Factors Influencing the Increased Number of Stages in Mohs Micrographic Surgery for Basal Cell Carcinoma at the Institute of Dermatology: A Retrospective Study

Sutthini Lertvivattrakul[1,2,*], Prapawan Chawvavanich[2], and Poonnawis Sudtikoonaseth[2]

[1]College of Medicine, Rangsit University, Pathum Thani, Thailand
[2]Institute of Dermatology, Bangkok, Thailand
*Corresponding author, E-mail: sutthini.ling@gmail.com

Abstract

Basal cell carcinoma (BCC) is the most common form of non-melanoma skin cancer, with increasing incidence worldwide. Early detection and treatment are vital for effective management, with the goal being to remove the tumor while preserving healthy tissue. Mohs micrographic surgery (MMS) is highly effective, offering a nearly 100% cure rate with minimal tissue damage. This study aimed to explore the factors influencing the number of MMS stages required to achieve tumor-free margins in BCC. Variables such as patient age, tumor size, anatomical location (especially the high-risk areas or H-Zone), histologic subtypes, ulceration, slide quality, and whether the tumor was primary or recurrent were analyzed. This is a retrospective study involving 207 patients treated by six different surgeons. Data were collected from medical records at the Institute of Dermatology, covering the period from October 1, 2015, to September 30, 2021. Statistical analysis was performed using SPSS software, and a multilevel Poisson regression model was applied. Surprisingly, the results showed that larger tumor size (P-value = 0.000), aggressive histologic subtypes (P-value = 0.001), H-zone involvement (P-value = 0.001), and high-quality histopathological slides (P-value = 0.000 and 0.004) were associated with fewer MMS stages (Significant P-value is less than 0.05). Interestingly, patient demographics such as age and gender did not significantly correlate with the number of MMS stages, suggesting that tumor characteristics play a more decisive role in determining the extent of surgery. In conclusion, these findings underscore the critical role of preoperative tumor assessment in surgical efficiency. By recognizing key factors such as tumor size, histologic subtype, anatomical location, and slide quality, surgeons can make more informed decisions that lead to fewer MMS stages, reduced surgical time, and better outcomes for patients. The results of this research would not only help in optimizing surgical planning but also support a personalized approach to treatment, ensuring that BCC patients receive the most effective care while minimizing unnecessary procedures.

Keywords: *basal cell carcinoma, mohs micrographic surgery*

1. Introduction

Basal cell carcinoma (BCC) is the most common non-melanoma skin cancer, with increasing incidence worldwide, especially among Caucasians and Asians in sun-exposed areas. Typically, it is locally invasive with a low risk of metastasis, some subtypes can be more aggressive (Pelucchi et al., 2007). The head and neck are common sites for BCC (Scrivener et al., 2002), and treatment focuses on tumor removal with clear margins while preserving tissue and aesthetic outcomes (Lazareth, 2013). Mohs micrographic surgery (MMS) is the preferred treatment due to its high cure rate and precision in preserving healthy tissue (Bittner et al., 2021).

Although numerous studies have explored factors that influence the number of MMS stages required for tumor-free margins, most of these studies have focused on a limited set of variables and were conducted in different settings. They examined factors like age, tumor size, histological subtypes, and anatomical location, but few considered additional factors such as histopathologic slide quality, which can also affect the number of stages.

The gap in existing research lies in the limited combination of these factors and the lack of studies focusing on a specific population, such as patients treated at the Institute of Dermatology. This study aims to address these gaps by incorporating a broader range of factors, including histopathologic slide quality, along

with tumor size, age, histological subtype, anatomical location, ulceration, and whether the tumor is primary or recurrent. By examining these factors in a population from the Institute of Dermatology, this research seeks to improve preoperative planning, surgical outcomes, and also cost-effectiveness for BCC patients, offering a more comprehensive understanding of what influences the number of MMS stages required.

2. Objectives

To identify factors associated with a higher number of stages before achieving tumor-free margins in Mohs micrographic surgery for basal cell carcinoma, which can aid in pre-operative planning.

3. Materials and Methods

3.1 Population and Samples

Population - Patients of the outpatient department (OPD) and inpatient department (IPD) at the Institute of Dermatology (IOD) from October 1, 2015 to September 30, 2021, who were diagnosed with Basal cell carcinoma in the head and neck area, had a histopathologic result, were treated with Mohs micrographic surgery, and fulfilled the inclusion criteria were included in the study.

Based on the rule of thumb (20 samples per variable), a minimum sample size (N) should be 220 or more. The factors to be considered include tumor size (0-10 mm, 11-20 mm, >20 mm), anatomical location on the H-zone (yes, no), histological BCC subtypes (non-aggressive, aggressive), primary or recurrent tumor, patient age, presence of ulceration (yes, no), and histopathological slide quality (excellent, very good, neutral, fair, poor), accounting for 11 variables based on statistical methods.

Inclusion criteria:

- Male or female

-Patients who were diagnosed with Basal cell carcinoma in the head and neck area, had histopathologic results and were treated with Mohs micrographic surgery

Exclusion criteria:

- Patients who were treated with other treatment modalities
- Unclear diagnosis and treatment history
- Incomplete patient data in the case record form

3.2 Research Instruments

This is a retrospective study in which the author collected data from the electronic medical records of patients who were diagnosed with Basal cell carcinoma, who had histopathologic results and were treated with Mohs micrographic surgery at the Institute of Dermatology from October 1, 2015 to September 30, 2021.

3.3 Data Collection

This study is a retrospective analysis, with data collected from medical records using ICD-10 codes from both the outpatient (OPD) and inpatient (IPD) departments of the Institute of Dermatology, covering the period from October 1, 2015 to September 30, 2021. The data were collected solely by the author.

Patient data were gathered in a case record form by the author, including the following information: subject ID, age, gender, tumor size, anatomical location, histological BCC subtypes, histopathological slide quality, and the presence of ulceration, as well as whether the tumor is primary or recurrent, and the number of MMS stages. To ensure confidentiality, access to patient data will be restricted to the researchers, research team, and ethical committees only.

For some factors:

Tumor size: Clinicians measure the longest dimension of the tumor from visible lesions on the skin and record it in the medical record form, after which the author gathers the data from the record.

Anatomical location: High-risk areas include the eyelids, nose, ears, lips and perioral area, scalp, jawline, and chin. These areas are considered high-risk due to their complex anatomy, sensitivity, and the importance of preserving both function and appearance.

Histological BCC subtype: Aggressive subtypes - infiltrative, morpheaform, micronodular, and mixed subtype

Histopathologic slide quality: The author obtained the histopathologic slide from Mohs surgery, and then the histopathologist identified and graded it into five categories according to the Likert scale (excellent, very good, neutral, fair, poor). However, the results were graded into only three categories - poor, fair, and neutral - based on the findings of the pathologist (only one pathologist was involved in this study).

The presence of ulceration can be identified by the following signs - visible open sore, discharge or bleeding from the tumor, irregular borders, and tenderness or pain in the ulcerated area.

3.4 Data Analysis

The data analysis involved both descriptive and statistical approaches. For continuous data, the mean and standard deviation were used to summarize the data distribution, while discrete and qualitative data were summarized using percentages to describe the proportions or categories. Statistical analysis was performed using SPSS software. To assess which factors statistically influenced the number of Mohs stages, a Multilevel Poisson regression model was applied. Statistical significance was determined by a p-value less than 0.05, and additional metrics such as the odds ratio and confidence intervals were used to evaluate the strength and reliability of the results. All data analysis was performed by a statistician, and the author participated in the discussion.

4. Results and Discussion

4.1 Results

This study focused on 207 patients with Basal Cell Carcinoma (BCC) ranging in age from 34 to 89 years, with an average age of 70 years. Gender distribution revealed 68.1% of patients were female and 31.9% were male. Tumor size varied, with 51.7% of patients having tumors between 0 and 10 mm, 33.8% with tumors between 11 and 20 mm, and 14.5% with tumors larger than 20 mm. For the anatomical locations of the tumors, 72.0% were found in the “H-zone”. Histologically, 71% of tumors were nonaggressive, while 29% were aggressive subtypes such as morpheaform and micronodular BCC. Primary tumors accounted for 87.9% of cases, with the remaining 12.1% being recurrent. Ulceration was present in 33.3% of cases. Histopathological slide quality was considered neutral in 67.1% of cases, fair in 32.4%, and poor in just 0.5%. On average, 1.39 MMS stages were required to achieve clear margins (see Table 1).

Table 1 Data characteristics from the Mohs Micrographic Surgery Institute of Dermatology

Characteristics	Count (N = 207)	
Doctor, N (%)		
Dr. A	51	(24.6)
Dr. B	61	(29.5)
Dr. C	66	(31.9)
Dr. D	18	(8.7)
Dr. E	4	(1.9)
Dr. F	7	(3.4)
Age (years), mean (S.D)	70.01	(12.904)
Gender, N (%)		
Men (0)	66	(31.9)
Women (1)	141	(68.1)
Tumor size (mm.), N (%)		
0-10 (0)	107	(51.7)
11-20 (1)	70	(33.8)
>20 (2)	30	(14.5)
Anatomical location, N (%)		
No (0)	58	(28)
Yes (1)	149	(72)
Histological subtype, N (%)		
Non- aggressive (0)	147	(71)
Aggressive (1)	60	(29)
Primary or Recurrent tumor, N (%)		
Primary (0)	182	(87.9)
Recurrent tumor (1)	25	(12.1)
Presence of ulceration N (%)		
No (0)	138	(66.7)
Yes (1)	39	(33.3)
Histopathological slide quality N (%)		
Poor (0)	1	(0.5)
Fair (1)	67	(32.4)
Neutral (2)	139	(67.1)
MMS stage, mean (S.D)	1.39	(0.728)

This study aimed to explore the factors influencing the number of stages required to achieve tumor-free margins during Mohs Micrographic Surgery (MMS) for Basal Cell Carcinoma (BCC). Using a multilevel Poisson regression model, the research analyzed the impact of various independent variables such as age, gender, tumor size, location, histological subtype, ulceration, and slide quality on the number of MMS stages needed. The model accounted for variability introduced by different surgeons and included patient-level random effects.

Table 2 Rate ratios and confidence intervals for the multilevel Poisson regression model

Variable	Rate Ratio	95% CI	P-value
	Fixed Intercept		
	2.514	1.617 - 3.907	0.000
	Fixed effects		
Age	0.998	0.992 - 1.004	0.507
Gender	1.059	0.944 - 1.189	0.326
Tumor Size 1 (11-20 mm)	0.851	0.821 - 0.881	0.000*
Tumor Size 2 (>20 mm)	0.933	0.785 - 1.108	0.427
Anatomical Location (H-zone)	0.862	0.790 - 0.940	0.001*
Histological Subtype (Aggressive)	0.895	0.837 - 0.957	0.001*
Primary or Recurrent Tumor	0.944	0.908 - 1.089	0.896
Presence of Ulceration	0.922	0.766 - 1.095	0.355
Histopathological Slide Quality 1 (Fair)	0.864	0.807 - 0.924	0.000*
Histopathological Slide Quality 2 (Neutral)	0.858	0.774 - 0.951	0.004*
Variance of Random Effect	1.013		0.538

*Significant (p-value)

Note: The number of MMS stages needed for each variable is indicated in the table above. The variables influencing the number of stages thus include tumor size between 11-20 mm, localization in the H-zone, aggressive histological subtype, and fair/neutral quality of the histopathological slides (*).

The results of the study, as shown in Table 2, reveal the following:

Tumor size (11-20 mm): Rate Ratio = 0.851, 95% CI = 0.821-0.881, P-value = 0.000. This indicates a 14.9% decrease in the number of stages compared to tumors 0-10 mm in size.

H-zone anatomical location: Rate Ratio = 0.862, 95% CI = 0.790-0.940, P-value = 0.001. Tumors located in the H-zone are associated with a 13.8% reduction in the number of MMS stages compared to tumors not located in the H-zone.

Aggressive histological subtypes: Rate Ratio = 0.895, 95% CI = 0.837-0.957, P-value = 0.001. Aggressive tumor subtypes result in a 10.5% reduction in the number of stages compared to non-aggressive subtypes.

Histopathological slide quality: Fair: Rate Ratio = 0.864, 95% CI = 0.807-0.924, P-value = 0.000. Tumors with fair-quality slides show a 13.6% decrease in the number of stages compared to poor-quality slides.

Histopathological slide quality: Neutral: Rate Ratio = 0.858, 95% CI = 0.774-0.951, P-value = 0.004. Neutral-quality slides are associated with a 14.2% reduction in the number of stages compared to poor-quality slides, which is statistically significant (P-value = 0.004).

This finding is contrary to some previous studies and could be explained by surgeons paying more attention to complex cases, such as aggressive subtypes, larger tumors, or tumors located in the H-zone. In these cases, surgeons may excise with a wider margin, such as 3 mm, compared to the usual narrower margin of 1-2 mm. This could result in fewer stages of Mohs surgery. This observation is based on discussions with

surgeons and my advisor. Additionally, surgeons at this institute may use specific techniques to address aggressive cases, which could result in fewer stages. Differences in study populations and tumor types may also explain the variation in the findings.

Factors such as age, gender, tumor recurrence, and ulceration did not show significant effects on the number of stages needed. Additionally, surgeon-related variability did not significantly affect the number of stages, indicating that tumor characteristics played a more critical role.

In this study, patient demographics such as age and gender did not significantly influence the number of stages required in Mohs surgery. This suggests that other variables, such as tumor size, location, histopathological subtype, or histopathologic slide quality, had a greater impact on the number of stages. The results may also reflect a balanced study population, where age and gender variations were not excessive (e.g., very young or elderly patients), and gender-related factors had no significant effect on tumor prevalence, limiting noticeable differences in the surgical approach.

The results suggest that early tumor detection, accurate pre-surgical planning, and high-quality histopathological slides are essential for reducing the number of MMS stages. While in slight contrast to other studies, the findings in this study offer valuable insights into improving MMS outcomes as well as preparing both surgeons and patients for the surgical process.

4.2 Discussion

This study aimed to identify factors influencing the number of stages needed in Mohs Micrographic Surgery (MMS) for patients with basal cell carcinoma (BCC). Key findings highlighted tumor size, location, histological subtype, and histopathological slide quality as significant predictors for the number of MMS stages.

The research found a negative correlation between tumor size and MMS stages: larger tumors (over 10 mm) required fewer stages compared to smaller ones (0–10 mm), which contradicts prior studies suggesting larger tumors might require more stages due to greater subclinical spread (Flohil et al., 2013; Santos et al., 2020). The study suggests that tumor size alone may not significantly impact the treatment approach, and early detection of tumors is still critical to avoid surgical complications.

Tumors located in high-risk facial zones (e.g., nose, eyes, ears, lips) needed fewer stages than those in non-H-zone areas, possibly due to the precision of MMS in preserving vital tissues while achieving tumor-free margins. The research also found that aggressive BCC subtypes (e.g., morpheaform and micronodular) required fewer stages than noninvasive ones, which challenges previous studies that suggested more stages would be needed for aggressive subtypes (Orengo et al., 1997). This could be due to better-defined tumor borders in these cases.

Histopathological slide quality was crucial, with poor-quality slides leading to more stages due to difficulty in accurately defining tumor margins. High-quality slides ensured fewer stages and more accurate assessments, aligning with previous research that emphasized the importance of slide quality in reducing surgical intervention.

Factors such as tumor size, H-zone location, histological subtype, and the presence of ulceration were expected to increase the number of MMS stages. However, this study found the opposite, with these factors being associated with fewer MMS stages. This could be due to differences in patient populations, tumor characteristics, and possibly the techniques used at this institute. For example, if the surgeons treat complex cases more aggressively such as by cutting wider margins it may result in fewer stages being needed.

In contrast, the study revealed that demographic factors such as age, gender, tumor recurrence, and ulceration had no significant impact on the number of MMS stages, differing from earlier research that linked these factors with surgery complexity.

In conclusion, the unexpected finding in the study that factors such as tumor size, location in high-risk areas, histological subtype, and slide quality were associated with fewer stages in Mohs surgery can be explained by several factors. Larger tumors may have more defined margins, making them easier to excise in fewer stages. In contrast, aggressive subtypes, which often have ill-defined borders, may still require fewer stages due to factors such as early detection or refined surgical techniques. Additionally, high-quality

histopathological slides enable more accurate margin delineation, reducing the need for further stages. Surgical techniques, such as wider initial excision margins in complex cases or high-risk locations, could also contribute to fewer stages by ensuring more complete removal from the outset. Surgeons may adopt more aggressive approaches for tumors in high-risk zones, larger tumors, and aggressive subtypes, using wider margins to ensure clear tumor-free borders, potentially reducing the need for additional stages. The precision inherent in Mohs surgery also plays a significant role, as the layered approach allows for more focused tissue removal, minimizing the chances of leaving behind residual tumor cells. These factors, combined with early tumor detection, could explain the observed results. The findings suggest that tumor-related characteristics, surgical techniques, and slide quality are key factors in minimizing the number of stages required. The research emphasizes the importance of early detection, pre-operative planning highlighting tumor-related factors, and high-quality histopathological slides in optimizing surgical outcomes. By enabling surgeons to anticipate potential complications, brief patients on the expected duration of surgery, and improve overall outcomes, these findings help reduce recurrence and preserve cosmetic appearance. Further research is needed to explore the exact mechanisms behind these findings, particularly concerning surgical practices and their influence on outcomes.

5. Conclusion

This study analyzed the factors influencing the number of MMS stages required for BCC patients and found that tumor size, H-zone location, histological subtype, and histopathological slide quality significantly impacted the number of stages. Larger tumors, tumors located in the H-zone, aggressive histological subtypes, and high-quality slides were linked to fewer stages. Contrary to expectations, tumors in the H-zone and aggressive subtypes required fewer stages, challenging previous findings that suggested more stages for these cases (Greywal et al., 2020). A key takeaway is the importance of maintaining high-quality histopathological slides, which were associated with more efficient tumor excision and fewer stages. These findings emphasize the need for thorough pre-operative evaluation based on tumor characteristics, rather than patient demographics, to guide optimal MMS planning and improve patient management by reducing unnecessary surgical stages and ensuring more accurate treatment outcomes.

This study has several potential biases and limitations, including its retrospective design, which may introduce selection and information bias, as well as the fact that it was conducted at a single center, limiting the generalizability of the findings to other institutions or geographic locations. Additionally, missing or incomplete data could impact the validity of the results, and the small sample size in certain subgroups may reduce statistical power. To improve generalizability, future studies should include multi-center data with larger, more diverse patient populations and use prospective designs to minimize biases and capture evolving surgical techniques. Understanding the influence of specific surgical approaches across different settings would also help apply these findings more broadly to clinical practice.

6. Acknowledgements

I would like to express my deepest gratitude to my academic advisors and co-advisor for their unwavering support and guidance throughout my studies. Their insightful feedback and continuous encouragement have been crucial to the success of this thesis. I am also grateful to the members of the thesis committee for their valuable contributions, advice, and expertise, which significantly shaped my research. Additionally, thanks to the research participants for their valuable contributions to this study.

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