

RESEARCH LETTER

The Impact of the COVID-19 Pandemic on Skin Cancers Treated with Mohs Micrographic Surgery: A Retrospective Analysis at a Single United States Academic Institution

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The coronavirus disease 2019 (COVID-19) pandemic led to changes in practice among skin cancer surgeons, especially through restrictions placed on elective procedures, leading to a negative impact on skin cancer care.¹⁻⁴ Preliminary studies in the United Kingdom plastic surgery literature showed the short-term negative impact of the European lockdown on skin cancer outcomes, demonstrating that patients seen during the first wave of the pandemic had larger, more aggressive tumors with an increase in incomplete excision margins.^{1,5} Prior studies in the United States literature have also shown that the COVID-19 pandemic led to delayed diagnosis and care for patients with skin cancer.⁶ However, there remains limited data on the effect of these delays on skin cancer surgery outcomes, including stage of surgery and tumor size. To fill this gap, additional studies are warranted to determine the impact of the COVID-19 pandemic on Mohs Micrographic Surgery (MMS) outcomes. The aim of this single center retrospective study was to determine changes in skin cancers treated with MMS at a large, U.S. medical center in the context of evolving COVID-19 pandemic restrictions over the course of several months.

MMS case logs identified patients treated with MMS for skin cancer from March–

September 2020 and March–September 2019. Inclusion criteria included a diagnosis of skin cancer treated with MMS. Medical records were accessed using the electronic medical record. All pertinent patient and pathologic characteristics were documented.

Statistical analysis included Kruskal-Wallis, unpaired t-tests, and Chi-square tests.

This study included 1150 patients treated for 1307 tumors. The majority of patients were non-Hispanic (79%), white (89%) and male (73%). The most common tumor was basal cell carcinoma (BCC) (43%), followed by squamous cell carcinoma (34%). 536 patients treated with MMS during the study period in 2020 were compared to 614 seen in 2019 (**Table 1**). Age, gender, and race/ethnicity of patients were comparable between both groups, as was type of tumor being treated. Patients treated in 2020 were strikingly more likely to be immunosuppressed (34% versus 13%, $p < 0.0001$), and trended towards having larger tumors, both factors likely impacting providers' decisions to treat, as these features could indicate more aggressive skin cancers. Patients seen in 2020 also had a greater difference between pre-operative tumor size and post-operative defect size,

Table 1. Comparison of Patient Demographic and Clinical Characteristics. Table 1 depicts demographic and clinical characteristics of patients seen in 2019 compared to those seen in 2020. Patients seen in 2020 were much more likely to have recurrent tumors, were strikingly more likely to be immunosuppressed, had a greater difference in pre- and post-operative tumor size, and had an increased number of stages required for treatment.

	2019	2020	p-value
Number of Patients	614	536	
Number of Tumors	698	609	
Age, median (IQR)	73 (66-79)	72 (64-79)	ns ^a
Age, mean (SD)	72 (11)	71 (11)	
Gender, n (%)			ns ^b
Male	441 (72%)	399 (74%)	
Female	173 (28%)	137 (26%)	
Ethnicity, n (%)			ns ^c
Non-Hispanic	486 (79%)	432 (81%)	
Hispanic	22 (4%)	29 (5%)	
Unknown	106 (17%)	75 (14%)	
Race, n (%)			ns ^c
White	556 (91%)	481 (90%)	
Asian	2 (0%)	1 (0%)	
Native American	2 (0%)	2 (0%)	
Other/Unknown	54 (9%)	52 (10%)	
Immunosuppression, n (%)	80 (13%)	180 (34%)	<0.0001 ^b
Type of Tumor, n (%)			ns ^c
BCC	321 (46%)	242 (40%)	
SCC	229 (33%)	213 (35%)	
SCCIS	102 (15%)	112 (18%)	
MIS	34 (5%)	33 (5%)	
KA	10 (1%)	6 (1%)	
Other	2 (0%)	3 (0%)	
Pre-operative tumor size, cm ² , mean (SD)	1.70 (2.58)	1.72 (3.72)	ns ^a
Post-operative defect size, cm ² , mean (SD)	4.91 (6.08)	5.47 (8.1)	ns ^a
Difference in pre/post-operative size, cm ² , mean (SD)	3.21 (4.19)	3.75 (5.22)	0.03 ^a
Number of Stages, n (%)			0.03 ^c
1	360 (52%)	297 (49%)	
2	271 (39%)	228 (35%)	
3	51 (7%)	55 (9%)	
4	14 (2%)	17 (3%)	
5+	2 (0%)	11 (2%)	
Number of Stages, mean (SD)	1.61 (0.74)	1.73 (0.95)	0.01 ^a
Type of Repair, n (%)			ns ^c
Simple closure	471 (77%)	444 (81%)	
Second intention	151 (25%)	126 (21%)	
Primary closure	320 (52%)	318 (58%)	
Advanced repair	140 (23%)	104 (19%)	
Advancement flap	38 (6%)	44 (8%)	
Transposition flap	7 (1%)	13 (2%)	
Rotation flap	31 (6%)	19 (3%)	
Full thickness skin graft	26 (4%)	15 (3%)	
Xenograft	9 (1%)	3 (1%)	
Other (combination)	29 (4%)	10 (2%)	
Referral to other specialist for repair, n (%)	87 (12%)	61 (10%)	
Tumor Status, n (%)			0.02 ^b
Primary	682 (98%)	605 (99%)	
Recurrent	26(2%)	4 (1%)	

Abbreviations: ns: non-significant; IQR: interquartile range; SD: standard deviation; BCC: basal cell carcinoma, SCC: squamous cell carcinoma; SCCIS: squamous cell carcinoma in situ; MIS: melanoma in situ; KA: keratoacanthoma; cm: centimeter

^aValues computed with Kruskal-Wallis Test

^bValues computed with Fischer's Exact Test

^cValues computed with Chi-Square Test

(3.75 centimeters squared (cm²) versus 3.21cm², p=0.03), and required more MMS stages (mean 1.73 versus 1.61 stages in 2019, p=0.01, with a higher proportion of patients requiring three or more stages in 2020, p=0.03), suggesting an increase in subclinical spread of tumors potentially due to delay in presentation and subsequent treatment. However, patients seen in 2020 and 2019 had equivalent rates of advanced reconstruction such as flaps or grafts compared to primary closure or second intention.

The COVID-19 pandemic brought a significant disruption in non-emergent procedures, not only through governmental restrictions but also through changes in patient behavior. With COVID-19-related changes and restrictions, patients presented with larger tumors and required more MMS stages. Treatment of high-risk, immunosuppressed patients was prioritized, and low-risk patients may have delayed treatment due to the pandemic. Limitations of this study include that it is a single-center study at a tertiary referral center, potentially leading to overrepresentations of more severe presentations and its limited long-term outcome data. Future analysis will be required to see long-term effects on skin cancer outcomes in subsequent years. Providers should be aware of the potential effects of the COVID-19 pandemic on skin cancer surgery and outcomes, with potential associated morbidity and mortality, in the context of preparation for long-term post-pandemic sequelae, and additionally in preparation for any future large-scale pandemics or care interruptions.

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