Occult Surgical Glove Perforations in Otolaryngology–Head and Neck Surgery

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- With the advent of the acquired immunodeficiency syndrome crisis, it has become imperative that all surgeons minimize their risk of direct contact with the patient’s body fluids. In the course of performing surgery, perforations are frequently created in surgical gloves, which often go unnoticed. This study determined the frequency with which occult glove perforations occurred in 134 consecutive head and neck surgical procedures. One thousand fifty gloves (650 gloves used in surgery; 400 unused control gloves) were analyzed for the presence of perforations large enough to permit the passage of fluid. An unrecognized glove perforation was detected in 25% of surgical cases. The duration of surgery correlated strongly and positively with the incidence of perforation. Perforation rates varied widely for specific types of procedures, and are reported for each of the five subdivisions within otolaryngology–head and neck surgery. The implications of these results are described, and recommendations for the use of protective measures, especially in reference to the use of double-gloving, are made.


Contamination across surgical barriers is a bidirectional problem. The introduction of infective agents into the surgical site may lead to a wound infection. Conversely, direct exposure of the surgical team to the patient’s body fluids may result in life-threatening, and even fatal infection. Given the increasing prevalence of the human immunodeficiency virus (HIV) in the general population, as well as the well-recognized risk of hepatitis B, it has become increasingly important for all surgical personnel to minimize their exposure to potentially infective fluids. Protective barriers available to the surgical team include: (1) intact skin, (2) gown, mask, and cap, (3) drapes, (4) eyeglasses, goggles, and face shields, and (5) surgical gloves.

In the course of performing surgery, perforations are inevitably created in surgical gloves, and frequently go unnoticed. This study determined the frequency with which occult glove perforations occurred in 134 consecutive head and neck surgical procedures. The efficacy of double-gloving and use of heavy-duty “orthopedic-type” gloves, as well as perforation rates for the five major subdivisions within otolaryngology–head and neck surgery are presented. Finally, the relevance of these findings is described, and recommendations designed to help surgeons minimize their risk of exposure and possible infection are made.

MATERIALS AND METHODS

A total of 1050 latex surgical gloves comprised the materials of this study. Four hundred of the gloves were unused control gloves, and the remaining 650 gloves were collected from all operating room personnel at the end of 134 consecutive head and neck surgical procedures. All gloves were tested according to the method set forth by the American Society for Testing and Materials. Each glove was filled with 300 ± 25 mL of water, and twisted securely at the cuff. The palm and each finger were then compressed individually, and perforations were easily observed by the production of a fine stream of water. This method has been shown to be 80% effective in demonstrating holes purposely made by a 25-gauge needle, and 100% effective in demonstrating holes made by a 23-gauge needle. Clinical data were recorded for each of the 650 gloves worn in surgery.
Table 1.—Data Recorded for Each Glove Used in Surgery

<table>
<thead>
<tr>
<th>Number of perforations</th>
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</thead>
<tbody>
<tr>
<td>Site of perforation on glove</td>
</tr>
<tr>
<td>Inner or outer glove</td>
</tr>
<tr>
<td>Wearer: faculty, resident, student, or staff</td>
</tr>
<tr>
<td>Wearer: surgeon, assistant, or nurse</td>
</tr>
<tr>
<td>Duration of procedure</td>
</tr>
<tr>
<td>Elective or urgent procedure</td>
</tr>
<tr>
<td>Procedure performed</td>
</tr>
<tr>
<td>Dominant or nondominant hand</td>
</tr>
<tr>
<td>Brand and type of glove</td>
</tr>
<tr>
<td>Human immunodeficiency virus status: known positive, ± risk factors</td>
</tr>
</tbody>
</table>

and included the identity of the wearer, presence or absence of perforations, and time and type of case (Table 1). All data were tested for significance using χ² analysis, except for the correlation between case duration and risk of glove perforation, which was proved using a two-tailed t test.

Urgent procedures were defined as cases that had not been scheduled on the previous day. Many of these occurred under hurried conditions or late at night, when the surgical team may not have been able to give full attention to avoiding accidental exposure. In six of 134 cases, glove perforations were noticed intraoperatively. These gloves were changed immediately, and thus are not included in this study.

RESULTS

Control Gloves

Four hundred unused gloves were tested for the presence of perforations. Eight of these, or 2%, had at least one hole. One (0.25%) of 400 gloves had two holes.

Experimental Gloves

At least one glove perforation that went unnoticed at surgery was found in 13 of 134 consecutive cases. Thus, in 25% of all cases, at least one occult perforation occurred. Of 650 gloves tested, 49 (7.5%) had at least one unrecognized perforation.

The average duration of all cases was 62.6 minutes. The average duration of the 101 cases without perforations was 43.3 minutes, whereas the 33 cases with occult perforations lasted an average of 121.7 minutes. Thus, the duration of the case correlated strongly (P < .001) and positively with the risk of glove perforation.

Procedures were divided among the five major subdivisions within otolaryngology—head and neck surgery, as set forth in the classification scheme used for certification by the American Board of Otolaryngology (Figure). The rate of perforation was 10% for otology, 50% for head and neck surgery, 19% for general otolaryngology, 10% for endoscopy, 12% for facial plastic and reconstructive surgery not involving use of metal wires, screws or plates, and 100% for facial plastic and reconstructive surgery cases in which metal implants were used. Perforation rates were significantly higher than the mean for head and neck surgery (P < .01), and facial plastic and reconstructive cases using metal implants (P < .001), lower than the mean for otologic (P > .20), endoscopic (P > .20), and general otolaryngology (P > .30) cases.

Fourteen cases designated as facial plastic and reconstructive surgery procedures involved the repair of traumatic injuries. In these procedures, 16 (28%) of 58 gloves were found to have holes. In the seven cases that involved the use of metal plates and screws to repair fractures, or of arch bars and wires to attain mandibulomaxillary fixation, 14 (37%) of 38 gloves had perforations. Furthermore, in these seven cases, eight (66%) of the 12 people who wore only one pair of gloves had perforations through the gloves to the skin. Conversely, two (29%) of seven subjects who double-gloved for these cases had perforations through both gloves to the skin. The statistical difference between perforation rates for these single and double glove wearers was significant (P < .05). Interestingly, four of the five people who double-gloved and did not have inner glove perforations did have a hole in an outer glove. For these people, double-gloving spared them from possible direct contact with the patient's body fluids.

Seventeen cases were recorded as urgent procedures according to the criteria listed above, and an occult glove perforation was discovered in nine of these (53%).

The majority of perforations (75%) occurred on the nondominant hand; surgeons, and especially nurses, were most likely to perforate the nondominant thumb. Heavy duty, "orthopedic-type" gloves were worn only in cases involving the repair of traumatic injuries, all of which employed the use of metal implants. Perforations were discovered in five of nine pairs of "orthotype" gloves, compared with three of three pairs of regular single gloves, six of seven pairs of regular outer gloves, and two of seven pairs of regular inner...
gloves. Thus, the use of heavy-duty surgical gloves was not associated with a significantly different perforation rate than wearing regular surgical quality latex gloves ($P > .20$).

Finally, six occult perforations were demonstrated in the 16 cases in which the patient was known to be positive for HIV, or to have risk factors strongly associated with HIV infection. The perforation rate for this group was not significantly different from that in patients with no known infection or risk factors ($P < .20$).

**COMMENT**

There is no question that the prevalence of HIV infection has increased dramatically in the general population. In a 1988 study of inner city emergency department patients, Keilen et al. found that 5.2% of all patients and 4% of patients with unknown HIV status were seropositive for HIV. Furthermore, the interval between exposure and the development of clinical signs and symptoms of HIV infection can be several years. Given these facts, it has become imperative for surgical personnel, who come into contact with patient body fluids on a daily basis, to observe universal precautions for prevention of transmission of HIV, hepatitis B virus, and other bloodborne pathogens.

Transmission of HIV has been shown to occur not only through sexual intercourse, needlestick, and contaminated blood transfusion, but from contact of infected fluids with mucous membranes and nonintact skin as well. It has even been postulated that transmission could occur through intact skin by way of the epidermal Langerhans cell, a normally occurring cell that functions to present antigen to T lymphocytes. Skin exposure to the patient's body fluids occurs frequently in surgery, as emphasized by Sim and Dudley who determined that blood staining was present on surgeon's fingers in 20% of operations lasting 2 hours or longer, even if no defect in the glove had been identified.

The fact that accidental injuries to the operating team are inevitable also underscores the need for surgical personnel to take all reasonable precautions to avoid body fluid exposure. Hussain et al. studied 2016 consecutive general and subspecialty surgical operations and found that accidental injury to the operators occurred in 5.6% of cases. Ninety-five percent of these injuries were needlesticks, 4% were knife cuts, and one was a cautery burn. The study concluded that not only were such injuries unavoidable, but that they were most likely to occur at night, and during wound closure. In this study, perforations were more than twice as frequent in urgent cases (53%) than in scheduled, elective cases (21%). Procedures in which glove perforations occurred (average length approximately 2 hours) were over twice as long as cases in which no perforation occurred (average length approximately 45 minutes). Therefore, we would add both urgency and duration of the case to the list of factors that compound the risk of injury to the surgical team. Furthermore, even in cases where the patient was known to be positive for HIV or have strong risk factors for HIV infection, our study found no significant difference in the incidence of glove perforations. One must conclude that accidental injuries are unavoidable, even in the presence of known HIV infection.

It has been shown, however, that intact latex surgical gloves are an effective mechanical barrier against the passage of human immunodeficiency viruses. Dalgleish and Malkovsky subjected six different brands of latex surgical gloves to severe compression tests and found no penetration of HIV through the gloves as measured by reverse transcriptase assays. While some authors have argued that intact vinyl gloves are equal to latex as a mechanical barrier, most studies have shown latex to be a superior material.

Two percent of control gloves (unused gloves) were found to have perforations in this study. This compares favorably with previous reports that cited the incidence of holes in unused gloves as 1.1% to 11.6%. The overall glove perforation rate of 8.5% (Table 2) was also lower than previously published articles, and may reflect the fact that certain of the subdivisions within the diverse field of otolaryngology—head and neck surgery had very low puncture rates (Figure).

The glove perforation rate for otolaryngologic trauma cases (28%) emphasizes that these procedures carry an increased risk of injury to operating personnel, especially when metal implants are required (37% of all gloves were perforated). The risk to the surgical team is compounded by the fact that the trauma patient population is characteristically at a higher risk of HIV infection than the general population. Double-gloving protected four subjects in our study from direct exposure to the blood of trauma victims. Although this number is small, other authors have also shown the wearing of a second pair of gloves to be protective. In a series of 290 orthopedic cases, McLeod reported perforations in 19% of outer gloves, but only 6% of inner gloves.

Our study also showed no significant advantage in the use of heavy-duty or "orthopedic-type" surgical gloves. An inherent bias in this finding is that this type of glove was only selected in procedures in which the surgeons believed they were at high risk of glove puncture, such as mandibulomaxillary fixation with circumdental arch bar wiring. It is now our preference to double-glove using the heavy-duty gloves as an outer pair during such procedures.

In the course of performing surgery, accidental injuries to members of the operating team are inevitable. With the increasing prevalence of HIV-positive persons in the hospital population,
however, it is imperative for surgical personnel to take all reasonable steps to avoid contamination and possible infection. Double-gloving is recommended whenever it is feasible, and is especially vital in urgent procedures, cases likely to last 2 hours or more, and procedures where bone fragments and metal screws, plates, and wires may be involved. Additionally, gloves should be changed after every 2 hours of continuous surgery, even if no perforations are noticed. Whenever possible, blunt instrumentation should be favored over sharp. Finally, double-gloving should be considered mandatory when the patient is known to be positive for HIV, or have strong risk factors associated with HIV infection.

References

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