Association Between Surgeon-Specific Features and Number of Stages, Flaps, and Grafts in Mohs Micrographic Surgery: A Retrospective Observational Study of 59 Early-, Mid-, and Advanced-Career Mohs Surgeons

Marwan Alhaddad, MD, John Zade, BSc, Adam Nabatian, MD, David Kriegel, MD, and Hooman Khorasani, MD*

BACKGROUND There is limited data available to correlate Mohs surgeons' behavior and years of experience. Moreover, the recent standardization of Mohs surgery training programs may allow for the prediction of future trends in Mohs micrographic surgery surgery based on the current behavior of recently trained Mohs surgeons.

OBJECTIVE To better understand the relationship between surgeon-specific characteristics and the number of Mohs micrographic surgery total cases, stages per case, number of grafts, and number of flaps performed by each surgeon.

MATERIALS AND METHODS Procedure data of 59 early-career, mid-career, and advanced-career Mohs surgeons were obtained from the website of the Centers for Medicare & Medicaid services.

RESULTS No statistically significant differences were identified in the number of stages per case between the 3 groups. Two-proportion testing between advanced-career surgeons and early-career surgeons indicated a statistically significant difference in the number of surgeons performing flaps or grafts ($p < .05$). Similarly, a statistically significant difference was noticed between mid-career surgeons and early-career surgeons ($p < .05$).

CONCLUSION The result of this study showed that more years of experience was significantly associated with reported utilization of flaps or grafts in practice. Furthermore, no significant difference was observed between years in practice and number of stages per case.

The authors have indicated no significant interest with commercial supporters.

Mohs micrographic surgery (MMS) is the treatment of choice for many malignant skin neoplasms. Mohs micrographic surgery combines surgery with microscopic evaluation of tissue to allow accurate control of margins. Mohs micrographic surgery offers the highest cure rate for basal cell carcinoma and squamous cell carcinoma, with a 5-year cure rate of 99% and 95%, respectively.[1,2]

Margin clearance in MMS can be achieved through a single stage or multiple stages for each given case. Several factors have been shown to influence the number of stages performed. These include the size, location, and histology of the tumor, the patient age, and whether the tumor is primary or recurrent.[3] Surgeon's technique may also affect the number of stages performed in MMS, such as the decision to take 2 or 3 mm margin initially or to curette the tumor before making the first excision.[3,4]

After obtaining clear surgical margins, the surgeon decides whether to reconstruct the defect or let the

All authors are affiliated with the Department of Dermatology, Icahn School of Medicine at Mount Sinai, New York, New York

ISSN: 1076-0512 • Dermatol Surg 2017;43:1358–1362 • DOI: 10.1097/DSS.0000000000001187

defect heal by secondary intention. Reconstruction techniques include linear closure, skin flaps, and partial or full-thickness skin grafts. The choice of the closure technique depends on many factors, including the size, depth, and location of the defect, patient characteristics, and surgeon's preference.[5,6]

The purpose of this study was to better understand the relationship between surgeon-specific characteristics and the number of MMS stages, the number of flaps and the number of grafts performed by each surgeon. In particular, the authors are interested in assessing the behavior of Mohs surgeons as it relates to the number of years in practice. They believe that recently trained Mohs surgeons' behavior will show some variability compared with more experienced Mohs surgeons. Moreover, the recent standardization of Mohs surgery training programs may allow for the prediction of future trends in MMS surgery based on the current behavior of recently trained Mohs surgeons.

Methods

Mohs surgeons were selected from the American College of Mohs Surgery (ACMS) website. All Mohs surgeons who are maintained on the ACMS website with at least 1 office address either in or within 25 miles of New York City were included. The surgeon finder tool was used to create a preliminary list of Mohs surgeons included in this study. Eighty-five surgeons were initially selected; however, 26 surgeons were eliminated because they did not submit any claims to Medicare for the year of 2012 or 2013. The final number of surgeons included in the authors' study was 59 surgeons. The name and year of graduation from the procedural fellowship programs were collected from the ACMS website, their medical practice website, US News doctor finder website, or by contacting the Mohs surgeons directly.

Thirty-seven thousand three hundred forty-four MMS procedures by 59 surgeons included in the study were collected from submitted claims to Medicare for the year of 2012 and 2013. The data were obtained from the Centers for Medicare and Medicaid services website. Current procedural terminology (CPT) codes were used for data stratification. Current procedural terminology codes were used to identify the number of MMS procedures, number of flaps, number of grafts, and number of stages per case performed by each surgeon. Current procedural terminology code 17311 for the first stage and code 17312 for any additional stage were used to identify the number of MMS procedures performed on the head, neck, hands, feet, and genitalia. Current procedural terminology code 17313 for the first stage and code 17314 for any additional stage were used in the same manner for the trunk, arms, and legs. Current procedural terminology codes 14000, 14001, 14020, 14021, 14040, 14041, 14060, 14061, and 14301 were used to identify the number of flaps performed by each surgeon. For the number of grafts, CPT codes 15220, 15240, 15260, 15271, and 15275 were used.

Data Analysis

Descriptive statistics were compiled, and analyzed using a computer software program (NCSS 10 Statistical Software [2015]; NCSS, LLC, Kaysville, UT). Differences between 2 means were determined using independent 2-tailed *t*-test analysis. One-way analysis of variance (ANOVA) with a post hoc multiple comparison test was used to test differences between multiple mean values. Furthermore, a 2-proportion analysis was conducted to test the association between numbers of individual subjects in various specific groups and sub-groups. All data are presented as the mean and standard error of the mean. A $p < .05$ was considered significant.

Results

Of the 59 Surgeons, 59.3% were men and 40.7% women. Also, it was observed that 35.6% of the surgeons have 5 or fewer years of practice, 25.4% of the surgeons have 6 to 9 years of practice, and 39% of the surgeons have 10 or more years of practice. The sex and the number of practicing years are summarized in Table 1.

Of the 37,344 MMS cases analyzed, the mean number of stages was 1.88, and the median was 1.81. The mean number of cases, stages, flaps, and grafts

TABLE 1. Distribution of Surgeons Based on the Sex and Years of Practice

	N (%)
Sex	
Male	35 (59.3)
Female	24 (40.7)
Years of Practice	
5 yrs or less	21 (35.6)
Between 6 and 9 yrs	15 (25.4)
10 yrs or more	23 (39)

performed by each surgeon according to sex, years of practice, and body sites are summarized in Table 2.

Anatomic location seems to influence the number of stages required for margin clearance, with a mean of 1.96 for tumors of the head, neck, hands, feet, and genital areas and a mean of 1.62 for tumors of the trunk, arms, and legs. Statistical analysis showed a statistically significant relation between the anatomic location and number of stages ($p < .0001$).

Surgeons were divided into 3 groups based on their years of experience after the completion of their procedural fellowship programs. The division was as follows: early-career (5 years or less), mid-career (6–9 years), and advanced-career surgeons (more than 10 years). No statistically significant difference was observed for of the number of stages per tumor between the 3 groups. When comparing the average number of cases performed by each group, ANOVA analysis indicated a statistically significant difference ($p < .05$). Advanced-career surgeons performed the greatest number of cases (897.9 cases), whereas early-career surgeons performed the least (372.4 cases).

The comparison between the average number of flaps or grafts per case according to physician gender and years of practice is summarized in Table 3. The analysis results indicate no statistically significant differences between the average number of flaps or grafts per case and sex or years in practice.

The relation between the number of surgeons in each career level and how many flaps or grafts they perform is summarized in Table 4. Approximately 91.3% of advanced-career surgeons are performing flaps or grafts, as compared with 80% of mid-career surgeons and only 57.1% of early-career surgeons. One-way ANOVA analysis indicated no significant correlation between the number of surgeons performing flaps or grafts and their years of experience. However, interestingly, on 2-proportion testing between advanced-career surgeons and early-career surgeons, more advanced-career surgeons performed flaps or grafts in their practice ($p < .05$). Similarly, significantly more mid-career surgeons reported the utilization of flaps or grafts as compared with early-career surgeons ($p < .05$). There was no significant difference in the reported utilization of flaps or grafts between advanced- and mid-career surgeons.

TABLE 2. Average Number of Cases and Stages Per Case Based on Surgeons' Gender, Years in Practice, and Body Site

Characteristic	*Average No. of Cases*	*Difference Between Groups, p*	*Average Stages Per Case*	*Difference Between Groups, p*
Sex of the surgeon				
Male	659.89	.38144	1.90	.71631
Female	593.67		1.85	
Years in Practice				
5 yrs or less	372.39	.00079	1.80	.39807
6–9 yrs	591.33		1.97	
10 yrs or more	897.87		1.89	
Head, Neck, Hands, Feet, and Genital Areas	484.03		1.96	.0001
Trunk, Arms, and Legs	148.92		1.62	
Overall Mean	632.95		1.88	

TABLE 3. The Average Number of Flaps or Grafts Per Case Per Surgeon

	N	Mean Grafts Per Case, %	Difference Between Groups, p	Mean Flaps Per Case, %	Difference Between Groups, p
Male	35	2.9	.14663	20.2	.91184
Female	24	1.7		18.8	
5 yrs or less	21	1.2	.06295	17.6	.89546
6–9 yrs	15	2.4		20.8	
10 yrs or more	23	3.4		20.8	
Total	59	2.4		19.6	

Discussion

Although surgeons' years of experience was not associated with the number of stages needed to clear tumors in the authors' study, other criteria showed some variability based on years of experience. Furthermore, sex of the surgeon did not appear to affect the number of stages needed for clear tumor margins. The number of stages did show significant variation according to the anatomical sites. Tumors of the head, neck, hands, feet, and genitalia required more stages to clear. These findings are likely explained by the cosmetic sensitivity of these areas, which led the surgeons to be more conservative with narrower margins and thus an increased number of stages per case.

According to the authors' data analysis, the number of years of experience after Mohs fellowship training positively affected the total number of cases performed by each surgeon. This finding could be explained by the higher approval of more experienced surgeons among patients, or by the fact that more experienced surgeons could be more efficient than their younger counterpart. Moreover, this finding could be attributed to an emerging trend among younger surgeons practicing MMS surgery "as part time" in parallel to their general or cosmetic dermatology practice.

TABLE 4. Surgeons Performing Flaps or Graphs Versus Years in Practice

	N	% of Surgeons Performing Grafts or Flaps	Difference Between Groups, p
5 yrs or less	21	57.1	.20959
6–9 yrs	15	80	
10 yrs or more	23	91.3	
Total	59	76.3	

Flaps were the method of closure of choice in 19.6% of cases; this result is similar to previously published survey of 20 surgeons.[7] Grafts, however, were used in 2.4% in the authors' observation, whereas they were the closure technique of approximately 8.7% of cases in the cited study.[7] Interestingly, 2-proportion statistical testing showed greater number of early-career surgeons abstaining from performing flaps or grafts in their repairs compared with mid- and advanced-career surgeons. One explanation for these differences is the lower number of overall cases performed by early-career surgeons, which subsequently led to the lower number of surgeons using flaps or grafts. However, it is unclear if these differences were due to lower number of cases performed by early-career surgeons, lack of expertise in these techniques, or due to other reasons. However, these differences could predict the future behaviors of MMS surgeons, especially with the belief that ACGME accredited procedural fellowship programs are relatively uniform in recent years.

The results of this study were susceptible to selection bias, as only publicly available submitted claims to Medicare were included. Other patients with commercial insurances or self-paying patients could not be included in the authors' analysis. Furthermore, the restriction of the study's data to Medicare patients may skew the age distribution of the analysis. Also, the analysis of this study only included patients within 25 miles of radius from New York City, which may make the results of this study less applicable to other parts of the country outside New York City urban area where surgeons' pattern of practicing MMS may be different.

The authors' used CPT codes for data stratification, and these codes limited the authors' ability to sub-stratify the data further. For example, in-depth assessment and head-to-head comparison of all repair choices were not possible because of the lack of CPT codes for secondary intention closure, referral for repair, or complex linear closures specific for MMS procedures. Furthermore, correlating the location of the tumor and repair choice could not be analyzed because of the same reason.

Conclusion

In conclusion, the authors' study demonstrates the current behavior among MMS surgeons according to their years of practice. More years of experience was significantly associated with a higher total number of cases performed. There was no statistical significance between the number of years in practice and the total number of stages per case. Furthermore, the authors' results showed that more years of experience was significantly associated with reported utilization of flaps or grafts in practice. These results might be a predictor of the future trend among the younger generation if the authors take into account the relatively uniform ACGME accredited procedural fellowship training.

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Address correspondence and reprint requests to: Hooman Khorasani, MD, Department of Dermatology, Icahn School of Medicine at Mount Sinai, 234 East 85th Street, 5th Floor, New York, NY 10029, or e-mail: hooman.khorasani@mountsinai.org