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Margin Status following Simple Excision of Head and Neck Basal Cell Carcinoma: A Population-Based, Cross-Sectional Study of 9,291 Excisions

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A mainstay treatment of head and neck basal cell carcinoma (BCC) is excision with a fixed surgical margin. Large-scale evaluation of post-surgical margin status is necessary to improve outcomes. This cross-sectional study assessed margin outcomes following excision of head and neck BCCs across Danish healthcare settings, including risk factors for tumour-positive margins. Histopathology records on BCCs excised by all medical specialities between 1 January and 31 December 2022 were retrieved from the Danish Pathology Bank. Cases with intraoperative microscopic margin assessment were excluded. Descriptive analyses and multivariable logistic regression determined complete excision proportions and risk factors for positive margins. Including 9,291 BCC excisions in 7,741 patients, the tumour-free proportion was 80.0% (95% CI: 79.2–80.8%). Significant variation occurred by histopathological subtype, with tumour-free margins ranging from 60.6% in morpheaform to 83.6% in nodular BCCs. Multivariable analyses also identified morpheaform, micronodular, infiltrating, and superficial subtypes, auricular/postauricular locations, small specimen size, and advancing age as risk factors for tumour-positive margins. The nose was a risk factor in univariable analysis. Simple excision of head and neck BCCs showed notable variation in margin outcomes by patient, tumour, and specimen profile. To minimise recurrence and optimise resources, increased awareness of positive margins is essential.

Key words: basal cell carcinoma; margins of excision; skin neoplasms; operative surgical procedures; keratinocytes.

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SIGNIFICANCE

A mainstay treatment for basal cell carcinomas of the head and neck is simple excision with a fixed surgical margin. This large-scale national cross-sectional study assessed 9,291 head and neck basal cell carcinoma excisions throughout 2022. Overall, 4 out of 5 basal cell carcinomas (80.0%; 95% confidence interval 79.2–80.8%) were excised with free margins, with the highest odds of tumour-positive margins in high-risk histopathologic subtypes, superficial basal cell carcinomas, auricular, postauricular, nasal anatomic locations, and small specimen sizes.

Basal cell carcinoma (BCC) is one of the most common cancers in fair-skinned populations, with ultraviolet exposure comprising the major extrinsic aetiological driver (1, 2). Rising BCC incidence has been observed globally, partly due to ageing populations, deleterious sun behaviours, and improved disease awareness and detection (3, 4). Histopathologically, BCCs are categorized into subtypes, including the frequently occurring and less aggressive superficial and nodular tumours, as well as the more rare and aggressive micronodular, infiltrative, morpheaform, and basosquamous subtypes (5). Although BCCs rarely metastasize, the risk of tumour recurrence and development of subsequent lesions is substantial. Considerable morbidity and resource consumption are associated with BCC management (6, 7).

BCC treatment is tailored to suit the patient profile, specific tumour subtype and size, anatomic location, and local resource constraints (8). For BCCs of the head and neck, surgical excision under local anaesthesia is considered standard treatment, typically using surgical margins of 3–5 mm, sometimes up to 10 mm (9). Achieving free margins is important: positive surgical margin has been found to be the strongest predictor of recurrence after simple excision of head and neck BCCs (odds ratio [OR] 6.71; 95% confidence interval [CI] 3.69–12.2) (10). The European treatment guideline report recurrence rates from 26% to 41% for incompletely excised tumours, with up to 5 years' follow-up (8). In the head, achieving free margins is key to avoiding additional procedures, preserving the function and aesthetics of facial structures. Ensuring free surgical margins has implications for healthcare systems, lowering the need for intensified follow-up and additional interventions (11).

Simple excision involves demarcating the tumour's borders and excising it with a margin of healthy tissue,

typically including the subcutaneous plane for BCCs. Most procedures are done under local anaesthesia, with few exceptions. Intraoperative histopathological assessment excludes the procedure from being classified as a simple excision.

To minimise the BCC burden and optimise healthcare resource utilization, current treatment standards require continued evaluation. This large-scale study examined the proportion of simple excisions of BCCs of the head and neck that achieve tumour-free margins across all healthcare sectors in Denmark over the course of a year. Possible risk factors for tumour-positive margins, including patient, tumour, and specimen characteristics, were secondarily examined.

MATERIALS AND METHODS

Study design, data source, and review board approval

The study was a cross-sectional analysis of data from the Danish Pathology Data Bank (*Patobank*) originating from the period 1 January 2022–31 December 2022. The database contains detailed, nationwide records of all pathology specimens analysed across Denmark irrespective of primary, secondary, or tertiary provider origin. Data from Patobank is of high quality and completeness, offering detailed information on histopathological specimens (12). Demographic data registered in the database include patients' personal identification numbers (civil registration number [CPR]), age, and sex. Data related to BCC excisions include a unique record ID, ICD-10 codes, histopathological diagnoses, tumour subtypes, anatomic locations, procedure codes, and free text macro- and microscopic specimen descriptions including dimensions.

Ethical approval

The study was approved by the governing body of data privacy protection, Research Law, Capital Region of Denmark, with approval number p-2023-14865 and by the governing body of medical records access, Team for Records Data, Science Ethics and Research Support, Capital Region of Denmark, with approval number R-23059658. According to Danish legislation, register-based studies are not required to gain acceptance by the national ethics committee. The study was performed in accordance with the Declaration of Helsinki.

Data retrieval and variable definitions

Described in detail in Appendix S1, data were retrieved by applying the Danish version of the Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT) in a combined search string (13). Extracted anatomic locations were aggregated into the following groups: corners of the eye, eyelids, and periorbital areas were categorized as periorbital areas; cheeks, mandibular borders, and preauricular areas as the cheek; and neck and throat as the neck. Data on histopathological BCC subtype were extracted first according to the SNOMED CT, or, if unavailable, from free text derived from macro- and microscopic specimen descriptions. Data cleaning was completed using a set of algorithms described in detail in Appendix S1, and Tables SI and SII. For specimens where a combination of two or more histopathological subtypes was described, the most aggressive subtype was noted in the following descending order: basosquamous, morpheaform, infiltrative, micronodular, nodular, or superficial.

Specimen resection size, based on the largest noted specimen dimension in mm, was only available as free text in the macroscopic description of pathology records and was extracted using text search algorithms. To minimise the impact of erroneous records, all conspicuously large specimen sizes (50–499 mm) were manually reviewed and removed if obvious errors were identified. Due to the high likelihood of error for specimen sizes >500 mm, these records were altered to "not available" regarding specimen size. The cutoff was chosen based on feasibility considerations for manual review, rather than specific clinical criteria. Categorization of surgical specimen resection sizes was decided by inspection of frequency distribution diagrams, sample sizes in each category to provide statistical strength, and consensus in the author group. Of note, macroscopic tumour size and surgical margin dimension were not available in Patobank, and thus not included in the analysis. Macroscopic tumour details regarding tumour borders, i.e., if tumours were well demarcated or not, were also not available in the database.

Inclusion and exclusion criteria

The study included all BCCs (SNOMED CT codes M809*xx*) located on the head or neck (codes T015*xx*, T021*xx*-T023*xx*, T21*xxx*, TX*xxxx*, or TY01*xx*-TY06*xx*) performed in primary, secondary, or tertiary healthcare settings irrespective of treatment provider. Excluded from the study were BCCs coded as biopsies, punch biopsies, incisional biopsies, curettages, intraoperative frozen sections, repeat sections, or recurrences (codes P30610, P30613, P3061A, P30626, P32200, P30624, or ÆYYY07) (**Fig. 1**). The study did not assess tumour size, surgical margin dimensions, applications of methods to demarcate the tumour perioperatively (e.g., dermoscopy or intraoperative microscopic margin control), skin closure techniques, possible complications to treatment, or recurrence rate.

Information on the context of excisions, including whether the procedure was intended to be curative or diagnostic, was not available. Regarding surgical specimens, as extremely small sizes carried a high risk of being curettage/biopsy samples that had escaped our

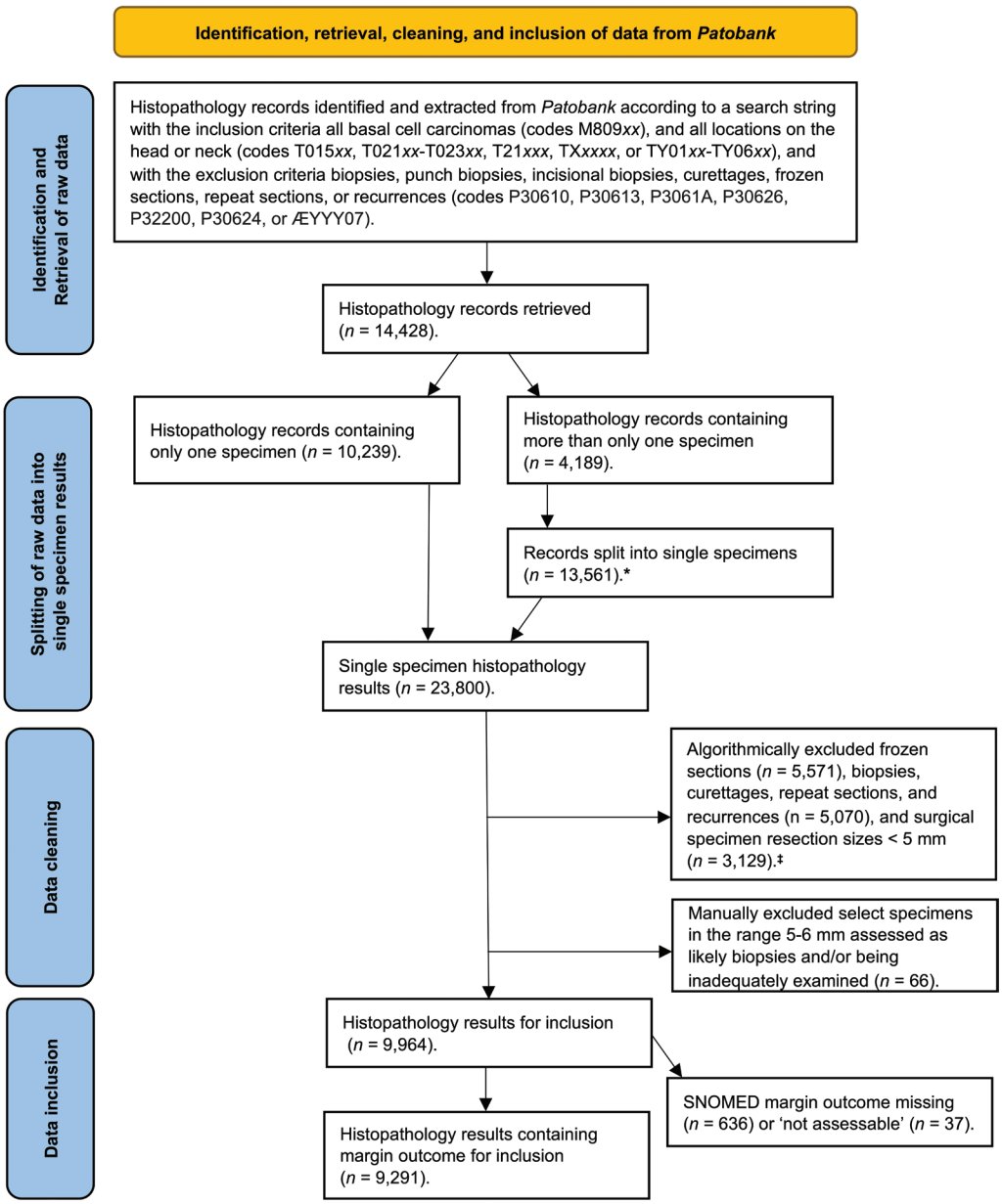

Fig. 1. Data inclusion flowchart. Adapted from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372: n71. https://doi.org/1136/bmj.n71. *One histopathology report can contain descriptions of several specimens (e.g., when a clinician surgically excises a tumour and performs a biopsy on another tumour on the same patient in 1 setting). Therefore, reports containing more than 1 specimen description had to be split to single specimen results as preparation for further analysis. ‡Similarly, searching for data in *Patobank*, their system outputs any histopathology record fulfilling the inclusion and exclusion criteria, even when a particular specimen description in the report does not meet the criteria. Consequently, after splitting records into single specimen results, another round of filtering for inclusion and/or exclusion criteria had to be carried out.

search filter rather than surgical excisions, we chose to exclude all excisions with sizes <5 mm. Sizes of 5–6 mm were manually reviewed and corrected if obvious errors were identified (Fig. 1).

Study outcomes

The proportion of complete excisions, based on tumour-free margins reported in retrieved pathology records (SNOMED CT *free margins* M09400), was calculated as a percentage (%) of all surgical excisions of head and neck BCCs. Data on remaining excisions comprised records describing tumour-positive margins (*not free margins* M09401) or margin status unavailable (*margins not assessable* M09402).

To evaluate risk factors for tumour-positive margins, uni- and multivariable logistic models incorporated and adjusted for patient, tumour, and specimen variables, including patient age, sex, anatomical tumour localization, histopathologic BCC subtype, and surgical specimen resection size.

Table I. Patient, tumour, and specimen characteristics stratified by tumour subtype

		BCC subtype[a]						
Characteristic*	Total[b]	Superficial	Nodular	Micronodular	Infiltrating	Morpheaform	Basosquamous	Not available
Patient and material								
Number of unique patients	8,378	603	5,942	160	1,142	70	36	376
Percentage of females/males	49.6/50.4	58.2/41.8	49.1/50.9	59.4/40.6	46.8/53.2	47.1/52.9	44.4/55.6	45.2/54.8
Median age at time of surgery in years (IQR)	75.6 (66.9–81.4)	75.2 (65.5–80.1)	75.4 (66.8–81.2)	74.7 (63.7–81.5)	77.1 (69.6–82.8)	76.9 (68.2–82.3)	79.5 (75.3–83.2)	76.8 (69.0–82.2)
Number of excisions (% of total)	9,964	659 (6.6)	6,743 (67.7)	165 (1.7)	1,217 (12.2)	71 (0.7)	36 (0.4)	397 (4.0)
Anatomic location								
Scalp	985 (9.9)	104 (15.8)	678 (10.1)	11 (6.7)	96 (7.9)	8 (11.3)	–	36 (9.1)
Forehead	1,475 (14.8)	113 (17.1)	1,011 (15.0)	29 (17.6)	185 (15.2)	11 (15.5)	–	52 (13.1)
Temples	1,134 (11.4)	93 (14.1)	747 (11.1)	20 (12.1)	155 (12.7)	8 (11.3)	–	58 (14.6)
Postauricular areas	288 (2.9)	13 (2.0)	198 (2.9)	–	35 (2.9)	–	–	20 (5.0)
Ears	820 (8.2)	26 (3.9)	476 (7.1)	–	186 (15.3)	17 (23.9)	6 (16.7)	42 (10.6)
Periorbital areas	659 (6.6)	22 (3.3)	423 (6.3)	14 (8.5)	52 (4.3)	–	–	23 (5.8)
Nose	1,207 (12.1)	59 (9.0)	824 (12.2)	17 (10.3)	134 (11.0)	5 (7.0)	6 (16.7)	44 (11.1)
Cheeks	1,712 (17.2)	104 (15.8)	1,201 (17.8)	26 (15.8)	214 (17.6)	9 (12.7)	5 (13.9)	65 (16.4)
Lips	310 (3.1)	14 (2.1)	232 (3.4)	8 (4.8)	30 (2.5)	–	–	–
Chin	177 (1.8)	8 (1.2)	129 (1.9)	8 (4.8)	14 (1.2)	0 (0.0)	–	–
Neck	753 (7.6)	88 (13.4)	512 (7.6)	13 (7.9)	69 (5.7)	5 (7.0)	–	26 (6.5)
Other facial areas	444 (4.5)	15 (2.3)	312 (4.6)	11 (6.7)	47 (3.9)	–	–	22 (5.5)
Surgical specimen resection size								
> 3.5 cm	543 (5.4)	50 (7.6)	324 (4.8)	–	94 (7.7)	–	5 (13.9)	30 (7.6)
2.5–3.5 cm	1,657 (16.6)	95 (14.4)	1,074 (15.9)	28 (17.0)	288 (23.7)	21 (29.6)	9 (25.0)	81 (20.4)
1.5–2.5 cm	4,278 (42.9)	297 (45.1)	2,950 (43.7)	72 (43.6)	547 (44.9)	32 (45.1)	16 (44.4)	169 (42.6)
0.5–1.5 cm	3,325 (33.4)	210 (31.9)	2,290 (34.0)	56 (33.9)	266 (21.9)	9 (12.7)	6 (16.7)	110 (27.7)
Not available	161 (1.6)	7 (1.1)	105 (1.6)	–	22 (1.8)	–	0 (0.0)	7 (1.8)

*All entries are of the format "*n* (percentage of number of excisions)" unless otherwise stated. Fields with "–" are omitted for privacy reasons due to $n < 5$ or distinguishable *n*.
[a]$n = 673$ tumours ($n = 637$ patients) are not counted in subtypes due to missing or not assessable margin outcome. BCC–SCC mixed tumours not shown due to $n < 5$.
[b]The total column summarizes all specimens included from the population, whereas the subtype columns count only specimens included for analysis.
IQR: interquartile range.

Statistics

Categorical values are presented as a frequency with proportions, while age is presented as medians and interquartile ranges (IQR). Complete excision proportions with 95% CIs are calculated using an asymptotic normal approximation. The odds ratios (ORs) and adjusted ORs were obtained through uni- and multivariable logistic regression, respectively, using the *statsmodel* package version 0.14.1 in Python utilizing the Newton-Raphson method. Data cleaning and statistics were performed in Python version 3.7.4. (Python Software Foundation; https://www.python.org/).

RESULTS

Patient and tumour characteristics

A total of 9,964 BCCs of the head and neck treated with simple excision were included. At time of surgery, median patient age was 76 years with a female:male ratio of 1:1 in 8,378 unique patients. Information on surgical margin status was unavailable for 673 excisions (6.75%), prompting exclusion from subsequent analysis (**Table I**).

In the remaining 9,291 excisions, nodular BCC (nBCC) was the most common histopathological subtype (67.7%), followed by infiltrating (12.2%), superficial (6.6%), unknown (4.0%), micronodular (1.7%), morpheaform (0.7%), or basosquamous (0.4%). Due to the small sample of mixed BCC–SCCs, this histopathological subtype was omitted from further analysis. Based on anatomic location, tumours located on the cheek, forehead, nose, or temple accounted for more than half of included BCCs, with the remainder located on the scalp, ears, neck, periorbital areas, "other facial areas", lips, postauricular areas, and chin. Surgical specimen resection sizes of 1.5–2.5 cm were the most frequent (42.9%), while >3.5 cm were rare (5.4%) (Table I). Included surgical specimen resection sizes ranged from 0.5 cm to 5.04 cm (99th percentile).

Margin status following simple excision

Tumour-free margins were recorded in 7,436 out of 9,291 pathology reports, yielding a complete excision proportion of 80.0% (95% CI 79.2–80.8%) (**Table II**). Stratifying according to histopathologic subtypes, morpheaform BCCs had the lowest proportion of free margins at 60.6% (95% CI 49.2–71.9%), while basosquamous and nodular BCCs had the highest at 86.1% (95% CI 74.8–97.4%) and 83.6% (95% CI 82.7–84.5%), respectively. Tumour-free margin proportions were thus observed in the following increasing order: morpheaform, micronodular, infiltrating, superficial, nodular, and basosquamous (Table II).

Risk factors for tumour-positive margins

Presented in **Fig. 2**, patient, specimen, and tumour factors were linked to increased odds of tumour-positive surgical margins in the univariable and multivariable analyses. Regarding patient characteristics, increasing

Table II. Excisions and margin status stratified by tumour subtype

BCC subtype	Number of excisions with free margins, *n*	Total number of Excisions, *n*	Proportion of complete excisions, %	95% CI
Overall	7,436	9,291	80.0	79.2–80.8%
Superficial	497	659	75.4	72.1–78.7%
Nodular	5,635	6,743	83.6	82.7–84.5%
Micronodular	106	165	64.2	56.9–71.6%
Infiltrating	820	1,217	67.4	64.7–70.0%
Morpheaform	43	71	60.6	49.2–71.9%
Basosquamous	31	36	86.1	74.8–97.4%
Not available	304	397	76.6	72.4–80.7%

BCC: basal cell carcinoma.

age was weakly associated with a minimally increased multivariable odds ratio (mOR) for positive margins (for every 1-year increase: mOR 1.02; 95% CI 1.01–1.02), while no significant differences was detected between the sexes (Fig. 2).

Stratifying by histopathological subtype, superficial, infiltrating, micronodular, and morpheaform BCCs were associated with significantly increased mORs for positive margins as compared twith nBCCs, with the highest mOR detected for morpheaform tumours (mOR 4.10; 95% CI 2.49–6.75) (Fig. 2). Overall, high-risk histopathologic subtypes were associated with 2.4-fold higher odds of tumour-positive margins vs nBCCs (mOR 2.42; 95% CI 2.13–2.75). More specifically, morpheaform and

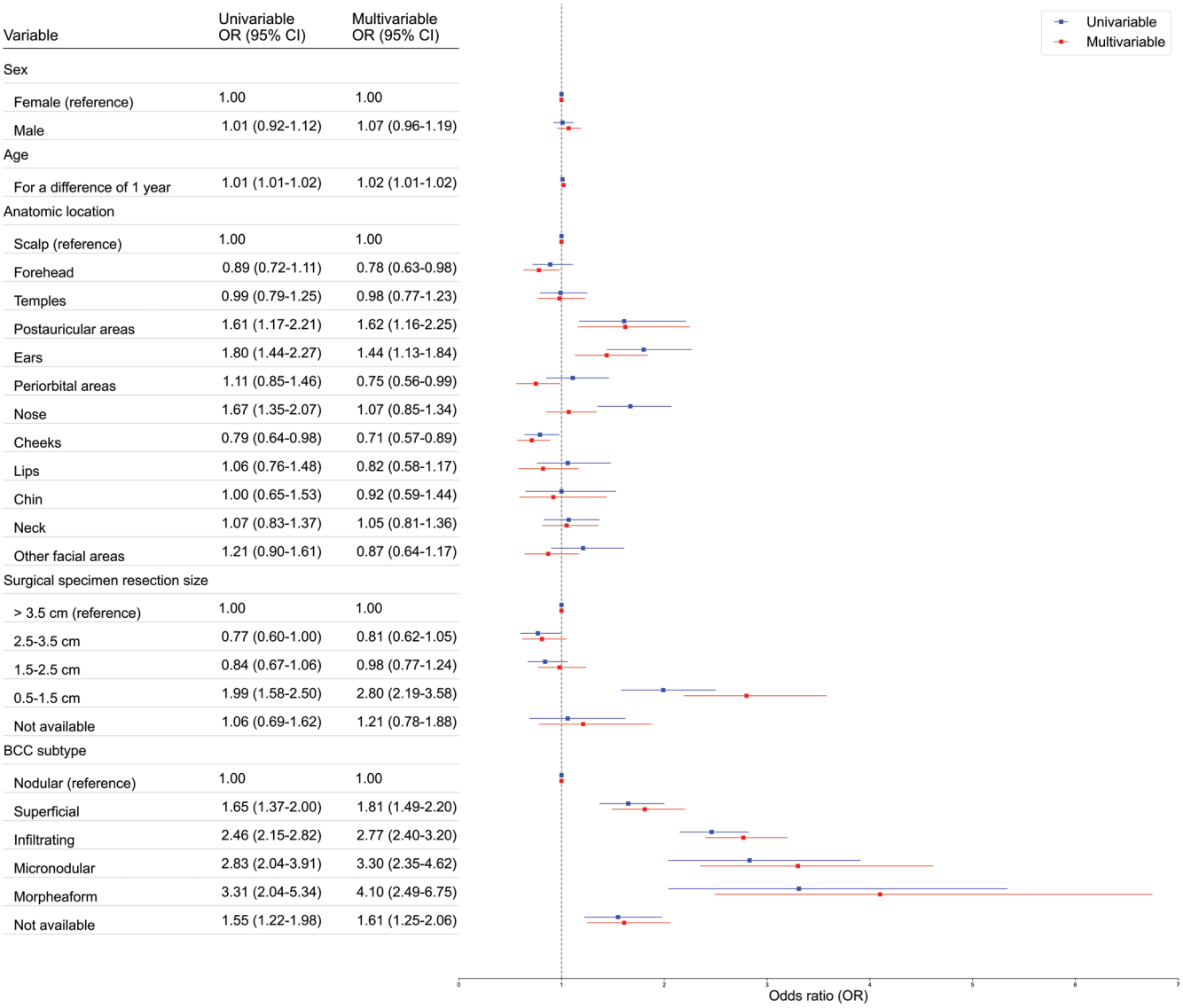

Fig. 2. Uni- and multivariable odds ratios (ORs) of tumour-positive margins based on patient, specimen, and tumour characteristics. ORs are presented in numerically increasing order followed by not available (N/A) for sex, surgical specimen resection size, and subtype, while ORs for anatomic location are presented in topographic cranial to caudal order, followed by "Other facial areas".

micronodular BCCs carried a greater than 4- and 3-fold higher odds of positive margins compared with nBCCs, respectively. Superficial BCCs (sBCC) also had 81% higher odds of tumour-positive margins vs nBCC.

Based on anatomic location and using the scalp as a reference, BCCs located on the ears and postauricular areas had significantly increased mOR for positive surgical margins (mOR 1.44; 95% CI 1.13–1.84, and mOR 1.62; 95% CI 1.16–2.25). In univariable analysis, BCCs on the nose were also associated with a significantly increased OR for positive margins (OR 1.67; CI 1.35–2.07), but the association disappeared upon multivariable analysis (mOR 1.07; 95% CI 0.85–1.34). Conversely, tumours located on the periorbital area and cheek were associated with significantly lower mORs (mOR 0.75; 95% CI 0.56–0.99, and mOR 0.71; 95% CI 0.57–0.89) (Fig. 2).

Regarding surgical specimen resection size, small specimens < 1.5 cm were associated with the highest mOR for positive margins (mOR 2.80; 95% CI 2.19–3.58) using specimens > 3.5 cm as reference. Indeed, all specimen categories > 1.5 cm displayed lower mORs for positive margins compared with specimens < 1.5 cm in size (Fig. 2).

DISCUSSION

In one of the largest samples to date, this nationwide cross-sectional study assessed 9,291 head and neck BCC excisions from every level of the Danish healthcare sector throughout 2022 (14). Tumour-free margins were achieved in 80.0% of simple excisions, with notable variation in tumour-positive margins depending on histopathological BCC subtype, anatomic location, surgical specimen resection size, and age. High-risk histopathological subtypes, which represented 15% of included excisions, were associated with an over 2-fold higher odds of tumour-positive margins compared with nBCCs. Tumours on or behind the ears were similarly associated with 44–62% higher odds of positive margins vs scalp tumours. Small surgical specimen size < 1.5 cm was also associated with an elevated risk of positive margins. In sum, this study provides insight into the factors that impact margin status, an important surgical outcome for simple excisions of BCCs (14).

Generally, in BCC excision, the goal is complete tumour removal with free surgical margins, preserved function, and an acceptable aesthetic outcome. Minimizing morbidity may in some instances be more appropriate than a zero-tolerance for recurrence. A current British guideline suggests aiming for a ≥95% excision rate with free margins, while other European and American guidelines do not provide explicit targets (8, 15, 16). Our proportion of 80% falls short of the ≥95% target which, at face value, signals a need for more regular assessment of treatment outcomes. However, this study did not address the context of these excisions. Whether surgeries were intended to be curative, diagnostic, or palliative, was not known. Further, we analysed excisions irrespective of medical setting, ranging from general practices to tertiary centres. A Swedish study found that between 15.9% and 37.0% of high-risk BCCs of the head were incompletely excised (17).

Variable margin outcomes are reported in larger studies in the literature (**Table III**). Assessing all healthcare settings including primary, secondary, and tertiary sectors, Cho et al. reported free margins in 84.0% of 2,202 excisions of scalp BCCs (18). In a secondary sector study, a 78.0% free margin proportion was reported in 1,570 head and neck BCCs (19). Including 3,309 head and neck BCCs excised in a tertiary sector plastic surgery setting, an 84.2% free-margin proportion was noted, while an 86.9% proportion was reported for 2,092 BCC excised in a dermatology setting (20, 21). Other tertiary plastic surgery studies found considerably higher complete proportions up to 96.5% (Table III) (22). These studies are, however, heterogeneous and include different patient populations. Making direct comparisons between them is challenging.

The relationship between margin status and histopathological BCC subtype in our study corresponds with well-established evidence; high-risk histopathologic subtypes (including micronodular, infiltrative, and morpheaform BCCs) were significantly associated with incomplete tumour excision (18, 23, 24). Although superficial BCCs are considered low risk histopathologically,

Table 3. Comparison of margin status with other studies

Author	Year	Tumours, *n*	Proportion of complete excisions, %	Setting	Risk of bias
Betti et al. (21)	2012	2,092	86.0	Dermatology, tertiary	Moderate
Cho et al. (18)	2016	2,202*	84.0	All sectors	Moderate
Codazzi et al. (20)	2014	3,309	84.2	Plastic surgery, tertiary	Low
Gualdi et al. (30)	2015	2,845	92.9	Dermatology, tertiary	Moderate
Hansen et al. (31)	2009	2,872	90.2	General practitioners (GPs) with a special interest, secondary	Low
Kyrgidis et al. (32)	2010	1,480	90.8	Maxillofacial surgery, tertiary	Low
Malik et al. (23)	2010	1,589	84.6	Plastic surgery, tertiary	Low
Ramdas et. Al. (19)	2018	1,570	78.0	GPs, dermatology, plastic surgery, secondary	Low
Shahshahani et al. (24)	2011	1,394	87.7	Dermatology, tertiary	Moderate
Sherry et al. (22)	2010	2,500	96.5	Plastic surgery, tertiary	Moderate

Table developed with permission and background data from Nolan GS, Kiely AL, Totty JP, Wormald JCR, Wade RG, Arbyn M, et al. Incomplete surgical excision of keratinocyte skin cancers: a systematic review and meta-analysis. Br J Dermatol 2021; 184: 1033–1044. https://doi.org/10.1111/bjd.19660. *Study included only scalp BCCs.

these tumours were also found to carry a significantly greater odds of positive margins compared with nBCCs in our study. This may reflect the greater challenge of delineating sBCCs as compared with nBCCs (25). Additionally, surgically excised sBCCs may belong to a clinically select subset of BCCs.

Certain anatomical locations, such as central areas of the face, are well-known risk factors for positive surgical margins (20). Subclinical spread has been linked to positive margin rates (26). Interestingly, we identified the nose to be a significant risk factor in the univariable analysis, while the association disappeared when adjusting for specimen size, histopathologic subtype, sex, and age. It may be interpreted that this possibly reflects the tendency for excisions in sensitive areas like the nose to have narrower margins due to limited tissue, as previously reported (22).

The inverse association between specimen size and incomplete excision was unexpected. The finding may reflect confounding, as surgical margin data, a crucial variable, was unavailable. Small specimens may indicate narrower margins. Consistent with this, Ramdas et al. found that specimen sizes ≤2 cm were linked to higher positive margin risk. Small specimen sizes may also result from limitations in surgical fields near vital facial structures. Contributing to the higher risk, small BCCs might be more difficult to clinically demarcate especially after biopsy or scar formation (19). Codazzi et al. recorded actual tumour sizes, noting that lesions <0.5 cm were most associated with positive margins (20). Conversely, two studies of a total of over 2,000 head and neck BCCs found large tumour size to be a risk factor for positive margins (24, 25). Taken together, these studies seem to support that all facial BCCs should be considered high risk irrespective of size, as proposed by the National Comprehensive Cancer Network (NCCN) (27). The European Association of Dermato-Oncology (EADO) recommends wide surgical margins >5 mm or micrographically controlled surgery for (*i*) nBCCs located on critical areas defined as the central face, eyelids, eyebrows, nose, lips, chin, ear, or periauricular areas; (*ii*) tumours with poorly defined margins or perineural invasion, and (*iii*) aggressive subtypes (8). Our findings imply that intraoperative margin-controlled surgery could be considered more often for high-risk BCC tumours of the head and neck.

This study has several weaknesses, including the data processing necessary to arrive at a final dataset. Some data disruption was unavoidable, e.g., biopsies erroneously registered as excisions. While excisions coded as recurrences were excluded, it is conceivable that a subset remained in our sample due to inadequate registry (28). Due to the large size and range of variables in the source data, we aggregated related variables, potentially overlooking discrete nuances on anatomic location. Most importantly, our study did not include two factors significantly associated with margin status: (*i*) clinical tumour size and (*ii*) surgical excision margin. Surgical excision margin is possibly the most significant independent factor ensuring complete tumour removal (8). Finally, we did not evaluate margin status's effect on actual recurrence rate.

For simple excision, margin assessment is performed using 2D vertical sections of a portion of the specimen (in contrast to examination of the horizontal planes of the specimen and visualization of the whole tumour margin during 3D micrographically controlled surgery). As such, a segment of surgical excisions here deemed to have tumour-free margins could still recur up to a decade later (29). Finally, because our study combined data from all healthcare sectors, generalizability of our results is limited, and our outcomes may be poor reflections of those achieved in specific settings.

The main strength of this study was its population-based and large dataset of almost 10,000 excisions. Data were drawn directly from a national histopathology database with a high degree of completeness, providing records from primary-to-tertiary sectors, as well as public and private services in the Danish universal healthcare system. Extracting data from prospectively recorded patient data instead of, for example, via audit, minimised recall and selection bias. The study thus offers a look into real-world outcomes for a surgical treatment for head and neck BCC across multiple sectors, useful in guiding clinical decision-making regarding treatment.

Conclusion

Surgical excision of primary head and neck BCCs is associated with notable variation in tumour-positive margins depending on patient, tumour, and specimen characteristics. Minimizing recurrence and optimizing use of resources are important in BCC treatment. A heightened awareness of the risk of positive surgical margins following simple excision is needed for especially high-risk and superficial histopathologic subtypes, auricular, postauricular, and nasal locations, and small specimen resection sizes.

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Data availability statement: Due to the nature of the research collecting data from a patient registry, Danish health legislation does not provide support for sharing data.

Ethics statement: The study was approved by the governing body of data privacy protection, Research Law, Capital Region of Denmark with approval number p-2023-14865, and by the governing body of medical records access, Team for Records Data, Science Ethics, and Research Support, Capital Region of Denmark, with approval number R-23059658. According to Danish legislations, register-based studies are not required to gain acceptance by the national ethics committee. The study was performed in accordance with the Declaration of Helsinki.

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