et al[41] suggest earlier exposure to cosmetic surgery, which may facilitate

**TABLE 4.** Impact of Resident Experience on Surgical Outcomes: Per Progressional PGY Year

| Variable | Odds Ratio (95% Confidence Interval) | *P** |
|---|---|---|
| All complications | 0.906 (0.839–0.979) | **0.013** |
| Surgical | 0.943 (0.859–1.036) | 0.220 |
| Infectious | 1.148 (0.838–1.574) | 0.391 |
| Thromboembolic | 0.780 (0.631–0.964) | **0.022** |
| Operative time, min | −2.7 (−4.2 to −1.1) | **0.001** |
| Length of stay, d | 0.06 (0.01 to 0.12) | **0.031** |

*Adjusted for BMI, sex, age, inpatient care status, race, alcohol use, smoking, comorbidities, ASA classification, and number of concurrent BCPs.

**TABLE 5.** Impact of Resident Experience on Surgical Outcomes: PGY1–3 Versus PGY4+

| | PGY1–3 (n = 1129) | PGY4+ (n = 2065) | *P** |
|---|---|---|---|
| All complications | 112 (9.9%) | 136 (6.6%) | **0.049** |
| Surgical | 81 (7.2%) | 96 (4.6%) | 0.612 |
| Infectious | 3 (0.3%) | 12 (0.6%) | 0.251 |
| Thromboembolic | 11 (1.0%) | 12 (0.6%) | **0.018** |
| Operative time, min | 181.5 ± 90.0 | 180.2 ± 92.6 | **0.002** |
| Length of stay, d | 0.93 ± 2.14 | 1.67 ± 13.9 | **0.014** |

*Adjusted for BMI, sex, age, inpatient care status, race, alcohol use, smoking, comorbidities, ASA classification, and number of concurrent BCPs.

increased resident comfort with these procedures by the end of their training. Hashem et al[42] performed a survey among plastic surgery residents and ranked resident clinics, staff cosmetic patients, and cadaver dissections as the best teaching modalities for cosmetic surgery. Cadaver dissections can be seen as an excellent teaching modality for plastic surgery residents to perform BCPs in a controlled setting. The Accreditation Council for Graduate Medical Education stipulates a minimum number of cosmetic procedures performed during the plastic surgery residency.[20] Recently, the minimum case numbers for aesthetic procedures have been doubled from a minimum of 5 B.P. to 62.[42,43] Unfortunately, the results of this increase could not be analyzed in our study because our study contains data until 2012. Hopefully, this will lead to an increase in resident confidence in performing BCP and translates to better patient care with less surgical morbidity.

## Limitations

There are several limitations in this study. The ACS-NSQIP database only provides information on incidence of complications, which occur within 30 days, precluding any evaluation of complications that occur outside of this period. We were limited to the complication variables provided in the database; thus, we were unable to determine the incidence of other complications that have been associated with BCPs including seroma and hematoma formation. In addition, resident involvement may vary from observation to complete surgical participation. Furthermore, because institution-specific information is anonymous, we were unable to evaluate any effects attributed to hospital-level effects. This has the potential to introduce bias as residents are more likely to operate in academic centers compared with outpatient, ambulatory surgical centers. Lastly, we were limited to ACS-NSQIP database years up to and including 2012, due to the discontinuation of the resident involvement variables in the following years.

## CONCLUSIONS

Resident involvement in BCPs was associated with an increased rate of overall complications, which is mainly ascribed to an increase of superficial surgical site infections, an increase in thromboembolic events, and longer operative time. However, the clinical significance of these outcomes may be debated, with absolute differences being as low as 0.3% and average time differences of 8.8 minutes. It is interesting to see these significant differences also recurring when we look at PGY year, with yearly progression of experience associated with a significant decrease in odds of overall complications. It may be important to emphasize guided resident autonomy in BCPs and more teaching modalities for residents. Earlier exposure to these procedures could lead to an optimization of clinical outcomes and resident education.

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