

INCIDENCE OF GLOVE FAILURE DURING ORTHOPEDIC OPERATIONS AND THE PROTECTIVE EFFECT OF DOUBLE GLOVES

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Objective: To determine the usefulness of double gloves in protecting against the exposure of surgical team members' hands to blood.

Methodology: Five-hundred-ninety-six gloves were studied during 71 orthopedic operations using the water-loading test (filling a glove with water and occluding its cuff tightly to identify leaking points).

Results: In all, 73 glove perforations occurred, but only nine resulted in exposure to blood (blood touching the skin). The incidence of glove perforation was 12% (73/596), and overall exposure (blood touching the skin) per operation was 13% (9/71). The latter would have been 87% (62/71) but for the use of double gloves. Sixteen percent of the perforations in double gloves were in the inner gloves, while 84% were in the outer gloves. Exposure of surgeons was reduced from 54% to 10%, first assistants from 27% to 3%, and second assistants from 7% to 0 ($p < 0.02$, $df = 2$) by double-gloving. Significantly more perforations occurred during operations on bone, compared with soft tissue operations, $p < 0.0001$, $RR = 4$ (95% CL 1.87–8.55). The most common sites of glove perforation were the index finger (47%), thumb, and the palm region: 14% each. More glove perforations occurred in nondominant hands.

Conclusion: Double-gloving offers additional protection to surgeons and assistants by preventing hand exposure to blood intraoperatively. (*J Natl Med Assoc.* 2003;95:1184–1188.)

Key words: gloves ♦ surgical ♦ orthopedics
♦ perforation ♦ incidence ♦ exposure

INTRODUCTION

The percutaneous exposure of operating team members to blood is a known occupational hazard^{1,2}. Such exposure may result in the transmission

of hepatitis-B virus and human immunodeficiency virus (HIV) infections³.

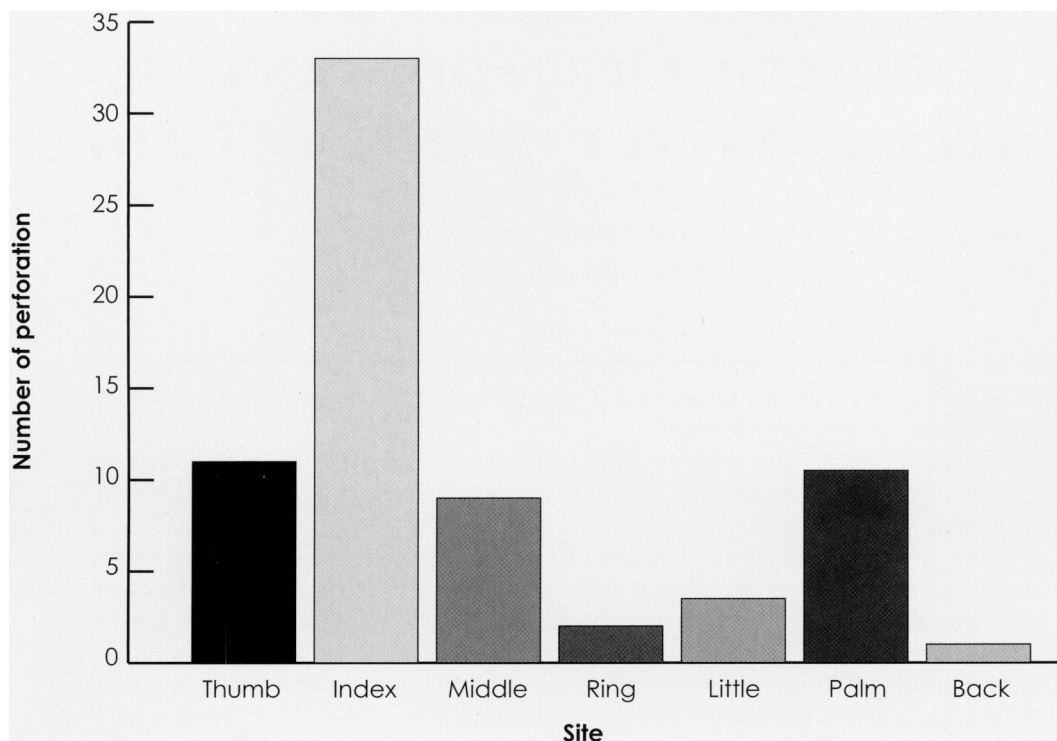
Donning of a single pair of gloves during operations is one of the traditional precautions to prevent blood contamination. The need for additional precautions has been highlighted⁴. This study was conducted to determine the efficacy of additional protection consisting of double-gloving to prevent blood exposure.

MATERIALS AND METHODS

Latex surgical gloves used during 71 consecutive orthopedic operations over 30 minutes in duration were studied at Olabisi Onabanjo University Teaching Hospital, Sagamu, and the National Orthopedic Hospital, Igbobi, Lagos. At the end of

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Figure 1. Location of Glove Perforation



all operations, each glove was immediately examined for perforation by filling it with water and occluding its cuff tightly to identify leaking points (water-loading test). The data recorded included the dominant hand, the glove sizes, and the size preferred by the surgeons and assistants. The site and number of perforations were also recorded, as well as the effect of double-gloving on comfort, sensitivity, and dexterity in the hands of the team members.

DEFINITIONS

Wearing two pairs of gloves has been termed as double-gloving, while single-gloving is the wearing of a pair of single gloves. In a double-gloved hand, perforation involving the inner glove without affecting the outer glove (and vice versa) was classified as sole inner- or sole outer-glove perforation, whereas perforation of both donned pair of gloves was classified as simultaneous perforation. Single-glove and simultaneous perforations (of both inner and outer gloves of the same hand) leading to exposure of the gloved hand to blood were termed significant perforations. Contact of the skin of a

gloved hand with blood was termed exposure. An operative procedure involving the manipulation of a bone, an implant, or an external fixator is classified as a bone operation. All others are classified as soft-tissue operations.

STATISTICAL ANALYSIS

Observed differences were compared using Fisher's exact test and taken to be significant at a *p* value of less than 0.05. Epi info statistical software version 6.02 (Centers for Disease Control, USA) was used.

RESULTS

A total of 596 gloves were used during 71 operations, of which 20 were soft-tissue and 51 were bone procedures. All gloves were of the preferred sizes of the surgeons. There were no reports of impairment of comfort, finger sensitivity, or hand dexterity. There were no glove changes during the procedures. As shown in Table 1, the surgeons used 47% of the gloves, while the first and second assistants used 37% and 16% of the gloves, respectively. All members of the surgical team were right handed.

Table 1. Characteristics of the Surgical Team Members and Their Gloves

	Surgeon (%)	Assistant I (%)	Assistant II (%)	Total
<i>Designation</i>				
Consultant	51	-	-	
Senior registrar	16	22	-	
Registrar	4	48	29	
Total	71	70	29	170
<i>Dominant hand</i>				
Right	71	70	29	
Left	0	0	0	
<i>Number of gloves used</i>				
† Double [pair]	272 [68]	164 [41]	76 [19]	512
† Single [pair]	6 [3]	58 [29]	20 [10]	84
Total	278 (47)	222 (37)	96 (16)	596
<i>Pattern of glove perforation</i>				
<i>Double glove perforation</i>				
Sole inner perforation	5	0	0	5
Sole outer perforation	31	17	5	53
Simultaneous perforation	6	0	0	6
Significant perforation	6*	0	0	6
<i>Single glove perforation</i>				
Total	1*	2*	0	3
Total	49	19	5	73

* = Significant perforations
† = Multiply double pair by 4 and single pair by 2 for number of gloves used

There were 71 surgeons, 70 first assistants, and 29 second assistants involved in the study. The surgeons included 51 consultants (attending surgeons), 16 senior registrars (residents) and four registrars (residents). Sixty-eight of the surgeons, 41 first assistants, and 19 second assistants wore double pair of gloves, while three surgeons, 29 first assistants, and 10 second assistants wore single pairs.

Seventy-three perforations occurred in all, representing an incidence of 12% (73/596). Forty-nine of the perforations occurred in the surgeons' gloves (8%), while 19 occurred in the first assistants' gloves (3%), and five were in the second assistants' gloves (0.8%). Of these, seven perforations in the surgeons' gloves (six simultaneous and one single-glove perforations), two in the first assistants' gloves (single-glove perforations), and none in the second assistants' gloves were significant perforations (Table 1). The overall exposure of hands to blood per operation was 13% (9/71: significant perforations during all procedures). But for double-gloving, the overall exposure would have been 87% (62/71: all outer-glove [sole outer + simultaneous]

and single-glove perforations). Exposure of surgeons was 10% (7/71), that of first assistants 3% (2/71), and that of second assistants 0. These differences were significant, $p < 0.02$; $df = 2$. Without double-gloving, the exposure per operation would have been 54% (38/71), 27% (19/71), and 7% (5/71) {all outer glove [sole outer + simultaneous] and single-glove perforations}, respectively, for the operating team members.

As shown in Table 2, 68 perforations occurred during bone operations, while five occurred in soft-tissue operations, $p < 0.0001$; $RR = 4.00$ (95% CL 1.87–8.55). Of the 73 perforations, three were in single gloves, while 70 occurred in double gloves. Of the latter, 16% (11/70: sole inner and simultaneous perforations) were in the inner gloves and 84% (59/70: sole outer and simultaneous perforations) were in the outer gloves.

The incidence of glove perforation varies with the duration of operation. Table 2 shows that 16 perforations occurred during operations lasting up to an hour, compared with 12 in those lasting up to 1.5 hours, a difference that is not significant.

Table 2. Pattern of Glove Perforation

Type of operation	Number of operations	Number of perforation
Bone	51	68
Soft tissue	20	5
	<hr/> 71	<hr/> 73
Duration of operation (minutes)		
31-60	30	16
61-90	17	12
91-120	7	9
>120	17	36
	<hr/> 71	<hr/> 73

However, 36 perforations occurred during procedures lasting over two hours, significantly more than the former, $p < 0.0001$.

The most common site of glove perforation was the index finger (47%: 34/73), followed by the thumb and palm region (14% each: 11/73), and the least common was the back of the glove (1%: 1/73), Figure 1. The middle, little and ring fingers had 10, four, and two perforations, respectively. Significantly more perforations occurred in the left-hand gloves (45/73), compared with the right-hand gloves (28/73), $p < 0.001$.

DISCUSSION

Intraoperative glove failure is an important occupational hazard of the surgical team. Through intraoperative glove failure, the hands of the surgeon and the other operating team members are exposed to blood, among other parts of the body, such as the face⁵. The overall incidence of glove failure in this study was 12%. This is similar to the finding of 10.5% in our earlier study⁶ and is within the commonly reported range of 5-17%^{5,7,8}. The perforation rate in outer gloves is usually greater than in the inner gloves when double gloves are worn⁹. Our results indicate an outer and inner glove perforation rate of 11.5% and 2%, respectively, while Rice et al.¹⁰ observed a perforation of 16% of outer gloves, and 6% of inner gloves. The occurrence of perforation in the inner but not the outer-glove (in double gloves) cannot be explained by our findings. However, it may be the result of sporadic production line errors, but this requires confirmation by carefully designed studies.

The incidence of exposure in this series was

13% but would have been 87% if not for the additional protection of double-gloving. This is similar to the finding of Naver⁷ (a gastrointestinal surgery series) in which the surgeons' exposure was reduced from 13% to 2%, an over-six-fold reduction by double-gloving. The use of fabric gloves over one pair or between two pairs of latex gloves may be similar to double-gloving in efficacy, reducing exposure to blood through the hands¹¹⁻¹³. It is noteworthy that the incidence of glove perforation may actually be greater than what was observed because the water-loading test employed may not be as sensitive as the electronic method^{14,15}.

Orthopedic gloves are thicker than common latex gloves and have a greater resistance to perforation but are not commonly available in Nigeria. Double-gloving, however, has equal protective efficacy as and is a viable alternative¹⁶ to orthopedic gloves, although both may impair sensitivity and dexterity^{9,16,17}. Our results did not confirm the latter. Due to the importance of latex gloves in surgical practice, and the fact that all gloves do not have similar qualities regarding comfort and protection, surgeons should actively participate in choosing which brands to use.

That in our study most perforations occurred in the index finger was consistent with our earlier observation⁶. This may be because it is the most active finger during surgery. The thumb and palm region are also often involved¹⁸. In this study, the dominant right-hand gloves had fewer perforations than the left, which has not been previously documented⁶. This was probably because more injuries are self-inflicted than caused by other operating team members¹⁹.

It can be concluded that double-gloving confers additional protection to surgeons and other surgical team members in preventing hand exposure to blood intraoperatively.

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