Clinical Review

Mohs' Micrographic Surgery of the Head and Neck

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Mohs' micrographic surgery, a method originally developed in the 1930s to remove contiguously spreading cutaneous cancers under precise microscopic control, has emerged as the most reliable method for removing certain primary, incompletely excised, and recurrent basal cell and squamous cell carcinomas. Indications for its use have expanded to include many other cutaneous and noncutaneous neoplasms. Usually done as an outpatient procedure and using local anesthesia, a layer of tissue is excised, mapped in relation to the site of removal, sectioned horizontally, and examined for the presence of residual tumor. This sequence is repeated, removing only tissue that contains residual tumor, until a margin completely free of cancer is reached. Extremely high cure rates are achieved, and surrounding tissue is maximally conserved for wound repair.

(Darmstadt GL, Steinman HK: Mohs' micrographic surgery of the head and neck. West J Med 1990 Feb; 152:153-158)

Skin cancer is the most common carcinoma in humans, with an annual incidence of more than 500,000 cases.[1] The most common types are the nonmelanoma carcinomas: basal cell carcinoma and, less frequently, squamous cell carcinoma. About 85% of these cutaneous neoplasms present on the head or neck. The majority are of extremely low metastatic potential, have well-defined borders, and are treated by excision, electrosurgery, cryosurgery, or irradiation with greater than 90% overall success (Table 1).[2] For treatment of the other, more difficult primary, recurrent, and incompletely excised skin carcinomas, Mohs' micrographic surgery gives the most reliable assurance of tumor-free margins regardless of tumor shape, size, depth, or invasion into bone or cartilage or along nerves or blood vessels. This procedure also conserves the maximum amount of normal tissue.

Historical Development

As a medical student in the mid-1930s, Frederick Mohs, MD, developed a method for removing cutaneous cancers under complete microscopic control. He began by examining the leukocytic reaction in normal and cancerous tissues of rats following the administration of various irritants and noted that a 20% solution of zinc chloride produced tissue fixation rather than just irritation. On removing the fixed tissue, he noted excellent preservation of its microscopic features.[3] He then conceived the idea of applying zinc chloride to various carcinomas, fixing them in situ, removing the cancer in layers, and microscopically examining each layer until a tumor-free plane was reached.[4] In the 1940s and 1950s there was much reluctance to accept Mohs' technique. The zinc chloride fixative seemed old-fashioned, bordering on quackery, and many surgeons were contemptuous of deliberately incising through known cancer and removing tissue piecemeal. But as Mohs produced high cure rates, preserved maximal amounts of adjacent normal tissue, and frequently salvaged patients who had been deemed inoperable, the value of the method began to be recognized.

In 1953 Mohs introduced a modification, the fresh-tissue technique, using a local anesthetic and no fixative, for cancer of the eyelid margins, where swelling and discomfort due to zinc chloride treatment was particularly troublesome.[5] In 1974 Tromovitch and Stegman provided significant impetus to the more widespread use of the fresh-tissue technique when they presented results from the first series of patients on whom this technique was used.[6] For the treatment of difficult basal cell carcinomas, this study showed a success rate similar to that with the fixed-tissue technique. Also, by omitting the zinc chloride treatment, several advantages were noted: the perioperative pain from tissue fixation in situ was relieved; several stages could be done in one day, allowing complete treatment in a few hours; and the tissue slough that occurred after the final stage of chemical fixation was eliminated, permitting immediate reconstruction of the surgical wound when indicated. Because of its many advantages, the fresh-tissue technique has replaced the fixed-tissue one, and most surgeons doing Mohs' technique now use the fresh-tissue technique exclusively.

Braun outlined some situations where the fixed-tissue method may still be advantageous[7]:

- Basal cell carcinomas invading bone, meninges, or brain;
- Squamous cell carcinomas invading deeply and around narrow spaces such as the external auditory canal;
- Lesions on highly vascular structures such as the penis; and
- Miscellaneous situations for the palliative removal of large, unresectable neoplasms.

Mohs also advocated using the fixed-tissue technique for malignant melanoma.[8] With the exception of melanoma, how-

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TABLE 1.—*Comparative Success in Treatment Methods Used for Basal Cell Carcinoma**

Treatment Method	Success Rate, %	Treatment Method	Success Rate, %
Electrosurgery	92.6-98.0	Radiation therapy	92.1-96.0
Excisional surgery	93.2-95.5	Mohs' surgery	97.4-99.1
Cryosurgery	94.0-97.0		

*From Swanson et al.[2]

ever, most surgeons using microscopic control think that even these cases can be handled with the fresh-tissue technique. Current research on melanoma will help clarify the role of Mohs' micrographic surgery in treating these tumors.

There are many synonyms for the technique, including chemosurgery and fixed-tissue technique, chemosurgery and fresh-tissue technique, microscopically controlled surgery, microcontrolled surgery, Mohs' microscopic surgery, Mohs' histographic surgery, Mohs' technique, Mohs' surgery, and the acronym MOHS (microscopically oriented histographic surgery). The nomenclature recommended by the American College of Mohs' Micrographic Surgery and Cutaneous Oncology is "Mohs' micrographic surgery."[9]

Surgical Technique

A surgeon begins by outlining the visible clinical margins of the lesion. After the induction of local anesthesia, the tumor is debulked with a scalpel or curette. Then, with the scalpel angled at approximately 45 degrees to the skin to create a beveling effect, a thin layer of tissue is removed 2 to 4 mm beyond the clinical margin of the tumor.

At the time of tissue removal, several steps are taken to ensure the proper orientation of the excised specimen. Before the specimen is completely detached, orientation marks are made on the excised tissue and at corresponding points on the surrounding skin using a scalpel, dyes, sutures, or staples. A map is drawn showing the relative size and shape of the specimen in relation to the area of the body from which it was taken. The tissue is cut on the orientation marks into pieces small enough to fit on a microtome cassette. Each of these smaller specimens is then numbered, turned over so that the undersurface is facing up, and color coded on the cut edges with stains. The position of the numbered specimens and the color coding schema are also indicated on the map.

A technician then carefully cuts from the undersurface serial frozen horizontal sections 5 to 7 μm thick. By first compressing the tissue flat and cutting horizontally across the bottom, the entire edge and undersurface of the excised tissue is sectioned. Horizontal sectioning is pivotal to Mohs' micrographic surgery, as it allows the complete peripheral and deep margins of the removed tissue to be examined. This has been superior to conventional vertical sectioning in showing all contiguous strands of tumor.[10,11] The sections are interpreted by the surgeon with or without the aid of a pathologist, and any remaining tumor foci are precisely located on the map and, therefore, also on the patient. An essential and unique feature of this technique is the active involvement of the surgeon in all phases of the procedure, including the orientation and processing of the surgical specimen, interpreting the histologic slides, and personally marking areas of residual tumor on the Mohs map. The Mohs' micrographic surgeon can then return to the patient and precisely remove only tissue where tumor is microscopically present.

The process can be repeated as often as necessary to extirpate tumor totally, removing only tissue with residual neoplasm and maximally preserving normal surrounding tissue. Because several stages can be completed in a day, and most tumors can be completely removed in three layers or less, all except the most advanced cancers can be removed in one day as an outpatient procedure. When a plane free of cancer is reached, the wound can be allowed to heal by second intention or may be closed primarily.[12,13]

Indications for Mohs' Micrographic Surgery

Mohs' micrographic surgery has become most widely accepted for the treatment of certain basal cell and squamous cell carcinomas. Because the procedure is labor-intensive, time-consuming, and expensive, and because most cutaneous carcinomas are successfully removed by routine methods (Table 1), Mohs' micrographic surgery should be used only for specific indications.

Basal Cell Carcinoma

Overall indications for the use of Mohs' micrographic surgical treatment of basal cell carcinoma include primary tumors in locations associated with an increased risk of local invasion and recurrence such as the midface and ear, tumors larger than 1 to 2 cm, or tumors with aggressive histopathologic or clinical characteristics indicative of a poor treatment response (Table 2). Incompletely excised and recurrent basal cell carcinomas are also generally best approached with the Mohs technique.

Primary basal cell carcinoma. Tumor location: Some

TABLE 2.—*Indications for Mohs' Micrographic Surgery*

- Basal cell carcinoma
  - Primary
    - Problem anatomic location, nose, eyes, ears, and embryonic fusion planes
      - High propensity for recurrence
      - Cosmetic or functional import or both
    - Aggressive histopathologic features
      - Morpheaform or sclerosing
      - Infiltrating
      - Metatypical
    - Size >2 cm diameter
    - Indistinct clinical margins
  - Incompletely excised
  - Recurrent
- Squamous cell carcinoma
  - Primary—same principles as above for basal cell carcinoma
  - Incompletely excised
  - Recurrent
  - Radiation-induced
  - Bowen's disease (gluteal cleft or vulvar)
- Other cutaneous lesions
  - Any locally invasive lesion with histologic features interpretable by frozen section
- Noncutaneous neoplasms (selected cases)
  - Parotid gland
  - Tongue
  - Oral cavity
  - Palate
  - Tonsillar pillars
  - Paranasal sinus