NEEDLESTICK INJURIES AT OPERATIONS FOR TRAUMA

ARE SURGICAL GLOVES AN EFFECTIVE BARRIER?

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Surgeons are at risk from both hepatitis B and human immunodeficiency viruses. While vaccines have been developed against the former, barrier methods remain the mainstay of protection. Puncture wounds of the hand are a potential source of contamination; the protection afforded by surgical gloves has been investigated.

Gloves from 280 orthopaedic operations for trauma were tested for perforations; one or more was found after 30% of the operations in gloves worn by the surgeon or scrub nurse. About 60% of the perforations were noticed at the time of penetration and most affected the dominant thumb and index finger. Puncture was more common during operations lasting more than one hour. The incidence of perforation was 19%, for the outer of double gloves, 14%, for a single glove and 6% for the inner of double gloves. These results indicate that surgical gloves function poorly as a protective barrier, especially in difficult, lengthy, fracture surgery. The practice of double-gloving confers increased but not absolute protection.

Gloves were introduced into surgical practice less than a century ago. The first pair of rubber gloves were manufactured by the Goodyear Company, for William Halstead in 1890, to protect his scrub nurse from mercuric chloride dermatitis (Halstead 1924). The use of surgical gloves gradually became more widespread, principally to protect surgical staff whilst operating on patients with infections (Robb 1894). By 1900 attention had focused on the role of sterile gloves in protecting the wound from microbial contamination. A number of authors have confirmed their value in this regard but have been unable to relate glove perforations to increased risk of wound infection (Walter and Kundsin 1969; Ritter, French and Eitzen 1976; McCue, Berg and Saunders 1981).

The function of gloves to protect surgical staff received little attention until the emergence of the acquired immune deficiency syndrome (AIDS). Present day surgeons and nurses are at risk mainly from the viruses of hepatitis B and AIDS, which have similar epidemiology (MMWR 1987). Contaminated blood is known to be the source of infection and though eye contact is possible, the greatest risk is from skin puncture, specifically 'needlestick' injury to the hands.

Fracture surgery is frequently carried out on 'high risk' patients and involves the handling of bone fragments and many instruments. It was thus appropriate to investigate glove perforations at the trauma unit of the Royal Infirmary, Edinburgh, in an attempt to determine the protective efficiency of single and double gloves.

MATERIALS AND METHODS

A total of 777 pairs of Regent surgical gloves used by orthopaedic surgeons and scrub nurses in 280 operations in the operating theatre of the trauma unit were examined. Surgeons had used 189 single and 91 double pairs of gloves, 154 single and 126 double pairs of gloves had been used by scrub nurses. Personal preference determined single- or double-gloving.

Perforations were identified by placing 500 ml of water inside each glove at the end of each procedure and applying pressure by twisting the glove cuff through 360°. A fresh pair of gloves was worn while this test was done; these were subsequently examined as the controls. A perforation in the glove detected by this test was recorded as overt if it had been perceived by the original wearer and covert if not. Records were kept of the nature of the operation and its duration, the seniority of the surgeon, the use of single or double gloves and whether any perforation had been noticed. All operations had been performed by one of seven surgeons, all right-handed: two consultants, two senior registrars and three registrars.

RESULTS

Of 1,554 gloves examined, 89 single or outer of double gloves were found to be perforated (66 worn by surgeons, 23 by scrub nurses). This implied a breach of the glove
barrier in 30% of the operations (Fig. 1). Fifty-three of these perforations had been perceived by the wearer; this usually implied that the skin had been punctured. Sixty of the perforations affected the right (dominant) thumb or index finger (Table 1).

Forty-two outer double gloves had been perforated; in 14 of these, all perceived by the wearer, the inner glove had also been penetrated. The incidence of perforation of an outer double glove was 19% of a single glove 14% and of an inner double glove 6%. Of single glove perforations, 74% had been noticed (overt) compared to 43% for double gloves (p < 0.01). There were no perforations in 100 control gloves.

The duration of the operation was directly related to glove perforation (Fig. 2): 77% of the perforations occurred in operations taking more than one hour (p < 0.001). Two-thirds of the glove perforations occurred in operations for interlocking nailing, AO fracture fixations, hip arthroplasty and compression screwing of the hip. Gloves worn by consultants were more frequently perforated than those worn by junior surgeons (Fig. 3) (p < 0.001).

**DISCUSSION**

In 30% of the operations in an orthopaedic trauma theatre either the surgeon or the scrub nurse have perforation of a glove, placing that individual at risk of contact with contaminated blood. Perforation rates of up to 20% have been reported in investigations of the role of gloves in wound infection (Walter and Kundsin 1969; Ritter et al. 1976; McCue et al. 1981). Reports from general surgical sources suggest up to 40% of gloves are perforated at major operations (Lafferty and Wyatt 1987; Sim and Dudley 1988) but there are few detailed studies of this problem (Cobb 1987).

Perforation of a glove was noticed at the time in 60% of our series; this implies skin puncture. Hepatitis B and HIV can be contracted by such needlestick injury and it is known that hepatitis B virus is readily spread in this manner, seroconversion being documented in 6 to 30% of such contaminated injuries (MMWR 1985). Hepatitis B antibodies are frequently found in surgeons; medical personnel form a significant proportion of sufferers (Lancet 1980; Callender, Whyte and Williams 1982; Cobb 1987). Both active and passive immunisation for hepatitis B is available but information regarding vaccination of surgical staff is scant. Initial fears regarding the safety of the vaccine seemed unfounded (Zuckerman 1984) and a genetically engineered vaccine is now available.

HIV is estimated by the American Centre for Disease Control to be one hundred times less virulent than hepatitis B virus; less than 1% of contaminated needlestick injuries will result in seroconversion (MMWR 1987). One health care worker contracted hepatitis B infection following needlestick injury during a transbronchial biopsy on a patient with AIDS but had no evidence of HIV infection 15 months later (Gerberding et al. 1985). However, several cases have been reported of health care workers who have documented HIV seroconversion following needlestick injury without other risk factors (Lancet 1984; Neisson-Vernant et al. 1986; Oksenhendler, Harzic and Le Roux 1986; Stricof and Morse 1986; MMWR 1987). Three patients have seroconverted from a total of 737 who suffered HIV contamination needlestick injuries and were studied prospectively (Henderson et al. 1986; McCray 1986; Gerberding et al. 1987; McEvoy et al. 1987). Other health care workers, including a Danish surgeon who died in 1977, have been reported to be seropositive, but were not demonstrated to have converted as a result of contact (Bygbjerg 1983; McEvoy et al. 1987).

While the available evidence suggests that the occupational risk of AIDS is low, it is appropriate to consider precautions. High-risk screening for hepatitis has been shown to be of little value in identifying infected patients (Maynard 1978; Cobb 1987). There is no reason to expect selective screening for HIV to be more effective and this is further complicated by delay in seroconversion and ethical issues. There may be a case for regarding all trauma patients as high risk. The routine use of double gloves, eye cover and impermeable gowns seems to be indicated in prolonged and difficult fracture surgery; there is some evidence that heightened

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**Table 1. Site of glove perforations**

<table>
<thead>
<tr>
<th></th>
<th>Right hand</th>
<th>Left hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thumb and index</td>
<td>60 *</td>
<td>11</td>
</tr>
<tr>
<td>Ulnar fingers</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Palm</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cuff</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
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* includes six with multiple perforations

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**Fig. 1**

Number of perforated gloves, those not perceived are shaded.
awareness can reduce the incidence of glove perforation (Walter and Kudsin 1969). No touch technique has been suggested by Sim and Dudley (1988) but this would be impossible when dealing with complex fractures.

The use of double gloves does improve the protective barrier. Fewer perforations were perceived when wearing double gloves and of 42 perforations of outer gloves, only 14 had penetrated the inner glove as well. However, the 6% incidence of breaching of both the outer and inner gloves suggests that improvements in glove materials and design, including selective reinforcement, could contribute to reducing the occupational risk to surgical staff.

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