Prospective study of wound infections in Mohs micrographic surgery using clean surgical technique in the absence of prophylactic antibiotics

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Background: Mohs micrographic surgery (MMS) has a low rate of surgical site infection (SSI) without the use of prophylactic antibiotics. In the studies to date, there has been variation in the steps taken by each surgeon to prevent SSIs but in all cases sterile technique was used during wound reconstruction.

Objective: We sought to evaluate the rate of SSIs among patients undergoing MMS with the use of clean surgical technique for all steps of MMS including wound reconstruction in the absence of prophylactic antibiotics.

Methods: We prospectively evaluated 1000 patients undergoing MMS using clean surgical technique for SSIs. Clean surgical technique includes the use of clean surgical gloves and towels and a single pack of sterile instruments for all steps including wound reconstruction.

Results: There were 11 SSIs among 1000 patients with 1204 tumors, with an overall rate of infection of 0.91% (95% confidence interval 0.38%-1.45%). Three of the 11 infections were complications of hematomas. Four of the 11 infections occurred in flap closures, which had the highest rate of SSIs of 2.67% (4/150).

Limitations: The study was a prospective, single-institution uncontrolled study.

Conclusion: To our knowledge, this is the first study to examine the rate of SSIs with the use of clean surgical technique, in the absence of antibiotic prophylaxis, for all steps of MMS including wound reconstruction. Our rate of SSIs of 0.91% is exceedingly low, underscoring the overall safety of MMS and its performance in the outpatient setting without the use of antibiotic prophylaxis or sterile technique. (J Am Acad Dermatol 2010;63:842-51.)

Key words: clean surgical technique; Mohs micrographic surgery; surgical site infection.

Surgical wounds are historically classified into 4 groups: clean, clean-contaminated, contaminated, and infected. Clean wounds are those created in an operating room (OR)-like environment after the surgical scrubbing of noninflamed skin. Sterile technique is used to create and maintain clean wounds. Clean-contaminated wounds are also surgically created but there is a minor break in sterile technique including a delay in closure or allowing the wound to heal by secondary intention.[1-3] The reported acceptable rate of infection by the Centers for Disease Control and Prevention for procedures performed in an OR setting for clean wounds is 1% to 3% and 5% to 10% for clean-contaminated wounds.[1,4]

Abbreviations used:

MMS:	Mohs micrographic surgery
MRSA:	methicillin-resistant *Staphylococcus aureus*
OR:	operating room
SSI:	surgical site infection
VA:	Department of Veterans Affairs

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To reach these acceptable low rates of infection, most surgical specialties follow strict protocols to create a sterile environment to reduce the rate of surgical site infection (SSI). Dermatologic surgery does not have such protocols and, for the vast majority of Mohs surgeons, Mohs micrographic surgery (MMS) is not performed under OR-like conditions. The rooms are not decontaminated between cases, patients wear their street clothes during surgery, and the Mohs surgeon and assistants do not perform 5-minute hand scrub before each surgery and do not wear sterile gowns and gloves for the procedure. Further, the process of MMS requires that a surgical wound remain open while the harvested tissue is processed. During this waiting period, the wounds are bandaged and the patient is allowed to leave the procedure room to wait in the waiting room, in their home, or at times even a nearby restaurant. This inherent delay in MMS and the performance of most dermatology surgery in a nonsterile environment has led to classifying dermatologic surgery wounds as nonsterile or clean-contaminated.[5]

CAPSULE SUMMARY

- We prospectively evaluated 1000 patients undergoing Mohs micrographic surgery using clean surgical technique to monitor the development of surgical site infections (SSIs).
- The SSI rate was 0.91% (95% confidence interval 0.38%-1.45%) with 11 infections among 1000 patients with 1204 tumors.
- The SSI rate of 0.91% is exceedingly low, underscoring the overall safety of Mohs micrographic surgery and its performance in the outpatient setting without the use of antibiotic prophylaxis or sterile technique.

Even as clean-contaminated wounds, SSIs in outpatient dermatologic surgery including MMS are rare events, affecting from 0.07% to 4.25% of surgical cases.[6,7] More recently, 3 studies have illustrated that this low rate of SSI is achievable without the use of prophylactic antibiotics, finding SSIs in 0.7%, 1.47%, and 1.8% of dermatologic surgeries.[8-10] When comparing these studies, each has its own surgical protocol to prevent infection. This variation can also be found when comparing the practices of Mohs surgeons. Some surgeries are performed in ORs, some in ambulatory surgery centers, others in examination rooms only used for surgery once a week. Some surgeons take layers using sterile gloves whereas others use clean gloves. These differences are most dramatic when comparing the protocols followed for wound reconstruction where some surgeons don surgical hats, shoe covers, sterile gowns, and gloves, and use a new set of sterile instruments whereas others simply use clean gloves and the same instruments used when harvesting the tumor. These variations in surgical protocol raise the question: if dermatologic surgery is inherently a nonsterile procedure performed in a nonsterile environment, does using clean, instead of sterile, surgical technique still lead to an acceptably low rate of infection?

To date, there have been 3 articles reporting the rate of SSIs when not using sterile technique in skin surgery. Rhinehart et al[10] performed a study in 2006 to determine if the infection rate in MMS is affected by the use of sterile versus clean gloves in the tumor extirpation phase. This was a retrospective chart review including 1400 MMS cases without the use of antibiotic prophylaxis. The study reported an infection rate of 1.74% in the sterile glove arm versus 1.83% in the clean glove arm with no statistical difference in SSI rates between using sterile versus clean gloves during tumor extirpation. All wound reconstructions were performed using sterile gloves.

Rogues et al[11] performed a study assessing infection control practices of private dermatologists in France. He reported not wearing sterile gloves was associated with an increased risk of SSIs. Based on the data presented in the article, this conclusion was reached after 14.7% (5/34) of surgical cases requiring reconstruction (including flaps and grafts) performed not using sterile gloves developed SSIs. This was compared with a SSI rate of 3.4% (13/386) for surgical cases requiring reconstruction when using sterile gloves. It is unclear why the rate of infection in the first, very small cohort is unusually high but when comparing the rate of SSIs in the larger cohort of simple excisions, the same study found there was no increased risk of infection when not using sterile gloves in the simple excision group compared with the sterile glove group: 1.7% (15/886) versus 1.6% (35/2185).

There is one randomized controlled trial looking at sterile versus clean gloves for the repair of uncomplicated lacerations in the emergency department.[12] This study included 816 patients who were randomized to have their wound repaired by using either sterile or clean gloves without the use of perioperative antibiotics. The infection rate for the sterile glove group was 6.1% whereas the infection rate for the clean glove group was 4.4% with no statistically significant difference between the two groups.

With the exception of a 34-patient cohort in the second study, these 3 studies suggest there is no clinical difference in the rate of SSIs with the use of clean versus sterile gloves in skin surgery. Yet, no study to date has assessed the rate of SSIs in dermatologic surgery with the use of clean surgical technique. Therefore, we elected to perform a prospective study of 1000 patients to identify the rate of SSIs in MMS using clean surgical technique for tumor extirpation and wound reconstruction, without the use of prophylactic antibiotics.

METHODS

This 9-month study, from September 2008 to May 2009, was performed at the primary private offices of two fellowship-trained Mohs surgeons (Y. D. E. and E. B. D.). These physicians have an American College of Mohs Surgery—approved fellowship with a single fellow (H. D. R.). All 3 physicians were also faculty at the Department of Dermatology at Columbia University Medical Center, New York, NY, at the time of the study. Their schedules were divided among 3 private offices and a MMS clinic at the Bronx Department of Veterans Affairs (VA) Hospital, New York, NY. Dermatology residents from the university medical center assisted in surgery at the VA clinic and once weekly at the private offices.

The purpose of this study was to evaluate the rate of infection in MMS using clean technique for tumor extirpation and reconstruction without the use of prophylactic or topical antibiotics. Data were collected on both the day of surgery and the day of suture removal or follow-up appointment. The protocol was evaluated and approved by the university medical center internal review board. The study was performed at the Center of Dermatologic and Laser Surgery in Pomona, NY. This site was where the fellow spent the majority of her time with one or both of her attending physicians.

All patients presenting at the Pomona, NY, office for MMS during the study period were considered for enrollment. Patients were excluded if they were taking oral antibiotics for any reason, took prophylactic antibiotics for skin surgery because of an underlying condition (eg, artificial heart valve or prosthetic joint), presented to the office in the first 48 hours after surgery with a hematoma requiring evacuation and prophylactic antibiotics, were unable to return to the office for suture removal, or if the closure was performed by an outside physician.

A one-page data sheet was completed at each patient's MMS visit and at the suture removal or follow-up visit. Data points collected at the MMS visit for each patient included medical history, medications and herbal supplements known to increase bleeding times, type of skin cancer, location of cancer, the number of Mohs layers required to clear the tumor, the size and depth of the final defect, the type and size of closure, the time required to complete all stages of the surgery, the time required to close the defect, and the surgeon performing the closure. The data collected at the suture removal visit included documentation of possible infection, hematoma, seroma, and dehiscence or other wound complication.

The treatment protocol followed for each patient is also the standard of care at the authors' offices (Y. D. E. and E. B. D.). All patients undergoing MMS completed a medical screening questionnaire and were given perioperative instructions. Any patients on antiplatelet or anticoagulant medications were to continue their medications unless their prescribing physician recommended discontinuation. Patients were asked to limit their intake of nonsteroidal anti-inflammatory drugs, alcohol, herbal supplements, and cigarettes for the week before and week after surgery.

On the day of surgery, after obtaining consent from the patient, the patient's tumor was identified. The tumor was outlined with a surgical marker and local anesthesia was achieved using 0.5% bupivacaine with epinephrine (1:200,000). If the tumor was in a hair-bearing site, the hair was shaved using a disposable razor before prepping the site for surgery. The surgical site was cleansed only once, immediately before taking the first layer with 4% chlorhexidine gluconate (Hibiclens, Molnlycke Healthcare US, Norcross, GA). The patient was draped with clean towels and a sterile Mohs pack containing a needle driver, toothed forceps, suture scissors, SuperCut (Moore Medical, Farmington, CT) tissue scissors, two hemostats, gauze, and cotton-tip applicators was then opened. The tumor extirpation was performed using clean gloves. At the completion of the first stage, a pressure dressing was applied using clean gauze soaked in normal saline and high tensile—strength adhesive tape (Hypafix, BSN Medical, Hamburg, Germany). The patient's Mohs pack and towel were then refolded, labeled with the patient's name, and stored for reuse on additional layers and defect reconstruction. At each additional layer, the patient was draped with the same surgical towels and the same surgical pack was used. Once the patient was cleared of the skin cancer, the defect was closed using the same towels and surgical pack. The wound was not recleansed before the reconstruction of the defect.

Reconstructions of the head and neck were performed using 5.0 polyglactin 910 (coated Vicryl, Ethicon, Somerville, NJ) and 6.0 nylon (Ethilon, Ethicon). For closures involving the mouth, 5.0 silk

(Ethicon) was used for vermilion and 5.0 chromic gut (Ethicon) was used for oral mucosa. Primary closures of the trunk and the upper and lower extremities were performed using 4.0 polydioxanone (Ethicon) for both the subcutaneous sutures and a running subcuticular stitch that was removed at 2 weeks. Grafts were sewn in place using 5.0 chromic gut and when bolsters were used, they were secured using 5.0 nylon (Ethilon, Ethicon).

All dermatologic surgeons and assistants followed clean surgical technique including the use of hand sanitizer before and after each patient encounter. Face masks were worn at all times during surgery; eye protection was encouraged but was not always worn by all staff. Once clean gloves were donned the care provider touched only the prepped surgical area and instruments. If the surgical light or table needed to be adjusted a gauze barrier was used between the glove and handle or the care provider degloved, performed the task, and regloved with a new pair of clean gloves.

After the reconstruction was completed, the patients were given wound care instructions tailored to their wound. Both verbal and written wound care instructions were provided. If someone was waiting with the patient, he or she was invited to listen to the instructions. The closed wound was cleaned with full-strength hydrogen peroxide then petroleum jelly was applied to the suture line. A pressure dressing composed of a layer of nonadherent material (Telfa, Tyco Healthcare Group, Mansfield, MA) covered with absorbent cotton gauze and Hypafix (BSN Medical) was applied to the wound. The patient was instructed to remove the pressure dressing in 24 hours except in cases of increased bleeding risk secondary to anticoagulation medications, when the dressing was to remain in place for 48 hours. Thereafter, sutured wounds were cleaned with full-strength hydrogen peroxide twice daily then dressed with petroleum jelly and a bandage. Grafts and open wounds were cleaned with normal saline twice daily then dressed with petroleum jelly, petroleum-impregnated gauze (Xeroform, Tyco Healthcare Group), and a bandage. Despite being educated to use petroleum jelly, some patients reported using topical antibiotics while performing wound care at home. Patients returned for suture removal or follow-up between 5 to 14 days after the surgery.

If cartilage was breached during surgery the patient was instructed to perform once-daily vinegar soaks. Written vinegar soak instructions were provided for the patient and included boiling 1 qt of water then adding 1/2 cup of white vinegar. The mixture was applied directly to the wound with cotton gauze for 5 to 10 minutes daily before redressing the wound. The vinegar mixture was then to be stored in the refrigerator in a dishwasher-cleaned glass jar. Neither oral nor topical antibiotics were prescribed.

At the patient's suture removal or follow-up appointment, the wound was evaluated for signs of infection. Other complications including hematoma or seroma formation and wound dehiscence were also noted. All wounds were evaluated by the fellow and her attending of the day. Infection was defined clinically as purulent discharge or the presence of two of the following clinical signs and symptoms: edema, erythema, or tenderness. Every wound clinically suspected of an infection was cultured and oral antibiotics were started in the patient. The antibiotic of choice depended on the patient's drug allergies and their risk factors for methicillin-resistant *Staphylococcus aureus* (MRSA). All wounds with fluctuance were incised and drained. If the patient was found to have MRSA but the wound was responding well to the initial treatment choice, the antibiotic was continued for the full course of treatment. If the wound was not responsive, the treatment was changed to an antibiotic to which the organism was known to be sensitive, either trimethoprim/sulfamethoxazole or doxycycline. All patients with any surgical complication were seen at least one additional time to confirm resolution of the complication.

Statistical analysis

Descriptive statistics including means for continuous variables and percentages for categorical variables were conducted to evaluate the data collected. Two-sample *t* test was used to compare continuous measures for two groups and Fisher exact test was used to test the association between two categorical variables. For this study the area of each Mohs defect was measured as an oval {area = [(width/2 × length/2)π]} as has been previously used.[10,13] The area of the reconstruction for each defect was measured as a rectangle (area = length × width) to account for the entire area of undermining during complex closures and adjacent tissue transfers.

RESULTS

A total of 1000 patients underwent MMS for the treatment of 1204 tumors during the 9-month period of the study. Of the 1204 tumors, 11 SSIs occurred with an overall infection rate of 0.91% (95% confidence interval 0.38%-1.45%). The average patient age was 68.4 years, 6.0% of patients were smokers, 51.7% were taking aspirin and/or another form of anticoagulation medication, 11.7% were taking

Table I. Patient demographics

	Total
Total patients	1000
Patient who had >1 case of MMS performed on same day	8
Average patient age	68.5 y
Total skin cancers	1204
Sex	
Female	557 (46.3%)
Male	647 (53.7%)
Smoker	72 (6.0%)
Diabetic medication	141 (11.7%)
Immunosuppressive medication	57 (4.8%)
Anticoagulation total	622 (51.7%)
ASA total	483 (40.1%)
ASA alone	421 (35.0%)
ASA + warfarin	12 (1.00%)
ASA + clopidogrel	41 (3.41%)
ASA + NSAIDs	9 (0.75%)
Warfarin total	94 (7.81%)
Warfarin alone	81 (6.73%)
Warfarin + clopidogrel	1 (0.08%)
Clopidogrel total	67 (5.56%)
Clopidogrel alone	25 (2.08%)
NSAIDs total	29 (2.41%)
NSAID alone	20 (1.66%)
ASA/dipyridamole	12 (1.00%)

ASA, Aspirin; *MMS*, Mohs micrographic surgery; *NSAIDs*, non-steroidal anti-inflammatory drugs.

Table II. Tumor and closure demographics

Total skin cancers	1204
Average number of stages	1.38
Average size of defect	2.73 cm^2
Average size of reconstruction	4.80 cm^2
Average time of reconstruction	21.64 min
Average time of MMS case (start to finish)	193.04 min
Tumor type	
Basal cell carcinoma	776 (64.5%)
Squamous cell carcinoma	377 (31.3%)
Melanoma and melanoma in situ	50 (4.2%)
Other (dermatofibrosarcoma protuberans)	1 (0.08%)
Location of tumor	
Head and neck total	882 (73.3%)
Ear	313
Nose	242
Lip	112
Trunk total	112 (9.3%)
Upper extremities total	93 (7.7%)
Lower extremities total	117 (9.7%)
Above knee	21 (1.7%)
Below knee	96 (8.0%)
Type of closures	
Secondary intention	122 (10.1%)
Primary closure	887 (73.7%)
Skin graft	35 (2.9%)
Skin flap	150 (12.5%)
Wedges of lip or ear	9 (0.7%)

MMS, Mohs micrographic surgery.

medication for diabetes, and 4.8% were taking immunosuppressive medication. In all, 70% of tumors were cleared with the first stage, 24% with the second stage, and 6% required 3 or more stages. The majority of the cases (73.3%) were performed on the head and neck, 9.3% on the trunk, 7.7% on the upper extremities, and 9.7% on the lower extremities. Primary closures were used for 73.7% of wounds, skin flaps (including wedges of the lip or ear) for 13.2%, secondary intention for 10.0%, and skin grafts for the remaining 2.9%. Patient demographics are presented in Table I. The tumor and closure demographics are presented in Table II. The type of closure by location of the tumor is presented in Table III. A summary of each of the 11 SSIs is presented in Table IV. A summary of infection rates in dermatologic surgery is presented in Table V. Fig 1 shows examples of SSIs at the time of clinical diagnosis of infection and 1 week after initiation of antibiotic therapy.

Characteristics of the SSIs by type of closure

The rate of infection was greatest for skin flaps at 2.67% (4/150) compared with 0.78% (7/888) for primary closures. There were no infections with skin grafts, wedges of the lip or ears, or wounds allowed to heal by secondary intention including patients who underwent fenestration of the cartilage of the ear.

Characteristics of SSIs by location

The location with the highest incidence of infection was the head and neck (7/11, 63.6%) including all 4 of the infected flaps. Of note, nearly all skin flaps were performed on the face: 98.7% (148/150). Of the remaining 3 infections of the head and neck, one was a complication of hematoma and two were near the hairline, of which one was shaved. The rate of infection was the greatest on the trunk with 3 of only 112 (2.68%) cases becoming infected compared with 7 of 888 (0.79%) for the head and neck. The 3 infections on the trunk were all large, high-tension wounds and one was a complication of a hematoma. The remaining infection occurred on the upper aspect of the leg, just above the knee and was also a complication of a hematoma. There were no SSIs involving wedges of the lips or ears, cartilage, mucosa, or legs below the knee.

Table III. Type of closure by location of tumor

Location	No. of cases
Head and neck	882/1204 (73.3%)
Total secondary intention	84 (9.54%)
Porcine	9 (1.02%)
Pursestring	1 (0.11%)
Fenestrations	9 (1.02%)
Secondary intention alone	65 (7.39%)
Primary	607 (68.82%)
Skin graft	34 (3.86%)
Total flaps	157 (17.84%)
Wedge	9 (1.02%)
Skin flap	148 (16.82%)
Trunk	112/1204 (9.3%)
Total secondary intention	8 (7.14%)
Porcine	2 (1.79%)
Pursestring	2 (1.79%)
Secondary intention alone	4 (3.57%)
Primary	104 (92.86%)
Skin graft	0 (0.00%)
Skin flap	0 (0.00%)
Upper extremities	93/1204 (7.7%)
Total secondary intention	5 (5.3%)
Porcine	1 (1.08%)
Pursestring	1 (1.08%)
Secondary intention alone	3 (3.23%)
Primary	86 (92.47%)
Skin graft	0 (0.00%)
Skin flap	2 (2.15%)
Lower extremities	117/1204 (9.7%)
Total secondary intention	25 (21.38%)
Porcine	15 (12.82%)
Pursestring	2 (1.71%)
Secondary intention alone	8 (6.84%)
Primary	91 (77.78%)
Skin graft	1 (0.85%)
Skin flap	0 (0.00%)

Characteristics of SSIs by infection and complications

All clinically suspected infections were cultured and all grew *S aureus* on culture. Five of the 11 (45.5%) infections grew MRSA and two of these 5 cultures had identical sensitivities. The reported rate of community-acquired MRSA infections presenting to the emergency department in New York State is 55%.[14]

DISCUSSION

Since 1988, there have been 11 studies evaluating SSIs in dermatologic surgery, all showing low rates of SSIs (0.07%-4.25%) (Table IV).[5-11,13,15,16] Six of these studies include at least control arms where no antibiotic prophylaxis was used and the rates of SSIs remained low (0.72%-4.25%), providing strong evidence that antibiotics are not warranted for the majority of dermatologic surgery cases.[7-10,15,16] Yet, all of the studies to date used sterile technique at least during the wound reconstruction phase of the dermatologic surgeries. Our study is the first to identify the rate of SSI using clean surgical technique for all steps of MMS, including wound reconstruction, without antibiotic prophylaxis or topical antibiotics for postoperative wound care. We found the rate of SSI to be 0.91% (95% confidence interval 0.38%-1.45%), confirming that SSIs are exceedingly rare and underscoring the safety of performing MMS in the outpatient setting without the use of antibiotic prophylaxis. More importantly, we report for the first time that the use of clean technique for tumor extirpation and reconstruction in MMS in the absence of antibiotic prophylaxis and topical antibiotics is associated with an exceedingly low rate of SSIs.

The greatest limitation to our study is that it is a prospective, single-institution uncontrolled study of SSIs when using clean surgical technique. It is not a randomized controlled trial comparing the rate of SSIs when using clean versus sterile technique. Therefore, when comparing our rate of SSIs and the rates of SSIs reported in the 11 previous studies, there are many variables that cannot be standardized between the studies. For example, our rate of infection may be inflated when compared with other studies because we excluded all patients taking antibiotics for any reason, an exclusion criterion not reported by other studies to date. Also, more than one third of our cases were performed by the Mohs fellow or a resident. As these providers have less developed surgical skills than attending Mohs surgeons, the rate of infection may have been elevated by prolonged closure times, increased tissue trauma, and a higher incidence of postoperative bleeding seen with trainees versus an established attending Mohs surgeon. Our rate of SSIs could be understated by the inclusion of 9 patients with exposed ear cartilage who used vinegar soaks to prevent infection. Also, a smaller percentage of our closures were skin flaps and/or skin grafts when compared with 4 of the previous 11 studies and both types of closures have been associated with an increased risk of infection (Table IV).

While acknowledging the many limitations in comparing studies, there is one additional prospective, single-institution, uncontrolled study of SSIs in MMS in the absence of prophylactic antibiotics of 1000 patients.[8] Our study is modeled after this study published by Maragh and Brown[8] in 2008 except that during the reconstruction of the defect instead of using sterile gloves and a new, sterile surgical tray as Maragh and Brown[8] did, we used clean gloves and the same surgical tray used earlier for taking the

Table IV. Surgical site infections

Patient No.	Lesion	Location	Area of defect, cm^{2*}	Depth of defect	Stages	Closure type	Area of reconstruction, $cm^{2\dagger}$	Time of closure, min	Surgeon	Culture	Treatment	Complications
1	BCC	Upper aspect of back	6.59	Fat	2	Linear	18.20	20	Y. D. E.	MRSA	I&D Keflex 500 mg TID	
2	BCC	Upper cutaneous lip	1.73	Muscle	3	Island pedicle	6.45	90	Y. D. E.	MRSA	Bactrim DS 2 tabs BID	
3	SCC	Upper aspect of back	9.73	Fascia	1	Linear	29.45	75	Resident	MSSA	Keflex 500 mg TID	
4	BCC	Forehead	2.83	Fat	3	Linear	12.20	20	E. B. D.	MSSA	Bactrim DS 2 tabs BID	
5	BCC	Cheek	2.47	Fat	2	Advancement flap	9.30	20	E. B. D.	MSSA	Bactrim DS 2 tabs BID	
6	SCC	Upper aspect of leg	3.77	Fat	1	Linear	17.00	30	H. D. R.	MSSA	I&D Doxycycline 100 mg BID	Hematoma
7	BCC	Nose	3.89	Muscle	3	Advancement flap	7.20	20	H. D. R.	MSSA	Keflex 500 mg TID, doxycycline 100 mg BID	
8	SCC	Front of neck	5.65	Fat	1	Linear	8.50	25	H. D. R.	MRSA	I&D Keflex 500 mg TID, doxycycline 100 mg BID	Hematoma
9	SCC	Temple	3.14	Fat	1	A to T advancement	17.05	60	H. D. R.	MRSA	Keflex 500 mg TID	
10	DFSP	Upper aspect of back	40.04	Muscle	3	Linear	119.00	60	H. D. R.	MSSA	I&D Keflex 500 mg TID	Hematoma
11	BCC	Temple	3.53	Fascia	2	Linear	10.44	20	H. D. R.	MRSA	I&D Keflex 500 mg TID, doxycycline 100 mg BID	

BCC, Basal cell carcinoma; *BID*, twice daily; *DFSP*, dermatofibrosarcoma protuberans; *I&D*, incision and drainage; *MRSA*, Methicillin-resistant *Staphylococcus aureus*; *MSSA*, Methicillin-sensitive *Staphyloccus aureus*; *SCC*, squamous cell carcinoma; *TID*, three times daily.

*Calculated using formula for oval: area = (Width/2 $\times$ Length/2)π.

†Calculated using formula for rectangle: area = Length $\times$ Width.

Table V. Summary of infection rates in dermatologic surgery

Author	MMS	2°	1°	Graft	Flap	Wedge ear, lip	Excision	Total	Technique	Other
Whitaker et al[5] 1988	NA	NA	NA	NA	NA	NA	NA	3961 (27) 0.68%	T: NA C: Sterile, clean	Included 48 patients who received preoperative antibiotics. Procedures include MMS, excisions, linear closures, flaps, grafts, hair transplantation, nail surgery, scar revisions.
Futoryan and Grande[13] 1995	530 (13) 2.45%	18 (1) 5.56%	280 (5) 1.79%	91 (5) 5.50%	141 (2) 1.41%	E: 6 (0) L: 1 (0)	517 (11) 2.13%	1047 (24) 2.29%	T: Clean* C: Sterile*	Included patients who received preoperative antibiotics, number not reported.
Bencini et al[7] 1991	NA	NA	NA	NA	NA	NA	NA	541 (23) 4.25%	T: NA C: Sterile	Control of 4-arm study examining antibiotic prophylaxis in skin surgery. Patients with diabetes, chronic liver insufficiency, anemias, visceral cancers, or on immunosuppression were excluded from study.
Griego and Zitelli[15] 1998	414 (NA)	NA	323 (1) 0.30%	93 (6) 6.45%	31 (4) 12.90%	NA	33 (NA)	447 (11) 2.46%	T: Clean* C: Sterile	Control arm in study of intraincisional prophylactic antibiotics.
Huether et al[16] 2002	574 (23) 4.00%	NA	444 (NA)	80 (NA)	50 (NA)	NA	NA	NA	T: Clean* C: Sterile	Control arm in study of intraincisional prophylactic antibiotics.
Cook and Perone[6] 2003	1343 (1) 0.07%	NA	NA	NA	362 (NA)		NA	NA	T: Clean C: Sterile	No patients excluded, empiric antibiotics were "frequently prescribed."
Rhinehart et al[10] 2006	634 (11) 1.74%	NA (2)	NA (5)	NA (1)	NA (3)	NA	NA	NA	T: Sterile C: Sterile	Two arms of one study comparing sterile with clean gloves during tumor removal.
Rhinehart et al[10] 2006	766 (14) 1.83%	NA (4)	NA (3)	NA (4)	NA (3)	NA	NA	NA	T: Clean C: Sterile	Two arms of one study comparing sterile with clean gloves during tumor removal.
Dixon et al[9] 2006	NA	NA	NA	69 (6) 8.70%	1601 (47) 2.94%	B: 35 (3) 8.57%	NA	4679 (72) 1.54%	T: Sterile C: Sterile	Included MMS and excision, curettage results removed from data.
Rogues et al[11] 2007	NA	NA	1721 (NA)	41 (NA)	379 (NA)	NA	3491 (67) 1.9%	NA	T: Sterile, clean C: Sterile, clean	Includes 67 patients receiving antibiotic prophylaxis.
Maragh and Brown[8] 2008	1115 (8) 0.72%	76 (1) 1.3%	589 (1) 0.17%	154 (0)	29296 (7) 2.4%	E: NA (0) L: NA (0)	NA	NA	T: Clean C: Sterile	
Current study	1204 (11) 0.91%	120 (0)	887 (7) 0.79%	35 (0)	146 (4) 2.7%	E: 3 (0) L: 6 (0)	NA	NA	T: T: Clean C: Clean	Patients with exposed ear cartilage instructed to do daily vinegar soaks.

1°, Primary intention; 2°, secondary intention; *B*, both; *C*, closure of defect; *E*, ear; *L*, lip; *MMS*, Mohs micrographic surgery; *NA*, not available; *T*, taking of layers.
Number of infections is in parentheses followed by rate of infection as a percentage.
*Information collected by personal correspondence.

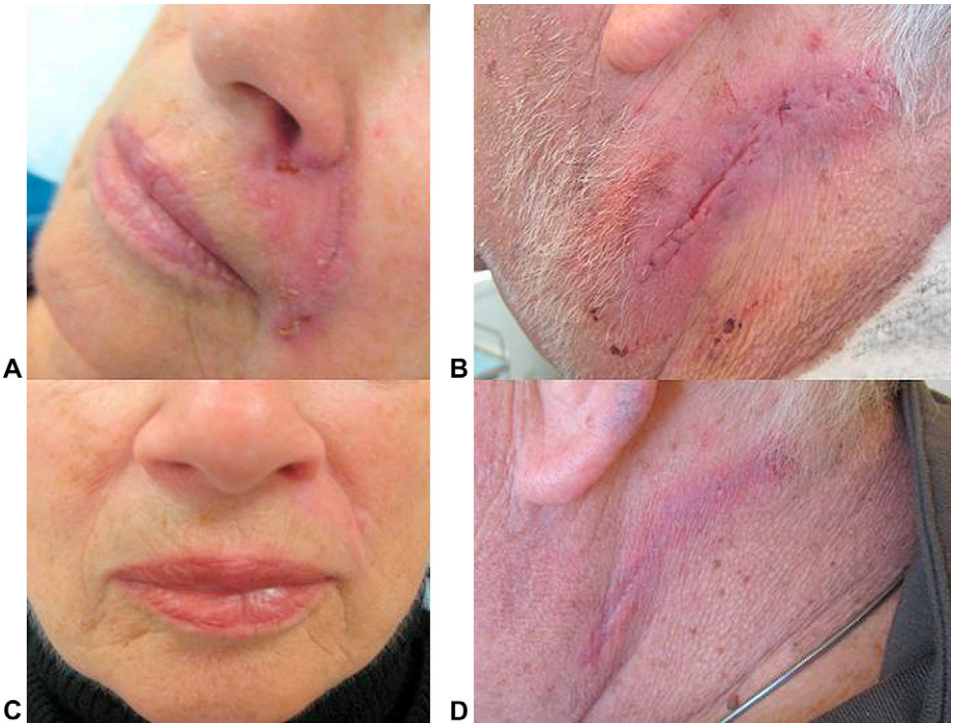

Fig 1. Patients 2 and 8 at time of clinical diagnosis of infection (**A** and **B**) and 1 week after initiation of antibiotic therapy (**C** and **D**).

Mohs layers. The study of Maragh and Brown[8] reported a total rate of SSI of 0.72%, rate of SSI of flaps of 2.4%, and no SSIs of skin grafts or surgeries below the knee. Our study reported a total rate of SSI of 0.91%, a rate of SSI of flaps of 2.7%, and no SSIs of skin grafts or surgeries below the knee with no significant difference in rate of SSI found between the two studies. Our rate of SSI of 0.91% is also well within the range of all reported SSI rates (0.07%-4.25%) in dermatologic surgery.

To conclude, our study further confirms the safety of performing MMS in the outpatient setting without the use of prophylactic antibiotics and for the first time illustrates the safety of using clean surgical technique for all phases of MMS including wound reconstruction. We hope these results will contribute to the growing data highlighting the efficacy and safety of outpatient dermatologic surgery and challenge our specialty to develop an evidence-based standard of care for our surgeries that optimizes patient outcomes while limiting potential adverse effects and unnecessary cost.

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