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Association of Sociodemographic Factors in Reconstructive Head and Neck Surgery Procedures

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1. ABSTRACT

1.1. Objective: Identify sociodemographic factors associated with reconstruction after head and neck procedures

1.2. Study design: Retrospective cohort analysis

1.3. Setting: Ambulatory surgical centers in Florida, Kentucky, Nevada, North Carolina, New York, and Maryland.

Level of Evidence for Prognostic/Risk Study: III.

1.4. Methods: State Ambulatory Surgery and Services Database (SASD) from the Healthcare Cost and Utilization Project (HCUP) were used to identify patients undergoing reconstruction after resection of a lesion in the head and neck.

1.**5. Results:** 6,967 patients underwent a head and neck resection and subsequent reconstruction; 3,439 (49.4%) were simple reconstructions and 3,528 (50.6%) were advanced reconstructions. Simple reconstruction included secondary intention healing, linear/standard repair of defect, and skin grafting, while advanced reconstruction included all other reconstruction choices local tissue rearrangement and pedicled grafts. Medicaid patients were significantly less likely to undergo reconstruction (OR 0.70, CI 0.4-1.00, p=0.048). Higher patient income was associated with greater rate of reconstruction, as were geographic area, race, and defect size.

1.6. Conclusions: Sociodemographic factors including insurance status, geographic area, and race are associated with likelihood of advanced reconstruction.

2. Keywords: Head and neck neoplasms; Mohs surgery; Demography; Reconstructive Surgical procedures; Otolaryngology; Surgery, Plastic

3. INTRODUCTION

Excision of lesions in the head and neck region are common procedures, and becoming more commonplace with the increasing incidence of skin cancer. [1] After lesion removal the patient is left with a combination of cosmetic and functional deficits. In general, surgeons attempt to offer patients reconstruction that provides the least invasive repair while maximizing function and aesthetic appearance. However, each patient has unique preferences, and each surgeon can offer a subset of surgical procedures for reconstruction. The factors that influence choice of reconstruction after excision of head and neck lesions have not been fully elucidated.

Simple reconstruction, including healing by secondary intention, can result in satisfactory outcomes for many wounds. [2] However, defects with complicated shape, size, or location require more complex repair to achieve an acceptable outcome. Prior work examining determinants of reconstruction has shown a variety of factors including lesion location, surgeon experience, defect size, gender, and age all contribute to the type of reconstruction completed. [3-5] However, these studies are overall limited in number, typically single institution studies, and limited in sample size. Gaining a thorough understanding of contributing factors is an important preliminary step to developing targeted policy interventions and addressing factors limiting care.

In this study, we aimed to evaluate sociodemographic factors that affected head and neck reconstruction after lesion excision. Rates of head and neck reconstruction based on sociodemographic factors have not been previously compared in a population-based study. It was our goal to provide insight into possible disparities in reconstruction based on factors such as race, insurance status, and geographic location. We hypothesized that minority patients, patients with Medicaid or no insurance, and patients from rural areas would have lower access to advanced reconstruction.

4. METHODS

4.1. Data source

The Healthcare Cost and Utilization Project (HCUP) State Ambulatory Surgery and Services Database (SASD) from Florida (FL), New York (NY), North Carolina (NC), Kentucky (KY), Nevada (NV), and Maryland (MD) were used to identify patients undergoing removal of a head and neck lesion and subsequent wound closure or reconstruction. The SASD includes encounter-level data from both hospital-affiliated and non-hospital owned ambulatory surgery facilities.

Inclusion criteria for the study were patients greater than 18 years old who underwent resection of a head and neck lesion as identified using International Classification of Disease [ICD-10-CM] codes and Current Procedural Terminology (CPT) codes. The full list of included procedures and codes are available in Appendix A. The patients were then divided into either “simple reconstruction” or “advanced reconstruction” cohorts. Simple reconstruction included secondary intention healing and linear/standard repair of defect, any more complex closure without local tissue rearrangement, and skin grafting. Advanced reconstruction included all other reconstruction choices, including local tissue rearrangement and pedicled grafts.

4.2. Variables

Baseline patient variables included patient age, race/ethnicity as reported by the HCUP data source (White, Black, Hispanic, Asian or Pacific Islander, Native American, or “other”), insurance status (private insurance, Medicare, Medicaid, no charge, or self-pay) median household income (by quartiles), and comorbidity status as

measured by the Charlson Comorbidity Index (CCI). Patient locations were stratified into large metropolitan area (population greater than or equal to 1,000,000 persons,) small metropolitan area (population greater than or equal to 50,000 persons and less than 1,000,000,) micropolitan (population greater than to equal to 10,000 persons and less than 50,000,) and rural (less than 10,000 persons.) Patient tobacco use, alcohol use, and anticoagulation status were assessed. Lesion size was stratified into groups of <1 cm, 1-2 cm, 2-3 cm, 3-4 cm and greater than 4 cm. Patients without data for all variables were excluded from the study.

4.3. Statistical analysis

Our primary outcome of interest was the relationship between level of reconstruction and patient variables. For bivariate analysis, categorical variables were tested with Pearson chi-squared testing. Multivariable logistic regression modeling was used to identify predictors associated with advanced reconstruction. A two-sided alpha of 0.05 and 95% confidence intervals were used to assess for statistical significance. Statistical analysis was performed using STATA 15.1. (STATACorp, College Station, Texas). This study involved a national cohort publicly available database and was exempt from requiring IRB approval.

5. RESULTS

Study population characteristics are shown in Table 1 for the overall cohort (N=6,967) of patients who underwent resection of a head and neck lesion, and simple or advanced reconstruction per the study parameters. 3,439 patients underwent simple reconstruction, and 3,528 patients underwent advanced reconstruction. The mean age for patients undergoing advanced reconstruction was significantly lower than patients undergoing simple reconstruction: 73 years old (IQR 63-81) versus 76 years old (IQR 66-83, p<0.001). Female patients were significantly more likely to undergo advanced reconstruction than simple reconstruction (38.4% *vs.* 33.3%, p <0.001). Insurance status and income status also differed significantly between simple and advanced reconstruction groups (p=0.001 and p<0.001, respectively). For example, the percentage of patients with Medicaid was significantly higher in the simple reconstruction group than the advanced group. Simple and advanced reconstruction groups differed significantly with respect to rural, micropolitan, small metropolitan, and large metropolitan status, as the advanced reconstruction group had a slightly higher ratio of patients from more rural areas (p<0.001).

Table 2 shows factors that were significantly associated with advanced reconstruction when evaluated in a multivariate regression model. Hispanic ethnicity was associated with a lower rate of advanced reconstruction compared to White ethnicity (OR 0.52, CI 0.35-0.77, p=0.001). There were no significant differences when comparing Black, Asian, or other ethnicities to White ethnicity. Medicaid insurance status was associated with a significantly lower rate of advanced reconstruction compared to a reference of Medicare status (OR 0.70, CI 0.49-0.1.00, p=0.048). Self-pay insurance status was associated with a significantly greater rate of advanced reconstruction (OR 1.54, CI 1.04-2.28, p = 0.030). Lower population areas were associated with significantly higher rates of advanced reconstruction than large metropolitan areas (micropolitan OR 1.26, CI 1.01-1.57, p<0.040) (rural OR 1.36, CI 1.09-1.70, p<0.007). Higher income levels were significantly more likely to undergo advanced reconstruction compared to the reference of <43,000.00 USD annual income (OR 1.38, p<0.001 and OR 1.23, p0.025). Lesion size was associated with a greater rate of advanced reconstruction (OR

1.57, CI 1.37-1.74, p<0.001). Female sex was associated with a higher rate of advanced reconstruction (OR 1.12, CI 1.00-1.26, p<0.001).

Table 1: Study Population Characteristics. (N=6,967)

	Simple Reconstruction (N=3,439)		**Advanced Reconstruction (N=3,528)**		
		Percent or IQR		Percent or IQR	P-value
Age median (years)	76	66-83	73	63-81	**<0.001**
Gender					
Female (N)	1,086	33.3	914	38.4	**<0.001**
Charlson Comorbidity Index					
0 (N)	1,854	56.9	1,591	66.9	**<0.001**
1 (N)	498	15.3	343	14.4	
>=2 (N)	907	27.8	445	18.7	
Insurance Status					
Medicare (N)	2,268	69.6	1,524	64.1	**<0.001**
Medicaid (N)	99	3	61	2.6	
Private (N)	764	23.4	661	27.8	
Self-pay (N)	51	1.6	70	2.9	
No charge (N)	10	0.3	5	0.21	
Ethnicity					
White (N)	3,010	93.3	2,215	94.3	**<0.001**
Black (N)	25	0.78	9	0.38	
Hispanic (N)	100	3.1	36	1.5	
Asian (N)	8	0.25	4	0.17	
Other (N)	82	2.5	91	3.7	
Income					
<43,000 USD (N)	961	29.5	652	27.4	**<0.001**
43,000 to 53,999 USD (N)	1,008	30.9	665	28	
54,000 to 70,999 USD (N)	707	21.7	621	26.1	
71,000 USD (N)	583	17.9	441	18.5	
Urban / Rural					
Large metro area (N)	1,370	42	967	40.7	**0.054**
Small metro area (N)	1,374	42.2	973	40.9	
Micropolitan (N)	254	7.8	204	8.6	
Rural (N)	261	8	235	9.9	
Size of Lesion					
< 1 cm (N)	254	7.8	263	11.1	**<0.001**
1-2 cm (N)	756	23.2	830	34.9	
2-3 cm (N)	705	21.6	529	22.2	
3-4 cm (N)	434	13.3	307	12.9	
> 4 cm (N)	1,110	34.1	450	18.9	
Current Anticoagulant Use (N)	180	5.5	101	5.3	**0.029**
Tobacco Use (N)	198	6.1	134	6.2	**0.49**
Alcohol Use (N)	10	0.3	5	0.27	**0.49**

Table 2: Multivariate regression analysis of patient factors for advanced reconstruction after Mohs micrographic surgery.

	Odds Ratio	95% Confidence Interval		P value
Current Anticoagulant Use	0.89	0.66	1.15	0.364
Tobacco Use	0.92	0.72	1.16	0.475
Alcohol Use	0.72	0.24	2.21	0.566
Age	0.99	0.98	0.99	<0.001
Female (reference: Male)	1.12	1	1.26	<0.001
Ethnicity (ref: White)				
Black	0.57	0.26	1.24	0.154
Hispanic	0.52	0.35	0.77	0.001
Asian	1.01	0.29	3.57	0.982
Other	1.22	0.88	1.69	0.243
Insurance (ref: Medicare)				
Medicaid	0.7	0.49	1	0.048
Priv. Insurance	1	0.86	1.17	0.971
Self-pay	1.54	1.04	2.28	0.03
No charge	0.72	0.24	2.18	0.562
Other	1.1	0.74	1.64	0.63
Income (ref: <43,000 USD)				
43,000 - 53,999 USD	1	0.86	1.16	0.952
54,000 to 70,999 USD	1.38	1.18	1.63	<0.001
71,000+ USD	1.23	1.02	1.48	0.025
Urban / Rural (ref: Large metro)				
Small metropolitan	1.03	0.9	1.17	0.689
Micropolitan	1.26	1.01	1.57	0.04
Rural	1.36	1.09	1.7	0.007
Size of Lesion	1.57	1.37	1.74	<0.001

6. DISCUSSION

This study focuses on sociodemographic patient factors associated with the level of reconstruction following head and neck lesion excision. The findings of this study indicate a number of interesting associations between sociodemographic variables and rate of advanced reconstruction. Specifically, Medicaid, low income, and Hispanic patients were significantly less likely to undergo advanced reconstruction.

Medicaid patients were less likely to undergo advanced reconstruction. One explanation for this is that fewer providers accept Medicaid. A recent study from Beltrami et al. reported that of 2,712 US Mohs surgeons, only 1,072 (39.5%) accept Medicaid. Average Medicaid reimbursements to otolaryngologists are significantly lower than Medicare.6 Administrative burden on practices also differs between insurance types. In a 2020 survey of 110 Mohs surgeons, more prior authorizations were required in patients with private insurance (56.4%) than Medicare (only 24.5%). More than a third of responding surgeons requested an advance deposit prior to treatment for patients with high-deductible plans. [7] Improved Medicaid reimbursement may increase access for these patients. Higher income patients were more likely to undergo advanced reconstruction, which may be related to more comprehensive insurance coverage and better access to providers.

Ethnicity was associated with lower rates of advanced reconstruction after head and neck lesion excision. Patients undergoing advanced reconstruction were significantly less likely to be Hispanic, with Hispanic

patients undergoing advanced reconstruction nearly half as frequently as White patients in our study. Black patients had lower rates of advanced reconstruction as well but this was not statistically significant. Authors of other studies on patient demographics have speculated on reasons for these differences. One contributing factor is that care is less accessible for these populations, as counties with a higher proportion of minorities have fewer dermatologic surgeons per capita and fewer surgical subspecialists. [8,9] In a recent study, Morenstein et al. reported that dermatologic appointments with Black patients resulted in an average of 0.86 fewer work relative value units (wRVUs) per visit than White patients. [10] Blumenthal et al. suggested that factors contributing to the racial discrepancy in reconstruction following Mohs surgery may include access to transportation, rate of referrals to a reconstructive surgeon, and patient preference. [11] Previous research in head and neck cancer has suggested that increasing access to transportation may be a target to improve outcomes for Black patients. [12] The findings in this study with regard to ethnicity support future studies examining these areas. [13]

Female patients were significantly more likely to undergo advanced reconstruction in this study. In a retrospective review of Mohs surgery patients, Boyle et al, similarly, reported a ratio of reconstruction in favor of female patients (44% of females and 27% of males). [4] The authors suggested that this could be related to differences in the relative size of facial features between sexes, such that a wound of the same size would affect more of a facial cosmetic subunit in a female, and therefore require more advanced reconstruction. Alam et al reported a greater rate of flap (advanced reconstruction) closure in female patients and greater rate of referral to a reconstructive surgeon for closure, (e.g. otolaryngology, plastic surgery, or oculoplastic surgery) for women (14.6%) compared to men (7.7%). [14] Thomas et al. did not find a significant difference in defect size or closure pattern but did suggest that female patients are more likely to be referred for Mohs surgery overall to prioritize cosmetic outcomes. [5] Our results coincide with previous authors for more advanced reconstruction in female patients.

Geographic location affected the level of a patient's post-excision reconstruction. Surprisingly, patients in micropolitan and rural areas were more likely to undergo advanced reconstruction than patients from large metropolitan areas. We expected a lower rate of advanced reconstruction in rural patients because of a lack of access to surgeons with reconstructive expertise in these regions. Feng et al. reported that in 2014 94.6% of Mohs surgeons resided in metropolitan areas, 5% in non-metropolitan, 0.4% in rural areas and that the density of Mohs surgeons in metropolitan areas was 0.78:100,000 and 0.23:100,000 in rural areas. Similarly, otolaryngologists are unevenly distributed across the country, which has been shown to affect care outcomes in head and neck cancer. [15-17] One potential explanation for more advanced reconstruction is that rural patients may present later, with larger, more aggressive lesions, even when controlling for size. Regardless, it is encouraging that rural patients appeared to have appropriate access to advanced reconstruction. Previous authors have shown that, despite some challenges, advanced reconstruction is possible even in areas with limited access to care, as evidenced in literature examining resource limited settings globally. [18] Telemedicine is an option for follow-up for this population to allow for a degree of continued monitoring following surgery and could be considered as the proportion of the population living in rural areas increases. A recent study on telemedicine during the COVID-19 pandemic showed that facial plastics patients were significantly more amenable to the medium than other otolaryngology patients, and would be applicable to care in this population. [19]

Older age was significantly associated with lower rate of advanced reconstruction in our study but this may not represent a clinically significant difference (OR 0.99). There does not appear to be a consensus in the literature on this topic. Boyle et al. reported that younger patients were more likely to undergo reconstruction (average age 64.3 years old) than no reconstruction (average age 67.2 years old,) (p=0.037). [4] Thomas et al. did not find an association between age and level of reconstruction. [5]

The results of this study must be viewed in the context of the study design. As a retrospective cohort analysis, this study was unable to establish causality and, as a national database study, there is an inherent lack of granularity present in the data. One specific limitation of this data set is that exact lesion location was not included, as this is known to affect reconstruction choice. Rather, lesions had groupings that were specified by the CPT codes, which were only loosely stratified by subsite. [4] Furthermore, lesions were stratified by size, but the aggressiveness of the lesion is only partially impacted by size, and other features may direct reconstructive decision making that were not captured in this study. Future studies may focus on patient and surgeon shared decision-making regarding the risks and benefits of reconstruction. This may provide some insight into the discrepancy in reconstructive rates between demographic groups. This study is hypothesis-generating in that it attempts to delve into factors associated with decision making on a large scale. However, there may be significant confounding as there are surgeon and institution related factors that may play a role and must be carefully studied in the future. Furthermore, we did not evaluate long term cancer-specific or overall mortality. Nevertheless, this study is a well-powered examination of factors associated with reconstruction after head and neck lesion excision. It provides important novel information in the context of patient factors such as race, insurance status, geographic location, sex, and age, and provides a basis from which to approach further study in the field.

7. CONCLUSION

Patient sociodemographic factors, including insurance status, income, race, and gender are associated with level of reconstruction after head and neck lesion excision in appropriately selected cohorts. Equitable access to surgery to restore function and appearance is important for all patients. Further study of the factors affecting how head and neck excision defects are managed will be necessary to ensure appropriate care.

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