

Evaluating Arbitrary and Histological Margins in High-Risk Nonmelanoma Skin Cancers: A One-Center Experience

Andrei L. Porosnicu^{1,2}, Karim A. Jebreen², Stefania M. Riza^{1,2}, Patricia A. Cepi², Ruxandra D. Sinescu^{1,2}

¹ Plastic and Reconstructive Surgery Discipline, Bucharest Clinical Emergency Hospital, University of Medicine and Pharmacy Carol Davila, Bucharest, Romania

² Department of Plastic Surgery and Reconstructive Microsurgery, Elias Emergency University Hospital, Bucharest, Romania

Correspondence: Stefania M. Riza, stefania-mihaela.riza@drd.umfcd.ro

Abstract: Background: Nonmelanoma skin cancers (NMSCs), including basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (cSCC), often occur in high-risk areas like the face, ears, and scalp. Surgical excision is standard, but achieving tumor-free margins while preserving function and appearance is challenging. This study evaluates the adequacy of arbitrary surgical margins versus histopathological clearance. Methods: A retrospective analysis was conducted on 147 patients with BCC or cSCC in high-risk areas treated at Elias Emergency University Hospital (2020–2024). Data included demographics, tumor type, size, location, excision margins, and histological clearance. Margins were grouped from 0 mm to >10 mm. Results: Most patients were male (59.2%) with a mean age of 70.6 years. BCC accounted for 70.7% of cases. Arbitrary margins averaged 5.4 mm; mean histological margins were ~2.5 mm. Complete excision was achieved in 91.2%; positive margins were most common on the nose and scalp. Discussion: Arbitrary margins in high-risk areas are often narrower than guidelines recommend, especially where tissue is limited, increasing the risk of incomplete excision. Conclusion: While aesthetic and functional considerations often necessitate smaller margins, improved intraoperative margin assessment could enhance oncological outcomes in high-risk NMSC.

Keywords: Nonmelanoma skin cancer (NMSC), Basal cell carcinoma (BCC), Cutaneous squamous cell carcinoma (cSCC), Surgical margins, Histopathological clearance, High-risk anatomical areas, Mohs micrographic surgery, Arbitrary excision margins, Incomplete excision, Oncologic safety

INTRODUCTION

Basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (cSCC) represent the two most common forms of nonmelanoma skin cancer (NMSC), with BCC being the most prevalent malignancy globally. While BCC is characterized by slow growth and minimal metastatic risk, its potential for local destruction and disfigurement, especially in anatomically sensitive areas, underscores the importance of timely and adequate treatment. cSCC, although less frequent, poses a relatively higher risk of local invasion and lymphatic metastasis, particularly in immunosuppressed patients [1].

The cornerstone of NMSC treatment remains surgical excision, favored for its efficacy, cost-effectiveness, and accessibility across healthcare systems. Surgical excision allows for histopathological evaluation of the margins and is generally sufficient for low-risk lesions. However, for high-risk tumors located in functionally and cosmetically sensitive areas (defined as Area H: central face, ears, eyelids, nose, genitals, and hands), standard excision can be technically challenging. In these zones, even small tumors may have subclinical extension, increasing the risk of incomplete excision and recurrence [2].

A surgical margin refers to the outer edge of the tissue removed during surgery. The tumoral involvement of the resected margins is a crucial prognostic element. Evaluating the tumoral invasion of the margins is essential for determining whether the excision is sufficient or incomplete. In instances of cancer, follow-up management choices depend on whether the margins are devoid of tumors. Consequently, precise and timely margin evaluation is essential. Attaining clear surgical margins guarantees the complete removal of cancerous tissues, minimizing the chances of local recurrence [3].

While standard excision remains widely used, it has notable limitations in high-risk areas. One of the primary drawbacks is the inability to assess 100% of the peripheral

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and deep margins during surgery. Mohs micrographic surgery (MMS) is considered the gold standard for treating high-risk NMSCs, particularly recurrent or infiltrative lesions. MMS provides complete circumferential and deep margin control (CCPDMA), resulting in superior cure rates—over 98% for primary BCCs and above 95% for recurrent cases. Moreover, MMS allows for maximal tissue conservation, which is crucial in cosmetically sensitive areas. However, its disadvantages include longer operative times, higher costs, and limited availability, which restrict its universal application [4].

This study aims to demonstrate that standard surgical excision can yield acceptable oncological outcomes in the management of high-risk nonmelanoma skin cancers, particularly in under-resourced hospitals where Mohs micrographic surgery is not available.

MATERIALS AND METHODS

This study included 147 patients who underwent surgical excision of non-melanoma skin cancer at the Plastic Surgery Department in „Elias Emergency University Hospital”, Bucharest, Romania, between 2020-2024.

Inclusion criteria – all patients admitted to our plastic surgery department with skin lesions with high suspicion of non-melanocytic skin cancer/histopathological confirmation, in a high-risk area, who accepted the surgical treatment. The high-risk areas were defined using NCCN guidelines depending on anatomical localization and size: head, scalp, genital area, trunk, and extremities >2cm.

Exclusion criteria – patients with BCC/cSCC in low-risk areas, premalignancies, melanoma, psychological disorders, and refusal of future treatments.

Arbitrary surgical margins were defined as preoperative markings based on local tissue availability, skin elasticity, and the surgeon’s experience. Data regarding sex, age, comorbidities, type of anesthesia used, type of reconstruction, surgical dissection plane, arbitrary surgical margins, peripheral and deep clean margins, tumor diameter, and ulceration were collected and analysed. Surgical standard excision was performed using a no.15 blade in a full-thickness fashion. The deep dissection plane was chosen depending on the case. Excisions were performed under local, regional, or general anesthesia. For wound closure, depending on defect size and location, we used primary closure, skin grafts, and/or flaps. Specimens were oriented using sutures as markings for histopathological evaluation. Excised specimens were sent for histopathological examination to assess tumor clearance.

The histological clearance margins of the lesions were measured peripherally and in depth, recorded in millimeters to one decimal place. They were categorized into five groups:

- zero clearance (indicating margin involvement)
- clearance under 1 mm (0.1–0.9 mm)
- clearance between 1 and 4.9 mm
- clearance between 5 and 9.9 mm
- clearance greater than 10 mm.

Those with zero clearance were advised to have a re-excision following their histopathological results. Patients with clearance margins under 1 mm underwent dermatoscopy surveillance every 3 months; in case of recurrence, the tumors were re-excised. Patients were monitored for wound healing and recurrence.

RESULTS

Demographic

In the 4 years, there were 147 patients, predominantly men with 87 cases (59.2%), with an average age of 70.6 years (see Table 1). BCCs were the predominant cancer, with 104 excisions (70.7%), while cSCCs had 43 excisions (29.3%).

Regarding comorbidities, cardiovascular diseases were predominant in 68 cases (46.2%), followed by diabetes mellitus in 11 cases (7.4%) and other malignancies in 10 cases (6.8%). The anesthesia of choice was local in 143 cases (97.3%), regional and general anesthetics were less prevalent at 2 and 3 cases, respectively. The preferred method of reconstruction was the local flap, with 54 cases (36.7%), followed by full-thickness skin grafts with 38 cases (25.9%), and direct sutures with 36 cases (24.5%). On the other hand, reconstruction techniques such as regional flaps and split-thickness skin grafts were rarely used.

The surgical plane of choice was subcutaneous with 62 cases (42.2%), suprafascial with 42 cases (28.6%), while deeper planes such as supracondylar (14.3%) and suprapariosteal (8.2%) have been rarely used.

Incomplete excisions

There were 13 cases of incomplete excisions (see Table 2). The areas with incomplete excisions were located on the nose, with 5 out of 13 cases, followed by the scalp, 4 out of 13 cases. The cheek and peri-orbital regions had a lower rate of incomplete excisions, accounting for 2 cases. Notably, no incomplete excisions were recorded for lesions located on the lips, limbs, or trunk.

Table 1: Demographics and Clinical Characteristics

Sex	
- female	60 (40.8%)
- male	87 (59.2%)
Age	70.6 years (29 – 94 years)
Type	
- BCC	104(70.7%)
- SCC	43 (29.3%)
Comorbidities	
- CV	68(46.2%)
- Diabetes Mellitus	11(7.4%)
- other malignancies	10 (6.8%)
Type of anesthesia	
- local	143 (97.3%)
- regional	2 (1.4%)
- general	3 (2%)
Type of reconstruction	
- direct suture	36 (24.5%)
- skin graft	
-STSG	6 (4.1%)
-FTSG	38 (25.9%)
- local flap	54 (36.7%)
- regional flap	3 (2%)
Surgical dissection plane	
- subcutaneous	62 (42.2%)
- suprafascial	42 (28.6%)
- supracondral	21 (14.3%)
- supraperiostal	12 (8.2%)
Arbitrary surgical margins (mean, mm)	5.4 mm (2-15mm)
Largest diameter (mean, mm)	21.6 mm (5 – 184mm)
Peripheral clearance margins (mean, mm)	2.52 mm (0-9.2mm)
Deep clearance margins (mean, mm)	2.65mm (0-20mm)

Table 2: Incomplete excisions expressed as % of all incomplete excisions depending on anatomic site

Anatomic site	Total Lesions	Incomplete Excisions	% of All Incomplete Excisions	Mean Diameter (mm)	Mean Arbitrary Margin (mm)	Presence of Ulceration (n)
Cheek	17	1	7.7%	17.11	4.3	16
Forehead	15	2	15.4%	18.6	4.4	9
Nose	33	5	38.5%	14.1	4.3	24
Peri-orbital	24	1	7.7%	15.45	5.2	15
Lips	8	0	0%	13.3	6.2	8
Scalp	26	4	30.8%	22.6	5.0	19
Limbs	14	0	0%	35.2	9.2	11
Trunk	10	0	0%	58.6	7.6	6
	147	13				

The majority of cancers (64.6%) had peripheral histological clearance margins between 1.0–4.9 mm, as we can see in Table 3. Margins with clearance under 1 mm were present in 15.6% of cases. Complete margin involvement (0 mm clearance) was identified in 4.8% of tumors, comparable to the 8.8% incomplete excision rate. No cases exceeded peripheral margins larger than 10 mm, balancing oncological safety with tissue preservation.

The most common deep margin range was 1.0–4.9 mm, present in 57.1% of cases. Deep margins between 0.1–0.9 mm were observed in 19% of cases. Complete deep margin involvement (0 mm clearance) was identified in 8.8% of cases, reinforcing the necessity of

achieving adequate excision depth to minimize recurrence risk. Only 4.1% of lesions had deep clearance margins exceeding 10 mm.

Table 3: Margin Clearance Distribution Among Excised Tumors

Margins (mm)	Peripheral total	% total lesions	Deep total	% total lesions
0	7	4.8%	13	8.8%
0.1-0.9	23	15.6%	28	19.0%
1-4.9	95	64.6%	84	57.1%
5.0-9.9	13	8.8%	16	10.9%
>10	0	0%	6	4.1%

Peripheral Margins >1 mm

The highest histological clearance rates, with peripheral margins over 1 mm, were noted in lesions located on the limbs (100%) and scalp (73%), suggesting that these regions allow a wider excision. In contrast, the lowest rates of peripheral clearance beyond 1 mm were documented in lesions on the forehead (6.1%) and lips (4.8%), revealing the technical difficulties of obtaining wider margins in these areas.

Table 4: Distribution of Peripheral and Deep Histological Clearance Margins depending on anatomic site

Anatomic site	Total lesions	Peripheral histological clearance margins > 1mm	%	Deep histological clearance margins (0.5-4.9 mm)	%
Cheek	17	13	8.8%	17	11.6%
Forehead	15	9	6.1%	11	7.5%
Nose	33	21	14.3%	27	18.4%
Peri-orbital	24	16	10.9%	22	15.0%
Lips	8	7	4.8%	8	5.4%
Scalp	26	19	12.9%	21	14.3%
Limbs	14	14	9.5%	13	8.8%
Trunk	10	8	5.4%	10	6.8%
	147	107	72.8%	129	87.8%

Deep Margins (0.5–4.9 mm)

The nasal region had the greatest number of cases with deep margins in the 0.5-4.9 mm range, with 27 cases (18.4%), as seen in Table 4, explaining its elevated rate of incomplete excisions. Areas such as the peri-orbital region, presented 22 cases (15.0%), the scalp with 21 cases (14.3%), reveal the difficulties of achieving sufficient deep margins in said locations.

DISCUSSION

Basal cell carcinoma is the most prevalent cancer, presenting with a slow growth rate and a very low metastatic risk, located predominantly on the head and neck, but also on the limbs and trunk [5]. BCCs tend to be locally destructive and may cause deformity or recurrences if not fully excised [6]. The most important risk factor is long-term/chronic sun exposure, followed closely by a history of either BCC or SCC, with patients being more likely to develop another BCC compared to patients without a history of NMSCs. The rate of developing BCC increases with age, with an average age of 68 years; men have higher rates of BCC than women [7]. The treatment of choice is removing the tumor through different methods, such as Mohs micrographic surgery, peripheral and deep en face margin assessment, cryosurgery, electrodesiccation, and surgical excision. Surgical excision remains the staple method of removing the tumor [8,9].

Cutaneous squamous cell carcinoma, while not as prevalent as BCC, is still a frequent malignancy with similar risk factors as the BCC, such as sun exposure, Fitzpatrick skin types I-II, male gender, and other etiologies such as immunosuppression and chronic wounds (e.g., Marjolin Ulcer). Regarding the recurrence rate following surgical excision, cSCCs located in areas prone to prolonged sun exposure yielded a higher rate of recurrence compared to areas with less sun exposure. The primary risk of recurrence is invasion of the dermis. On the other hand, there was no noticeable difference between the 2 areas regarding the rate of metastases [10,11]. SCCs pose a low metastatic risk, the preferred metastatic site being the lymph node [12,13]. They can be more aggressive than BCCs, with a higher likelihood of local invasion and potential for metastasis, especially in high-risk cases. Understanding the local invasiveness of NMSCs is crucial for determining appropriate treatment strategies and improving patient outcomes [14].

Surgical excision of NMSCs aims to completely remove the tumoral tissue while sacrificing as little normal tissue as possible. This can be achieved through simple elliptical excision. However, Mohs micrographic surgery is the gold standard for treating high-risk tumors. Its primary benefit lies in conserving healthy tissue, preserving anatomical structures, and ensuring tumor-free margins. A recent randomized clinical trial found that Mohs surgery yielded superior outcomes for recurrent BCC compared to direct excision, although no significant differences were observed for primary BCC treatment [15].

Area H refers to high-risk regions, including the central face, ears, genitals, and hands, which require balancing oncologic control with cosmetic and functional outcomes [16]. Mohs surgery is an excellent option for preserving function and enhancing cosmetic outcomes. From a reconstructive perspective, imaging techniques help to identify optimal blood supply for flaps, minimizing complications and improving success rates. As a result, the focus of skin cancer surgery has evolved from simple excision and flap coverage to superior functional and aesthetic outcomes [17].

Peripheral and deep en face margin assessment (PDEMA), also known as complete circumferential peripheral and deep margin assessment (CCPDMA), is associated with the highest cure rates for NMSCs, due to complete peripheral and deep margin visualization, and re-excision of residual tumor [18]. Mohs is the most common method of PDEMA; however, there are also other techniques, such as the Tübingen method, which differs from Mohs by having a histopathological examination in a 1-5 day interval over Mohs's rapid frozen section and interpretation [19].

The mean age of patients with NMSCs in our study was 70.6, with a tendency to be more represented in males. Ciężyńska et al. observed no significant differences between genders. However, the mean age of men in their group was 70.9 +/- 11.4 years, and for women 71.4 +/- 11.9 years [20].

According to NCCN Guidelines Version 2.2025, high-risk criteria for both BCCs and cSCCs are: tumor diameters ≥ 2 cm in the trunk and extremities, any size pertaining to the head, neck, feet, pretibial and anogenital area, recurrence, immunosuppression, and poorly defined borders [21,22].

The issue with arbitrary surgical margins is that they can lead to either removing more normal tissue than necessary or less than required, and thus leading to recurrence. A study from the Hospital Universitari Vall d'Hebron in Barcelona reviewed histopathological reports from all BCCs treated by different specialties, aiming to determine the influence of a surgical specialty on assessing and excising a tumor with proper safety margins. It revealed that dermatologists had the lowest rate of positive margins out of other specialties, such as plastic surgery, general surgery, etc. attributed to their broader knowledge and expertise in evaluating tumor margins macroscopically. Therefore, proper identification of macroscopic tumoral margins for excision must be emphasized [23].

Australian Journal of Plastic Surgery conducted a study in which they monitored subjects with different levels of experience, as they were drawing a 3 mm, 5 mm, and 10 mm margin around different lesions without using a measurement device, with acceptable margins being considered to be approximately within 0.5 mm of the recommended surgical margin. Margins were underestimated, no matter the level of experience, being smaller in size for each bracket. Margins of 3 mm have been the most accurately estimated out of the 3, increasing the margin size leads to an increase in inaccuracy. This serves to enforce the importance of proper safety margins and the risk of re-excisions caused by improper measurements [24,25].

The majority of excised tumors (64.6%) displayed peripheral histological clearance margins ranging between 1.0–4.9 mm. Narrow peripheral margins (0.1–0.9 mm) have been observed in 15.6% of cases. Complete margin involvement (0 mm clearance) was identified in 4.8% of tumors. No cases exceeded peripheral margins larger than 10 mm, balancing oncological safety with tissue preservation. The most common deep margin range was 1.0–4.9 mm, present in 57.1% of cases. Deep margins between 0.1–0.9 mm were observed in 19% of cases. Complete deep margin involvement (0 mm clearance) was identified in 8.8% of cases, reinforcing the necessity of achieving adequate excision depth to minimize recurrence risk. Only 4.1% of lesions had deep clearance margins exceeding 10 mm. Khalid-Raja M. suggested identifying the peripheral margin of excision by using the wet blotting technique and applying a 4-mm margin of excision to all NMSCs. Their results showed a 95% successful excision rate and a peripheral clearance margin of 0.1–14 mm, a mean peripheral margin of 3.73 in the case of BCCs, and a 96% successful excision rate with peripheral margins varying from 0.5 to 19.0 mm, a mean peripheral margin of 4.86. Comparatively, our study showed a 92% successful excision rate and a mean peripheral margin of 2.52 mm, with the mean average surgical margin being 5.4 mm. The highest number of incomplete excisions was located at the nose and scalp with arbitrary surgical margins of 4.3 and 5.0 mm, respectively. Lesions over 2 cm lead to a 91.2% complete excision with a 4 mm margin while using the wet blotting technique. This coincides with our findings [26,27].

J Kiely et al. recommend the excision of poorly differentiated cSCCs with a minimum peripheral margin of 6 mm, well-differentiated cSCCs were excised with an average peripheral margin of 4.72 mm, and the poorly differentiated ones with an average margin of 6.42 mm. This led to an involvement of peripheral margins in 3% of well-differentiated lesions and 13.2% of poorly differentiated ones. Deep margins were also close or involved in 50% of poorly differentiated cSCCs, demonstrating that poorly differentiated cSCCs are not properly excised in both peripheral and deep planes, in spite of the guidelines [28].

Australian Journal of General Practice recommends for high-risk lesions over 5 mm margins for BCCs and a 6 mm margin for cSCCs, claiming selection of surgical margin should aim to balance between incomplete excision of the tumor and normal tissue sacrifice, affecting cosmetic and functional outcomes [29].

Eva Van Loo et al. found the recommended excision margins for BCC too defensive, evaluating the Dutch Guideline, which states that the margin for low-risk BCC should be 3-4 mm, and the high-risk BCC up to 20 mm, incorporating the H-zone as a high-risk BCC. Currently, the Dutch and European consensus is that high-risk BCC should have a minimum of 5 mm, or 5-15 mm (European guideline). The findings indicate that adherence to the guideline in high-risk BCC was not adequate, yet it had a limited effect on the incomplete excision rate. A margin of 3 mm was sufficient for 99.6% of low-risk BCCs, and a 5 mm margin for high-risk BCCs up to 94% [30].

High incomplete excision rates (8.8%) suggest that in certain areas, such as the nose and scalp, wider margins might be needed. The lowest incomplete excision rates were found in the peri-orbital region and the cheek, while no incomplete excisions were documented on the lips, trunk, and limbs. Ceder H found higher incomplete excision rates located on the face and scalp, the highest ones being on the nose, ear, and peri-orbital area; also noteworthy, circular excisions were also more often incomplete compared to elliptical excisions [31].

Despite its high cure rates and tissue-sparing advantages, Mohs micrographic surgery (MMS) presents several notable disadvantages that limit its universal application. One of the primary concerns is the limited availability of specialized centers and trained personnel, making access difficult in under-resourced or rural healthcare settings. MMS is also more time-consuming than standard excision, as it involves intraoperative histological analysis of multiple tissue layers, requiring patients to remain in the facility for extended periods. Additionally, the procedure is costlier due to the need for specialized equipment and trained histopathologists, potentially placing a financial burden on healthcare systems and patients alike. From a logistical standpoint, not all lesions are suitable for MMS—tumors with extensive subclinical spread, poorly defined borders, or aggressive histologic subtypes may require complementary or alternative approaches. Lastly, in settings where rapid frozen-section pathology is not feasible, delays in diagnosis and treatment can occur, reducing the practicality of MMS outside high-volume dermatologic surgery centers [32]. While Mohs surgery offers excellent cure rates, its use in elderly patients requires careful consideration. The prolonged procedure time, need for patient immobility, and potential for postoperative care challenges may be poorly tolerated by those with comorbidities or cognitive impairment. Therefore, treatment should be individualized based on the patient's overall health, functional status, and life expectancy [33].

CONCLUSION

This study highlights the challenges of achieving adequate surgical margins in high-risk anatomical areas affected by nonmelanoma skin cancers. Although arbitrary margins based on surgeon experience averaged 5.4 mm, histopathological evaluation revealed that a significant number of excisions had suboptimal peripheral or deep clearance, particularly in constrained areas like the nose and scalp. Despite a 91.2% overall rate of complete excision, the 8.8% rate of positive margins underscores the limitations of visual and tactile margin estimation alone. The findings support existing guidelines recommending wider margins ≥ 5 mm for BCC and ≥ 6 mm for cSCC, while also emphasizing the need to balance oncologic safety with aesthetic and functional preservation. In high-risk regions, individualized surgical planning, improved intraoperative margin assessment, and consideration of techniques like Mohs micrographic surgery in selected cases may optimize outcomes and minimize recurrence. Ultimately, refining margin estimation and tailoring surgical strategy to both tumor characteristics and anatomical context are essential for improving the quality of care in patients with high-risk NMSCs.

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Authors' contribution

Conceptualization, S.M.R and K.A.J, methodology, A.L.P.; formal analysis, A.L.P.; data curation, P.A.C; writing—original draft preparation, K.A.J, A.L.P; writing—review and editing, S.M.R.; visualization, R.D.S.; supervision, R.D.S.; project administration, A.L.P. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Elias University Emergency Hospital, Bucharest, Romania (protocol code 3606 and 19.06.2025).

Patient consent for publication

Informed consent was obtained from all subjects involved in the study.

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