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ORIGINAL ARTICLE SPECIAL TOPICS

The Impact of Training Pathway on Breast Surgery Cases Performed during Plastic Surgery Residency

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Abstract

Background Operative volume is a critical component of surgical resident education. This study compares reported breast surgery case volume between resident training pathways in plastic surgery.

Methods This retrospective cohort study reviewed case logs of plastic surgery residents in the independent/combined and integrated training pathways. Breast surgery case volume was compared via *t* tests across two major categories: reconstructive and aesthetic. Differences in intra-pathway variability were compared with *F* tests. Five consecutive cohorts of plastic surgery residents ($n = 818$): independent/combined ($n = 526$, 64%) and integrated ($n = 292$, 36%) at Accreditation Council for Graduate Medical Education (ACGME) accredited residency programs, were included (2011–2015).

Results Independent/combined residents reported significantly more aesthetic cases than integrated residents, but similar reconstructive cases. Independent/combined residents reported more breast augmentations, mastopexy, cosmetic breast fat grafting, and other cosmetic breast cases. Within the reconstructive category, independent residents reported more breast reconstruction fat grafting cases while integrated residents reported more breast reconstruction with pedicle flap, other breast reconstruction, and breast reduction cases. Independent residents had greater intra-pathway variability in five case subcategories, while integrated residents had greater variability in one case subcategory.

Conclusions Disparities in breast surgery case volume exist by plastic surgery residency training pathway. Given the importance of case volume to residents and faculty, these disparities may warrant greater attention.

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Keywords Resident · Education · Surgery · Breast · Accreditation · Integrated

Introduction

In the USA, disparities in access to breast reconstruction services exist in part due to the asymmetric distribution of breast reconstruction surgeons [1]. While these disparities are expected to increase, few studies have addressed the capacity to better train breast surgeons during plastic surgery residency [2–4]. Currently, two residency training pathways exist for plastic surgery: independent and integrated. Residents under the independent training model complete 3 years of training generally after general surgery residency training, while residents under the integrated training model complete 6 years of training under the direction of the plastic surgery residency program director. Despite the equivalency of these two training pathways in producing plastic surgeons, few studies have addressed

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disparities in operative case volume at the conclusion of residency.

Case volume is an important barometer for surgical resident education under the Next Accreditation System (NAS). Under NAS, resident case logs are used to assess residency programs for adequacy in providing surgical cases to graduating residents [5]. We analyzed these case logs to understand disparities in breast surgery cases performed by plastic surgery residents by training pathway.

We hypothesized that integrated residents would perform significantly more breast surgery cases given their additional years of exposure to plastic surgery rotations [6]. Furthermore, we hypothesized that given the more recent introduction of the integrated training pathway and the evolution of its curriculum, that integrated residents would exhibit greater variability in breast surgery case volume [7]. Ultimately, this study may highlight areas to optimize breast surgery training during plastic surgery residency.

Materials and Methods

The institutional review board permitted analysis of case logs from plastic surgery residents at Accreditation Council for Graduate Medical Education (ACGME) accredited residency programs. These case logs are publicly available and represent cumulative case experience at the end of residency [8]. All data were self-reported and actively updated during residency. Supplemental Table 1 provides the specific Current Procedural Terminology (CPT) codes for breast surgery case categories analyzed in this study. Similar ACGME case logs were used in a previous study to assess the impact of work hour restrictions on general surgery and plastic surgery residency training [9].

The ACGME maintains unique case logs for integrated and independent/combined plastic surgery residents. The integrated pathway was defined as 6 years of post-graduate medical training under the plastic surgery residency program director. Independent/combined training was defined as 3 years of post-graduate medical training under the plastic surgery residency program director. The now retired combined pathway was defined as 3 years of plastic surgery training following 3 years of general surgery training. The integrated pathway generally affords more time in plastic surgery training versus the combined/independent pathways, although significant variability exists in the number of plastic surgery rotations [6, 7].

Two major breast surgery categories were analyzed: reconstructive and aesthetic. The reconstructive category was comprised of seven subcategories: breast reconstruction with implant, breast reconstruction with pedicle flap, breast reconstruction with free flap, breast reconstruction secondary procedures, breast reconstruction fat grafting, other breast reconstruction, and breast reduction. The aesthetic category was comprised of four subcategories: breast augmentation, mastopexy, cosmetic breast fat grafting, and other cosmetic breast. In each case category, case volume was compared between training pathways with unpaired Student's *t* tests and Welch's correction.

To generate data for statistical analysis, 10th, 30th, 50th, 70th, and 90th percentile thresholds for breast surgery case volume were extracted for five consecutive national

Table 1 Comparison of case volume in breast surgery upon graduation from plastic surgery residency

Case category	Mean number of cases		*p*	Standard deviation of cases		*F* value	*p*
	Integrated	Independent/combined		Integrated	Independent/combined		
Breast reconstruction with implant	75.7	75.7	0.988	32.1	31.3	1.05	0.624
Breast reconstruction with pedicle flap	17.1	14.4	< 0.001	9.9	7.7	1.67	< 0.001
Breast reconstruction with free flap	31.6	31.8	0.910	19.8	19.4	1.04	0.720
Breast reconstruction secondary procedures	123.1	130.3	0.088	56.8	60.9	1.15	0.177
Breast reconstruction fat grafting	6.6	11.0	< 0.001	7.7	12.1	2.47	< 0.001
Other breast reconstruction	41.2	30.5	< 0.001	15.7	15.9	1.02	0.825
Breast reduction	66.8	62.4	0.023	25.9	26.5	1.05	0.659
Total—reconstructive	362.1	356.1	0.618	162.4	168.7	1.08	0.468
Breast Augmentation	38.5	43.4	< 0.001	16.3	24.2	2.20	< 0.001
Mastopexy	23.1	28.3	< 0.001	11.5	15.8	1.90	< 0.001
Cosmetic breast fat grafting	6.6	11.0	< 0.001	7.7	12.1	2.47	< 0.001
Other cosmetic breast	2.7	3.9	< 0.001	2.8	3.4	1.54	< 0.001
Total—aesthetic	70.9	86.5	< 0.001	34.4	53.4	2.41	< 0.001

graduating cohorts (2011–2015). These percentiles were assigned to individual residents using the following logic: Ten percent of residents comprised the 10th percentile group; twenty percent of residents comprised each of the 30th, 50th, and 70th percentile groups; and thirty percent of residents comprised the 90th percentile group. These percentages were multiplied by the annual number of graduating residents to assign the percentile case volume to each resident. Raw data from the five annual graduating cohorts were then combined for statistical comparison.

Case experience was summarized with means and standard deviations. Student's t test with Welch's correction was used to compare case experience between integrated and independent/combined plastic surgery residents. The F test was used to compare the standard deviations in case experience between integrated and independent/combined plastic surgery residents. All statistical tests were two-tailed and performed on GraphPad Prism 6.02 Software (GraphPad, La Jolla, CA). P values less than 0.05 were considered significant.

Results

Case log data from 818 plastic surgery residents were analyzed. Most residents trained under the independent/combined pathway (n = 526, 64.3%). Independent/combined residents reported more aesthetic case volume than integrated residents (86.5 ± 53.4 vs 70.9 ± 34.4, $p < 0.001$), but similar reconstructive case volume (356.1 ± 168.7 vs 362.1 ± 162.4, $p = 0.468$).

Table 1 summarizes the disparities in reported breast surgery case volume by training pathway. Within the reconstructive category, there were significant disparities in four out of the seven aesthetic case subcategories (Fig. 1). Independent residents reported more breast reconstruction fat grafting cases (11.0 ± 12.1 vs 6.6 ± 7.7, $p < 0.001$), while integrated residents reported more breast reconstruction with pedicle flap (17.1 ± 9.9 vs 14.4 ± 7.7, $p < 0.001$), other breast reconstruction (41.2 ± 15.7 vs 30.5 ± 15.9, $p < 0.001$), and breast reduction cases (66.8 ± 25.9 vs 62.4 ± 26.5, $p = 0.023$).

There were significant disparities in all four aesthetic case subcategories (Fig. 2). Independent/combined residents reported more breast augmentations (43.4 ± 24.2 vs 38.5 ± 16.3, $p < 0.001$), mastopexy (28.3 ± 15.8 vs 23.1 ± 11.5, $p < 0.001$), cosmetic breast fat grafting (11.0 ± 12.1 vs 6.6 ± 7.7, $p < 0.001$), and other cosmetic breast cases (3.9 ± 3.4 vs 2.7 ± 2.8, $p < 0.001$).

Intra-pathway disparities were compared with F tests (Table 1). Independent residents had significantly greater intra-pathway variability in five case subcategories, while integrated residents had significantly greater variability in one case subcategory.

Conclusion

Disparities in breast surgery case volume exist by plastic surgery residency training pathway. Overall, independent/combined residents reported more aesthetic breast surgery cases than integrated residents with some disparities in reconstructive cases. Given the importance of case volume in achieving clinical competency, these disparities may warrant greater attention.

Discussion

Plastic surgery residents report variable operative training in breast surgery by residency training pathway. Contrary to our hypothesis, independent/combined residents reported more aesthetic breast surgery cases than integrated residents. The exact cause of this observation remains a topic for future research but may stem both from resident- and program-specific variables. It may be that independent/combined residents are more motivated to pursue a career in aesthetic plastic surgery or independent/combined programs afford greater exposure to aesthetic plastic surgery. Interestingly, independent/combined residents also reported more fat grafting cases, which may become increasingly valuable as fat transfer techniques increase in popularity for breast reconstruction [10]. Encouragingly, there were no significant disparities in free flap breast reconstruction by training pathway highlighting the continued concentration of microsurgery at academic medical centers [11, 12]. Ultimately, this study has implications on standardized training in breast surgery and highlights future areas of research.

This study had several limitations. Comparisons at the CPT code level were not available, thus limiting the granularity of our analyses. However, case categories are defined by the ACGME and scrutinized under the NAS to assess residents and residency programs [5]. Thus, these categories are meaningful to residents, faculty, program directors, and governing bodies of graduate medical education. ACGME data were also devoid of program-specific variables. Future studies should explore the impact of residency program characteristics like the presence of microsurgery fellowships, clinical faculty size, and resident class size on operative breast experience. While there were significant differences in case volumes between pathways, there was also overlap in the ranges of all cases and does not signify any clinical implications. Also, case logs are an imperfect measure of operative experience as varying

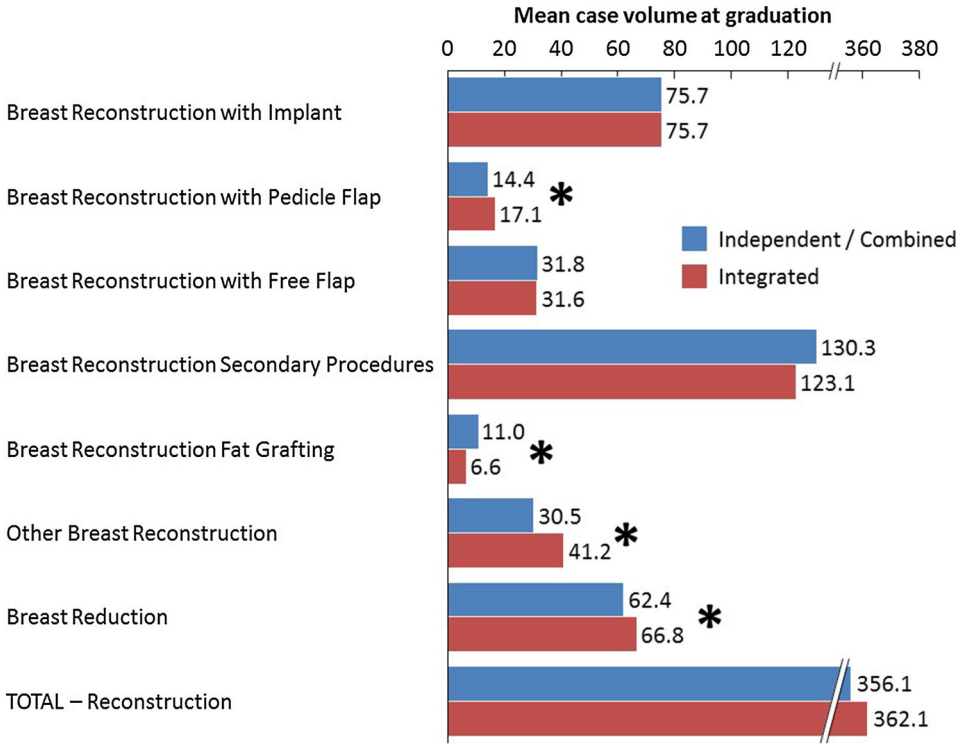

Fig. 1 Comparison of reconstructive breast surgery case volume by plastic surgery residency training pathway. Asterisk indicates *t* test with Welch's correction gives $p < 0.05$

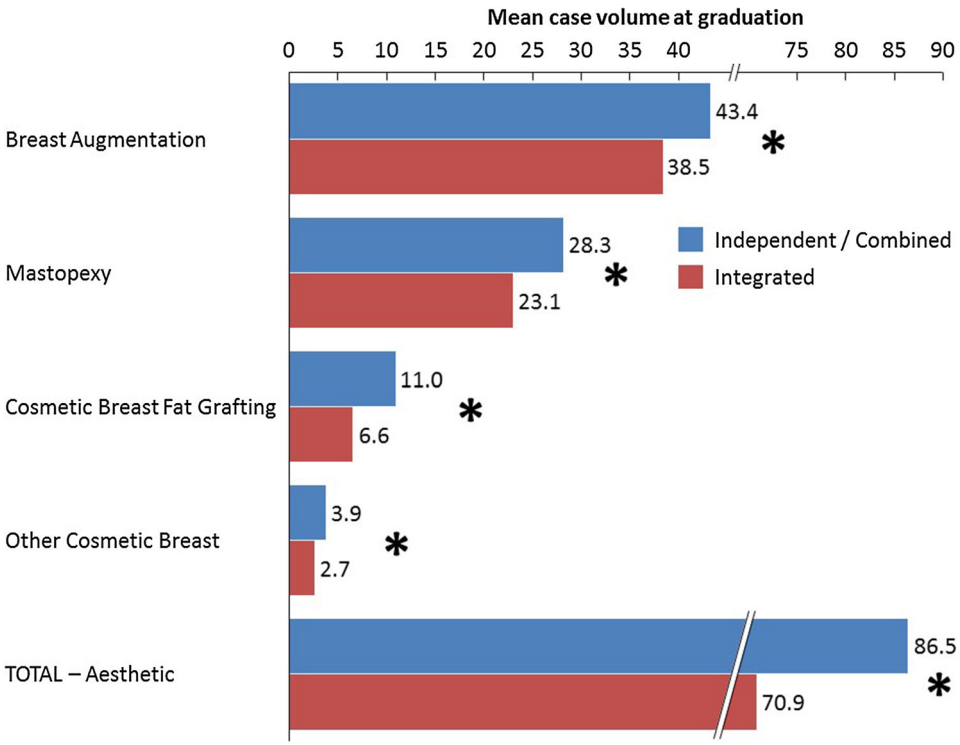

Fig. 2 Comparison of aesthetic breast surgery case volume by plastic surgery residency training pathway. Asterisk indicates *t* test with Welch's correction gives $p < 0.05$

degrees of surgical autonomy are represented by equivalent entries on ACGME case logs. Factors inherent to the supervising surgeon and perceived resident competency may influence operative independence during surgical cases [11]. The operative learning environment can also be expanded to pre-op, post-op, and follow-up experiences, as well as year in training. Furthermore, differences in case logging behavior can produce variabilities in case numbers, which may limit the reporting utility of ACGME case logs [12]. However, given the importance of these case logs on

program accreditation, we feel this limitation is minimal and would certainly not vary by training pathway.

Currently, evidence-based guidelines for clinical competency during surgical residency programs are lacking. The Plastic Surgery Milestones Project (PSMP) was created in part to meet this void [13]. PSMP provides faculty with objective milestones in checklist format to monitor resident progression along the six ACGME core competencies. One topic for future research is incorporating case volume into PSMP for patient care. Currently, PSMP maintains categories for 'Breast Reconstruction' and 'Non-Cancer Breast Surgery,' which incorporates elements of aesthetic breast surgery. In the UK, for example, the Joint Committee on Surgical Training requires a minimum of 100 aesthetic cases to be completed (either performed or assisted) during training [14]. Moving forward, it may be important for the USA to define case minimum requirements in an evidence-based manner and design graduated case volume milestones to ensure completion upon graduation from residency. As such, future research will also compare US case numbers with UK case numbers to inform differences and educators across both countries.

Increasingly, alternative methods for resident education hold promise in plastic surgery [13, 15–20]. Residency programs could adopt these alternative methods to augment deficiencies in procedural competency. For example, advances in virtual reality have made surgical simulation increasingly useful [19]. Furthermore, ample opportunities exist in the operating room to increase educational value through coaching and debriefing methods. Intraoperative recording techniques may improve resident feedback and skill acquisition [20]. Ultimately, these teaching methods will become increasingly popular as surgical residents face increasing work hour restrictions and administrative burdens [21, 22].

Training for breast reconstruction surgery is increasingly complex given the proliferation of available methods [23, 24]. In the USA, implant-based methods are increasing in popularity although autologous tissue options remain popular. In our study, integrated residents reported more breast reconstruction with pedicle flap and other breast reconstruction cases. However, whether a twenty percent increase in breast surgery case volume translates into greater clinical competency remains debatable. Previous literature highlights the impact of procedural volume on surgical competency [25]. One study of bariatric surgeons demonstrated that perceived technical skills can predict complication rates including mortality [26]. Thus, it can be presumed that purposeful practice and surgical skill acquisition impact clinical outcomes. The focus on competency-based training in plastic surgery will continue in the future and become increasingly important as surgical techniques evolve and indications expand [27, 28].

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Statement of Human and Animal Rights, or Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study, formal consent is not required.

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