ORIGINAL ARTICLES

Prospective Study of Wound Infections in Mohs Micrographic Surgery Using a Single Set of Instruments

Eiman Nasseri, MD[*][†]

BACKGROUND   Mohs micrographic surgery (MMS) has a low rate of surgical site infections (SSI). To date, there are variations in the measures surgeons take to prevent SSI, although these may be costly without benefit to patients.

OBJECTIVE   The purpose of the study was to evaluate the rate of SSI in MMS performed with a clean technique using a single set of instruments for both tumor extirpation and reconstruction.

MATERIALS AND METHODS   The author prospectively evaluated 338 patients undergoing MMS using a single set of instruments for SSI.

RESULTS   There were 7 SSI among 332 patients, with an overall infection rate of 2.1% (7/332). Graft closures had an SSI rate of 3.1% (2/64) and flap closures had an SSI rate of 1.9% (5/268).

CONCLUSION   Using a single set of sterile surgical instruments for both the tumor extirpation and repair stages of MMS leads to cost savings without harming patients and maintains SSI rates within an acceptable range.

The author has indicated no significant interest with commercial supporters.

The rising cost of performing cutaneous surgery in North America is directly related to a growing industry of governmental and private interests set on regulating and accrediting every aspect of the medical profession while simultaneously decreasing reimbursements. To survive, dermatologists must control overhead costs using evidence-based medicine to re-evaluate commonly used infection control practices in cutaneous surgery and eliminate those that are not beneficial to patients.

Several studies have already proven that using clean nonsterile gloves as opposed to sterile gloves during the tumor extirpation and repair stages of Mohs micrographic surgery (MMS) can save a practice thousands of dollars annually without affecting the surgical site infection (SSI) rate.[1,2] Other authors have also shown that self-sterilizing gauze, cotton-tipped applicators, and preassembled instrument sets can also save a practice time and money without increasing infection rates.[3]

Although surgical instrument selection in Mohs surgery varies based on the surgeon's training, experience, and personal tastes, a common practice is to use one sterile set for tumor extirpation and a different sterile set for the repair. The assumptions behind this practice are several fold: used instruments may have become dull, could implant tumor floaters when cutting into fresh tissue leading to recurrence, and increase infection rates because of the prolonged nature of Mohs surgery and waning sterility. None of these assumptions have been proven. However, using 2 sets of instruments for every patient requires a greater upfront investment in equipment, increases spending on disposables like gauze, sterilization wrap and pouches, indicator strips and tape,

*Department of Dermatology, University of Illinois at Chicago, Chicago, Illinois; †Department of Medicine, Division of Dermatology, University of Ottawa, Ottawa, Ontario, Canada

distilled water and electricity, and manpower to perform device reprocessing and setup a second tray.

Objective

The purpose of this study was to evaluate the rate of SSI in MMS performed with a clean technique using a single set of instruments for both tumor extirpation and reconstruction.

Materials and Methods

Patients were recruited during a 20-week period, from May to September 2014, at the hospital-based outpatient clinic of a single fellowship-trained Mohs surgeon. Dermatology residents from the local medical school and a clinic nurse assisted in performing surgery. Patients were excluded from the study if they were referred to another physician for repair, were allowed to heal by secondary intention, underwent a delayed or interpolated repair, or failed to return for their suture removal or follow-up appointment.

Data collected on the day of surgery included the age and sex of the patient, the type and location of skin cancer, the number of MMS levels required to clear the tumor, and the type and size of repair (flap vs graft). Data collected on the suture removal or follow-up visit included signs of a possible infection, hematoma, dehiscence, necrosis, or other wound complications. The main outcome measured was the rate of SSI.

Before their appointment for surgery, all patients completed a medical screening questionnaire and were given preoperative instructions by the clinic nurse over the telephone. Antiplatelet and anticoagulant medications were continued, but patients were asked to avoid nonsteroidal anti-inflammatory drugs, alcohol, herbal supplements, and nicotine for 1 week before surgery until suture removal.

The Mohs surgeon and all assistants performed a 2-minute hand scrub with soap and water at the beginning of each day and used alcohol-based hand sanitizer before and after each patient encounter. Clean scrub sets, a surgical cap, face masks, and eye shields were worn at all times during surgery. Clean nitrile gloves were donned for any contact with patients and were changed before touching surgical instruments for each stage of tumor extirpation. Sterile surgical gloves were donned before touching surgical instruments for reconstruction. During surgery, gloves were changed if they came into contact with anything other than the prepared surgical site, surgical towels, or opened surgical tray.

The surgical site was identified with the patient's help and cleaned using a swab stick containing 2% chlorhexidine gluconate in 70% isopropyl alcohol (SoluPrep; 3M Healthcare, London, ON, Canada) off the tray. If the tumor was in a hair-bearing site, the hair was trimmed using scissors before cleaning. The tumor was outlined with a sterile surgical marker and injected with a preparation of 1% lidocaine with 1:100,000 epinephrine buffered with 8.4% sodium bicarbonate in predrawn syringes, labeled with the patient's name and kept off the tray.

A sterile Mohs pack containing a scalpel handle, toothed forceps, tissue scissors, suture scissors, 2 hemostats, a needle driver, gauze, and 4 towels was opened, and a sterile No. 15 blade was dropped onto the tray. The patient was draped using a single towel from the tray, and tumor extirpation was performed. After use, the scalpel blade and surgical instruments were carefully wiped clean of visible blood and tissue using sterile gauze to minimize the risk of floaters. At the completion of the first stage, a pressure dressing was applied using sterile gauze and clean adhesive paper tape (Micropore; 3M Healthcare). The towel used to drape the patient was then placed over the Mohs tray to cover it, with the side that touched the patient facing upwards and away from the instruments. If the towel was soiled with blood, it was discarded and replaced with a new towel from the tray. The Mohs pack was then labeled with the patient's name and stored for reuse. Each additional level was performed in the same manner using the surgical towel covering the tray as a drape (tray side up), along with the same surgical instruments.

Once the tumor was completely removed, the surgical site was cleaned with another swab stick containing 2% chlorhexidine gluconate in 70% isopropyl alcohol

(SoluPrep; 3M Healthcare) off the tray. The repair was drawn using the patient's labeled surgical marker and injected with local anesthesia using the patient's labeled syringes. The defect was draped with the remaining towels from the tray, and sterile sutures were opened and dropped on the tray. The surgical blade was replaced if dull. Reconstruction was performed using 5.0 polyglactin 910 (Vicryl; Ethicon, Somerville, MA) for deep tissue approximation, 5.0 nylon (Ethilon; Ethicon) for most epidermal approximations, and 5.0 gut (Ethicon) for oral mucosa and grafts. Bolsters made of sterile cotton balls rolled in clean petroleum jelly (Aquaphor ointment; Beiersdorf, Hamburg, Germany) were secured over all grafts using 5.0 nylon (Ethilon; Ethicon).

After the reconstruction was completed, patients were given both verbal and written wound care instructions. The closed wound was cleaned with normal saline, and petroleum jelly was applied to the suture line. A dressing composed of a layer of nonadherent material (Telfa; Tyco Healthcare Group, Mansfield, MA) covered with gauze and high tensile strength adhesive tape (Hypafix; BSN Medical, Hamburg, Germany) was applied to the wound. Patients were instructed to remove the dressing in 24 to 48 hours. Thereafter, the wound was cleaned with normal saline or distilled water daily and dressed with petroleum jelly and a bandage. Patients with grafts were instructed to take cephalexin 500 mg 4 times a day orally for 7 days starting immediately. All patients were scheduled to return for suture removal or follow-up between 5 and 14 days after their surgery.

At the patient's suture removal or follow-up appointment, the wound was evaluated for signs of infection. Surgical site infection was defined as the presence of one of the following—pain, tenderness, localized edema, erythema, or heat—in combination with purulent drainage or a positive culture from the incision site.

Every wound clinically suspected of infection was cultured, and oral antibiotics were started immediately. The antibiotic of choice was cephalexin 500 mg 4 times a day orally for 7 days if the repair was a flap. Because all grafts received a 7-day course of cephalexin immediately after repair, grafts diagnosed with infection on suture removal or follow-up were treated with ciprofloxacin 500 mg 2 times daily orally for 7 to 14 days. Patients were scheduled for another follow-up appointment in 1 week. If the wound responded well to the initial treatment, no new antibiotics were prescribed. If the wound was not responsive, the treatment was changed to an antibiotic to which the organism was known to be sensitive— invariably ciprofloxacin 500 mg 2 times daily orally for 7 to 14 days—and 1 final follow-up appointment was arranged.

Results

A total of 332 patients who underwent MMS for nonmelanoma skin cancer were included in the study and underwent 268 flaps and 64 full-thickness skin grafts. There were 5 infections noted in the flap group (1.9%) and 2 infections noted in the full-thickness skin graft group (3.1%) for a total of 7 infections (2.1%; Table 1). The nose was the most common site of surgery with 141 cases. However, the flap infection sites consisted of the scalp, forehead, temple, cheek, and upper cutaneous lip, whereas the graft infection sites consisted of the forehead and conchal bowl. There was a minimal difference in the average number of stages required to clear the tumor at 2.3 stages for all patients as opposed to 2.4 stages in infected patients only. The average repair area was larger in infected patients at 15.6 cm² as opposed to all patients at 4.9 cm². *Staphylococcus aureus* was isolated in 3 cases, *Enterobacteriaceae* and *Pseudomonas aeruginosa* in 2 cases each, and *Serratia marcescens* in 1 case of infection. All *Staphylococcus* isolates were sensitive to cephalexin, and all *Enterobacteriaceae*, *Pseudomonas*, and *Serratia* isolates were sensitive to ciprofloxacin. None of the patients included in the study required admission, nursing care, or suffered long-term sequelae from their infections, and all patients were able to return to work after suture removal.

Discussion

Mohs micrographic surgery is usually performed in an outpatient clinic over the course of several hours, with the patient moving between the procedure and waiting

TABLE 1. Infection Characteristics After MMS

Age/Sex	Dx	Location	Stages	Repair Size, cm²	Repair Type	Cultured Bacteria	Sensitivity/Treatment
58/F	BCC	L infraorbital cheek	2	5.25	RF	*Staphylococcus aureus*	Cephalexin
53/F	BCC	L forehead	2	6	RF	*Staphylococcus aureus*	Cephalexin
82/M	SCC	L upper cutaneous lip	2	5.7	RF	*Staphylococcus aureus*	Cephalexin
						Enterobacteriaceae	Ciprofloxacin
76/M	BCC	R temple	2	7.2	RF	*Enterobacteriaceae*	Ciprofloxacin
78/M	BCC	L frontal scalp	3	70	Bilateral RF	*Pseudomonas aeruginosa*	Ciprofloxacin
70/M	BCC	R conchal bowl	2	5.06	FTSG	*Pseudomonas aeruginosa*	Ciprofloxacin
84/F	BCC	Central forehead	4	10	FTSG	*Serratia marcescens*	Ciprofloxacin

BCC, basal cell carcinoma; Dx, diagnosis; F, female; FTSG, full-thickness skin graft; L, left; M, male; R, right; RF, rotation flap; SCC, squamous cell carcinoma.

rooms using only a nonsterile bandage to cover their wound. As such, MMS wounds are often considered nonsterile or clean–contaminated.[4] Despite this designation, SSIs in cutaneous surgery including MMS are rare, with an incidence in the literature ranging from 0.07% to 5% of cases.[2,3,5–9]

In contrast, the reported acceptable rate of infection by the Centers for Disease Control and Prevention for procedures performed in an operating room is 1% to 3% for clean wounds and 5% to 10% for clean–contaminated wounds.[5]

Although dermatologists performing MMS have increasingly adopted infection control practices originating from hospital ORs in an effort to reduce SSI, individual practices vary greatly,[10] whereas reported MMS SSI rates remain low. A prospective study of SSI in MMS where the authors used the same tray for both tumor extirpation and repair demonstrated infection rates similar to this study, at the lower end of the spectrum (0.91%).[5] This lends supports to the notion that low SSI rates seen in MSS are likely inherent to the location and type of surgery being performed as opposed to the surgical environment.

The purpose of minimizing SSI is to improve patient safety and surgical outcomes while reducing the associated costs of managing infections and lost patient productivity. The reality is that SSIs from cutaneous surgery are generally of low morbidity, respond well to oral antibiotics, and resolve with little to no sequelae apart from scarring.[2] In this study, patients were given time off work until suture removal if their job involved heavy lifting or excessive physical labor; all patients were able to return to work after suture removal regardless of the presence of infection. All infections responded to a course of oral antibiotics with cephalexin 500 mg 4 times daily orally for 7 days or ciprofloxacin 500 mg 2 times daily per orally for 7 to 14 days along with the standard wound care. No patients required hospitalization, and only 1 to 2 follow-up appointments beyond suture removal were necessary for patients with a diagnosis of SSI to ensure adequate response to therapy.

In this current health care system, the benefits and cost savings of preventing SSI in MMS are distributed equally among patients, the government and the private sector, whereas the financial burden of preventing SSI falls solely on the dermatologist's practice. It is obvious then that determining which infection control practices are beneficial to patients in MMS is the dermatologist's prerogative and should be a priority.

The author believes that using a single set of sterile surgical instruments for both the tumor extirpation and repair stages of MMS leads to cost savings and maintains SSI rates within an acceptable range. The greatest limitation to this study is the fact that it is prospective, uncontrolled, and based on a small number of cases from 1 physician at a single institution. Other studies have shown that MMS infection rates lower than this study are possible, and it remains

to be seen whether the use of a different sterile tray for closure would help reduce the infection rate even further. Although instruments were regularly wiped clean, the risk of implanting tumor floaters when cutting into fresh tissue leading to recurrence was also not measured. Finally, administering prophylactic antibiotics for all graft repairs may have lead to an underestimation of the infection rate. Additional studies including prospective randomized controlled trial and long-term follow-up would be beneficial. Until then, dermatologists should continue to question our habits and assumptions regarding infection control in the practice of cutaneous surgery.

References

1. Rhinehart MB, Murphy MM, Farley MF, Albertini JG. Sterile versus nonsterile gloves during Mohs micrographic surgery: infection rate is not affected. Dermatol Surg 2006;32:170–6.

2. Xia Y, Cho S, Greenway HT, Zelac DE, et al. Infection rates of wound repairs during Mohs micrographic surgery using sterile versus nonsterile gloves: a prospective randomized pilot study. Dermatol Surg 2011;37:651–6.

3. Liu A, Lawrence N. Incidence of infection after Mohs micrographic and dermatologic surgery before and after implementation of new sterilization guidelines. J Am Acad Dermatol 2014;70:1088–91.

4. Whitaker DC, Grande DJ, Johnson SS. Wound infection rate in dermatologic surgery. J Dermatol Surg Oncol 1988;14:525–8.

5. Rogers HD, Desciak EB, Marcus RP, Wang S, et al. Prospective study of wound infections in Mohs micrographic surgery using clean surgical technique in the absence of prophylactic antibiotics. J Am Acad Dermatol 2010;63:842–51.

6. Martin JE, Speyer LA, Schmults CD. Heightened infection-control practices are associated with significantly lower infection rates in office-based Mohs surgery. Dermatol Surg 2010;36:1529–36.

7. Elliott TG, Thom GA, Litterick KA. Office based dermatological surgery and Mohs surgery: a prospective audit of surgical procedures and complications in a procedural dermatology practice. Australas J Dermatol 2012;53:264–71.

8. Alam M, Ibrahim O, Nodzenski M, Strasswimmer JM, et al. Adverse events associated with Mohs micrographic surgery: multicenter prospective cohort study of 20,821 cases at 23 centers. JAMA Dermatol 2013;149:1378–85.

9. O'Neill JL, Shutty B, Sun Lee Y, Solomon JA, et al. Comparing demographic characteristics and adverse event rates at two dermatologic surgery practices. J Cutan Med Surg 2014;18:337–40.

10. Eisen DB, Warshawski L, Zloty D, Azari R. Results of a survey regarding perioperative antiseptic practices. J Cutan Med Surg 2009; 13:134–9.

Address correspondence and reprint requests to: Eiman Nasseri, MD, Department of Dermatology, University of Illinois at Chicago, Room 380 CME, 808 South Wood Street, Chicago, IL 60612, or e-mail: eiman_nasseri@ yahoo.ca