Mohs Micrographic Surgery: A Synopsis

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Mohs micrographic surgery is a method for removal of non-melanoma skin cancer in thin layers, allowing frozen-section examination of all peripheral and deep margins. Subsequent tissue layers are removed as dictated by microscopic examination, allowing for maximal sparing of normal tissue. This method offers cure rates significantly higher than excision or other modalities. Mohs micrographic surgery is the method of choice for removal of large, recurrent or incompletely excised skin cancers or for tumors located in regions of high recurrence.

Nationally, it is estimated that more than 500,000 new cases of non-melanoma skin cancer (primarily basal cell carcinoma (BCC) and squamous cell carcinoma (SCC)) are diagnosed each year[1]. With exposure to the sun being the most important risk factor, Hawaii can be expected to have a high incidence rate. Indeed, skin cancer rates on Kauai, observed prospectively for 5 years, appear disproportionately high to the rest of the nation in unpublished data.

The majority of these cancers may be effectively treated with as compared curettage and electrodesiccation, excision, cryosurgery and irradiation. However, certain subsets of these carry with them higher recurrence rates and present a more demanding therapeutic challenge. Mohs micrographic surgery has emerged as the most reliable and effective method for removing the more difficult non-melanoma skin cancers. Mohs surgery offers maximal normal tissue preservation as well as the lowest recurrence rates of all current modalities for the treatment of non-melanoma skin cancer at high risk for recurrence.

Historical background

Frederic Mohs developed the technique originally in the 1930s at the University of Wisconsin. He applied a fixative paste of zinc chloride and stibnite directly to a patient's skin cancer, the paste was allowed to fix the skin overnight, and then the fixed skin was removed (without bleeding or need for local anesthesia) the following day. The tissue was processed using horizontal permanent sections after carefully mapping, grossing and color-coding the tissue to maintain strict orientation. The tissue was examined by Mohs for remaining tumor, which, when found, was drawn on the map as a positive area. The process was then repeated daily, removing tissue only in the remaining positive areas until the patient was tumor-free. This technique, called chemosurgery, was published in 1941[2] and was found in this and in subsequent studies to result in extraordinarily low recurrence rates, in the range of 1% or lower for primary BCC[2,3,4,5] and 2% to 4% for recurrent BCC[2,6,7,8].

In light of the extraordinarily low recurrence rates as a result of chemosurgery, some investigators began to modify the technique. Tromovitch and Stegman of the University of California at San Francisco found that fresh tissue, rather than fixed, removed from the patient and processed as frozen sections yielded equally good results as the fixed technique[9,10,11]. In addition, the fresh tissue modification offered 3 advantages: 1) the pain from in situ tissue fixation was avoided[1]; 2) multiple stages (layers of tissue removal) could be performed in one day, shortening considerably the time needed; and 3) the post-fixation tissue slough was avoided, allowing for immediate reconstruction.

Because of these distinct advantages, the fresh tissue technique has virtually replaced the fixed technique. The term "chemosurgery" is of historic value at present. With universal acceptance of the fresh tissue modification, the technique was renamed "Mohs micrographic surgery" in 1981[13,14], by the American College of Micrographic Surgery and Cutaneous Oncology.

Indications

Mohs surgery is an ideal method for precisely removing non-melanoma skin cancers that are more likely to recur, and those whose clinical margins are unclear or inaccurate. In general, there are 5 main predictors of skin cancers that will have a higher recurrence rate: 1) An aggressive histologic subtype; 2) regions of the human body with a higher recurrence

TABLE 1
Aggressive Histologic Subtypes
Morpheaform or fibrosing BCC
Adeniod BCC
Infiltrative BCC
Micronodular BCC
Metatypical BCC (Basosquamous CA)
Anaplastic SCC
Acantholytic SCC
Dermatofibroma sarcoma protuberans
Microcystic adnexal CA

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rate; 3) recurrent tumors; 4) clinical size > 2 cm; and 5) incompletely excised tumors.

Aggressive histology refers to several subtypes of non-melanoma skin cancer that routinely have microscopic extensions beyond clinically apparent margins. The most commonly encountered aggressive subtypes for which Mohs micrographic surgery is appropriate therapy are listed in Table 1. Subclinical extensions of morpheaform BCC in one study[15] averaged 7.2 mm beyond clinically apparent margins. Figure 1 shows a preoperative clinical

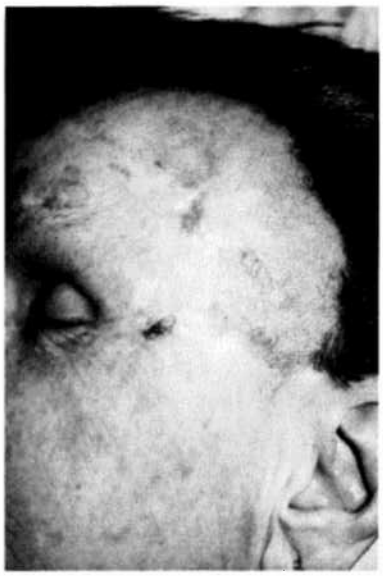

Figure 1: Preoperative appearance of morpheaform BCC

appearance of a patient with morpheaform BCC. The postoperative appearance, after Mohs sections were shown to be tumor-free, is shown in Figure 2.

Location of a non-melanoma skin cancer is somewhat predictive of likelihood of recurrence. Certain locations of BCC of the head and neck result in higher-than-expected recurrence rates. These locations are depicted in Figure 3[16] and include the nose (especially tip, ala, dorsum), nasolabial fold, columella, philtrum, periorbital areas, pre- and postauricular areas, temple, and the helix of the ear[17,18]. SCC recurs more frequently and is more likely to metastasize when located on the ear, lip or in a burn scar[19]. In addition to the higher recurrence rate of central facial and periauricular lesions, these areas also command a great deal of functional and/or cosmetic importance. Maximal sparing of normal tissue, as well as high

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cure rates may be best achieved with Mohs surgery in these areas.

Recurrent non-melanoma skin cancers pose a challenge to any modality of treatment. Recurrent tumors may track along old scar tissue and thus grow in an irregular fashion, producing subclinical extensions. Mohs surgery affords the highest cure rate compared with any other modality for recurrent BCC and SCC[19,20] and is the treatment of choice for recurrent lesions.

Tumor size (preoperative) of > 2 cm carries an increased recurrence rate due to greater subclinical extensions[21]. In addition, SCC > 2 cm also has an increased metastatic potential[19]. Mohs reported a cure rate of 99.8% for BCC < 2 cm^3. This rate decreased to 98.6% in tumors > 2 cm. By comparison, a study from NYU[18] calculated the overall 5-year cure rate in primary BCC treated with excision to be 90.7%. The cure rate dropped to 87.9% in tumors >1.5 cm and 76.9% in tumors > 3 cm.

Incompletely excised tumors (recent excision with positive margins histologically) pose a high risk of recurrence if no further therapy is given. Pascal[22] found that BCC treated by excision and found to have tumor present within 1 high-power field of the surgical margin showed a 12% recurrence rate if merely observed clinically. This rate increased to 35% when the tumor actually involved the surgical margin. Positive margins indicate an extension of tumor that was not otherwise apparent clinically. The most definitive method of ensuring that the margins are clear is subsequent treatment by Mohs.

There are several other situations in which Mohs is favored as a method of treatment. A BCC or SCC with perineural spread carries an increased risk of recurrence. BCC in a patient with basal cell nevus syndrome may be aggressive, making tissue-sparing especially important; such cancers also are more numerous. Some less common skin malignancies also are amenable to Mohs surgery, such as verrucous carcinoma, sebaceous carcinoma, eccrine carcinoma (especially microcystic adnexal carcinoma), and dermatofibroma sarcoma protuberans. Some Mohs surgeons have applied this method of removal to melanoma; however, its use in pigmented lesions is not universally accepted and remains controversial.

Preparation

A patient referred for Mohs surgery should have had a prior biopsy with report and have slides available for review by the Mohs surgeon. A preoperative visit is ideal as the patient's medical history can be reviewed and any special requirements on the part of the patient (such as discontinuing anticoagulants, arranging for anticipated repair with a reconstructive surgeon, initiation of any prophylactic antibiotics) can be planned. The

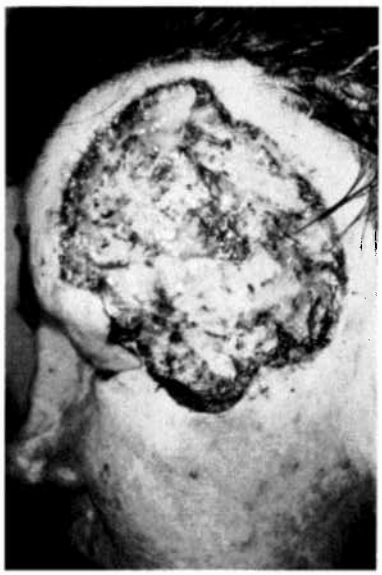

Figure 2: Postoperative appearance of patient in Figure 1

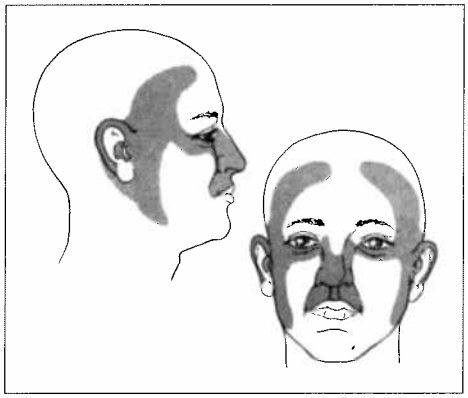

Figure 3: Areas with high risk of BCC recurrence*

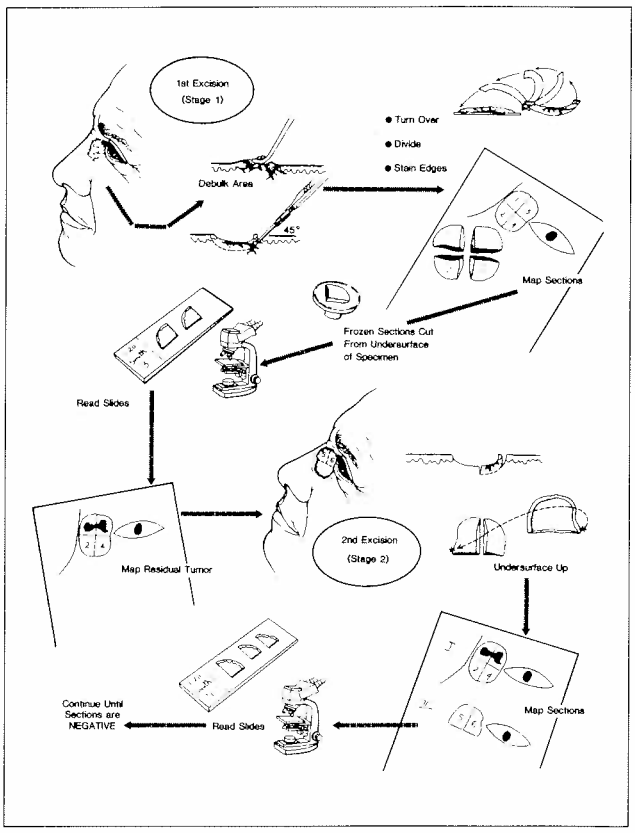

Figure 4: Schematic of Mohs micrographic surgical technique*

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lesion size may be determined on an initial visit and, if it is large, the case can be scheduled appropriately. Lesion size on clinical inspection, however, is not always accurately predictive of actual microscopic extent of tumor.

Technique

The procedure usually is performed in an outpatient setting, generally in a clinic, using local anesthesia. The tumor is first debulked, removing obvious cancer cells with a curette or scalpel. This process is outlined in Figure 4. A thin layer of tissue is then removed with a scalpel, beveling the edges to 45 degrees. Orientation is strictly maintained throughout the procedure. Several small cuts (scores) are made in the specimen and at the surgical site for alignment. Hemostasis is achieved with electrocoagulation and/or suture ligation, the patient is bandaged and is free to relax and wait in the waiting room while the tissue is being processed. The skin is mapped and divided into pieces of appropriate size by a technician (usually no larger than 1 cm) for frozen sectioning. Contrasting dye is used to mark cut edges to assist in orientation. The specimen is flattened on a glass slide to bring the epidermal edge into the same plane as the deep margin. The tissue is frozen in this position in a cryostat. The skin is then cut into horizontal sections on a cryostat, taking care to align the tissue chuck properly to ensure a complete section. Meticulous flattening of the tissue and positioning of the tissue chuck in the cryostat are essential in producing suitable horizontal sections. For this reason, cryostat models that do not allow flexible positioning of the tissue chuck are not appropriate for this procedure. The frozen sections are then stained, coverslipped and presented to the Mohs surgeon for interpretation. The slides are examined by the surgeon for evidence of remaining tumor and areas noted to be positive for tumor are clearly marked on the tissue map.

The patient then returns to the treatment room for removal of additional tissue. By comparing the tissue map to the operative site, only tissue in the positive area will be removed, sparing tissue observed to be tumor-free. The process is repeated until all the sections are found to be negative. Of prime importance is the fact that the Mohs surgeon acts as both the surgeon and the pathologist. The orientation of the specimen in this procedure can be lost or obscured when more than one person performs both roles.

Unlike routine pathologic examination of excisions, the entire peripheral and deep margins are examined in Mohs sections. Traditional histologic exams of excisions, even wide excisions, only sample the margins in several areas. Statements of "margins free of tumor" on pathology reports do not imply that all of the margins were examined.

In cases of aggressive spread of tumor into vital structures such as ear canals, orbits, bone, major nerve trunks, it may be necessary to work in conjunction with physicians from other specialties. In such cases, an ENT surgeon, for example, may be guided by the Mohs surgeon to an area that remains positive for tumor in an ear canal or nasal bone. This may be done in an operating room setting under general or IV anesthesia.

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Sometimes it is necessary to process a tissue layer in permanent sections often necessitating a 1-day wait for results in cases where bone is involved (requiring decalcification) or in tumors found difficult to discern on frozen section.

Recurrence rates

A thorough review of the literature and a weighted comparison of recurrence rates from all modalities was done in 1 study for primary BCC[23]. Looking at 5-year follow-up of primary BCC recurrence, surgical excision showed a 10.1% recurrence rate, curettage and electrodesiccation (C&E) a 7.7% recurrence, radiation therapy a rate of 8.7% and cryotherapy a rate of 7.5 %. Some caution is advised in considering rates in C&E and cryotherapy because large, high-risk lesions may not have been included in many of these studies.

Overall all non-Mohs modalities had a recurrence rate of 8.7%. At 5-years' follow-up, removal by Mohs surgery resulted in a recurrence rate of 1%.

A similar study on recurrent BCC[20] with 5- year follow-up also was observed. Surgical excision showed a recurrence rate of 17.4%, radiation therapy a rate of 9.8% and C&E a rate of 40%. Cryotherapy had a short-term recurrence rate of 13%, but there was no data on cryotherapy 5-year follow-up.

All non-Mohs modalities had an overall recurrence rate of 19.9%. Mohs surgery showed a weighted average of 5.6% recurrence rate 5-years later. Therefore, according to these studies, non-Mohs modalities have a recurrence rate 8 times that of Mohs in primary BCC and 4 times that of Mohs in recurrent BCC.

In primary SCC of the skin, a similar study examined the 5-year recurrence rate using the following therapeutic methods[19]: Surgical excision had a local recurrence rate of 8.1%, curettage and electrodesiccation a rate of 3.7, and radiation therapy a rate of 10%. Again, there may have been some bias in selection with respect to the C&E modality, as this method is not used very often in large, high-risk SCC. Overall non-Mohs methods show a 5-year recurrence rate of 7.9%.

Mohs surgery was found to have a 3.1% recurrence rate after 5 years. In locally recurrent SCC, surgical excision had a 5-year recurrence rate of 23%, compared with a 10% recurrence rate with Mohs surgery.

Several factors increase risk of recurrence or metastasis in SCC, including the degree of differentiation, the size of the tumor, its depth and site. In SCC of ≤ 2 cm, surgical excision affords a cure rate of 83.5%, but when > 2 cm, the cure rate drops to 58.3%. Comparison with Mohs shows 98.1% and 74.8% cure rates respectively. Surgical excision of well-differentiated SCC offers a cure rate of 81.0%, but this drops to 46.4% for poorly differentiated SCC. By comparison, Mohs cure rates are 97% and 67.4%, respectively. Mohs surgery affords the patient with SCC a significantly increased cure rate, even in cases at high risk for local recurrence and metastasis. Lower cure rates for Mohs surgery in poorly differentiated SCC may reflect the tumor's propensity for early metastasis; it is also more difficult to define this tumor on frozen section.

The pros and cons

As described above, Mohs micrographic surgery offers significantly increased cure rates in cases of BCC and SCC as compared with other methods. In addition, maximum sparing of healthy tissue is achieved; this is of prime importance when cancers occur on the face and ears. The vast majority of Mohs surgical procedures are done using local anesthesia in an outpatient setting, avoiding the risk of general anesthesia and operating room charges. Long-term cost is less, as recurrence is much less likely, thus avoiding subsequent procedures.

A relative disadvantage is that special training is necessary to perform Mohs micrographic surgery. Typically, fellowship programs require 1 to 2 years' training after a dermatology residency (or after an ENT or plastic surgery residency). A laboratory setting that incorporates a cryostat and staining hood also is necessary. It is essential that an expert technician be available who has had special training in preparing Mohs sections.

Mohs surgery is certainly more time consuming than other modalities, the time spent in processing often runs from a half hour to 1 hour per stage. Very large tumors may require numerous sections and will take several hours to process. This fact may deter some patients who may be unable or unwilling to wait for the tissue to be processed. The short-term costs of the procedure also are greater than those of other previously mentioned methods.

Conclusion

Mohs micrographic surgery offers the highest cure rates at present for non-melanoma skin cancer. It is the method of choice for patients at high risk of recurrence of non-melanoma skin cancer: Those with large, recurrent, incompletely excised or aggressive tumors or with tumors in areas of high potential for recurrence. Practitioners who evaluate patients with non-melanoma skin cancer are well-advised to be familiar with this method in order to give proper informed consent to their patients about the choice of therapeutic methods.

REFERENCES

1. National Institutes of Health: Incidence of nonmelanoma skin cancer in the U.S. Publication No. NIH 82-2433. Washington, DC, *U.S. Government Printing Office*, December 1981.
2. Mohs FE. Chemosurgery: A microscopically controlled method of cancer excision. *Arch Surg.* 1941;42:279-295.
3. Mohs FE. Chemosurgery: microscopically controlled surgery for skin cancer. Springfield, Ill. Charles C. Thomas, 1978.
4. Tromovich TA, Beirne GA, Beirne CG. Cancer chemosurgery.*Cutis.* 1965;523-529.
5. Phelan JT, Milgrom H. The use of Mohs chemosurgery technique of the treatment of skin cancers. *Surg Gynecol Obstet.*1967;125:549-560.
6. Bart R, Schrager D, Kopf A, et al. Scalpel excision of basal cell carcinoma. *Arch Dermatol.* 1978;114:739-742.
7. Robins P. Chemosurgery: A surer method to treat basal cell epithelioma. *Consultant.* 1974;14:137-142.
8. Robins P, Menn H. Chemosurgery in the treatment of skin cancer. *Hosp Pract.* 1970;5:40-50.
9. Tromovich TA, Stegman SJ. Microscopic-controlled excision. *Dermatol Digest.* 1976;15:12-19.

10.Tromovich TA, Stegman SJ. Microscopic-controlled excision of cutaneous tumors. *Cancer*. 1978;41:653-658.
11. Stegman SJ, Tromovich TA. Fresh tissue chemosurgery for tumors of the nose. *Eye Ear Nose Throat*. 1976;55:53-55.
12. Swanson NA, Taylor WB. Commentary: The evolution of Mohs stone surgery. *J Dermatol Surg Oncol*. 1982;8:650-654.
13.Bernstein G, Cottel WI, Bailin PL, et al. Mohs micrographic surgery. *J Dermatol Surg Oncol*. 1987;13:13.
14. Cottel WI, Bailin PL, Albom MJ, et al. Essentials of Mohs micrographic surgery. *J Dermatol Surg Oncol*. 1988;11-13.
15.Salasche SJ, Amonette R. Morpheaform basal-cell epitheliomas: A study of subclinical extensions in a series of 51 cases. *J Dermatol Surg Oncol*. 1981;7:387-392.
16. Swanson NA. Mohs Surgery: Technique, indications, applications and the future. *Arch Dermatol*. 1983;119:761-773.
17.Levine HL, Bailin PL. Basal cell carcinoma of the head and neck: Identification of the high risk patient. *Laryngoscope*. 1980;90:955-961.
18. Dubin N, Kopf AW. Multivariate risk score for recurrence of cutaneous basal cell carcinomas. *Arch Dermatol*. 1983;119:373-
19.Rowe DE, Carroll RJ, Day CL. Prognostic factors for local recurrence, metastasis and survival rates in squamous cell carcinoma of the skin, ear and lip. *J Am Acad Dermatol*. 1992;26(6):976-990.
20. Rowe DE, Carroll RJ, Day CL. Mohs surgery is the treatment of choice for recurrent (previously treated) basal cell carcinoma. *J Dermatol Surg Oncol*.1989;15(4):424-431.
21.Burg G, Hirsh RD, Birger K, et al. Histographic surgery: Accuracy of visual assessment of the margins of basal cell epitheliomas. *J Dermatol Surg Oncol*. 1975;1:21-24.
22.Pascal RR, Hobby LW, Lattes R, et al. Prognosis of "incompletely excised" vs. "completely excised" basal cell carcinoma. *Plast Reconstr Surg*. 1968;41:328-332.
23.Rowe, DE, Carroll RJ, Day CL. Long-term recurrence rates in previously untreated (primary) basal cell carcinoma: implications for patient follow-up. *J Dermatol Surg Oncol*.1989;15(3):315-328.

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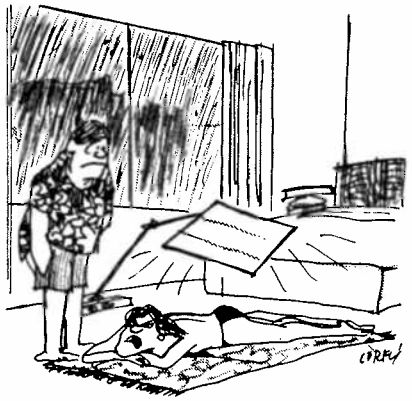
CORKY'S HAWAII



"I'M NOT GOING HOME WITHOUT A TAN!..."