

Title: Prospective study of wound infections in Mohs micrographic surgery using a single set of instruments

Background

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 by using evidence based medicine to re-evaluate commonly employed infection-control practices in cutaneous surgery and eliminate those that are not beneficial to patients.

Several studies have already proven that using clean, non-sterile 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

While 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 due to the prolonged nature of Mohs surgery and waning sterility. None of these assumptions have been proven. However, using two 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, distilled water and electricity as well as manpower to perform device reprocessing and set up a second tray.

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

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

46 delayed or interpolated repair or failed to return for their suture removal or follow-up
47 appointment.

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

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55 Prior to their appointment for surgery, all patients completed a medical screening
56 questionnaire and were given preoperative instructions by the clinic nurse over the
57 telephone. Antiplatelet and anticoagulant medications were continued, but patients were
58 asked to avoid non-steroidal anti-inflammatory drugs, alcohol, herbal supplements, and
59 nicotine for one week before surgery until suture removal.

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

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

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78 A sterile Mohs pack containing a scalpel handle, toothed forceps, tissue scissors, suture
79 scissors, two hemostats, a needle driver, gauze and 4 towels was opened, and a sterile #15
80 blade was dropped onto the tray. The patient was draped using a single towel from the
81 tray, and tumor extirpation was performed. After use, the scalpel blade and surgical
82 instruments were carefully wiped clean of visible blood and tissue using sterile gauze to
83 minimize the risk of floaters. At the completion of the first stage, a pressure dressing was
84 applied using sterile gauze and clean adhesive paper tape (Micropore, 3M Healthcare
85 Canada). The towel used to drape the patient was then placed over the Mohs tray to cover
86 it, with the side that touched the patient facing upwards and away from the instruments. If
87 the towel was soiled with blood it was discarded and replaced with a new towel from the
88 tray. The Mohs pack was then labeled with the patient's name and stored for reuse. Each
89 additional level was performed in the same manner using the surgical towel covering the
90 tray as a drape (tray side up), along with the same surgical instruments.

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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 Canada) 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, USA) 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 non-adherent material (Telfa, Tyco healthcare Group, Mansfield, USA) 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 24-48 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 500mg po qid for 7 days starting immediately. All patients were scheduled to return for suture removal or follow-up between 5-14 days after their surgery.

At the patient's suture removal or follow-up appointment, the wound was evaluated for signs of infection. SSI 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 500mg po qid 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 500mg po bid for 7-14 days. Patients were scheduled for another follow up appointment in one 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 500mg po bid for 7-14 days – and one final follow-up appointment was arranged.

Results

A total of 332 patients who underwent MMS for non-melanoma 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, while the graft infection sites consisted of the forehead and conchal bowl. There was minimal difference in the average number of stages required to clear the tumor at 2.3 stages for all all patients as opposed to 2.4 stages in infected patients only. The average repair area was larger in infected patients at 15.6cm² as opposed to all patients at 4.9cm². *Staphylococcus aureus* was isolated in 3 cases, *Enterobacteriaceae* and *Pseudomonas aeruginosa* in 2 case 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

MMS is usually performed in an outpatient clinic over the course of several hours, with the patient moving between the procedure and waiting rooms using only a non-sterile bandage to cover their wound. As such, MMS wounds are often considered non-sterile or clean-contaminated.⁴

Despite this designation, SSI in cutaneous surgery including MMS are rare, with an incidence in the literature ranging from 0.07-5% of cases.^{2,3,5-9}

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162 In contrast, the reported acceptable rate of infection by the Centers for Disease Control
163 and Prevention (CDC) for procedures performed in an operating room (OR) is 1-3% for
164 clean wounds and 5-10% for clean-contaminated wounds.⁵

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166 While dermatologists performing MMS have increasingly adopted infection-control
167 practices originating from hospital ORs in an effort to reduce SSI, individual practices
168 vary greatly¹⁰ while reported MMS SSI rates remain low. A prospective study of SSI in
169 MMS where the authors used the same tray for both tumor extirpation and repair
170 demonstrated infection rates similar to ours, at the lower end of the spectrum (0.91%).⁵
171 This lends supports to the notion that low SSI rates seen in MSS are likely inherent to the
172 location and type of surgery being performed as opposed to the surgical environment.

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174 The purpose of minimizing SSI is to improve patient safety and surgical outcomes while
175 reducing the associated costs of managing infections and lost patient productivity. The
176 reality is that SSI from cutaneous surgery are generally of low morbidity, respond well to
177 oral antibiotics and resolve with little to no sequelae apart from scarring.² In our study,
178 patients were given time off work until suture removal if their job involved heavy lifting
179 or excessive physical labor; all patients were able to return to work after suture removal
180 regardless of the presence of infection. All infections responded to a course of oral
181 antibiotics with cephalexin 500mg po qid for 7 days or ciprofloxacin 500mg po bid for 7-
182 14 days along with standard wound care. No patients required hospitalization and only 1-

2 follow up appointments beyond suture removal were necessary for patients with a diagnosis of SSI to ensure adequate response to therapy.

In our current healthcare system, the benefits and cost savings of preventing SSI in MMS are distributed equally among patients, the government and the private sector, while 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 one physician at a single institution. Other studies have shown that MMS infection rates lower than ours are possible, and it remains to be seen whether the use of a different sterile tray for closure would help reduce our infection rate even further. While 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 our infection rate. Additional studies including prospective randomized controlled trial and long-term follow up would be beneficial. Until then, we should continue to question our habits and assumptions regarding infection control in the practice of cutaneous surgery.

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Table 1. Infection characteristics following Mohs micrographic surgery

<u>Age/ sex</u>	<u>Dx</u>	<u>Location</u>	<u>Stages</u>	<u>Repair size in cm²</u>	<u>Repair type</u>	<u>Cultured bacteria</u>	<u>Sensitivity/ treatment</u>
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

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