

Intraoperative glove perforation—single *versus* double gloving in protection against skin contamination

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Abstract

Surgeons have the highest risk of contact with patients' blood and body fluids, and breaches in gloving material may expose operating room staff to risk of infections. This prospective randomised study was done to assess the effectiveness of the practice of double gloving compared with single gloving in decreasing finger contamination during surgery.

In 66 consecutive surgical procedures studied, preoperative skin abrasions were detected on the hands of 17.4% of the surgeons. In the double gloving pattern, 32 glove perforations were observed, of which 22 were in the outer glove and 10 in the inner glove. Only four outer glove perforations had matching inner glove perforations, thus indicating that in 82% of cases when the outer glove is perforated the inner glove will protect the surgeon's hand from contamination. The presence of visible skin contamination was also higher in perforation with the single gloving pattern (42.1%) than with the double gloving pattern (22.7%).

An overwhelming majority of glove perforations (83.3%) went unnoticed. Double gloving was accepted by the majority of surgeons, especially with repeated use. It is recommended that double gloves are used routinely in all surgical procedures in view of the significantly higher protection it provides.

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Surgeons and operation room personnel have the highest risk of contact with patients' blood and body fluids. Since medical history and examination cannot reliably identify all patients harbouring blood borne pathogens, universal precautions during exposure to blood and body fluids are now mandatory. Intact surgical gloves will prevent this transmission, but breaches in gloving material may expose the operating room staff to risk of infections, particularly if there are cuts or abrasions on the skin. Breached gloves not only indicate the potential for infection via skin, but also bear witness to the possibility of there having been a needlestick injury and thus potential inoculation of infected blood.

Double gloving is generally adopted by surgical teams when operating on high risk cases. There are varying opinions regarding the necessity of wearing double gloves routinely for

added protection, and the ability to operate when wearing double gloves. The Center for Disease Control, however, does not recommend routine use of double gloves in surgery, as there are not enough studies to show that double gloves definitely have a higher protection rate.

Subjects and methods

The aim of our present study was to assess the frequency of glove perforation, and subsequent blood or body fluid contact, associated with common general surgical operations, and to assess the effectiveness of the practice of double gloving in decreasing finger contamination with blood and body fluids during surgery as compared with single gloving.

This prospective randomised study was performed in the department of general surgery, Lady Hardinge Medical College and associated Srimati Sucheta Kriplani Hospital, New Delhi, and included surgical procedures lasting more than one hour performed in one surgical unit. Only the operating surgeon and the first assistant were included in the study. To record the presence of preoperative skin abrasions, the spirit wash method was used. After scrubbing for the case, methylated spirit available in the operating room was poured on the surgeon's hand to cover whole of the hand on both the dorsal and palmer aspect. The observer recorded any presence of burning sensation, which was indicative of preoperative skin abrasion.

The gloves used were made of latex (manufactured by Dial Rubber Industries, Surat, Gujarat, India) supplied under contract to the Sucheta Kriplani Hospital, and the same brand was used in all surgical cases. The gloving pattern was randomised into two groups of equal number by sealed envelopes which indicated a single gloving pattern or a double gloving pattern. The randomisation was done immediately preoperatively. The operating surgeon used the indicated gloving pattern, and the first assistant automatically used the alternative gloving pattern.

After surgery, both inner and outer gloves were tested for perforations by two standard methods, the air inflation method¹ and the water leak method.² As controls, 40 pairs of unused gloves were tested in an identical fashion for pre-existing leaks and perforations.

At the end of the surgical procedure, the observer inspected the participant's hands closely and recorded the presence of blood or fluid on their hands. Members of the surgical team being studied were also asked if they were

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aware of the occurrence of any glove perforation and associated skin puncture during the operative procedure. They were also asked to evaluate the subjective problems of wearing double gloves, which included impairment in tactile sensation and level of comfort.

Results

Sixty six consecutive surgical procedures, lasting more than one hour (both elective and emergency operations) were included in the study. A total of 396 gloves were collected; they included gloves from the single gloving pattern, and outer and inner gloves of the double gloving pattern.

The average duration of the procedure was 125.5 ± 11.3 minutes, and only three cases extended beyond 270 minutes. No significant correlation could be established between the duration of surgery and frequency of glove perforation.

Eighty unused gloves were tested as controls. In this control group, three gloves out of 80 had perforations; thus, 3.75% of the gloves supplied to the hospital had pre-existing minor perforations. Although this met the American standard specification for single use gloves,³ it implies that in three out of 40 (7.5%) cases a surgeon using single gloves is likely to have his hand contaminated from the patient's blood or body fluids because of these pre-existing glove perforations. This hazard would be statistically reduced to 0.14% if double gloves were used.

Preoperative skin abrasions were detected in 17.4% (23 out of 132) of the surgeons' hands. In comparisons between the various members of the operating team, the chief surgeons were found to be more prone to have glove perforations compared with first assistants; while the chief surgeons had glove perforations in 17.6% of cases, it was seen in only 13.4% in first assistants. This difference was, however, not statistically significant.

In the double gloving pattern, out of the 32 perforations observed, 22 (68.8%) were noticed in the outer glove and 10 (31.3%) in the inner glove. Out of the 22 perforations in the outer gloves, four cases (18%) had matching inner glove perforation; this indicates that in 82% of cases when the outer glove is perforated the inner glove will protect the surgeon's hand from contamination. In six cases, only inner glove perforations without corresponding outer glove perforations were noticed, probably representing pre-existing glove perforations (table 1).

This study also showed that an overwhelming majority of glove perforations (>83.3%) went unnoticed. In all the cases where surgeons were aware of perforations, it had been produced by a needlestick injury; no other cause of perforation could be determined.

The presence of visible skin contamination was higher in single glove perforations than in double glove perforations (42.1% *v* 22.7%, table 2). Although there was a positive association, this difference was not statistically

Table 2 Perforations and visible skin contamination after surgery

Gloving pattern	Perforations	No (%) with visible skin contamination
Single glove	19	8 (42.1)
Double glove	22	5 (22.7)

significant in view of the small number of perforations. Double gloves offer a higher protection in relation to visible skin contamination than single gloving.

Double gloving was accepted by the majority of surgeons. Forty one (62.2%) felt comfortable while using double gloves, whereas 19 (28.8%) and six (9%) felt that double gloves were tight or baggy respectively. Forty two surgeons (63.6%) felt that they had satisfactory tactile sensations with double gloving, whereas 24 (36.4%) felt that the tactile sensation was unsatisfactory. With repeated use most of the surgeons felt comfortable with double gloving.

Discussion

With increasing awareness of the risk of transmission of pathogens from patients to medical staff during surgery, particularly the hepatitis B virus and HIV, there is increasing interest in protecting the surgeon from the patient. It is seen that with adequate preoperative hand preparation there is little risk to the patient from surgical glove perforation.⁴ Nevertheless bacteria may survive this process and so gloves must be used to prevent surgical wound contamination.⁵ On the other hand, prolonged operating time with perforated gloves increases the risk of contamination of the surgeon's hand from pathogens from the patient.⁶

The hepatitis branch of the Center for Disease Control has estimated that 500–600 health care workers whose job entails exposure to blood are hospitalised annually because of hepatitis B related illness, with more than 200 deaths from cirrhosis, and approximately 40–50 from liver cancer.⁷ It is seen that among resident physicians, operating room personnel have the highest risk of contact with patient's blood.^{8,9}

After a single needlestick injury from a seropositive patient, the risk of HIV seroconversion is one in 250, and some have estimated a surgeon's cumulative life time risk of seroconversion to be as high as 1% to 10%.^{10–12}

The principal route of occupationally acquired HIV infection in a surgeon is by skin perforation with a hollow needle containing HIV infected blood. Solid needle prick also transmits infection but the risk is 10-fold less than with a hollow needle.¹³ Contact of a patient's blood with non-intact skin of the surgeon leaves the surgeon at high risk of

Table 1 Glove perforations in double gloving pattern

Site	No of perforations
Outer glove	22
Inner glove	10
Matching outer and inner glove perforation	4
Outer without corresponding inner glove perforation	18
Inner without corresponding outer glove perforation	6

exposure. It is seen that surgeons often have unnoticed minor abrasions on their hands, which place them at risk of contracting infectious diseases from their patients if the integrity of the surgical glove is compromised.¹⁴ A surgeon's breached glove not only indicates the potential for infection to the patient from the surgeon's skin, but also bear witness to the possibility of there having been a needlestick injury and potential inoculation of the surgeon with infected blood.¹⁵

In 1987, the Center for Disease Control issued guidelines, called "universal precautions", designed to minimise the risk of transmission of HIV in the health care setting. Although universal precautions were issued to reduce the transmission of HIV in health care settings, they are also appropriate for reducing the transmission of other blood borne infections.¹⁶

Gloves may be breached by a number of means, including accidental damage with needles. With a breach in this barrier, the disinfection process carried out before the start of the operation is neutralised, and it requires a repeat of the original cleaning and disinfection process. Studies show that in about 10% of the punctured gloves, bacterial culture of the area surrounding the puncture hole is positive. Cole and Bernard stated that as many as 18 900 *Staphylococcus aureus* bacteria could pass through a single needle hole in a gloved finger in 20 minutes.⁶

Studies on surgical gloves have looked at a variety of factors, such as change in tactility and dexterity occurring with the use of surgical gloves,¹⁷ which polymer to use, and what risks are posed by using single gloves. The problem of glove perforation, however, remains a major cause of exposure to contaminated body fluids and is yet to be solved satisfactorily.¹⁷

Our study shows that double gloving offers significantly better protection than single gloving, as in 82% of cases when the outer

glove is perforated, the inner glove will protect the surgeon's hand from contamination; subsequent visible skin contamination is also much lower with double gloves. As the majority of glove perforations go unnoticed, we recommend the routine use of double gloves in all surgical procedures exceeding one hour, or where chances of needlestick injury are high. Following this study, our surgical unit is now routinely using double gloves in all major surgical procedures.

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