The incidence of major complications from Mohs micrographic surgery performed in office-based and hospital-based settings

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Background: There has been significant interest in the safety of office-based surgery.

Objective: Our purpose was to compare the safety of Mohs micrographic surgery and related surgical repairs performed in office- and hospital-based settings.

Methods: The study included 3937 consecutive patients undergoing Mohs surgery. Surgery was performed at either an outpatient office or a hospital-based setting.

Results: Mohs surgery was performed on 1540 patients in the hospital and 2397 patients underwent surgery in the office. The mean patient age was 66 years, and 61% were men. Ninety-three percent of lesions were basal cell or squamous cell carcinomas, and 86% were located on the head and neck. The average tumor measured 1.1 × 1.0 cm, required 1.7 stages of Mohs surgery, and resulted in a defect measuring 2.4 × 1.8 cm. Linear closures, flaps, grafts, and second-intention healing were utilized in 69%, 14%, 6%, and 11% of defects, respectively. There were no differences in patient or tumor characteristics or the types of closures used at the two operating facilities. The only serious surgical complication was gastrointestinal hemorrhage due to naproxen prescribed postoperatively for auricular chondritis in one patient.

Conclusion: Mohs micrographic surgery and repair of associated defects can be safely performed in either an office- or hospital-based setting. (J Am Acad Dermatol 2005;53:628-34.)

Recently, there has been significant interest in the medical literature and in the lay press regarding the safety of office-based surgery. At the heart of this debate lies the concern that office-based surgery is unsafe for patients. This concern arises from a variety of anecdotes and poorly designed studies and contradicts the experience of dermatologic surgeons and studies confirming the safety of office-based dermatologic surgery.

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In general, surgical complications can be divided into two categories. The first includes localized complications such as wound dehiscence, localized bleeding, superficial wound infections, and flap or graft necrosis. In a landmark article, Cook and Perone[1] demonstrated the safety of Mohs micrographic surgery (MMS) by prospectively enrolling 1052 patients with 1358 tumors treated by MMS. The outcome measured was the incidence of common surgical complications, including postoperative hemorrhage and hematoma formation, graft necrosis, flap necrosis, postoperative infection, and wound dehiscence. They found the incidence of these complications to be 1.6%, which compared favorably with the results of hospital-based dermatologic surgery performed by other specialties.

The second type of complications includes severe or systemic complications that may be life-threatening or result in serious compromise of a bodily function or organ. The fact that the incidence of these complications has not been determined in the

Table I. Systemic and major surgical complications

1. Death
2. Patient admission or transfer of care
   a. Transfer to an emergency room, hospital, or other acute care facility
   b. Admission to a hospital for postoperative patient monitoring or for a surgical complication
   c. Return to the operating room for management of a surgical complication
   d. Consultation with another specialist regarding a surgical complication
3. Cardiovascular
   a. Cardiac arrest
   b. Shock
   c. Angina
   d. Symptomatic or severe bradycardia, tachycardia, or arrhythmia
   e. Hypertensive crisis or symptomatic acute severe hypertension
   f. Congestive heart failure
   g. Pulmonary edema
   h. Hypothermia
   i. Limb ischemia or loss
4. Pulmonary
   a. Respiratory arrest
   b. Intubation
   c. Acute obstructive airway disease
   d. Acute respiratory distress syndrome
5. Thrombotic
   a. Myocardial infarction
   b. Stroke or transient ischemic attack
   c. Deep venous thrombosis
   d. Pulmonary embolism
6. Infectious
   a. Fever (>101°F)
   b. Wound infection requiring parenteral antibiotics
   c. Deep wound infection
   d. Septicemia
   e. Pneumonia
   f. Endocarditis
   g. Septic arthritis
   h. Urinary tract infection
   i. Infection of any organ or tissue apart from the immediate surgical wound
7. Nutritional and renal
   a. Dehydration requiring intravenous fluids
   b. Malnutrition requiring nutritional supplements
   c. Metabolite disorder (eg, hyponatremia, hypokalemia)
   d. Acute renal failure
8. Hemostasis
   a. Bleeding requiring transfusion
   b. Bleeding requiring patient transfer or hospitalization
   c. Bleeding affecting stability of vital signs
9. Neuropsychiatric and sensory
   a. Pain requiring more than oral medications for control
   b. Brain or spinal damage
   c. Postoperative delirium
   d. Unplanned damage to motor nerve
   e. Loss of vision
   f. Impaired hearing or vestibular function
10. Surgical errors
   a. Wrong surgical procedure performed
   b. Procedure performed on the wrong person
   c. Procedure performed on the wrong site
   d. Unplanned foreign object left in patient
   e. Use of contaminated equipment or materials
   f. Absence or malfunction of critical equipment
   g. Thermal injury during surgery
   h. Physical injury during surgery
11. Serious drug reaction, including malignant hyperthermia
12. Inability to begin or complete surgery because of a complication

literature is due to the extreme rarity of such occurrences after MMS.[2] Nonetheless, a study claiming that there is a 12-fold increase in death and serious injury occurring after office-based surgery has significant implications for physician, public, and governmental attitudes toward office-based dermatologic surgery.[3]

In our practice, MMS is performed at two separate sites, one of which is an office-based facility (3 days per week), and the other is a surgical facility based within a major teaching hospital (2 days per week). Allocation of patients to either site is based primarily on scheduling and patient preference. This setup allows us to directly compare surgical complications arising in the two patient groups, as the operating physicians and surgical approach are identical and the only difference lies in the physical location in which the surgery is performed. If office-based surgery were inherently less safe, we would expect that our patients who undergo MMS in a physician office building not located in or affiliated with a hospital would have significantly more complications than those undergoing the procedure in a hospital.

METHODS

A retrospective study of all patients undergoing MMS between July 1, 2002 and April 30, 2004 was performed. Patients underwent MMS at one of two facilities: DermSurgery Associates, P.A., Houston, Texas, which is accredited by the Texas Department of Health and located in a physician office building

Table II. Less serious or localized complications of dermatologic surgery not included in this study

1. Superficial localized infection successfully treated with oral antibiotics and without fever or other complications
2. Uncomplicated wound dehiscence
3. Various degrees of flap or graft necrosis without other complications
4. Minor bleeding that did not require surgery
5. Minor scar revisions performed several months postoperatively
6. Planned removal of tumor-infiltrated peripheral nerves
7. Uncomplicated hematoma not requiring surgical intervention
8. Uncomplicated vasovagal reaction

that is not located within or adjacent to a hospital, and The Methodist Hospital, Houston, a major teaching hospital with an accredited surgical facility devoted to dermatologic surgery. This facility is located in the main hospital building complex. All patients underwent MMS by a single attending physician (L. H. G.) and his Mohs surgery fellows. No patients were excluded. At both facilities a prospective log of surgical complications has been maintained since inception. Operations are performed at Methodist Hospital on Mondays and Fridays and at DermSurgery Associates on Tuesday and Thursday mornings and all day on Wednesday. Patients were allocated to each site based primarily on scheduling and travel preference. In addition, a few insurance carriers preferred surgery at the hospital.

A total of 3937 patients were included, of whom 2397 underwent surgery at DermSurgery Associates and 1540 underwent surgery as The Methodist Hospital. Patients in whom systemic and major localized complications developed were recorded. The list of these complications appears in Table I. Table II includes a list of localized and less serious complications not included in this study.

Informed consent was obtained from all patients before surgery. A complete medical history, including a review of systems and list of medications, as well as a physical examination including evaluation of the heart and lungs were performed immediately before surgery. Vital signs including blood pressure, pulse, respiratory rate, and degree of pain were recorded before surgery, immediately after each stage of MMS, and at the completion of surgical repair. Physicians were notified if the heart rate was more than 100 beats/min, if the systolic blood pressure was more than 200 mm Hg, if the diastolic blood pressure was more than 100 mm Hg, or if there was any respiratory distress or pain. Oral propranolol (20-80 mg) and clonidine (0.1-0.2 mg) were the only medications used to control blood pressure. Patients with a history of arrhythmia or with irregular heart rhythms had constant cardiac monitoring during surgery.

Surgery was performed with the patient under local anesthesia (0.5% lidocaine with 1:200,000 epinephrine). In patients who reported an allergy to either lidocaine or epinephrine, 0.25% bupivacaine was used. In a few cases, oral diazepam (5 mg) was used as an anxiolytic. No patient received intravenous or intramuscular sedation or general anesthesia. Oral acetaminophen was used selectively for patients requesting oral analgesia. No other analgesics were used during surgery. Patients were allowed to ambulate, eat, drink, and use the restroom after each stage of MMS.

Patients taking platelet inhibitors were advised to consult their prescribing physicians regarding the appropriateness of withholding these agents before surgery. However, warfarin was not withheld before surgery. Hemostasis was typically achieved by pressure alone. When necessary, electrocoagulation, the use of sutures, or both were utilized to achieve hemostasis. Postoperatively, a pressure dressing was applied that would remain in place for 48 hours. Patients were allowed to drive home immediately after the completion of their procedure. Patients who were planning to drive after the surgery were not given diazepam.

Postoperatively, patients were instructed to use acetaminophen and ice packs for pain. In select cases, propoxyphene and acetaminophen (Darvocet-N100), acetaminophen with codeine (Tylenol #3), or hydrocodone and acetaminophen (Vicodin) were prescribed for pain if requested by the patient either at the time of surgery or postoperatively. Antibiotics were not prescribed prophylactically, except for prevention of endocarditis in patients with a history of valvular heart disease or for patients with a history of joint replacements. Postoperative antibiotics were not prescribed for prophylaxis of wound infection regardless of the closure used.

All patients were contacted postoperatively by a physician within 72 hours to determine whether there were any complications requiring physician attention. Patients were seen in follow-up within 1 to 2 weeks after surgery, and all returning patients were evaluated by the attending physician (L. H. G.). Patients seeking follow-up with their referring physicians were questioned regarding possible postoperative complications through postoperative calls.

Patient demographics, tumor characteristics, number of stages of MMS performed, and types of

closures used were recorded for each case. In addition, postoperative complications were tabulated and compared between the two operating facilities.

RESULTS

A total of 3937 cases of MMS were performed. Of this number, 2397 tumors were treated at DermSurgery Associates and 1540 were treated at The Methodist Hospital. The mean patient age was 66 ± 14 years; 61% were men and 39% were women. A comparison of patient demographics, tumor location, type, number of MMS stages, and surgical repair utilized is presented in Tables III, IV, and V. Overall, 93% of lesions were basal cell or squamous cell carcinomas of the skin, and 86% were located on the head and neck. The average tumor measured 1.1 × 0.95 cm, required 1.7 stages of MMS for histologic clearance, and resulted in a defect measuring 2.4 × 1.8 cm. Linear closures, flaps, and grafts were used to repair 69%, 14%, and 6% of defects, respectively. Second-intention healing was utilized in 11% of tumors and 0.4% were referred to another physician for further resection and/or surgical repair under general anesthesia. There were no significant differences in patient age or gender, tumor location, tumor type, stages of MMS, or types of closure used between the two operating sites.

There were no cases of death, cardiopulmonary arrest, or intubation. There were no thrombotic events, cardiac or pulmonary complications, neuropsychiatric sequelae, or unplanned damage to motor nerves or sensory organs. There were no cases of fever (>101°F), deep wound infection, septicemia, or infection affecting any organ or tissue apart from immediate surgical wound (eg, pneumonia, urinary tract infection, endocarditis, or septic arthritis). No patient required parenteral antibiotics, intravenous fluids, or nutritional supplementation, and there were no cases of metabolic disorders or acute renal failure. No surgeries were performed on the wrong person or site, no incorrect procedures were performed, and there were no cases in which contaminated equipment or materials were used or during which there was absence or malfunction of necessary or critical equipment. There were no physical or thermal injuries sustained as a result of surgery. No surgeries were prematurely terminated because of complications and no patient was transferred to a hospital or an acute care facility from the surgical facilities.

Overall, there was one serious drug-related complication in an 82-year-old man with a history of colitis in whom gastrointestinal hemorrhage developed after naproxen had been prescribed and taken. The medication was prescribed 2 weeks after surgery because of the development of auricular chondritis in an anterior ear defect that was allowed to heal by second intention. The patient required hospitalization and transfusion. This patient's surgery had been performed in the office setting.

DISCUSSION

We conducted a study comparing the occurrence of serious surgical complications in patients undergoing MMS as either an office- or a hospital-based surgical procedure. We limited the complications studied to major ones for two reasons. The first is that the safety of MMS with regard to the more common localized complications has been evaluated by previous studies.[1,4] The second is that much of the sensation in the medical literature and the media centers around death and serious complications arising from office-based surgery, not relatively minor complications limited to the surgical site. Indeed, complications such as flap and graft necrosis, which have been classified as serious postoperative complications in other studies, are typically not serious because they result in no systemic harm to the patient and because most cases heal with excellent cosmetic and functional outcome. Similarly, minor postoperative bleeding controlled by application of pressure or simple rebandaging by a health care provider is not a serious hemorrhagic complication, whereas significant blood loss requiring transfusion is.

We did not include as complications planned surgical interventions resulting in damage to a particular tissue. As such, planned peripheral nerve resection because of tumor infiltration or perineural spread was not considered a serious surgical complication. Similarly, planned surgical removal of anatomic structures such as a tear duct because of histologic proof of tumor invasion was not considered a surgical complication.

Our study confirms that MMS and repair of defects arising from MMS are virtually free of serious or systemic complications and can be performed safely in either a hospital- or office-based surgical facility. Our practice, in which patients are divided between surgery in a hospital setting and surgery in an office-based setting, is rather unique and makes it optimal for the comparison of patient safety in the two surgical settings. Our single serious complication, due an adverse gastrointestinal hemorrhagic effect from naproxen, was due to postoperative development of chondritis in a large ear defect that was allowed to heal by second intention and is not attributed to the location in which surgery was performed.

Claims that office-based dermatologic surgery is unsafe appear ludicrous to dermatologic surgeons.

Table III. Comparison of patient and tumor characteristics for patients undergoing Mohs micrographic surgery at hospital-based and office-based sites

		Hospital	Office	Overall
No. of patients		1540	2397	3937
Demographics	Patient age (y)	65.1 ± 14.2	66.5 ± 13.7	66.0 ± 13.9
	% Men	57.4	62.7	60.5
	% Women	42.6	37.3	39.5
Tumor location	Nose	417 (27.1%)	653 (27.2%)	1070 (27.2%)
	Ear	185 (12.0%)	248 (10.3%)	433 (11.0%)
	Lip	110 (7.1%)	157 (6.5%)	267 (6.8%)
	Periocular	90 (5.8%)	157 (6.5%)	247 (6.3%)
	Face, other	356 (23.1%)	626 (26.1%)	982 (24.9%)
	Scalp	79 (5.1%)	143 (6.0%)	222 (5.6%)
	Neck	59 (3.8%)	88 (3.7%)	147 (3.7%)
	Trunk	83 (5.4%)	107 (4.5%)	190 (4.8%)
	Upper extremity	80 (5.2%)	109 (4.5%)	189 (4.8%)
	Lower extremity	50 (3.2%)	61 (2.5%)	111 (2.8%)
	Hand, foot, digit	29 (1.9%)	43 (1.8%)	72 (1.8%)
	Genitalia	2 (0.1%)	5 (0.2%)	7 (0.2%)
Tumor type	Basal cell carcinoma	1150 (74.7%)	1688 (70.4%)	2838 (72.1%)
	Squamous cell carcinoma	292 (19.0%)	543 (22.7%)	835 (21.2%)
	Basosquamous cell carcinoma	5 (0.3%)	8 (0.3%)	13 (0.3%)
	Keratoacanthoma	19 (1.2%)	35 (1.5%)	54 (1.4%)
	Malignant melanoma	56 (3.6%)	92 (3.8%)	148 (3.8%)
	Dermatofibrosarcoma protuberans	4 (0.3%)	4 (0.2%)	8 (0.2%)
	Atypical fibroxanthoma	4 (0.3%)	10 (0.4%)	14 (0.4%)
	Adnexal tumor	6 (0.4%)	14 (0.6%)	20 (0.5%)
	Angiosarcoma	0 (0%)	1 (0.04%)	1 (0.03%)
	Merkel cell carcinoma	2 (0.1%)	1 (0.04%)	3 (0.1%)
	Other spindle cell tumors	2 (0.1%)	1 (0.04%)	3 (0.1%)
Mean tumor size (cm)		1.05 × 0.92	1.09 × 0.96	1.07 × 0.95
Mean stages of MMS (No.)		1.64 ± 0.94	1.68 ± 1.01	1.66 ± 0.98
Mean defect size (cm)		2.32 × 1.71	2.37 × 1.82	2.35 × 1.78

However, systematically establishing that MMS and associated surgical repairs are not associated with serious complications is of importance in several respects. First, dermatologic surgeons and referring physicians can be assured that performance of these procedures in an outpatient office—based setting is appropriate and safe. Second, patients can be informed that undergoing these procedures in an office-based setting is as safe as the procedures being performed inside a hospital and that office-based surgery does not increase their operative risks or place them at increased risk of serious complications. Third, state regulators and medical boards can be reassured of the safety of office-based dermatologic surgery performed with the patient under local anesthesia.

Although dermatologic surgeons are aware of the safety of the procedures they perform, it is imperative that their degree of safety be quantified to counter arguments that dermatologists should limit their use of office-based surgery. The safety of procedures performed by dermatologists in the office setting is highlighted by the favorable rating attributed to dermatologic surgeons by malpractice insurance companies.[2] Previous studies performed by Otley et al[4] and Cook and Perone[1] included a total of 1705 patients, none of whom had any complications that we classify as severe, and there were no cases of severe injury or death reported in their series.

Although the majority of studies have found office surgery to be safe,[5] a study by Vila et al[3] in 2003 claimed that patients undergoing office-based surgery are 12.4 times more likely to die than patients undergoing surgery in an ambulatory surgery center. This study resulted in significant media attention critical of the safety of office-based surgery. However, two important issues must be noted. The first is that there were no deaths in this study due to office-based surgery performed by dermatologists, and therefore one would conclude on the basis of this study that dermatologic surgery by a dermatologist in an office is indeed safe. The second is that

Table IV. Comparison of surgical repairs used at hospital-based and office-based sites

Surgical repair	Hospital	Office	Total
Granulation	159 (10.3%)	266 (11.1%)	425 (10.8%)
Linear closure	1038 (67.4%)	1675 (69.9%)	2713 (68.9%)
Skin graft	95 (6.2%)	151 (6.3%)	246 (6.2%)
Flap	243 (15.8%)	295 (12.3%)	538 (13.7%)
Referred to another specialist	5 (0.3%)	10 (0.4%)	15 (0.4%)

Table V. Comparison of flaps performed at hospital-based and office-based sites

Flap type	Hospital	Office	Total
Advancement	123 (50.6%)	163 (55.3%)	286 (53.1%)
Transposition	57 (23.5%)	58 (19.7%)	115 (21.3%)
Rotation	39 (16.0%)	42 (14.2%)	81 (15.1%)
Island pedicle	13 (5.3%)	16 (5.4%)	29 (5.4%)
Interpolation	11 (4.5%)	16 (5.4%)	27 (5.0%)

mandatory registration of offices was required only for offices performing what the state of Florida defined as level IIB and/or level III procedures, which involve the administration of either conscious sedation lasting longer than 5 minutes or general anesthesia. Level I procedures are defined as those "performed under topical or local anesthesia not involving drug-induced alteration of consciousness other than minimal pre-operative tranquilization of the patient," or "liposuction involving the removal of less than 4000 cc supernatant fat." Offices performing level I procedures would be excluded from that study, as they are not required to register with the state of Florida because "the chances of complications requiring hospitalization are remote."[6] MMS and surgical repair of the defects fall within the scope of level I procedures in the vast majority of cases and offices performing MMS are not required to register with the state of Florida because of the clear safety of the procedures being performed.

The results of Vila et al[3] have been challenged by a study performed by Venkat et al[7] comparing the adverse event and mortality rates of procedures performed in physician offices and ambulatory surgical centers. Based on National Ambulatory Medical Care Survey data, the adverse effect rate and mortality rates were 2.1 and 0.41 per 100,000 procedures, respectively. With the use of the Medicare Current Beneficiary Survey Data, these values were 0.24 and 0.10 per 100,000, respectively. However, for procedures performed in ambulatory surgery centers, these values were 4.4 and 0.9 per 100,000, respectively.

Coldiron, Shreve, and Balkrishnan[8] performed a study of office surgical incidents collected by the State of Florida. During the 3-year study period, no deaths were reported by dermatologists. There were 3 hospital transfers, one because of a vasovagal reaction, one because of atrial fibrillation, and one because of burns that subsequently healed. In the same time period, plastic surgeons reported 7 deaths due to cosmetic procedures performed with the patient under general anesthesia or intravenous sedation as well as 26 procedures resulting in hospital transfers. Coldiron, Shreve, and Balkrishnan concluded that that the complications seen in patients operated on by plastic surgeons is primarily a result of their use of general anesthesia and deep intravenous sedation in the office setting and not a result of the procedures themselves. It appears that patients who retain their ability to breathe and who are mobile during and immediately after surgery are far less likely to encounter complications such as acute respiratory distress syndrome, deep venous thrombosis, pulmonary embolism, and cardiopulmonary arrest. Accordingly, a study by Coleman, Hanke, and Glogau[9] found that hospital-based liposuction is associated with a 3 times higher rate of malpractice settlements than office-based liposuction procedures and that dermatologists accounted for less than 1% of malpractice claim settlements for liposuction.

The main limitation of our study is that patients were not randomly assigned to the two settings for surgery. However, they were not selected for either site on the basis of health considerations. Patient scheduling and travel preferences were primarily utilized in the determination. In addition, a few insurance carriers preferred for patients to undergo surgery in the hospital, and this group of relatively younger and healthier patients was mostly operated on in the hospital. However, the median age and tumor characteristics of the patients in the two settings were similar, showing that there is no significant bias. Another limitation is that approximately one third of our patients had follow-up with their referring physician, creating the possibility of inadequate data collection. This would not, however, bias our results in favor of either the office or the hospital. In addition, our study, as designed, could miss late-onset complications (those occurring after 72 hours), although we consider this to be a reasonable time frame to assess the onset of most of the complications being studied.

We conclude that MMS and associated surgical repairs performed by dermatologists are virtually

free of serious surgical complications, particularly those that are systemic or life-threatening in nature. As these procedures are equally safe whether performed in an office or hospital setting, dermatologic surgeons may continue to routinely perform these procedures in an outpatient office—based setting.

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