Mohs micrographic surgery allows for complete microscopic examination of the surgical margin when treating aggressive and recurrent facial basal cell carcinomas. This leads to the highest cure rates and maximal preservation of healthy tissue. The 5-year recurrence rates of 587 aggressive and/or recurrent facial basal cell carcinomas treated during 1993 to 2003 at our centre were studied retrospectively. The resulting 5-year recurrence rates using Kaplan–Meier survival analysis were 2.1% for primary (previously untreated) tumours, 5.2% for recurrent basal cell carcinomas and 3.3% overall. In total, 87.9% of the tumours required at least two stages of Mohs micrographic surgery. The surgical defect’s size after complete excision was, on average, approximately twice the size of the defect after excision of the clinically visible tumour with a 2–3 mm margin. Mohs micrographic surgery is underused in Scandinavia despite being the treatment of choice for aggressive and recurrent basal cell carcinomas. Key words: Mohs micrographic surgery; basal cell carcinoma; recurrence rates; skin cancer; therapy.

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Basal cell carcinomas (BCCs) are by far the most common form of cancer among the Swedish population, with more than 36,500 histopathologically proven cases per year (1). Surgery is generally considered the treatment of choice (2, 3). Even with surgery, there are several tumour characteristics that are associated with higher recurrence rates. These include: tumours located around the eyes, nose, lips and ears; morphoeic, infiltrative, micronodular and basosquamous histopathological subtypes; BCCs with ill-defined margins; recurrent lesions; incompletely excised lesions and perineural or perivascular involvement (3, 4). BCCs with these characteristics are preferably treated with Mohs micrographic surgery (MMS), which allows for complete examination of all tissue margins, minimizing the risk of recurrence and avoiding unnecessary removal of healthy tissue (3, 5).

MMS using the “fresh-tissue technique” (6), a modification of the “chemosurgical” technique originally described by Frederic Mohs in 1941 (7), has been carried out on the above-mentioned indications at the Department of Dermatology, Sahlgrenska University Hospital in Gothenburg, Sweden, since 1983. Until 2009, Gothenburg was the only centre regularly performing MMS in Sweden. We have previously published the results of MMS on 228 aggressive facial BCCs performed during 1983 to 1992 at our hospital. The 5-year recurrence rates (using Kaplan–Meier survival analysis) were 6.5% for primary BCCs and 10% for recurrent BCCs (8).

The aim of the current study was to analyse the 5-year recurrence rates in patients treated with MMS at our department during the period 1993 to 2003 to determine whether these had changed compared with our previous report. A secondary objective was to describe the clinical and histopathological characteristics of the tumours and the outcome of the surgical procedure, which might be associated with recurrence after MMS.

METHODS

The study was conducted at the Department of Dermatology, Sahlgrenska University Hospital in Gothenburg, Sweden. Approval of the study was granted by the local ethics committee, and procedures were carried out in accordance with the ethical standards on human experimentation and the Declaration of Helsinki of 1975, as revised in 1983.

We retrospectively analysed all patients who had undergone MMS at our clinic between 1 January 1993 and 31 December 2003. A description of the surgical technique used at our department (MMS using the “fresh-tissue technique”) has been published previously (8). In summary, the bulk of the tumour may be removed initially by curettage for further delineation and for reducing the number of MMS stages (9). The tumour is then excised with a 2–3 mm margin as a saucer-shaped layer of tissue with a 45° angle at the lateral margins. The specimen is processed in an adjacent laboratory into horizontal sections of frozen tissue that theoretically allow for inspection of 100% of the lateral and deep resection margins. The slides are examined by both a dermatopathologist and the Mohs surgeon to ascertain whether the margins are tumour-free. If residual tumour deposits are noted, the above-mentioned procedure is repeated until complete tumour removal has been achieved. Finally, reconstruction of the surgical defect is carried out by the Mohs surgeon. The whole procedure is generally performed under

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Among the 587 BCCs, 56% were primary ($n = 328$), and 44% were recurrent BCCs ($n = 258$). Data on the primary or recurrent nature of the tumour was not available for one case. Recurrent BCCs had been treated previously with a variety of treatment modalities, sometimes repeatedly, and often in combination (e.g. prior treatment with cryosurgery and surgical excision). Most commonly, patients had undergone one or more failed surgical excision(s) prior to MMS (67.4%). However, destructive or medical modalities (i.e. cryosurgery, curettage and electrodesiccation, radiotherapy, photodynamic therapy and/or laser ablation) had led to recurrence in 20.2% of the patients. The mean number of previously tested methods was 1.58 (95% confidence interval (CI), 1.46–1.70), with a number of failed treatments ranging from 1 to 8. Data regarding the histopathological subtype of BCC was available for 457 BCCs. Among these, 84.2% were morphoeic or infiltrative (aggressive subtypes) and the rest were nodular or superficial (non-aggressive subtypes). The nose was the most common location of the tumours included in the study (42.6%). Fig. 1 shows the anatomical distribution of the lesions.

The clinical and histopathological characteristics of the tumours and their surgical outcome are shown in Table I. Overall, the mean number of MMS stages carried out to obtain histopathological clearance of the lesions was 2.39 (95% CI, 2.32–2.47). In total, 77.2% of the BCCs were eradicated in 2–3 stages and only 12.1% were completely removed in a single stage (Fig. 2). The median area of the initial surgical defect was 1.98 cm$^2$ (range 0.19–53.4 cm$^2$). Meanwhile, the median area of the final defect after complete removal of the tumours was 3.90 cm$^2$ (range 0.19–53.4 cm$^2$), approximately twice the initial size (Table I). When reconstructing the surgical defects, primary closure was used in 95 cases (16.2%), grafts were carried out in 239 tumours (40.7%), flaps were performed in 171 BCCs (29.1%), secondary intention healed 38 wounds (6.5%) and 39 patients were managed using combinations of these techniques (6.6%). The remaining five patients (0.9%) were referred to other specialists for surgical reconstruction.

Data regarding follow-up was available for 486 BCCs (306 primary BCCs, 179 recurrent BCCs and 1 unknown) in 457 patients (82.8% of all cases). The median follow-up for these patients was 5 years (range 0.5–11.5 years).

**RESULTS**

Among the 587 BCCs, 56% were primary ($n = 328$) and 44% were recurrent BCCs ($n = 258$). Data on the primary or recurrent nature of the tumour was not available for one case. Recurrent BCCs had been treated previously with a variety of treatment modalities, sometimes repeatedly, and often in combination (e.g. prior treatment with cryosurgery and surgical excision). Most commonly, patients had undergone one or more failed surgical excision(s) prior to MMS (67.4%). However, destructive or medical modalities (i.e. cryosurgery, curettage and electrodesiccation, radiotherapy, photodynamic therapy and/or laser ablation) had led to recurrence in 20.2% of the patients. The mean number of previously tested methods was 1.58 (95% confidence interval (CI), 1.46–1.70), with a number of failed treatments ranging from 1 to 8. Data regarding the histopathological subtype of BCC was available for 457 BCCs. Among these, 84.2% were morphoeic or infiltrative (aggressive subtypes) and the rest were nodular or superficial (non-aggressive subtypes). The nose was the most common location of the tumours included in the study (42.6%). Fig. 1 shows the anatomical distribution of the lesions.

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**Fig. 1.** Anatomical distribution of the 587 basal cell carcinomas. Each rhomb corresponds to a single lesion. The placement of each rhomb is approximate. Data not available (NA) for 3 lesions.
Clinic follow-up was carried out for at least 5 years in 289 cases (59.5%). Follow-up was shorter in some cases due to the patients choosing to conclude follow-up visits at an earlier stage, change of residence, concomitant diseases or death. No deaths could be attributed to the treated tumours or to the surgical procedures. Follow-up information for the remaining 22 primary and 79 recurrent BCCs (101 BCCs in 98 patients) was unfortunately not available. Most of these cases (91 BCCs) were patients who lived outside of the Gothenburg region and were therefore followed by their referring physician instead.

During follow-up, 16 recurrences were observed among the 486 BCCs that were followed at our department after MMS (Table II). Six of these BCCs were registered as primary and 10 were recurrent BCCs. In the great majority of these 16 cases, 2 or more MMS stages were needed (87.5%). Recurrences were generally observed within the first 3 years (81.2%), although one recurrence was noted as late as 7 years after MMS. The Kaplan–Meier model yielded 5-year recurrence rates of 2.1% for primary BCCs (95% CI 0.4–3.8%) and 5.2% for recurrent BCCs (95% CI 1.6–8.7%), as shown in Fig. 3. The overall 5-year recurrence rate was 3.3% (95% CI 1.6–5.0%), as presented in Fig. 4.

Exact (permutation form) logrank tests showed no statistically significant correlations between recurrences after MMS and primary vs. recurrent BCC, histopathological subtype, number of MMS stages and size of the postoperative skin defect. Nevertheless, there was a trend towards higher risk of recurrence after MMS when treating recurrent BCCs ($p = 0.06$), morphoeic BCCs ($p = 0.14$) and in tumours demanding > 4 MMS stages ($p = 0.17$).

DISCUSSION

The use of MMS in our department during this 11-year period resulted in 5-year recurrence rates of 2.1% for primary BCCs and 5.2% for recurrent BCCs, with an overall recurrence rate of 3.3%. At first glance, we appear to have improved on our previous results from 1983 to 1992, in which the rates for primary and recurrent BCCs were 6.5% and 10%, respectively (8). Even though these results are not completely comparable, the surgical procedure and the indications for MMS remained the same during both periods. Also, the pro-

![Fig. 2. Number of stages required per tumour.](image)

![Fig. 3. Kaplan–Meier estimate for primary vs. recurrent basal cell carcinomas.](image)
Recurrent BCCs, histopathologically aggressive BCCs, >4 stages of MMS and large size of the skin defect (>4 cm in diameter) have previously been found to have predictive value for recurrence after MMS (11). Although our study did not show statistical significance for any predictors of recurrence, morpheaform BCCs, recurrent BCCs and a large number of MMS stages may have some relevance in this context. Until further studies show clearer results in recurrence prediction, all patients treated with MMS should be recommended a follow-up of 5 or more years. The importance of clinical follow-up should be emphasized even more for those patients treated for recurrent BCCs. Currently, we check our MMS patients at 1, 3 and 5 years postoperatively, with extra visits planned if the patient suspects a recurrence or new lesions.

MMS is globally recognized as the treatment of choice for high-risk BCCs due to its lower recurrence rates and tissue-sparing benefits (3, 5). In the USA, the 5-year recurrence rate for primary BCCs after MMS is as low as 1.0%, in comparison with other modalities, such as: surgical excision, 10.1%; cryosurgery, 7.5%; curettage and electrodesiccation, 7.7%; and radiotherapy, 8.7% (13). The corresponding rates for recurrent BCCs are: MMS, 5.6%; surgical excision, 17.4%; cryosurgery, 13.0% (followed up for <5 years); curettage and electrodesiccation, 40.0%; and radiation therapy, 9.8% (14).

Only one randomized controlled study has been carried out comparing MMS with surgical excision (15). After a 5-year follow-up, MMS achieved statistically significant lower recurrence rates than surgical excision for recurrent BCCs. The recurrence rates for primary BCCs were also lower in the MMS patients, but statistical significance was not reached (16). However, this study has been criticized, since several patients with positive margins after the first or second surgical excision were subsequently treated with MMS, but analysed as belonging to the surgical excision group, constituting a rescue bias. Furthermore, randomization unfortunately led to more histopathologically aggressive BCCs among the patients treated with MMS (17). Finally, 50% of the tumours included in their study were of a non-aggressive subtype, which could also have benefitted the results of surgical excision. In our study, 11 of the 12 recurrences in which the histopathological subtype of BCC was known, occurred in patients with BCCs of the morpheaform subtype. This highlights the relevance of including more or less BCCs with an aggressive histopathological subtype in MMS studies.

Regarding the tissue-sparing benefits of MMS, Smeets et al. (15) showed that surgical excision caused significantly larger defects than MMS for primary and recurrent BCCs needing more than one surgical excision or at least two stages of MMS for complete tumour removal. Moreover, a randomized controlled study showed significantly larger defects after surgical excision of nodular BCCs compared with those obtained after MMS. In this study,
a 4 mm margin was applied during surgical excision to guarantee 95% clearance rates, whereas a 2 mm margin was used for the initial stage during MMS (18). Nevertheless, the size of the surgical defect can be affected by the anatomical site of the tumour or diathermy used during surgery and is therefore not always equivalent to the actual size of the tumour (19).

We should not underestimate the value of physician continuity that can be obtained with MMS. Patients who undergo surgical excision of an aggressive BCC instead of MMS can end up needing to see several physicians in the process of making a correct diagnosis, excising the lesion, reconstructing the defect and ruling out a recurrence postoperatively. In the case of MMS, the Mohs surgeon follows the patient from beginning to end. In fact, less than 1% of our patients required referral to another surgeon for reconstruction.

In Scandinavia, MMS for the aforementioned indications is underused. During the study period (1993 to 2003), Gothenburg was the only active MMS centre in Scandinavia. Our resources for MMS are currently insufficient and limited to approximately 70 cases per year. The most common issue hindering the more extensive use of MMS in Sweden is the opinion that the procedure is time-consuming and expensive.

Several attempts have been made to study the cost-effectiveness of MMS in comparison with surgical excision, rendering disparate results depending on the country’s reimbursement systems, the indications applied and the clinical settings of the procedure (16, 20–23). Given the difficulty in interpreting these studies and the fact that cost-effectiveness studies that apply to Scandinavian healthcare systems are lacking; it is our viewpoint that cost-effectiveness studies that apply to Scandinavian country’s reimbursement systems, the indications applied for MMS should be offered to all patients with aggressive and recurrent facial BCCs in which preservation of aesthetics and function is important, regardless of their place of residence or their socioeconomic background. Thus, we conclude that our indications for MMS (aggressive, ill-defined, recurrent or incompletely excised BCCs located in the “H-zone”) should be maintained.

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