Background: Treatment of nonmelanoma cutaneous carcinoma with Mohs micrographic surgery (MMS) is a well-recognized therapy. However, there are infrequent times when MMS must be aborted before achieving adequately clear margins. Reasons cited by those who have aborted MMS include patient discomfort and/or concern regarding damage to deeper structures.

Methods: A retrospective cohort was created consisting of patients who were referred for reconstructive procedures following MMS during a 4-year period. Patients who experienced aborted MMS were identified from this cohort, and a chart review performed.

Results: The overall occurrence of aborted MMS in the community was significantly less than 1% with a cumulative frequency in this particular cohort of 1.7%. Approximately one-third of patients had persistent tumor on subsequent treatment, and approximately 14% required multiple excisional procedures to clear tumor. Risk factors for experiencing aborted MMS include histology of dermatofibroma sarcoma protuberans, multiple excisional procedures to clear tumor. Reasons cited by those who have aborted MMS are infrequent times when MMS must be aborted before achieving adequately clear margins. Tumor easily invades structures which MMS cannot physically clear and/or the tumor volume is too great to allow the patient to comfortably tolerate the procedure under local anesthesia.

Conclusions: Preoperative identification of patients at risk for aborted MMS would allow for direct referral using surgical excision, hence decreasing anxiety, morbidity, and cost. A treatment algorithm is proposed for patients who experience aborted MMS.

Key Words: Mohs micrographic surgery, failure, nonmelanoma cutaneous carcinoma

Mohs micrographic surgery (MMS) is one of several recognized treatments for nonmelanoma cutaneous carcinoma. Cited cure rates are above 95% for both basal cell and squamous cell carcinomas.1–3 MMS as modified by Tromovitch and Stegman,4 involves sharp excision of all visible tumor in saucer-like layers while simultaneously mapping the exact size and shape of the lesion under local anesthesia; only tumor is removed in this manner. This technique therefore limits removal of normal tissue, keeping the defect size to a minimum.

Popularity of MMS has increased because of its ability to conserve tissue. Indications for MMS include the following: tumors in sites with a relatively high recurrence rate (paranasal, periorbital); tumors with poorly delineated clinical borders or arising from scar; morpheaform (sclerosing) basal cell carcinoma; tumors in critical locations such as the eyelid where tissue conservation is paramount; tumors with perineural invasion; and recurrent neoplasms.5 Although there are no strict contraindications for MMS, there is concern that it may be over used for simple lesions.6 Moreover, the actual amount of tissue conserved may not be standardized.7

Nevertheless, there exist infrequent cases that MMS proves unable to adequately attain tumor-free margins. This scenario arises when (1) the tumor invades structures which MMS cannot physically clear and/or (2) the tumor volume is too great to allow the patient to comfortably tolerate the procedure under local anesthesia. These infrequent instances where MMS is abandoned prior to complete oncologic resection are known as aborted procedures. No published data exist documenting the management or frequency of this event.

Physicians who routinely perform MMS should ideally identify those patients at risk for failure, and in lieu of proceeding, generate a direct referral for surgical resection. For example, fixed cutaneous tumor to bone indicates that deep margins will not be cleared by MMS. Preoperative facial nerve dysfunction is another sign suggestive of deep structural involvement making MMS potentially inappropriate. Large tumor volume, leading to difficulty in attaining prolonged analgesia, is yet another indication that a patient is at risk for aborted MMS. In all of these settings, the overall utility of MMS should be questioned.

Unfortunately, there are indeed those infrequent and unexpected instances when a physician performing MMS is truly surprised by the tumor volume and is forced to abort the procedure. These cases warrant further characterization to identify possible risk factors, hence decreasing patient anxiety, morbidity, and cost.

MATERIALS AND METHODS

All MMS reconstruction cases referred to a private, solo practice in a suburban setting were reviewed during a 4-year period from January 1, 2005 to December 31, 2008. Cases were gleaned from a patient database by scanning International Classification of Diseases Ninth Revision Clinical Modification definitions for cutaneous neoplasms. Only those cases who underwent surgical reconstruction following MMS were selected for review. There were 6 referring dermatologists performing MMS in the database. Among the cohort of cases, only those patients who were aborted underwent chart review.

Follow-up data after surgery were obtained. Telephone interviews were performed between patients and referring dermatologists for those patients whose local disease status was not known by January 1, 2010.

Algorithm for Managing Aborted MMS

Foremost, discussion must occur between the responsible surgeon and the MMS dermatologist to ascertain specifically where tumor burden persists and why complete tumor clearance was not achieved. The region with persistent tumor must be given sufficient oncologic attention. Radiologic imaging is performed when indicated. Reassessing positive margins with only frozen section runs the risk of significant sampling error in a large defect. Tumor easily could be missed in regions located between the frozen section sites. To avoid this potential problem, the protocol followed is to completely excise the positive area in continuity; allowing complete and careful review of permanent specimens by the pathologist. If the

Identifying and Managing Those Patients at Risk for Aborted Mohs Micrographic Surgery

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exact location of persistent tumor is unknown, the entire wound is radically excised and submitted for permanent section. Vital structures (cranial nerve, large vessels, and outer cortex of bone) are sacrificed when located within the ablative field. This is necessary to achieve oncologic clearance.

The en bloc resection is meticulously oriented for careful pathologic review. Sutures can be helpful to indicate the cardinal points, especially superficial and deep margins. Corresponding sutures can also be placed in vivo to aid orientation if the need arises to excise more tissue. Discussion and planning with the pathologist prior to resection is of benefit. Photographic documentation may be helpful. Planning the procedure to allow for expedient analysis of specimen is important. Processing the specimen by the pathologist entails inking all the margins in a 3-dimensional manner. Although MMS processes the pathologic specimen in saucer-like layers, standard surgical pathology performs bread- loafing type cuts. Therefore, maintaining the orientation of the inking is critical. All margins in the 3-dimensional orientation are inspected for persistent microscopic tumor. Specimen is further microscopically inspected within the 3-dimensional margins to assess whether or not there is in fact persistent tumor, and if so, how deep it sits within the excision specimen. If tumor is identified at a resection margin, the orientation of the specimen allows additional site-specific resection in vivo. The process is repeated until complete oncologic clearance is verified. Due to size or location of the defect, sedation or general anesthesia may be required for patient comfort.

Since the process of pathologic review is time consuming, this algorithm generally cannot be used intraoperatively with frozen section; due to the sheer volume of tissue. Therefore, temporizing local wound care is pursued based on the size and location of the defect. Smaller wounds are easily dressed with topical ointments. If the wound is particularly large, modern wound dressings which have both absorbent and have antibacterial properties, make the patient’s task of care much simpler. If the patient is unable to care for the wound, secured bolster is useful. Although the use of negative pressure wound therapy facilitates wound care, because the possibility of residual carcinoma, this is an off-label use.

The risk of missed positive margins is avoided by delaying reconstructive closure. Once tumor clearance is indeed microscopically verified, reconstruction may proceed per routine. In all cases, consideration of postoperative radiation is appropriate. This algorithm is diagrammatically summarized in Figure 1.

RESULTS
A total of 828 plastic surgical reconstructions were referred after greater than 5000 MMS were performed. Of these cases, 14 were aborted. Table 1 summarizes findings of these 14 cases. Histology was mixed as follows: basal cell carcinoma (BCC) (6); dermatofibrosarcoma protubersans (DFSP) (5); squamous cell carcinoma (SCC) (2); and spindle cell sarcoma (1). Seven cases (50%) were aborted because of patient discomfort contrasted to 7 cases (50%) who were aborted due to concern by the dermatologist about risk of damage to underlying structures. Five (36%) of the cases had documented persistent tumor in the region upon subsequent pathologic review. Two cases (14%) each required 2 additional excisions before complete clearing of all neoplasm.

Eight cases (57%) were female and 6 (43%) were male. The average surface area of the defect was 26 cm². Two patients were advised to undergo postoperative radiation therapy after achieving tumor clearance due to the sheer volume of tumor.

No particular referring dermatologist performing MMS predominated in generating these cases. Follow-up from 1 to 5 years was achieved in all patients. There were no instances of recurrent tumor. One patient died of unrelated causes. Several cases are detailed (Figs. 2, 3).

DISCUSSION
Clearly aborted MMS cases are an exceedingly infrequent phenomenon, as there are many cases extirpated and reconstructed successfully by dermatologists without any involvement of oncologic or plastic surgeons whatsoever. The 828 reconstructed cases in this study represent only those cases referred for plastic surgical closure. Nonetheless in this practice, the prevalence of aborted cases is 1.7%. As such, it is indeed an infrequent event. The absolute rate of aborted cases in the community is significantly less than 1% (0.28%) when the total number of patients undergoing MMS is considered.

Interestingly, one-third (36%) of the patients who experienced aborted MMS had persistent positive margins upon permanent

![Diagram](image_url)
microscopic review following subsequent surgical excision. In fact, approximately 14% of the aborted cases required a second excision before obtaining clear margins. This suggests that patients who experience aborted MMS are at true risk of carrying persistent tumor. What about those patients with aborted MMS who did not show persistent tumor following additional surgical resection? Similar to this study, Griffiths shows only half of the specimens he examined with previously positive margins upon re-excision contained persistent tumor. Possible explanations for this discrepancy include tissue damage at the positive margin site by the subsequent surgical manipulation or simply missing the microscopic region of positive tumor on pathologic review. Nevertheless, this discrepancy does not mean that positive margins can be ignored.

Management options for incompletely excised tumor include further tissue resection; tissue resection with postoperative radiation; or radiation therapy alone. There is not enough evidence-based data regarding the best management option. However, studies have confirmed that residual tumor persisting in an incompletely excised neoplasm will recur in greater than half the cases if not addressed. Therefore, it is recommended that further surgical excision is undertaken with successfully clear margins when incomplete tumor removal is recognized. In those cases where the defect is massive, absolute certainty of tumor clearance, despite pathologic review, is not guaranteed. In these situations, radiation therapy should be entertained because of the possibility of microscopic residual tumor.

Although radiation therapy can serve as a primary modality for treatment of cutaneous neoplasm, the risk of fibrosis, ectropion, osteitis, or ulceration is not uncommon. Primary radiation therefore is typically reserved for those patients who are poor surgical candidates. Conversely, radiation is an indicated adjuvant therapy in those cases with positive margins or lymph node metastasis. The use of postoperative radiation therapy in cases with histologic evidence of perineural invasion is controversial, but nevertheless increasing.

Risk Factors for Aborting MMS

Concern Regarding Deeper Structures

Of 14 patients, 7 (50%) experienced aborted MMS due to concern about potential damage to adjacent structures by the dermatologist who performed MMS. Of these 7 patients, 4 were specifically aborted with concern for a cranial nerve. The remaining 3 were terminated with regard to exposure of the calvarium (2) and nasal cartilage (1).
There were various reasons cited for aborting MMS in cases possibly involving a cranial nerve. Two of these patients had defects located in the pretragal region. Although none of these particular cases had true exposure of the parotid gland; the deep subcutaneous fat, superficial to the parotid fascia, was in fact exposed. Nevertheless, this led to questioning of potential injury to the facial nerve by the dermatologist. One patient had a defect at the temple with exposure of the temporalis branch of the facial nerve which ultimately had to be excised. Another patient had a defect which was located on the anterior portion of the sternocleidomastoid muscle, well away from the facial nerve. However, there was concern about potential injury, as a previous parotidectomy had been performed on this ipsilateral side. The final patient had MMS terminated due to fear about the accessory nerve, although the defect was well away from this structure.

Clear understanding of the anatomic course of cranial nerves is critical when performing procedures on the head and neck. When MMS is performed in this region, deep dissection does indeed run the risk of damage to distal branches, or even main trunks, of cranial nerves; particularly the trigeminal (V), facial (VII), and accessory (XI). In those cases where deep structural involvement of a cranial nerve by a cutaneous neoplasm is suspected preoperatively, proper counseling of the patient is required prior to starting MMS. The patient must be instructed about the potential need to sacrifice deeper structures. Aborting MMS with positive margins due to concern about damage to underlying cranial nerves fails to accomplish the primary goal of tumor clearance. It may even lead to unnecessary sacrifice of a cranial nerve if a cuff of tissue is excised to clear tumor via subsequent surgical excision. Arguably, it would be better to identify those cases with potential involvement (or even proximity) of cranial nerves prior to undertaking MMS procedure. These higher risk cases could be considered for primary surgical excision with margin control. Of interest is the fact that despite concerns about potential cranial nerve injury, no patient who underwent aborted MMS actually had a main trunk injured. Thus, these patients underwent fragmented treatment unnecessarily due to inaccurate concern by the dermatologist performing MMS. The importance of knowing the deep surgical anatomy argues for primary surgical treatment in cases when there is significant potential for cranial nerve involvement. Otherwise, there is a possibility of aborting MMS because of anatomic naivety. This adds unnecessarily to health care costs and patient anxiety.

**Patient Discomfort**

The other 7 patients (50%) who experienced aborted MMS procedures were terminated prematurely due to intolerable pain during the procedure. The average surface area of these defects was 34 cm². Because MMS is typically performed under local anesthesia in an office setting by the dermatologist, perhaps there are some larger tumors simply not amenable to adequate analgesia for the duration of the procedure. Of course another etiology which could lead to aborting MMS due to pain is poorly administered local anesthetic. Since inadequate analgesia is easily correctible, ideally this should be an infrequently cited reason for aborting MMS. On the other hand, patients with severe anxiety or low pain threshold should be identified prior to commencing MMS by performing a thorough history and physical examination. These patients would benefit from primary surgical excision with margin control using sedating or general anesthesia. Another option would be having MMS performed in a setting which permits sedating anesthesia; such as an outpatient ambulatory surgical center.

**Dermatofibromasroma Protuberans**

One-third of aborted MMS in this study involve cases with histology of DFSP. Interestingly, this infrequent tumor is disproportionately represented in the current study with 5 cases. In fact, DFSP can be considered a rare tumor, with a frequency of cases between 1 and 5 in a million. Although highly invasive, DFSP is not metastatic. Nevertheless, due to its locally aggressive nature, high recurrence rates remain commonplace. Although there is a large body of literature supporting MMS as the treatment of choice for DFSP, there is also literature demonstrating that large tumors are in fact better managed with primary surgical excision.

Looking closely at those aborted MMS cases with the histology of DFSP in this study, it appears that a large surface area is predictive of failure. The average surface area of the wound defect for the aborted cases with histology of DFSP is 42 cm². This is clearly a large surface area that could easily lead to patient discomfort during the procedure, and hence failure to complete the procedure under local anesthesia alone.

**CONCLUSIONS**

Aborted MMS is indeed an infrequent event. Follow-up of patients who experience aborted MMS and who then undergo further resection until tumor clearance is achieved with/without radiation therapy demonstrates a cure rate no different than that achieved by MMS or frozen section control. Although the low numbers in the study generate little statistical power, the evidence appears to support this treatment algorithm given the absence of tumor recurrence.

Identifying those patients at risk for aborted MMS is the best strategy to avoid unnecessary anxiety, morbidity, and cost. This study shows that those patients with large DFSP; poor pain tolerance; or tumor overlying cranial nerves run the greatest risk of failing MMS (Table 2). Careful planning will better allow coordinated care.

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**REFERENCES**


