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Cardiac Surgical Procedures and Glove Reinforcements

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SUMMARY

The purpose of this prospective study is to determine the frequency and site of glove perforation during cardiac surgical procedures. Over a period of six months, gloves from 206 surgical team members were collected at the conclusion of surgery. All cases of known perforations were eliminated from the study. The percentage of glove perforation was 14%. The distribution of perforation across locations of the hand was significantly unequal (P = 0.001). We found that 73% of the punctures occurred in one of four contiguous locations on the glove: the radial side of the index finger (28%), the radial side of the thumb (21%), the palmar side of the index (14%), and the palmar side of the thumb (10%). Therefore, we recommend glove reinforcement on these locations that would provide better protection against transmission of infectious agents. Discomfort from restricted dexterity and impaired sense of touch with double gloving renders glove reinforcement a suitable alternative for universal precautions, especially in cardiac surgery while high level of perfection and dexterity were needed in lengthy, critical operations.

INTRODUCTION

In 1889, William Halstead of Johns Hopkins Hospital introduced gloves into the surgical arena to protect the surgeon's hands from the toxic chemicals used in the operative procedures. In 1890, he arranged to have the Goodyear Rubber Company produce two pairs of rubber gloves for use in surgical procedures. The gloves were designed for Halstead's operating nurse, Caroline Hampton, to protect her hands from irritation by the disinfectant mercuric chloride. Halstead himself used gloves with holes for the thumb and index finger. His protégé, Joseph Colt Bloodgood, was the first to show that postoperative infection rates were dramatically reduced when all members of the surgical team wore gloves [Hanen 1998].

Today surgical gloves have become an important part of the barrier to the passage of microorganisms between the surgeon and the patient. An intact barrier prevents the possibility of transmission no matter how infrequently it might occur in its absence. The possible risk of transmission of lethal blood-born pathogens, such as hepatitis B virus (HBV), the hepatitis C virus (HCV), and the human immune deficiency virus (HIV) from infected patients to operating theatre personnel, has focused attention on the reliability of intact surgical gloves in preventing contact with the patient's body fluids. Neither HIV virus particles could penetrate intact rubber gloves, nor is there evidence that HBV, HCV, and HIV can pass through intact skin. Needle stick inoculation injury is usually recognized and carries a risk of seroconversion of approximately 0.2% from HIV seropositive patients and about 25% from HBe antigen positive patients [Eckford 1997]. Simple skin contamination through glove perforation is considerably more common than inoculation injuries. It is associated with significantly lower risk of seroconversion [Eckford 1997]. Although intact skin surfaces are considered effective barriers against HIV, minor cuts and abrasions are frequently overlooked. Exposure to blood from HBe antigen carriers involves a significant risk of transmission for the non-immune even with apparently intact skin surfaces [Eckford 1997]. The surveillance of HIV is increasing in the general population. It is also likely that a growing number of surgical patients will be infected with HIV [Jensen 1997]. Estimates of the relative risk of HIV seroconversion in surgeons and other operating room staff was reported to be as high as 10% [Eggleston 1997].

Surgical gloves are relatively inefficient at resisting puncture. Glove perforations have been reported in 22-52% of procedures [Macintyre 1994, Jensen 1997] and surgeons were aware of these in only 15% of these cases [Macintyre 1994]. Glove perforation occurs in up to 57% of cases during trauma surgery [Brown 1996]. Several studies have reported glove perforation rates of 13.3% in obstetrical procedures [Kovavisarach 1998] and 55% during cesarean delivery [Eggleston 1997, Kovavisarach 1998]. Unfortunately, most glove breeches are not noticed for some time after perforation. Results of the study by Palmer and Rickett showed that glove damage goes unnoticed

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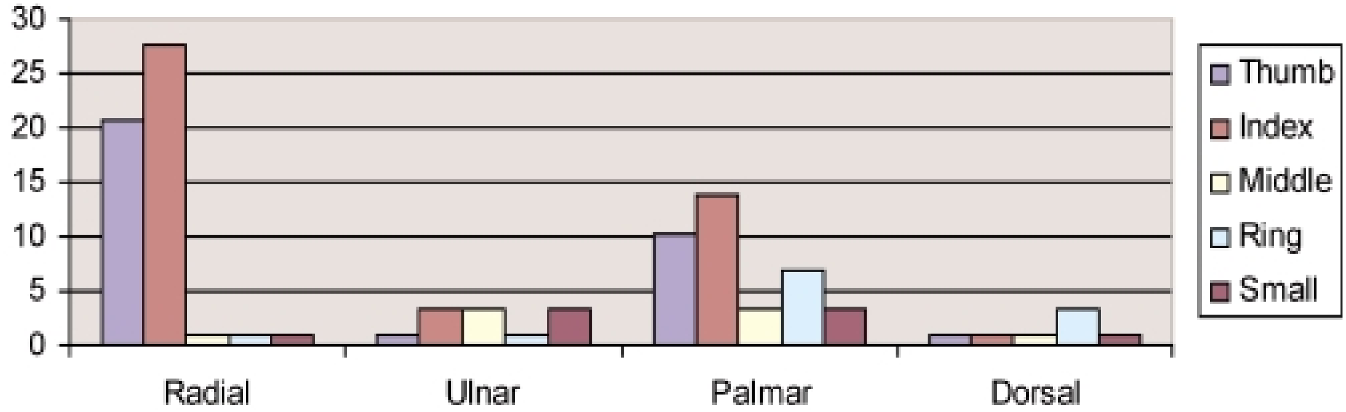

Figure 1. Proportions of glove perforation on each anatomic orientation according to glove fingers.

in as many as 58% of the cases [Brown 1996]. The conventional surgeon-patient barrier is clearly inadequate.

Glove damage studies, mostly retrospective in nature, may be grouped into three distinct categories: breech of the sterile barrier by sharp injury, exposure of the mucus membranes through spill, splash, spray, or failure of surgical barrier garments. Obstetricians performing cesarean sections are at risk of contamination from all three sources [Eggleston 1997]. Wearing two sets of gloves (double gloving) offers a measure of protection against damage to the inner glove because the observed difference in frequency of damage to outer versus inner gloves was found to be significant [Kovavisarach 1998]. However, discomfort, restricted dexterity, and impaired sense of touch of the surgeon were reported and present a significant setback to double gloving [Kovavisarach 1998].

New puncture resistance materials are being developed and incorporated into hand protection systems for health professional use as barriers against disease transmission and needle stick injuries. Manufacturers have developed finger guards, glove liners, and thicker latex gloves that enhance the protection of the single latex glove to puncture. This study was undertaken to examine the frequency of glove perforation during emergency and elective cardiac and thoracic surgical procedures (including CABG and valve replacement) and to assess the value of the punctured site in terms of frequency and location.

MATERIALS AND METHODS

From June 1998 to January 1999, gloves used in elective and emergency cases at Lutheran Medical Center (Level I trauma) and from Maimonides Medical Center were examined. A total of 206 glove pairs were investigated for perforation by the water-squeezing test. Each glove was filled with water and each glove finger and the glove palm was squeezed. Perforation was recognized by the production of a jet of water. At the completion of the procedure, the following data was documented: the awareness of perforation, the number of holes, the site of perforation, and the frequency of perforation.

RESULTS

The percentage of pairs of gloves found to be perforated was 14%. The distribution of perforations across the digits was significantly unequal ($P < 0.01$, χ^2 test), with 45% occurring on the index, 31% on the thumb, 10% on the ring, and the remaining 14% on the middle and little fingers. The distribution of perforations across the four possible locations of the hand was also significantly unequal ($P < 0.01$, χ^2 test), with 48% of the perforations occurring on the radial side, 38% on the palmar, 10% on the ulnar, and 3% on the dorsal side. We found that 73% of the punctures occur in one of four contiguous locations on the glove: the radial side of the

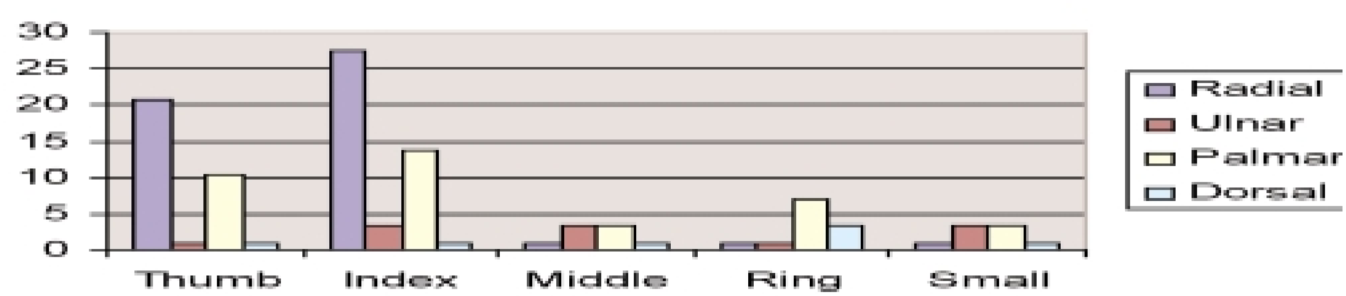

Figure 2. Proportions of glove perforation on each glove finger according to anatomic orientation.

index finger (27.6%), the radial side of the thumb (20.7%) the palmar side of the index (13.8%), the palmar side of the thumb (10.3%). All cases of known perforations were eliminated from the study [see Figures 1 and 2, ◎].

DISCUSSION

Until recently, surgical gloves were never questioned as being safe and effective barriers that provide protection for health care workers and patients. Increasing recognition of the importance of preventing cross infection has stimulated considerable interest in the perforation of gloves during surgical procedures. Regardless of the cardiac surgical procedure and duration of the operation, our study shows that of the four possible anatomic planes of each finger, 48% of the perforations were on the radial side, 38% on the palmar side, 10% on the ulnar, and 3% on the dorsal side. Across the five digits, the perforation was unequally distributed with 45% on the index, 31% on the thumb, 10% on the ring, and the remaining 14% were on the middle and the little finger. Therefore, the majority of glove perforations occurred on the radial side of the index finger.

Various studies about finger guards, glove liners, and double gloving have suggested many ways and techniques to decrease the incidence of glove perforation [Macintyre 1994, Brown 1996, Leslie 1996, Eggleston 1997, Jensen 1997, Kovavisarach 1998]. However, there are important limitations due to restricted dexterity and the extra cost required. Reinforcement on both radial and palmar sides of the index and the thumb will have a great effect on reducing the incidence of perforation with minimal effect on dexterity, most likely in lengthy operations as CABG and valve replacement.

Our study has many limitations. The anatomical localization of the perforation on each finger is imprecise, due to the lack of a proper topographic model. Therefore, it is likely that random misclassification bias has affected our results. Furthermore, the reliability of the water-filling and squeezing test is uncertain and the possibility that some perforations might have been overlooked cannot be dismissed. It is important to emphasize that we have examined only one parameter being the resistance to needle penetration. While needle puncture is the most common cause for glove failure, cut resistance by a knife blade has not been tested and will be the subject for future studies.

CONCLUSION

Glove perforations occur with relatively high frequency on the index and the thumb both on the radial and palmar sites. Therefore, we recommend the reinforcement of gloves on these sites. This will provide better protection for both the patient and the surgical team member. Discomfort from restricted dexterity and impaired sense of touch with double gloving renders glove reinforcement a suitable alternative for future comfortable cardiac surgery.

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REVIEW AND COMMENTARY

1. Editorial Board Member SG14 writes:

This paper examines a topic that surgeons and operating staff in general face every day, but most of them ignore. It is a good issue for the industry to work on and might simplify perioperative treatment of patients, thereby reducing wound infections for patients. It may also lead to a decrease of intraoperative infections or even of infections of every worker using rubber gloves.

Error sources in this study could be habits or certain operating maneuvers of the working personnel leading to more frequent lesions in particular areas of the gloves. The authors should indicate the number of the surgeons or scrubbing nurses of which the gloves were investigated, as one would suppose that a rather greater number of persons than used in this study would be needed for such a study.

Authors' Response by Sadir Alrawi, FRCS:

This article includes preliminary data for a point needed to attract attention. Further studies with more numbers of teams and different cardiac surgical procedures needed to be evaluated. However, the standard team in our cardiac surgical procedures are: attending surgeon, first assistant as a fellow, second assistant as a second year resident and a scrub nurse, with additional personnel needed depending upon the difficulty of the operation.