



## Glove punctures in major and minor orthopaedic surgery with double gloving

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We assessed the frequency of glove perforation during major and minor orthopaedic surgeries, in order to determine the efficacy of double gloving. A total number of 1528 gloves (622 inner and 906 outer) used in 200 procedures (100 major-100 minor), and 100 pairs of unused gloves were examined. Glove perforation rate, incidence among surgical team, location of perforation and duration of surgery were compared. The overall perforation rate was 15.8% (242/1528). Perforation rates for major versus minor surgical procedures were 21.6% and 3.6%, respectively. The perforation rate for the unused control group was 1% (2/200). Inner-outer gloves perforation rates were 3.7% (23/622) and 22.7% (206/906), respectively. Surgeons had a higher perforation rate compared with the other staff. The right thumb and left index finger had more punctures than other fingers. Routine use of double gloving during orthopaedic procedures is recommended, because this significantly reduces the perforation of inner gloves.

**Keywords** : surgical gloves ; glove puncture ; orthopaedic surgery ; double gloving.

### INTRODUCTION

Surgeons and operating room personnel have the highest risk of coming into contact with patients' blood and body fluids. During surgery, intact gloves act as a protective barrier against blood borne pathogens such as HIV, hepatitis B, and

hepatitis C viruses (5,7). Glove perforation is frequent but is often unrecognized by the surgeon and scrub nurses. It has been shown that with adequate preoperative hand preparation, there is no risk to the patient from surgical glove perforation (8). Glove perforation during operations occurs in all surgical specialties. Studies performed in other specialties have reported an incidence of perforation ranging from 10% in ophthalmologic surgery to 50% in general surgery (8,13). The orthopaedic literature reports a rate of surgical glove perforation for surgeon, assistant, and scrub technician altogether which vary depending on the type of surgery, ranging from 14% during pediatric procedures to 57% during hip fracture operations (1,10,14,16-19). A number of studies have

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shown that glove perforation is more common in orthopaedic operations than in any other surgical specialties (13,16).

One purpose of this study was to compare the incidence of surgical glove perforation during major (total hip and knee arthroplasty) and minor (arthroscopy) surgical procedures. A second purpose was to determine the efficacy of double gloving in these procedures and to differentiate the risk of glove perforation between surgeon, assistant and nurses.

### MATERIALS AND METHODS

This prospective study was conducted in the department of orthopaedic surgery, of Baskent University, Turkey, from June 2004 to June 2005. A total number of 1528 gloves were studied : 1036 gloves used in 100 consecutive major orthopaedic surgical procedures (70 total knee arthroplasties, 30 cementless total hip arthroplasties) and 492 gloves used in 100 consecutive minor orthopaedic procedures (100 arthroscopies) were examined. Of the 1528 gloves tested under actual surgical conditions, 622 were inner and 906 were outer gloves. In addition, one hundred unused pairs of gloves were examined as a control group.

All members of the surgical team wore double gloves in major and minor surgical procedures. The operating surgeon, the first assistant, the second assistant, and the scrub nurse were included in this study (200 surgeons, 164 assistants, and 240 scrub nurses). All surgeons, assistants, and scrub nurses were right handed. If a glove was visibly perforated, it was immediately replaced with a similar glove. After surgery, all gloves were examined for perforations by the approved standardized water leak test method EN455-1 (European Committee for standardization) by a single observer (11). Each glove was filled with  $1000 \pm 50$  ml of water and tested for leaks by gentle manipulation of the water into each digit. The location and number of perforations and the duration of surgeries were recorded.

Three types of statistical analyses were performed. The incidence of glove perforations between study groups and inner and outer gloves were compared using the Chi-square test. The mean duration of surgery for major and minor surgeries was compared using Student's t test. All calculations were performed on SPSS (SPSS 11.5 ; Chicago, Illinois) and statistical values of 0.05 or less for *p* were considered significant.

### RESULTS

The overall glove perforation rate was 15.8% (242/1528) and the overall operative perforation rate was 35% (70/200). Perforation rates for major and minor procedures were 21.6% (224/1036) and 3.6% (18/492) respectively, and the difference was statistically significant ( $p < 0.0001$ ). The perforation rate for the unused control group was 1% (2/200), which reflected preexisting perforation or manufacturing defects. Twenty-three of the 622 inner gloves were perforated (3.7%), versus 206 of the 906 outer gloves (22.7%) ; the difference was statistically significant ( $p < 0.001$ ). No perforation was found in the inner gloves after minor procedures. Of a total number of 224 perforations noted following major procedures, only 9 (4%) affected both the inner and outer gloves.

Surgeons had a higher glove perforation rate of 25.2% (169/668), while the glove perforation rates of assistants and nurses were 8.3% (29/348) and 8.6% (44/512) respectively ( $p < 0.05$ ) (table I). The mean operative time for major and minor procedures was  $76.5 \pm 22.4$  minutes (range ; 45 to 125) and  $29.5 \pm 12.6$  minutes (range ; 17 to 60), respectively ( $p < 0.001$ ) (table II).

Of the 242 glove punctures, 176 (72.7%) were not noticed by the operative team members and were only detected after the operation. The location of the holes in perforated gloves is shown in table III. The most common site of perforation was the right thumb with 71 perforations (29.3%), and the second most common was the index finger of the left hand with 57 (23.5%) out of 242 perforations.

### DISCUSSION

Glove perforation is a common problem during surgical procedures. Surgeons are at risk of contracting infectious diseases from their patients if the integrity of surgical gloves is compromised (20). The risk of infection after percutaneous exposure to HIV, hepatitis B virus and hepatitis C virus varies greatly. The use of surgical gloves markedly reduces the volume of the blood inoculum present on suture needles, and double gloving is more

Table I. — Glove perforation rates in surgical team

Surgical team	Major procedures			Glove perforation rate (%)	Minor procedures			Glove perforation rate (%)
	Number of members n	Number of gloves used n	Number of perforations n		Number of members n	Number of gloves used n	Number of perforations n	
Surgeon	100	446	156	34.9%	100	222	13	5.8%**
Assistant	127	288	27	9.3%	37	60	2	3.3%*
Scrub nurse	140	302	41	13.5%	100	210	3	1.4%**

\*p < 0.05, \*\*p < 0.001, between major and minor procedures.

Table II. — Details of perforations with major and minor surgical procedures

	Number of procedures n	Total number of gloves used n	Glove perforations n	Glove perforation rate (%)	Average operation time (min)
Major procedures	100	1036	224	(21.6%)	76.5 ± 22.4
Minor procedures	100	492	18	(3.6%)**	29.5 ± 12.6*

\*p < 0.05, \*\*p < 0.001, between major and minor procedures.

Table III. — Puncture sites in both groups

Location of perforation	Major procedures				TOTAL	Minor procedures				TOTAL
	Right		Left			Right		Left		
	Inner	Outer	Inner	Outer		Inner	Outer	Inner	Outer	
Thumb	8	57	3	33	103	–	6	–	1	7
Index finger	5	36	5	46	98	–	3	–	6	9
Middle	1	8	–	7	9	–	1	–	–	1
Ring Finger	–	–	–	2	1	–	–	–	–	–
Little	–	–	–	1	1	–	–	–	–	–
Palmar	1	8	–	3	12	–	1	–	–	1
Total	15	109	8	92	224	–	11	–	7	18

efficient than single gloving on this respect (4,20,24). In this study, the perforation rate was significantly lower for the inner glove than for the outer glove (p < 0.001).

Studies from other specialties have reported different rates of glove perforation. In gynaecologic procedures, operators sustained glove perforations in 10.1% to 43% of procedures, in general surgery in 35% to 54%, in plastic surgery in 21.4% and in thoracic surgery in 26% (2,9,13,20,24).

In orthopaedic surgery, oscillating saws are used, as well as a variety of metal instruments and

implants. Manipulation of these implants and devices result in strong shear forces on the surgeon's gloved hands (24). Laine and Aarnio (14) found glove perforation rates in 18.5% in conventional procedures and 5.8% in arthroscopic procedures in their series. The perforation rates in our study are similar to those found in the literature (1,6,14,16-19,24).

It is natural that surgeons more frequently have perforations in their gloves than scrub nurses and assistants, as these do not use the knife or needles as much as the surgeon.

According to the literature (2,14,24), the index finger of the left hand of the surgeon appears to be most prone to present glove tear or puncture. In our study however, the most common location was the right thumb. The risk for perforation of surgeons' gloves during minor orthopaedic procedures is minimal. In major procedures, perforations represent a higher risk for surgeons because of longer time of exposure to blood contact.

Double gloving has proved to be an effective second barrier with minor disadvantages including discomfort, clumsiness and tightness (1,13,14,20,24). This study showed that an overwhelming majority of glove perforations (176/242, or 72.7%.) went unnoticed.

We noted a lesser amount of pre-existing glove perforations. In a study by Thomas *et al* (22), 40 pairs of unused gloves were examined and a 3.75% (3/80) rate of perforation was detected implying that in three out of 40 cases (7.5%) a surgeon using single gloves was likely to have his hand contaminated from the patient's blood or body fluids. As a conclusion, the authors recommended using double gloves to reduce this risk. We also believe that wearing double gloves can reduce the risk of contamination through pre-existing perforations.

It is well known that, while intact surgical gloves are impermeable to the HIV and hepatitis B virus, perforated gloves are not (7). While the operating team members are at risk for contracting blood borne diseases from patients, it has been shown that with adequate pre-operative hand preparation, there is very limited risk of surgical site infection from surgical glove perforation (8), although, bacterial culture in the area around the holes was found to be positive in about 10% of the punctured gloves (8). There is limited risk to the patient from surgical glove perforation regarding HIV transmission, but the risk is higher for hepatitis B virus, which also makes double gloving highly advisable. In a study by Lemaire and Masson, the risk of transmission of blood-borne viral infection in orthopaedic surgery was reviewed; the lifetime risk for surgeons of HIV seroconversion following percutaneous exposure was found to lie between 0.01% and 12%, depending on the population served and the type of

surgery; the risk is much higher however for Hepatitis B and C viruses (15). Several surgeons have already been infected with HIV and hepatitis from percutaneous exposure (12,15,21). The mean risk of transmission of HIV infection after one major percutaneous exposure was reported as 0.3% in literature (3,15). The risk markedly increases with a larger volume of blood and a higher titer of HIV in the blood of the source patient.

In conclusion, we recommend using guidelines for gloving techniques to maximize protection in all situations, both high risk and low risk, and recommend the routine use of double gloving in orthopaedic procedures, because it can significantly reduce the incidence of perforation of inner gloves. Besides, the outer gloves must be changed during long operations to decrease the amount of blood contact. It is important to identify factors causing glove puncture so as to reduce their impact.

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