An Outbreak of Mycobacterium chelonae Infection Following Liposuction

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Among 82 patients who underwent liposuction performed by a single practitioner in a 6-month period, 34 (41%) developed cutaneous abscesses. An organism identified as *Mycobacterium chelonae* by polymerase chain reaction restriction-enzyme analysis was recovered from cultures of samples from 12 of those patients. DNA large restriction-fragment pattern analysis by pulsed-field gel electrophoresis demonstrated that a strain of *M. chelonae* recovered from biofilm in the piped-water system in one of the physician’s offices differed by only 2 restriction fragments from the 12 patient isolates, which differed from each other by 0 or 1 restriction fragment. A detailed retrospective cohort study that included interviews with former employees and statistical analysis of risk factors indicated that inadequate sterilization and rinsing of surgical equipment with tap water were likely sources of mycobacterial contamination. This is the first reported outbreak of nosocomial infection due to *M. chelonae* in which a source has been identified and the first to occur in association with liposuction in patients in the United States.

Infections caused by rapidly growing mycobacteria (RGM) are relatively uncommon [1–13]. Cutaneous infection is the most common presentation [2–4] and, in most cases, follows penetrating trauma [3, 4]. Outbreaks of nosocomial surgical-site RGM infection [4–8], most often due to *Mycobacterium fortuitum* or *Mycobacterium abscessus*, have been associated with cardiothoracic surgery, augmentation mammoplasty, and facial plastic surgery [6–9].

Liposuction is a common cosmetic procedure. Approximately 150,000 liposuction procedures were performed in the United States in 1997 by board-certified plastic surgeons who were members of the American Society for Aesthetic Plastic Surgery (ASAPS) [14]. The tumescent technique (infusion of a dilute solution of lidocaine and epinephrine into the areas to be suctioned) is recommended by the American Academy of Cosmetic Surgery and is used for most procedures in which large amounts of fat (>2000 cm³) are removed [15]. The number of liposuction procedures performed by ASAPS members more than tripled between 1992 and 1997, and there was an additional 50% increase between 1997 and 1999 in liposuction procedures performed by the same board-certified group [14]. These estimates do not include liposuction done by physicians who are board certified in other specialties (e.g., otolaryngology, dermatology, and obstetrics and gynecology) or by physicians who are not board certified. More recent summaries of procedures performed by ASAPS members (only plastic surgeons), as well as by dermatologists and otolaryngologists, are provided on the ASAPS Web site [16].

Complications associated with liposuction procedures have not been studied extensively. Case reports in the literature describe blood loss, intestinal perforation, pulmonary edema, and lidocaine toxicity [17–19]. Infections, including necrotizing fasciitis, rarely have been reported as complications [18–22].
On 12 June 1997, a dermatologist contacted the County of Orange Health Care Agency/Public Health in Santa Ana, California, to report that 3 patients (who had undergone liposuction performed by the same physician) had subcutaneous abscesses suspected of being caused by RGM. An investigation was begun to determine the character, source, mode of transmission, and risk factors for infection.

METHODS

Definition and ascertainment of cases. “Confirmed cases” were those in which the patient had at least 1 skin lesion from which a specimen tested positive for *Mycobacterium chelonae* by culture or, if no organism was recovered on culture, by acid-fast bacilli (AFB) staining. “Clinical (presumptive) cases” were those in which the patient developed papules, nodules, or abscesses in the area of liposuction or contiguous areas that were consistent with RGM infection but for which there was no laboratory confirmation (either because no laboratory testing was done or because the results of laboratory tests were negative.

The physician who performed liposuction on the 3 index case patients provided a list of all patients for whom he had performed the procedure from 1 month before the first identified case through 2 months after the last suspected case known to him (5 December 1996 to 20 June 1997). The County of Orange Health Care Agency contacted patients by telephone and/or mail to determine whether they had lesions consistent with RGM infection. A second contact, at least 6 months after the date of liposuction, was attempted for all patients. Infectious diseases physicians and dermatologists in Orange County were contacted twice by fax, supplied with information on RGM, offered laboratory support, and asked to report any cases of RGM infection that had occurred in the previous year.

Patients identified by the physician who performed the liposuction or the Orange County Health Department as having suspicious lesions were referred to infectious diseases specialists for evaluation. Physicians evaluating these patients were asked to submit biopsy specimens and queried regarding the diagnosis.

Epidemiological study. A cohort study to determine risk factors for infection was conducted. The outbreak period was defined as the first full week through the last full week in which a liposuction procedure was performed for a case patient. Data from all liposuction patients with confirmed or clinical RGM infection were compared to data from patients who underwent liposuction performed by the same physician but did not have any signs of RGM (non-case patients), and data only from patients with confirmed cases were compared with data from non-case patients.

Charts of liposuction patients on the list provided by the physician were abstracted. Risk-factor analysis was done for the following variables: sex, weight, age, amount of fluid aspirated during liposuction, body mass index (weight in kilograms divided by height in square meters), number of liposuction sites, start time of procedure (morning or afternoon), day of procedure, duration of procedure, current medications (as of the time the patient completed a questionnaire before surgery) and specific categories of medications, history of smoking, previous surgery and specific categories of previous surgery, history of chronic health condition(s), attending anesthesiologist, type of anesthesia, specific anesthetic medications used, and time interval between liposuction procedures. The amount of tumescent solution used was not recorded.

Procedural investigation. Site visits were made to the 2 offices used by the physician during the outbreak; the physician had changed offices in early May 1997. The physician and current and former employees of the physician were interviewed regarding infection-control practices and liposuction procedures. The County of Orange Health Care Agency, Environmental Health division, was contacted for information about the source of potable water for the 2 offices used by the physician.

Laboratory studies. Patient specimens submitted as swabs, needle aspirates, tissue biopsy samples, or culture isolates were forwarded to the County of Orange Public Health Laboratory by hospital or reference laboratories. Environmental samples from air-handler filters and water-faucet plumbing and samples of room dust, soil, and tap water were obtained from the physician’s vacant former office on 22 July 1997 and 23 September 1997. Samples from liposuction equipment and water-faucet plumbing and samples of cleaning and disinfecting solutions, irrigation water, tap water, and dust were obtained from the physician’s new office on 16 July 1997, 1 August 1997, and 4 November 1997. Opened multiuse vials of lidocaine and epinephrine were collected for culture on 1 August 1997.

All specimens were cultured by standard methods. Isolates were identified by standard methods [23] and by PCR restriction-enzyme analysis of the 65-kDa hsp gene [24, 25] and were shown by high-pressure liquid chromatography to have typical mycolic acid patterns [26].

Antimicrobial susceptibility was determined by the agar-disk elution method and broth microdilution for selected isolates [27, 28]. Genomic DNA large restriction-fragment patterns from outbreak *M. chelonae* isolates and from 6 control community isolates (i.e., *M. chelonae* or *M. abscessus* recovered from patients with unrelated cases of respiratory tract infection) were compared by pulsed-field gel electrophoresis. Genomic DNA was digested with *Dra*I and *Xba*I and separated by use of a CHEF-DRII system (Bio-Rad) [29, 30]. Isolates were characterized as “indistinguishable” (identical), “closely related,”
“possibly related,” or “different,” using criteria published elsewhere [31].

**Statistical analysis.** Student’s t test was used and P values were calculated for continuous variables. P <.05 was considered significant. Risk ratios and 95% confidence intervals were calculated for categorical variables. Categorical variables were created for 4 continuous variables (body mass index, interval between liposuction procedures, duration of procedure, and time of procedure) to calculate risk ratios. These analyses were done with Epi Info (version 6.04b; Centers for Disease Control and Prevention). Discriminant analysis (SPSS-PC+, version 4.0) was conducted to determine the predictive value of selected variables.

**RESULTS**

**Description of Case Patients**

Eighty-two patients (58 female and 24 male) underwent liposuction performed by 1 physician between 16 December 1996 and 1 June 1997. Seventy-three procedures were performed in the old office and 9 in the new office. Twelve patients had additional cosmetic procedures, such as laser treatments, blepharoplasty, and augmentation mammoplasty. Of the 34 case patients, 14 met the definition for a confirmed case (positive culture results for 12 patients and positive results of AFB stain only for 2 patients), and 20 met the clinical case definition. The liposuction procedure was performed in the old office for 32 and in the new office for 2 of the case patients (infection was confirmed for 1 of those 2 case patients only by AFB stain, and 1 had a clinical case).

Lesions (figure 1) occurred in areas of liposuction or contiguous areas, usually not at incision sites, and ranged in diameter from 0.5 to 7 cm. Most case patients had multiple lesions (mean diameter, 15–20 cm). The lesions were pink, red, or purple subcutaneous nodules; most were nonpruritic and not painful. Some lesions drained spontaneously. Few patients reported fever. Case patients who had multiple cosmetic procedures concurrent with liposuction had lesions only in the area of liposuction. The estimated incubation times from liposuction to the appearance of the lesions ranged from 2 to 20 weeks (median, 4 weeks).

Only 1 RGM skin infection not associated with this outbreak was discovered during the investigation. This patient had liposuction in an adjoining county. The isolate was reported to be *Mycobacterium fortuitum*.

**Epidemiological Study**

The outbreak period used for the cohort study was 16 December 1996 to 1 June 1997 (figure 2). Of the 48 non-case patients who underwent liposuction during the outbreak period, 39 reported no lesions at least 6 months after liposuction and were included in the analyses. Nine patients (6 women and 3 men) were excluded from the analysis because they had lesions of indeterminate origin that were not diagnosed (n = 4), they were available for <6 months of follow-up (n = 1), they did not respond to multiple attempts at contact by letter and telephone (n = 3), or they could not be located (n = 1).

The men in the cohort were significantly older than the women and had significantly higher weight and body mass index and statistically significantly fewer liposuction sites (data not shown). The attack rate among the 82 members of the cohort was 41.5% (34 of 82). The outbreak curve is shown in figure 2.

**Univariate analyses.** Results of univariate analyses of identified risk factors are given in table 1. Statistical analyses of potential risk factors were performed for case patients with confirmed cases versus non-case patients and for all case patients (confirmed and clinical cases) versus non-case patients. The results were essentially equivalent, indicating that the clinical case definition was valid. Female sex, lower body weight, longer duration of procedure, and higher number of liposuction sites were all highly statistically significantly associated with infection (P < .01). Patients who had procedures that lasted >2.75 h were at significantly higher risk than were patients with shorter-duration procedures. Duration of the procedure did not differ significantly between men and women (t = 1.75; P = .084). Two anesthesiologists attended 94% of the cohort patients; the attack rate did not vary significantly between patients attended by these 2 anesthesiologists.

**Stratified analyses.** Stratified analyses of the same variables were done to determine whether confounding or effect modification by sex occurred. The relationship between weight and duration and number of liposuction sites and infection remained significant for women but not significant for men.

**Discriminant analysis.** Discriminant analysis was conducted for all variables that were found to be significant by univariate analysis, for age, and for body mass index. The best predictor was number of liposuction sites, followed by duration of procedure and then weight (which was inversely associated with risk of infection). These 3 variables resulted in correct prediction of case status for 70% of patients.

**Site Visits and Interviews**

The physician reported having completed a residency in oto-laryngology and facial plastic surgery and having performed liposuction for 12 years. The physician was not board certified in these specialties.

The physician had moved to a new office in early May 1997 for reasons unrelated to the outbreak. At the time of the site visits, the physician had voluntarily ceased performing liposuction in the new office, and the old office was vacant. A surgical technician who had been employed by that physician...
for 1 year left in January 1997, approximately the time that the first case occurred. A second surgical technician started working for the physician on 13 March 1997. Neither surgical technician had any formal training in operative techniques or infection control.

Povidone iodine was used for patient skin preparation. The tumescent solution was instilled from 1-L bags of normal saline or lactated Ringer intravenous solution into which had been injected 15 mL of a solution of 20 milligrams of lidocaine per milliliter of water and 1 mL of a solution of 1 milligram of epinephrine per milliliter of water. The pharmaceutical companies supplying these medications and solutions had not
changed before or during the outbreak period. Multidose vials were used for epinephrine (30-mL bottles) and lidocaine (50-mL bottles).

The tumescent solution was attached to a 1-way pump by urologic tubing. A second tube ran from the pump to the infusion handle, which was attached to an infusion cannula. At an unknown date before the outbreak, the technique for disinfecting the infusion handles was changed from autoclaving to soaking in glutaraldehyde, although one employee reported that the tumescent solution infusion handles were not sterilized but only washed in dishwashing liquid and rinsed with tap water. Tumescent solution remaining at the end of a procedure was left hanging with its tubing until the next procedure, even if the next procedure was not for several days. The employees were instructed to clean the outside of the tumescent solution tubing with alcohol.

Liposuction was performed by use of suction cannulas of varying sizes (2.5–6 mm) attached to a metal handle joined to 9.53-mm tubing, which was attached to the first of 2 large glass bottles of a free-standing suction machine. Both the 9.53-mm liposuction tubing and the urologic tubing used for infusion of the tumescent solution were reused on a regular basis and, reportedly, were retrieved at times from the trash. The 9.53-mm tubing attaching the liposuction cannula to the suction machine was washed with a detergent solution, rinsed with tap water, and dried in ambient air.

No biological testing of the autoclave appeared to have been done until some time after the outbreak began, at which point, reportedly, it was done at monthly intervals. On one site visit, the autoclave was noted to be overfilled. The physician reported taking surgical towels home to wash in a personal laundry machine.

### Laboratory Results
Twenty-three patients had 1–6 samples submitted for culture. *M. chelonae* was isolated from samples from 12 patients (a total of 14 isolates). No other mycobacteria were isolated from pa-

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**Table 1. Univariate analyses of identified risk factors for infection for patients who underwent liposuction performed by a single physician at some point from 6 December 1996 to 1 June 1997.**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>No. of patients</th>
<th>RR (95% CI) or t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cases</td>
<td>73</td>
<td>4.17 (1.43–12.18)</td>
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</tr>
<tr>
<td>Confirmed cases only</td>
<td>53</td>
<td>RR undefined</td>
<td>.002a</td>
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<tr>
<td>Lower body weightb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cases</td>
<td>70</td>
<td>3.08</td>
<td>.0035</td>
</tr>
<tr>
<td>Confirmed cases only</td>
<td>51</td>
<td>2.69</td>
<td>.0098</td>
</tr>
<tr>
<td>Higher no. of liposuction sites</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All cases</td>
<td>73</td>
<td>4.33</td>
<td>.000047</td>
</tr>
<tr>
<td>Confirmed cases only</td>
<td>53</td>
<td>3.49</td>
<td>.000995</td>
</tr>
<tr>
<td>Longer duration of the procedure</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All cases</td>
<td>71</td>
<td>3.57</td>
<td>.00065</td>
</tr>
<tr>
<td>Confirmed cases only</td>
<td>51</td>
<td>4.15</td>
<td>.00013</td>
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<tr>
<td>Hormone treatmentc</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>All cases</td>
<td>62</td>
<td>1.96 (1.15–3.34)</td>
<td></td>
</tr>
<tr>
<td>Confirmed cases only</td>
<td>48</td>
<td>2.71 (1.09–6.76)</td>
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<tr>
<td>Previous abdominal surgery</td>
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<tr>
<td>All cases</td>
<td>63</td>
<td>1.65 (1.02–2.65)</td>
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<tr>
<td>Confirmed cases only</td>
<td>44</td>
<td>1.90 (0.75–4.86)</td>
<td></td>
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<tr>
<td>Previous cosmetic surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cases</td>
<td>65</td>
<td>1.94 (1.20–3.12)</td>
<td></td>
</tr>
<tr>
<td>Confirmed cases only</td>
<td>46</td>
<td>2.67 (1.09–6.50)</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE.** "All cases" includes patients with confirmed and clinical cases and non-case patients for whom data were available. The maximum potential no. of patients was 82.

a Calculated using Fisher’s exact test.

b Weight was inversely associated with risk of infection.

c Includes all therapeutic uses of female hormones, including contraception and hormone replacement.
Figure 3. Pulsed-field gel electrophoretic patterns of Mycobacterium chelonae isolates from Orange County, California. Chromosomal DNA was digested with DraI. Lane 1, λ DNA standard; lane 14, yeast DNA standard. Lanes 2–6, patient isolates obtained after liposuction. Lanes 7 and 8, environmental water-faucet isolates. Lanes 9–13, control strains of M. chelonae or Mycobacterium abscessus. A single extra band is noted in the patient isolates in lanes 5 and 6, whereas a 2-band difference is noted in the environmental isolates in lanes 7 and 8.

DISCUSSION

This large outbreak of cutaneous abscesses due to M. chelonae infection following liposuction was associated with a single physician. Isolates from the 12 patients with culture-confirmed cases and an environmental isolate collected from the faucet plumbing in the physician’s old office differed by only 1–2 restriction bands, which supports the hypothesis that M. chelonae was transmitted to these patients from the potable water system.

The investigation found multiple possible routes of transmission: reuse of liposuction tubing after rinsing in tap water, inadequate disinfection of the infusion handle for the tumescent infusion solution or failure to disinfect at all after rinsing in tap water, and inadequate sterilization of surgical equipment by autoclave after rinsing in tap water. Lidocaine is known to have some antibacterial properties when it is used at high concentrations, and it is possible that this was believed to provide some protection against infection. At the low concentrations used in the tumescent solution, however, lidocaine is not likely to have any antimicrobial properties. Glutaraldehyde may have been used as a disinfectant. The effectiveness of standard concentrations (2%) of glutaraldehyde in inactivating some RGM has been questioned [32, 33], and the disinfectant is effective only if used according to manufacturer’s instructions. Inadequate patient records, lack of any recording of equipment and disinfectant use, changes in personnel and practices over time, and lack of an opportunity to observe a liposuction procedure being performed by the physician impeded the ability to distinguish among these potential routes of transmission. Other factors that may have contributed to this outbreak include the use of a regular medical office (i.e., an examination room, rather than a physician’s office).
than a true surgical room or suite), rather than a licensed surgical center, for these procedures and lack of formal training in surgery or infection control on the part of the surgical technicians employed by the surgeon.

Outbreaks of nosocomial infection due to *M. chelonae* are relatively rare; most outbreaks of nosocomial RGM infection are, reportedly, caused by *M. fortuitum* and *M. abscessus* [6–13, 29, 30]. For the latter 2 species, tap water or distilled water has been the source most often identified [9, 29, 30]. This is the first outbreak of nosocomial infection due to *M. chelonae* in which a source has been identified; it was demonstrated that tap water is also a likely source for this species.

Liposuction is an increasingly common outpatient procedure. This is the first report of an outbreak of RGM infection following liposuction in the United States. Only 1 other such outbreak, in Venezuela in 1998, has been documented [34]. How often sporadic cases of disease caused by RGM occur as a result of liposuction is unknown.

Meticulous attention to infection control and proper sterilization are essential in the prevention of nosocomial RGM infections. Recognition that tap water, ice, ice machines that use tap water, and opened containers of distilled water are not sterile and are potential reservoirs for RGM is also important [9, 29, 30]. Although this outbreak appears to have been caused by multiple departures from standard practice, many physicians, including those trained in surgery, may not be familiar with sterilization practices and may have relied throughout their training on hospital central supply departments for assurance that equipment and instruments are adequately cleaned and sterilized. As more surgical procedures are performed in outpatient settings, independently of hospitals and hospital systems of equipment processing, it is critical that physicians fully understand and take responsibility for the proper methods of infection control and sterilization.

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