

Methicillin-Resistant *Staphylococcus aureus*-Positive Surgical Site Infections in Face-lift Surgery

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Objectives: To determine the incidence of methicillin-resistant *Staphylococcus aureus* (MRSA)-positive surgical site infections after face-lift surgery and to discuss the screening, prevention, and treatment of such infections.

Methods: The patient charts of 780 patients who underwent a deep-plane rhytidectomy between 2001 and 2007 were reviewed for postoperative wound infections. Culture results and sensitivities were recorded. To our knowledge, this is the first study that documents MRSA-positive surgical site infections after face-lift surgery.

Results: Five of 780 patients (0.6%) who underwent face-lift surgery by the senior surgeon had postoperative surgical site infections. Four of the 5 patients had cultures that were positive for MRSA. Two of these patients (0.3%) required hospitalization and had collections that had to be opened or drained and developed wound breakdown. Both patients eventually responded to wound care along with intravenous and then oral antibiotic therapy. The other 2 MRSA-infected patients responded to oral antibiotic therapy and local wound care alone. The 2 com-

plicated infections occurred on postoperative days 5 and 8. These 2 patients were the only ones among the 5 patients with positive cultures who had known recent contact with another physician or a hospital. All infections occurred in the year 2006, with 3 patients experiencing infection in the last 4 months of the year. Herein, we describe the incidence and sequelae of MRSA infections and colonization. The 2 major different subsets of MRSA are community-acquired MRSA and health care-associated MRSA. Surgical site infections that are positive for MRSA blur this division, which affects many aspects of the course of disease and treatment. We also discuss strategies for screening, preventing, and treating MRSA surgical site infections.

Conclusions: Methicillin-resistant *S aureus*-positive surgical site infection is an increasingly problematic issue in all surgical fields. In the future, MRSA-positive infections will be more prevalent and will require well-developed screening, prevention, and treatment strategies.

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METHICILLIN WAS INTRODUCED in 1959, and methicillin-resistant staphylococci were first described in the United Kingdom in 1961 as health care-related pathogens. More than 1 decade ago, methicillin-resistant *Staphylococcus aureus* (MRSA) became a community-acquired pathogen when physicians in Australia first reported the existence of a highly virulent community-acquired strain of MRSA (CA-MRSA).¹ In 2003, CA-MRSA became highly publicized after outbreaks occurred in athletic teams and correctional facilities in Los Angeles, California.² The prevalence of both health care-associated MRSA (HA-MRSA) and CA-MRSA is increasing in the United States. From 1989 to 2003, the National Nosocomial Infections Surveillance System collected data that reported a 40% increase in the rate of MRSA isolates from patients in intensive care units.³

Methicillin-resistant *S aureus* is now the leading causative pathogen in surgical site infections as well as in skin and soft tissue infections. In various recent studies involving patients who underwent vascular surgery, cardiac surgery, and orthopedic surgery, MRSA was the most common pathogen of surgical site infections.⁴⁻⁶ In most of the country, skin and soft tissue infections are now more likely to be MRSA positive. In Los Angeles County, CA-MRSA infections have rapidly become common and now exceed the frequency of infections caused by methicillin-sensitive *Staphylococcus aureus* (MSSA). Moran et al⁷ published data on cultures from skin and soft tissue infections from 11 US emergency departments. Results showed a mean positive MRSA culture rate of 59% vs a mean MSSA culture rate of 16%.

Methicillin-resistant *S aureus* is much more virulent than MSSA. It spreads through tissue planes more rapidly and is more difficult to control. Infections caused

by MRSA cost approximately \$3700 more to treat than infections caused by MSSA, and the death rate for MRSA infection is nearly 3 times that for MSSA infection. In a prospective observation, nasal swabs were obtained from 812 military personnel. The initial swabs showed that 24 individuals (3%) had cultures that were positive for CA-MRSA and 229 (28%) had cultures that were positive for MSSA. Nine of those who carried CA-MRSA (38%) developed soft tissue infections, compared with 8 of those who carried MSSA (3%).⁸ The increased propensity for MRSA to cause soft tissue infections demonstrates its increased virulence compared with MSSA.

In the United States, there is a high level of MRSA colonization. In a study performed using nasal cultures from 9622 patients during 2001 and 2002, national *S aureus* and MRSA colonization prevalence estimates were 32.4% and 0.8%, respectively.⁹ In a meta-analysis performed in 2003 on published studies, CA-MRSA had a prevalence of 30.2% among hospitals in 27 retrospective studies and a prevalence of 37.3% in 5 prospective studies. However, in the community, the pooled MRSA colonization rate was only 1.3%. The difference in colonization rate between hospitalized patients and patients in the community suggests that healthy patients have a relatively low rate of MRSA prevalence. In fact, 85% of patients with CA-MRSA had at least 1 health care-associated risk.¹⁰

Health care-associated MRSA is considered a different entity from CA-MRSA; HA-MRSA and CA-MRSA can be distinguished from each other by clinical syndromes, pulse-field gel electrophoresis patterns, toxin production, chromosome patterns, and antibiotic susceptibility patterns. Community-acquired MRSA has a striking propensity to present as skin and soft tissue infection, typically as a spontaneous abscess or folliculitis. While CA-MRSA is thought to be a more benign strain than HA-MRSA, there are virulent strains of CA-MRSA that can cause necrotizing fasciitis in healthy individuals.¹¹ Community-acquired MRSA commonly infects the young and the healthy, especially those who live in crowded conditions or have close physical contact with others. On the other hand, patients affected by HA-MRSA are older and have more underlying diseases. Health care-associated MRSA has a greater tendency to cause respiratory tract infections than does CA-MRSA. It also is more likely to cause bloodstream infections and catheter-related urinary tract infections. While still a cause of skin and soft tissue infections, HA-MRSA also has a decreased propensity toward affecting skin and soft tissue compared with CA-MRSA.¹²

Recently, CA-MRSA entered the hospital setting, co-existing with HA-MRSA. Therefore, patients can acquire both strains from the hospital.⁶ The clinical difference between the 2 strains is the ability to control the infections: CA-MRSA has a higher susceptibility to non- β -lactam antistaphylococcal antibiotics than does HA-MRSA, and HA-MRSA is much more difficult to treat given its narrower susceptibility profile. Recently, isolates with intermediate and full resistance to vancomycin have been reported. Isolates with resistance to linezolid have also been discovered.¹³

To our knowledge, there is no report of the incidence of MRSA-positive wound infections after rhyti-

dectomy. A literature search revealed only 1 published study on the incidence of postoperative surgical site infections after rhytidectomy.¹⁴ In a retrospective study performed more than 10 years ago on 6166 consecutive face-lifts, it was found that infections requiring hospitalization occurred in 11 cases (0.18%). None of the cultures were positive for MRSA. Of these 11 cases, 8 had no significant sequelae, and 3 had minor scarring. However, the study was performed before the development of CA-MRSA.¹⁴

METHODS

In this institutional review board-approved retrospective study, the charts of 780 consecutive patients who underwent rhytidectomy from January 2001 to January 2007 by the senior surgeon (D.B.R.) were reviewed for postoperative wound infections. All patients underwent a deep-plane rhytidectomy along with possible other procedures, including blepharoplasty, brow-plexy, rhinoplasty, autologous fat transfer, laser resurfacing, and chemical peel. Revision rhytidectomy cases were also included in the study. All surgical procedures were performed in various operating rooms at the same Manhattan-based outpatient surgicenter, New York, New York.

The technique for prevention of infection was as follows: The morning of surgery, all patients showered and washed their hair with chlorhexidine solution. After the induction of anesthesia and before incision, the patients' faces were scrubbed with chlorhexidine and povidone-iodine. Attention was placed along the areas of the face-lift incision, including the hair-bearing scalp 5 cm posterior to the hairline. Sterile towels were then secured around the patient's head to sterilely secure the surgical site. Before incision, 1 g of intravenous cefazolin sodium (Ancef) was administered (clindamycin if the patient was allergic to penicillin). After surgery, all patients were given a 7-day prescription for oral cefadroxil (Duricef). The patients were then seen on postoperative days 1, 5, 8 (suture removal), 21, and 40. During each visit, they were examined for any signs of infection, such as erythema and fluid collection.

RESULTS

Of 780 patients who underwent deep-plane face-lift surgery, 4 developed postoperative wound infections with cultures that were positive for MRSA. One other patient developed a wound infection that yielded anaerobic skin flora. Therefore, the overall infection rate was 0.6%. The overall MRSA-positive infection rate was 0.5%. Of the 5 patients with infections, 2 (0.3%) required hospital admission for intravenous antibiotic therapy. Both patients had MRSA-positive cultures. All infections occurred in the year 2006, with 3 patients experiencing infection in the last 4 months of the year.

Below, we summarize the course of each patient's infection in order of decreasing severity. The 2 patients admitted for intravenous antibiotic therapy (patients 1 and 2) had potential exposure to MRSA. Four months before her operation, patient 1 had spent a good part of 10 days visiting her spouse in the cardiac intensive care unit. Patient 2 had frequent contact with her brother-in-law, who is a cardiologist. The **Table** lists the sensitivities and resistances demonstrated in the wound cultures for the 4 cases involving MRSA-positive infections. All 4 patients were sen-

Table. Sensitivities and Resistances Demonstrated in Wound Cultures

Patient No.	Sensitive to	Resistant to
1	Trimethoprim-sulfamethoxazole Rifampin Vancomycin	Penicillin Oxacillin Cefazolin Clindamycin Erythromycin
2	Trimethoprim-sulfamethoxazole Rifampin Tetracycline Clindamycin Vancomycin	Penicillin Oxacillin Cefazolin Erythromycin
3	Trimethoprim-sulfamethoxazole Tetracycline Ciprofloxacin Rifampin Vancomycin	Penicillin Oxacillin Cefazolin Clindamycin Erythromycin
4	Trimethoprim-sulfamethoxazole Gentamicin sulfate Tetracycline Vancomycin	Penicillin Oxacillin Amoxicillin/clavulanate Cefazolin Ciprofloxacin Clindamycin Erythromycin Levofloxacin



Figure. Patient 2 showing erythema and a collection tracking into the neck on postoperative day 6.

sitive to trimethoprim-sulfamethoxazole and vancomycin. Only patient 2 was sensitive to clindamycin. Only patient 3 was sensitive to ciprofloxacin. All patients were resistant to erythromycin.

CASE 1 (MRSA POSITIVE)

In August 2006, a 57-year-old woman underwent a deep-plane rhytidectomy, endoscopic brow-lift, and upper and lower blepharoplasty under general endotracheal anesthesia. On postoperative day 8, she presented with a dry 3×3-cm eschar in the left postauricular area. The eschar was debrided, and culture of material underneath the eschar was performed. At this time, a petrolatum gauze dressing (Xeroform; Sherwood Medical, St Louis, Missouri) was used to cover the wound. Over the next 2 days,

while cultures were pending, the patient's wound enlarged. During the 7-day period from the time of discovery, the eschar evolved into a 6×8-cm skin loss and became exudative, with purulent discharge. The culture was determined to be MRSA sensitive only to vancomycin, trimethoprim-sulfamethoxazole, and rifampin. It was resistant to penicillin, oxacillin, clindamycin, erythromycin, and cefazolin. The patient was admitted for intravenous vancomycin therapy and wound care. Four days later, she had improved clinically and was discharged on a regimen of oral trimethoprim-sulfamethoxazole and rifampin. Over the next 2 months, the 6×8-cm area of retroauricular skin loss formed granulation tissue and a small amount of hypertrophic scarring developed. Six months after surgery, the scarring was barely perceptible.

CASE 2 (MRSA POSITIVE)

In November 2006, a 52-year-old woman underwent deep-plane rhytidectomy and revision rhinoplasty under intravenous sedation anesthesia. On postoperative day 5, 3 mL of viscous serosanguineous fluid was aspirated from the right postauricular region and sent for culture and Gram stain. Many white blood cells were seen on staining, and the next day the culture yielded MRSA. The patient was immediately admitted to the hospital for intravenous vancomycin therapy. She also developed an edematous, cellulitic, tender nasal tip and dorsum, without fluctuance. One day into the hospitalization, sensitivities were finalized. The strain was sensitive to vancomycin, clindamycin, tetracycline, trimethoprim-sulfamethoxazole, and rifampin. It was resistant to penicillin, oxacillin, erythromycin, and cefazolin. The 3-mL collection redeveloped in the right postauricular area, with downward tracking of the infection into the neck (**Figure**). The wound was opened and treated with dressing changes and irrigation. The patient improved over the next 72 hours and was discharged on hospitalization day 7 on a regimen of double-strength trimethoprim-sulfamethoxazole and rifampin twice a day. The cellulitic area at the nasal tip also resolved during this period. Four weeks after surgery, the patient had healed completely. She had no scarring, and the area of the incision that was opened had healed well. Cultures were again obtained from the wound site and nasal passage and showed no growth.

CASE 3 (MRSA POSITIVE)

In December 2006, a 57-year-old woman underwent a deep-plane rhytidectomy, rhinoplasty, and endoscopic brow-lift under general endotracheal anesthesia. She healed well until 3 weeks (postoperative day 21) after surgery, when she presented with a 0.5-cm exudative wound at the left postauricular incision site, where a deep polydioxanone suture (PDS; Ethicon Johnson & Johnson, Raleigh, North Carolina) had become exposed. The suture was removed, and culture was performed. The culture growth showed MRSA sensitivity to tetracycline, trimethoprim-sulfamethoxazole, ciprofloxacin, rifampin, and vancomycin. The strain was resistant to penicillin, oxacillin, clindamycin, erythromycin, and cefazolin. Oral tetracycline was prescribed, and the patient healed uneventfully over the next 7 days.

CASE 4 (MRSA POSITIVE)

In March 2006, a 73-year-old woman underwent a secondary deep-plane rhytidectomy under general endotracheal anesthesia. Seven days after surgery, the bilateral facial incision sites were moderately erythematous, and a sparse amount of purulent discharge was expressed from the right tragal incision and sent for culture. The culture growth showed MRSA sensitivity to trimethoprim-sulfamethoxazole, gentamicin sulfate, tetracycline, and vancomycin. The strain was resistant to penicillin, oxacillin, amoxicillin/clavulanate, cefazolin, ciprofloxacin, clindamycin, erythromycin, and levofloxacin. Trimethoprim-sulfamethoxazole was prescribed. The patient healed rapidly, and she had no evidence of infection or scarring after 7 days of treatment.

CASE 5 (ANAEROBIC SKIN FLORA, NO MRSA)

In January 2006, a 58-year-old woman underwent rhytidectomy along with upper and lower blepharoplasty. Thirty days after surgery, a palpable 2 × 2-cm lump began to develop over her right cheek. Culture of purulence from this lump revealed gram-positive cocci in chains, along with diphtheroidlike gram-positive rods that were sensitive to penicillin, cefazolin, clindamycin, erythromycin, and trimethoprim-sulfamethoxazole. Trimethoprim-sulfamethoxazole therapy was immediately initiated. Subsequently, another, 1 × 1-cm lump developed over the right malar eminence. The patient had a history of penicillin allergy but was sent to an allergist to confirm this. She was found not to be allergic to penicillin and was placed on a regimen of amoxicillin/clavulanate potassium (Augmentin, 875 mg twice a day). She improved rapidly and healed well.

COMMENT

The observed rate of postoperative wound infection is similar to that reported more than 10 years ago in the only other published study (to our knowledge) on postoperative rhytidectomy wound infections. The observed rate of hospitalization among 6166 cases in that study was 0.18%.¹⁴ Of course, this infection rate occurred at a time when MRSA was a rare hospital-acquired pathogen, which had yet to enter the community. Since 2001, among 780 consecutive cases, 2 infections required hospitalization, which is a rate of 0.3%. It is important to note that all 5 infections in our study occurred in 2006, when MRSA was the most common pathogen of surgical site infections. Three of the infections occurred during August, November, and December of 2006. There were no postoperative wound infections before 2006.

Four of the 5 surgical sites (80%) were infected with MRSA, although only 2 became clinically relevant (cases 1 and 2). The high proportion of MRSA infections compared with other pathogens is likely attributable to a combination of factors. Methicillin-resistant *S aureus* is an aggressive pathogen and is more likely to complicate postoperative sites.¹³ Also, the cephalosporin (Om-

nicef) that was prescribed after surgery is active against MSSA, which makes it less likely to be the causative pathogen. Another cause of the high proportion of MRSA-positive cultures is the documented increasing proportion of MRSA vs MSSA. Methicillin-resistant *S aureus* is the most common pathogen in surgical site infections and skin and soft tissue infections. For surgical site infections, the facial plastic surgeon should have a high suspicion for MRSA as the causative pathogen.

As for the timing of infection, the signs and symptoms of MRSA-positive infection were first seen on postoperative days 5, 7, 8, and 21. The infections requiring hospitalization (cases 1 and 2) were first noted on postoperative days 5 and 8. Two of the MRSA-positive wound infections were on the right side, and 2 were on the left side. The even distribution of laterality may suggest that the source of infection may not be instrument related.

Patients 1 and 2 were the only patients who had recent contact with a physician or a hospital. They also had the worst overall infections. Patient 1 had the most narrow sensitivity profile (Table). She had recently spent 10 days in a cardiac intensive care unit and may have been colonized with MRSA. Certainly, the strain cultured from her wound was the most clinically virulent. Her case stresses the importance of hospital and physician-related contacts in history taking. Patients 3 and 4 did not have the extensive infected wounds and areas of collection that patients 1 and 2 had. They were barely clinical in the sense that both had pustules that were smaller than 1 cm, without any sign of wound breakdown. On the contrary, patients 1 and 2 did experience a larger area of cellulitis that rapidly spread, and both had a significant collection. In all 5 patients, the outcome was minimal to no scarring once healing was complete. In the 1 patient who experienced skin loss, the skin defect healed by secondary intention, with an excellent cosmetic result.

As for patient 5, the infected areas were not near the incision sites. In fact, her incisions had healed well by the time the infection occurred. She also had the most delayed presentation, which was at postoperative day 30. A presentation at day 30 barely meets the Centers for Disease Control and Prevention's requirement that an infection must occur within 30 days of an operation to be considered a surgical site infection. Such a late declaration demonstrates the more indolent nature of this infection compared with that of the MRSA-positive infections that were seen in patients 1 and 2.

A sensitivity and resistance profile for each organism can help suggest whether the MRSA falls into the community-acquired or health care-associated strain. Community-acquired MRSA is generally sensitive to gentamicin sulfate, clindamycin, and trimethoprim-sulfamethoxazole.¹⁵ Naimi et al¹² documented the resistances and sensitivities of MRSA organisms, which they classified based on history into either a community-acquired group or a hospital-acquired group. In the community-acquired group, 79% of the organisms were sensitive to clindamycin, whereas only 21% in the hospital-acquired group were. In the current study, 1 of 4 patients affected was sensitive to clindamycin. This is consistent with recent data that have shown an increased prevalence of clindamycin-resistant MRSA.¹⁶ Similarly,

79% of the cases that were classified as CA-MRSA were sensitive to ciprofloxacin compared with 16% in the hospital-acquired group. Only 1 of 4 patients in the current study was sensitive to ciprofloxacin. In the community-acquired group, 44% were sensitive to erythromycin compared with 18% in the hospital-acquired group. All 4 surgical site infections in the current study had MRSA cultures that were resistant to erythromycin. More than 90% of both groups in the study had cultures that were sensitive to trimethoprim-sulfamethoxazole.¹² Given the overlap in the sensitivity patterns documented in the study by Naimi and colleagues, the pattern of cultures seen in our study suggest the possibility that the cultures could fall into either the community-acquired or the hospital-acquired class. As CA-MRSA becomes less susceptible to available antibiotic regimens, CA-MRSA and HA-MRSA will have sensitivity profiles that will increasingly resemble each other.

SCREENING

With the rise of MRSA colonization and infections, facial plastic surgeons performing rhytidectomy and other soft tissue procedures may want to consider introducing screening protocols to identify patients who are at increased risk for infection. In some medical centers, other surgical specialties have begun implementing MRSA screening on patients before surgery, and they are performing presurgical prophylaxis for MRSA when deemed necessary.

Noting the increased morbidity and mortality associated with MRSA infections in vascular surgery cases, a group of vascular surgeons in the United Kingdom introduced preoperative MRSA screening and treatment. Screening measures included preoperative cultures of the nose, throat, groin, and any existing wounds. After introduction of this screening protocol and appropriate preoperative prophylaxis, MRSA wound infections after surgery in MRSA-positive elective admissions was reduced considerably, from 55.6% to 22.4%. Screening also resulted in a reduction of complications of both elective and emergent procedures. Those cases with MRSA colonization and no clinical infection were treated with mupirocin (Bactroban) nasal ointment 3 times daily and 2% triclosan (Aquasept) washes twice daily for 5 days. Povidone-iodine (Betadine) mouthwash was also used 2 to 3 times daily as gargle for 5 days. Chlorhexidine mouthwash was used in patients with a contraindication to iodine.¹⁷

PREVENTION

During preoperative evaluation, a full medical history should include information on possible prior contacts with persons at high risk for carrying MRSA. Half of the patients in our retrospective review who were MRSA positive had either spent considerable time in a hospital or had close contact with a physician who cares for the chronically ill. Significant risk factors for developing MRSA in soft tissue infections include recent antimicrobial therapy, recent hospitalization, contact with a health care worker, and previous MRSA colonization.¹⁸ Among antibiotics, fluoroquinolones have been found to be a significant risk factor for MRSA isolation.¹⁹ Patients who are in contact with MRSA-

colonized or infected individuals are 7.5 times more likely to be colonized.²⁰ A complete social history will further help to identify patients who are at higher risk of colonization. Other risk factors include increased age, diabetes, smoking, obesity, and prolonged postoperative stay.²¹ Groups with higher incidence of CA-MRSA include athletes, military personnel, prison inmates, men who have sex with men, intravenous drug users, Native Americans, and Pacific Islanders.¹⁹

Because the medical, psychological, and cosmetic sequelae of wound infections can be devastating, every appropriate step should be used to prevent wound infections in facial plastic surgery. Chlorhexidine gluconate (Hibiclens), povidone-iodine (E-Z Scrub 201), and chloroxylenol (ParaSoft) sponge brushes were compared for antibacterial efficacy in 2-minute surgical scrubs. In studying cultures from surgical gloves, it was found that scrubbing with chlorhexidine achieved significantly ($P < .01$) greater bacterial count reductions than did scrubbing with povidone-iodine and chloroxylenol.²² Chlorhexidine is the agent of choice for preoperative showering and scrubbing. In a comparison study, the frequency of positive intraoperative wound cultures was 4% with chlorhexidine, 9% with povidone-iodine, and 14% with medicated soap and water.²³

Proper cleansing of a surgeon's hands between contacts with different patients clearly reduces the incidence of MRSA infections. A plastic surgery unit in Hertfordshire, England, decreased the incidence of MRSA infections after the introduction of alcohol gel application in between clinical patient contacts. As a modern equivalent to a chemical handwash (Chlorina liquida), the personnel of the unit chose alcohol gel, which kills more than 99.9% of transient organisms, including MRSA.^{24,25} It is also important to use a different and new marking pen on each patient for preoperative surgical planning. A recent study investigated 2 commercially available skin marker pens (Penflex; Penflex, Capetown, South Africa, and Viomedex; VIO Healthcare Ltd, Uckfield, England) after contaminating them with a standard inoculum of MRSA. The Penflex marker showed no survival of MRSA after 15 minutes, whereas the Viomedex marker continued to produce MRSA cultures for up to 3 weeks.²⁶

In numerous studies, prophylactic antibiotics have consistently been shown to reduce the incidence of surgical site infection. If systemic antibiotics are administered 3 hours after bacteria have gained access to the tissue, there is no benefit. Systemic antibiotics produce maximum suppression if they are administered before incision is made.²⁷ A randomized study published in the *New England Journal of Medicine* demonstrated that an intravenous dose of antibiotics administered within 1 hour before surgical incision (2 hours for vancomycin) has been associated with lower infection rates.²⁸ In cases lasting longer than the recommended redosing interval for a given antibiotic, it is important to readminister antimicrobial agents, especially cephalosporins. However, because almost all deep-plane face-lifts performed on our patients are completed within 3 hours, we do not need to readminister antibiotics. In known MRSA carriers, vancomycin is the appropriate antimicrobial agent for prophylaxis.²⁹

While all the patients in this study received postoperative antibiotics for 7 days, this action does not agree with the guidelines of the Surgical Care Improvement Project, which is a combined effort by the Centers for Medicare and Medicaid Services and the Centers for Disease Control and Prevention to reduce surgical mortality and morbidity. The guidelines state that the infusion of the first antimicrobial dose should begin within 60 minutes before surgical incision and that the administration of prophylactic antimicrobial agents should be discontinued within 24 hours of the end of surgery. Additional antimicrobial doses administered after wound closure have been shown to have no benefit. This inappropriate use of antibiotics is associated with emergence of resistant bacterial strains.²⁹ Since analyzing the data in the study as well as reviewing the Surgical Care Improvement Project guidelines, the senior author (D.B.R.) has stopped administering postoperative antibiotics.

One preventive approach is to identify MRSA carriers before surgery and to pretreat only these patients. However, some clinicians treat every patient with mupirocin before surgery. Numerous cardiac surgeons and orthopedic surgeons have done away with screening methods and prescribe perioperative prophylaxis with nasal mupirocin. In the study on orthopedic patients, after introduction of this protocol there was a marked decrease in incidence of MRSA surgical site infections (per 1000 operations) from 23.0 in the 6 months beforehand to 3.3 ($P < .001$) and 4.0 ($P < .001$) in subsequent consecutive 6-month periods. Similar results were achieved in patients undergoing cardiac surgery.³⁰⁻³² In the future, as the incidence of MRSA-positive surgical site infections increases, perioperative prophylaxis with nasal mupirocin may become part of the protocol in all surgical fields, including facial plastics. The senior author's practice has recently begun instructing patients to use mupirocin intranasally for the 5 days before surgery.

A controversial method of surgical site infection prevention is the provision of perioperative supplemental oxygen. Two different studies that randomized patients to either 30% oxygen or 80% oxygen during surgery and for at least 2 hours after surgery showed remarkable decreases in the incidence of surgical site infections in the 80% groups.^{33,34} Based on these studies, many hospitals have implemented the use of perioperative supplemental oxygen. As an added note, normothermia and normoglycemia during surgery have been shown to decrease the incidence of surgical site infections.^{35,36} In our practice, warming blankets are used routinely in all facial surgery.

POSTOPERATIVE SURVEILLANCE

The timing of postoperative visits must be carefully selected to ensure appropriate surveillance. After rhytidectomy, all postoperative patients are seen by the senior surgeon on postoperative days 1, 5, 8, 21, and 40; they are specifically examined for signs of infection. If there is any question of infection, any fluid that is expressed from the wound is immediately cultured and Gram stained. In our patient population, the MRSA-positive infections were first noticed and cultured on days 5, 7, 8,

and 21. The non-MRSA wound infection occurred at day 30. Methicillin-resistant *S aureus*-positive infections occur early. After the results of this study, the senior surgeon continues to perform postoperative examinations on days 1, 5, 8, 21, and 40.

Because of the rapid progression of a MRSA-positive surgical site infection, it is important for patients to know the signs of an infection. All of the patients who undergo rhytidectomy are instructed to perform daily inspections of their incisions and to report any discharge, collection, "redness" around the wound site, or increased tenderness. In this manner, patients may be able to aid in the earlier diagnosis and treatment of a surgical site infection.

INCISION AND DRAINAGE

Once MRSA infection is diagnosed after a face-lift, aggressive treatment is advised to prevent rapid progression of the infection. Prompt initiation of appropriate antibiotic therapy, along with incision and drainage, is essential. The cosmetic nature of rhytidectomy may make facial plastic surgeons hesitant to open wounds that have an infected collection. However, openly draining wounds that have collected MRSA-positive material is prudent.

Most patients in the community with spontaneous MRSA abscesses respond to incision and drainage alone. Surgical drainage, rather than antibiotic therapy, is the single most important intervention for these patients. The efficacy of this treatment is supported by a recent study that was published in the *New England Journal of Medicine* involving patients with skin or soft tissue MRSA infections.³⁷ As long as the abscess was drained appropriately, the empirical use of an antibiotic that is ineffective against MRSA did not adversely affect outcome.

The importance of incision and drainage was further demonstrated in a study of immunocompetent children with CA-MRSA skin and soft tissue abscesses smaller than 5 cm. No significant difference in response was observed in the patients who never received an effective antibiotic compared with those who did. The authors concluded that incision and drainage without antibiotic therapy was effective treatment.³⁸ This finding stresses the importance of opening a wound infected with MRSA if a collection exists. Failure to perform incision and drainage can pose serious risks, even in the face of directed antibiotic therapy. In 1 patient with MRSA-positive orbital cellulitis originating from a nasal pustule, incision and drainage was delayed, and the patient developed bilateral blindness.³⁹

ANTIBIOTIC THERAPY

The facial plastic surgeon must be quick to culture any suspicious fluid or discharge. The result of the sensitivity and resistance profile from these cultures will be the ultimate guide for the antibiotic regimen. Prompt culture cannot be stressed enough. The infection can spread rapidly along the surgical dissection site and become extensive in a very brief time frame. This outcome was evidenced by the rapid progression of the infection through

the dissection plane in patient 1. As the infection spreads through the plane, there is a higher likelihood of skin loss and ultimate scarring. Furthermore, the infection can spread to nearby structures, including the eyes.

While cultures are pending, factors that influence which antibiotic to administer include extent of infection, suspicion of health care-associated infection vs community-acquired infection, and institutional susceptibility patterns. Also, the patient's risk factors and comorbidities need to be considered as well. There are no concrete guidelines on what antibiotic to administer for a surgical site infection while cultures and sensitivities are pending. The question of initiating narrow-spectrum antibiotics vs broad-spectrum antibiotics vs agents that cover resistant organisms continues to pose a dilemma for the surgeon. The only antibiotics approved by the Food and Drug Administration for MRSA soft tissue infections are vancomycin, linezolid, daptomycin, and tigecycline. Non-Food and Drug Administration-approved agents that have been effective include clindamycin, trimethoprim-sulfamethoxazole, minocycline, rifampin, and some fluoroquinolones.

While HA-MRSA strains have developed resistance to vancomycin and linezolid, CA-MRSA has a broader susceptibility profile. Community-acquired MRSA is often susceptible to several non- β -lactam drug classes. In a study from an emergency department in Oakland, California, soft tissue infections that were positive for MRSA were 100% susceptible to trimethoprim-sulfamethoxazole, while only 86% were sensitive to tetracycline.⁴⁰ While clindamycin can successfully treat CA-MRSA, its use is discouraged owing to the rapid development of clindamycin resistance.⁴¹ Multidrug-resistant CA-MRSA is rapidly emerging. In Taiwan, CA-MRSA isolates showed a high rate of resistance to clindamycin (93%) and erythromycin (94%). However, 91% were susceptible to trimethoprim-sulfamethoxazole. It is unclear whether the addition of rifampin to trimethoprim-sulfamethoxazole improves treatment outcome, but this combination has been demonstrated to be more effective in eradicating MRSA colonization.⁴² Ciprofloxacin and erythromycin were once thought to be potential treatment options for MRSA. However, recent studies have shown an increasing resistance to both antibiotics.¹⁶

Most physicians prefer the use of vancomycin in any surgical patient with a wound infection that is positive for MRSA. However, the physician has other options based on the culture's sensitivities. Enteral antibiotic therapy is preferred and can prevent complications from intravenous lines. Furthermore, evidence tends to favor the use of linezolid over vancomycin. While vancomycin is only available in intravenous form, linezolid is available orally as well as intravenously. A randomized clinical trial comparing the efficacy of vancomycin and oral linezolid demonstrated a shorter length of hospital stay in patients with MRSA-positive wound infections that were treated with linezolid.⁴³ Linezolid, an oxazolidinone, is an expensive yet well-tolerated antibiotic that is very effective for both refractory MRSA infections and severe soft tissue infections. Oral bioavailability is almost 100%. Two other studies have shown superior cleaning and outcomes with the use of linezolid compared with vancomycin.^{44,45}

Daptomycin and tigecycline are 2 other antimicrobial agents that are approved by the Food and Drug Administration for combating MRSA. Daptomycin has been compared with vancomycin in 2 international, multicenter, double-blind, randomized trials in skin and soft tissue infection treatment.⁴⁶ Using the end point of resolution of clinical signs and symptoms, daptomycin was equivalent to vancomycin in both studies.⁴⁶ Similar results have been found in randomized trials comparing tigecycline with vancomycin plus aztreonam. Cure rates were 78.1% in the tigecycline group compared with 75.8% in the vancomycin plus aztreonam group.⁴⁷

CONCLUSIONS

To our knowledge, this is the first documented retrospective study on the incidence of MRSA-related surgical site infections after face-lift surgery. A future increase in MRSA-positive surgical site infections in face-lift may become a potential deterrent for patients contemplating face-lift. The potential consequence of soft tissue destruction can be devastating to the patient. Knowledge of the incidence of MRSA in postoperative wound infections is important information for the surgeon and the patient. Our rate of MRSA-positive surgical site infections was 4 in 780 face-lift procedures (0.5%). Two of the 4 patients had had contact within the medical field or with a hospital. These infections tend to occur early and are much more aggressive than other spontaneous community-acquired infections. They spread rapidly through planes of dissection. Therefore, any suspicious fluid must be cultured immediately. Early treatment is essential and includes incision and drainage, debridement of any necrotic tissue, and prompt administration of antibiotic therapy based on empirical data and patient/infection profile.

Methicillin-resistant *S aureus*-positive surgical site infection is an increasingly problematic issue in all surgical fields. Methicillin-resistant *S aureus* is now the most common cause of surgical site infections and skin/soft tissue infections. In the future, MRSA-positive infections may be more prevalent and will require well-developed screening, prevention, and treatment strategies. The implementation of screening techniques and prevention measures against MRSA will help reduce the risk of future infections.

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