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Major Article

Evaluation of surgical glove integrity and factors associated with glove defect

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Background: Surgical glove perforation may expose both patients and staff members to severe complications. This study aimed to determine surgical glove perforation rate and the factors associated with glove defect.

Material and methods: This descriptive cross-sectional study was conducted between January and March 2017 at a Tunisian university hospital center in 3 different surgical departments: urology, maxillofacial, and general and digestive. The gloves were collected and tested to detect perforations using the water-leak test as described in European Norm NF EN 455-1. For percentage comparisons, the χ^2 test was used with a significance threshold of 5%.

Results: A total of 284 gloves were collected. Of these, 47 were found to be perforated, a rate of 16.5%. All perforations were unnoticed by the surgical team members. The majority of perforated gloves (61.7%) were collected after urology procedures ($P = .00005$), 77% of perforated gloves were detected when the duration of the procedure exceeded 90 minutes ($P = .001$), and 96% were from brand A, which were the thicker gloves ($P = .015$).

Conclusions: This study highlighted an important problem neglected by surgical teams. The findings reaffirm the importance of double-gloving and changing gloves in surgeries of more than 90 minutes' duration.

Operating rooms are high-risk environments and among the most critical hospital units[1] where professionals are exposed directly to blood, body fluids, secretions, and excretions.[2] Gloves are considered a barrier that can prevent transmission of microorganisms from practitioners to patients and from patients to surgical team members and are of equal importance as surgical hand antisepsis.[3,4] However, tears and microperforations may occur, exposing both patients and surgical team members to several complications.[3,5,6] Studies have reported that glove perforation rate can be up to 50% depending on the type of surgery.[7]

This accident exposes surgical team members to many diseases such as HIV, hepatitis C virus, and hepatitis B virus.[4] Indeed, in cases of glove perforation, germs find a passage to wearers' hands.[3,5] In 2010, Harnoß et al[8] reported that 15% of gloves tested were perforated and concluded that the perforation in the glove layer allows bacteria to pass from the surgical site to the surgeon's hands.

Glove perforation increases also the risk of surgical site infection.[4] In their study, Jid et al[9] found a higher rate of surgical site infection during procedures in which gloves were defective.

Because of its importance, many studies worldwide have been interested in studying the problem of glove perforation and its risks for decades.[3,4,10-14]

Nevertheless, most operating room professionals tend to underestimate the risk caused by glove perforation and the importance of double-gloving in minimizing the rate of contamination.[5] Indeed, operating room team members, especially surgeons, prefer not to wear double gloves because they ascribe to this a diminishment of sensitivity. They choose to work comfortably although they are not protected enough.[15]

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More importantly, practitioners often fail to perceive perforations[3] and many tears are not noticed until the end of the surgery when gloves are removed.[14,16] This highly increases the risks to which surgical teams are exposed.[11]

Furthermore, studies have shown that several factors can be associated with glove perforation, including type and duration of surgery, instrumentation, function and experience of the wearer, and glove quality.[14,17,18]

Thus, the current study aimed to determine the rate of glove perforation in 3 different surgical departments and the factors associated with glove defect.

MATERIAL AND METHODS

Study design, duration, and setting

This study was descriptive and cross-sectional. It lasted for a period of 3 months (January-March 2017) and was conducted in 3 different surgical units in Tunisian University Hospital Center of Sahloul (Sousse).

Study population

Participants

The study included surgical teams, which are composed of surgeons, residents, operating room technicians, and scrub nurses. The selection of participants for our study was based on a convenience sampling method and the sample size was 49.

Gloves

The study material comprised all gloves used (n = 284) by aforementioned surgical teams during the different surgical procedures. In the course of this study, 2 brands (brand A and brand B) from 2 different manufacturers were used and all were made from natural rubber latex. The 2 brands are different in thickness: brand A gloves are thicker than brand B gloves (0.22 mm vs 0.18 mm). The gloves used were also different in whether the gloves were powdered or not.

Data collection

Gloves were collected after their removal by the wearer, separated, labeled, and identified in plastic bags according to the type of the surgery, the duration of the glove's use, function of the wearer and his or her dominant hand for activity, and the characteristics of the gloves (ie, fabricant and powder existence). It was also noted whether a given pair of gloves was the initially worn pair or a replacement pair and whether the glove perforation was noticed during the surgical procedure or not.

Also, after each procedure, each participant on the surgical team was asked to fill out a brief demographic characteristics questionnaire that requests information regarding age, gender, surgical specialty, function, years of experience, and dominant hand for activity.

Study instrument

The collected gloves were tested immediately at the practical training room of the Higher School of Health Sciences and Techniques of Sousse using the approved and standardized water-leak test method according to European Norm NF EN 455-1.[19]

This test runs as follows: a polyvinyl chloride tube the dimensions of which fit the glove and such that the tube is capable of holding any of the 1,000 mL water that may exceed the natural fill volume of the glove is inserted vertically into the glove and fixed with a ring positioned at 40 mm from the end to avoid glove damage.

One liter of water (±50 mL) is poured into the glove from the open side of the pipe, allowing the water to pass freely into the glove. Some water may remain in the filling tube depending on the glove being tested.

The glove is allowed to hang and is immediately inspected during a period of 2-3 minutes for visual water leakage as either a jet or droplets.

A data collection sheet was filled out by the researchers that allows recording of information about the type and the duration of the intervention, the glove characteristics (eg, manufacturer and powder existence), the wearer's function, the location, the number of perforations, and whether or not the perforation was perceived by the participant.

Ethical considerations

Data collection started after obtaining approval from the chiefs from the 3 concerned departments. The water-leak test does not require permission, although the participants were fully informed about the research being conducted. The study's aim and methods were explained to participants, as were their rights of anonymity, confidentiality, and the right to refuse participation. They gave verbal consent to participate and filled out the questionnaire.

Data analysis

Results were produced using the Statistical Package for Social Sciences version 20.0 (IBM-SPSS Statistics, Armonk, NY) for Windows. For percentage comparisons, the χ^2 test was used with a significance threshold of 5%.

RESULTS

Altogether, 284 gloves were collected from the different fields and 49 participants from the concerned operating rooms agreed to participate in this study, for a participation rate of 73.1%.

Demographic data and characterization of surgeries

Of all participants, 40.8% (n = 20) were members of the urology surgical team, the participants were predominately men (61.2%; n = 30) and were surgical residents in 38.8% of cases (Table 1). The right hand was the dominant one in 89.8% of cases (n = 44).

As for gloves used in the different procedures, they were from 2 brands (brand A and brand B) from 2 different manufacturers and were made of natural rubber latex. Brand A gloves, which were thicker than brand B gloves represented 83.8% (n = 238) of all gloves used. Powdered gloves represented 87.3% (n = 248) of gloves, whereas 12.7% (n = 36) of gloves used were powder-free.

The distribution of glove use according to surgical specialty, to wearer's function, and to surgery duration is represented in Table 2.

Water-leak test

Our findings were that the overall perforation rate was 16.5% (47 perforated gloves) with 52 perforations. The most-perforated finger was the index finger, with 18 perforations (34.6%), followed by the thumb with 12 perforations (23.1%), and the ring finger with 8 perforation (15.4%). One perforation occurred in the little finger (1.9%). As for perforation location with regard to hand dominance, our results showed that the index finger of the nondominant hand was the most common perforation location (21.1%) followed by the