



Original Article

Unnoticed surgical gloves perforation: A multicentric study of the leading factors.

Medhioub Fatma ^{1,2,*}, Jaber Eya ^{1,2}, Hamrouni Anouar ^{1,2}, Gharbi Lassad ^{1,2}.

1: Department of general surgery Mongi Slim Hospital Tunis, Tunisia.

2: College of Medicine Tunis, Tunis el Manar University, Tunisia.

* Corresponding author

Correspondence to:
f.medhioub@gmail.com

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Abstract:

Background

Surgical gloves act as protective barrier against blood-borne pathogens transmission from patients to healthcare workers and vice versa. The aim of this study was to assess the rate of surgical gloves intraoperative perforation and to highlight its leading factors.

Methods

A descriptive cross-sectional multicentric study was conducted at three different Tunisian university hospitals: Charles Nicolle, La Rabta and Mongi Slim. Four different surgical departments were involved: cardiovascular surgery, urology, general surgery and otorhinolaryngology. The gloves were collected and tested immediately at the sterilization units using the leak test as described in European Norm EN 455-1.19. Results were produced using the statistical package for social sciences version 19.0 and the X2 was used with a significance threshold of 5%.

Results

A total of 320 gloves were collected. Seventy-two were found to be perforated (22.5%). The majority of the perforated gloves were collected after cardiovascular procedures (40%, $p=0.001$), on the non-dominant hand (71%, $p=0.0001$), when the duration of the procedure exceeded 90 minutes ($p=0.0001$) and for thinner gloves (61%, $p=0.018$). The left index finger of the surgeon's glove is more likely to be perforated (38%).

Conclusion

This study showed considerable gloves perforation rate during surgical procedures that could indicate the implementation of new rules and policies in the operating theater practices.

Key words

Perforation, surgical gloves, operating theater, associated factors.

Introduction

Gloves were first recommended for medical staff as a protection from chemical products [1]. Since early 80^s surgical gloves were recognized as protective barrier against blood-borne pathogen transmission and their single use was recommended [2].

Gloves perforation occurs frequently during surgical procedures [3]. This incident may expose both patient and the surgical staff to various infections. As perforation may not be apparent, it seems useful to understand its mechanisms and the leading circumstances. This could minimize the infection risk for the patients and the health practitioners.

Our study aims to determine the rate of glove perforation and the contributing factors.

Materials and Methods

Study design

This study is descriptive, cross-sectional and multicentric. It was conducted in 4 different surgical units for 3 months (Tunis, Tunisia):

- *Department of urology ,Charles Nicolle hospital
- *Department otorhinolaryngology, Charles Nicolle hospital
- *Department of cardiovascular surgery,La Rabta hospital
- *Department of general surgery, Mongi Slim hospital.

Population

This study included surgeons, residents, operating room technicians and scrub nurses. The study included all gloves used by the participants during the different surgical procedures. We have tested two different brands of gloves made from natural rubber latex (A and B). The brand A glove thickness was 0.20mm and the brand B glove thickness was 0.16mm.

Data collection

Members of the surgical teams included were asked to fill out a brief questionnaire about age, gender, function, years of experience and dominant hand. All gloves were collected in a plastic bag labeled according to the type of the procedures, duration of the glove's use, position of member and the dominant hand for activity. The characteristics of the glove's brand were collected for each participant.

The gloves were collected and tested immediately at the sterilization units using the leak test as described in European Norm EN 455-1.19. Each Glove was evaluated separately. A 50-mm-diameter tube made of polyvinyl chloride is inserted vertically into the glove and fixed with a ring positioned at 40 mm from the end to avoid glove damage. One liter (+/- 50 ml) of water is poured into the glove. The glove was immediately inspected for 2-3 minutes to detect any leakage. The number and location of perforations as well as participant's perception were noted.

Data analysis

Data was entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 19.0. The Chi-square test (X²) was used for the comparative study. Significance was retained for P value <0.05. Results were presented in the form of tables and graphics using Microsoft Excel 2007.

Bibliographic review

We reviewed literature using several search engines and databases: Pub Med, Science Direct, EM consult, google scholar using these keywords: Perforation, surgical gloves, operating theater, associated factors. Twenty-eight relevant papers published over the past fifteen years were collected from the literature.

Ethical considerations

This study was approved by all the ethical committees of the participating centers.

Results

Our study included 320 gloves. The participants (n=87) were residents in 38% of cases, senior surgeons in 29%, operating room technicians in 26% and scrub nurses in 7%. There was a male predominance with a sex ratio of 2.5. Most of the participants were <30 years old. The professional experience was <5 years in 47% of cases. Most of the participants were right-handed (94%). (Table 1).

Table 1: socio-demographic characteristics of the participants

Characteristics	n	%
Gender		
Male	63	72.4
Female	24	27.6
Age		
20-30	47	54
31-40	12	13.8
41-50	17	19.5
>50	11	12.6
Surgical specialty		
Cardio-vascular	20	23
General and digestive	26	29.9
Urology	17	19.9
Otorhinolaryngology	24	27.6
Position		
Surgeon	25	28.7
Resident	33	37.9
Surgical technician /scrub nurse	29	33.4
Years of experience		
1-5	41	47.1
6-10	26	29.9
>10	20	23
Dominant hand		
Right	82	94.3
Left	5	5.7

The gloves usage characteristics is summarized in Table 2.

The overall perforation rate was 22.5% (n=72). Eighty different perforations were noted. The most perforated finger was the index finger (34%). Perforation was located in the thumb in 25% of cases, in the ring finger in 14% and the little finger in 11%. Most of the perforations occurred in the non-dominant hand (left hand).

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Table 2: glove usage characteristics

Variables	n	%
Surgical specialty		
Cardio-vascular	78	24.4
General and digestive	79	24.7
Urology	86	26.9
Otorhinolaryngology	77	24.1
Position		
Surgeon	94	29.4
Surgical resident	129	40.3
Surgical technologist and scrub nurse	97	30.3
Procedure duration		
<90	207	64.7
>90	113	35.3

The perforation rate was 67% (n=48) after procedures that exceeded 90 minutes (p=0.0001). Senior surgeons had the highest perforation rate (42%). Forty percent of the perforations occurred during cardio-vascular procedures. Table 3 summarized the perforations associated factors

Table 3: Glove perforation associated factors

Associated factor	Perforated glove	Non-perforated glove	P
Duration			0.0001
<90	24 (33.3%)	183 (73.79%)	
>90	48 (66.6%)	65 (26.21%)	
Surgical specialty			0.001
Cardio-vascular	29 (40.28%)	49 (91.76%)	
General and digestive	19 (26.39%)	60 (24.19%)	
Urology	14 (19.44%)	72 (29.03%)	
Otorhinolaryngology	10 (13.89%)	67 (27.02%)	
Participant's function			0.49
Surgeon	30 (41.66%)	105 (42.34%)	
Surgical resident	24 (33.34%)	64 (25.81%)	
Surgical technologist or scrub nurse	18 (25%)	79 (31.85%)	
Hand dominance			0.0001
Dominant hand	21 (29.17%)	139 (56.05%)	
Non-dominant hand	51 (70.83%)	109 (43.95%)	
Thickness			0.001
Brand A	28 (38.8%)	135 (54.4%)	
Brand B	44 (61.2%)	113 (45.6%)	
Powder			0.018
Powdered	56 (77.8%)	222 (89.52%)	
Powder-free	16 (22.2%)	26 (10.48%)	
Total	72	248	

Discussion

This study investigated the frequency of unnoticed surgical glove perforation at 3 different Tunisian university hospitals in 4 different surgical specialized units. It revealed a perforation rate of 22,5%. According to the literature, this rate varies from 8 to 61% [4]. The results reported by Tlili et al were comparable with a rate of 16,5%. However, a higher perforation rate of 52% was shown by Goldman et al [3,5].

The variability in these results may be explained by the difference in specialties, instrumentation, experiences and working conditions. One of the main issues encountered is the lack of perforation perception before the end of the procedure.

Glove perforation can expose both patients and surgical team members to considerable risks. It may increase the incidence of patient's nosocomial infections specially those caused by Staphylococcus Aureus. The practitioners maybe exposed to viral blood-borne diseases such as AIDS and Hepatitis [6]. The perforation remains unnoticed usually until the end of the procedure. This makes mandatory the identification of associated factors. These factors are related to the surgical procedure, the practitioner, and the glove itself. Gloves perforation is more common in orthopedic surgery than in soft tissue procedure [7].

The use of power tools, handling sharp bones and working in deep cavities could contribute more to glove perforation in orthopedic procedures [8]. It was reported in a study that the rate rises to 67% during a hip arthroplasty closure and with the use of cone-shaped needles [9].

In our study, the rate of perforation was significantly higher in cardio-vascular surgical procedures (40.3%) and in the senior surgeon's gloves (41.7%). Other studies had the same findings [10-13]. This high rate is explained by the fact that surgeons are the first users of instruments and that the manipulation of instruments and implants increases the risk of perforation [14,15].

Our study found that 70.8% of perforations are detected on the non-dominant hand. These findings are comparable to those revealed by some other authors [17,18]. The surgeon's index finger and thumb seem to be the site of predilection for glove perforation. [19].

Regarding the duration of the procedure, all authors agreed that the risk of unnoticed glove perforation is significantly higher for long and complex procedures. Our study showed a cut-off point at 90 minutes concurring with the findings of several other studies [20-22]. We have tested in two different brands of gloves (A and B) made from natural rubber latex. Brand A gloves are thicker than brand B gloves. We found significant higher perforation rate in the thinner brand. The glove characteristics may interfere with the perforation rate.

The optimized air and waterproofness as well as the balanced elasticity could ensure the barrier glove's role and minimize perforation risk [23].

The powder reduces the friction between the hand and the glove's wall. However, hand perspiration during long procedures may increase powder temperature and lead to microperforations [24]. Some authors recommended "double" gloving to prevent perforation and to optimize protection. Concordant studies showed that the inner glove is exceptionally perforated. The implementation of double

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gloving concept is sometimes difficult. It may reduce the precision of the movements according to some surgeons and may increase the cost of procedure consumables [25-28].

Our study identified a considerable issue in the daily surgical practice. The rate of the unnoticed surgical team gloves perforation is high and may interfere with the procedure's outcomes. The four subspecialized surgical units involved are performing a high number of cases. To improve the quality and the safety of the procedures done, the implementation of some operating theater guidelines looks mandatory. The glove should be changed regularly in long procedures. More precaution should be taken for risky tasks. Our study is limited by the small population and this might be interfering with the statistics. The leading factors demonstrated might not be independent and must be proven in a larger series.

Conclusion

For some sophisticated surgical centers, the recommendation of systematic double gloving and frequent changing of gloves are reasonable. This could reduce the perforation rate and prevent its risks. We also suggest training sessions for the surgical team members in order to increase their awareness about the gravity of glove perforation and how to avoid the factors and circumstances that lead to higher perforation rate.

Conflict of interest: None

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