Glove perforation in selected surgical procedures in a general hospital in La Habana, Cuba

Humberto Guanche Garcell*, Anayka Gonzalez Valdés, Luis Gonzalez Alvarez, Gloria Fresneda Septiém, Katerine Cardenàs Goulet, Yelina Matos Figueroa, Francisco Gutiérrez García

Hospital Epidemiology Department, Hospital Joaquín Albarrán, La Habana, Cuba

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SUMMARY

Background: Surgical glove perforation constitutes a risk for the maintenance of aseptic technique and the risk of surgical site infection and occupational exposure to blood borne infections for healthcare workers.

Aim: To identify the frequency of glove perforation in selected surgical procedures.

Methods: A cross-sectional descriptive observational study was carried out in the surgical unit of the Joaquin Albarrán Hospital (La Habana, Cuba) during the period September –December 2019. Gloves used by surgeons in major urgent or elective surgical procedures were collected and tested for perforations.

Findings: 757 gloves from 149 surgeons and 8 surgical specialties were tested and 95 (25.8%) had perforations. The highest frequencies of glove perforations were reported in vascular surgery (50.0%), proctology (37.9%), urology (28.0%) and general surgery (26.1%). The selected surgical procedures with the highest frequencies were open radical nephrectomy (87.5%), splenectomy (57.1%), open adenomectomy (55.6%), limb amputation (46.2%) and hysterectomy (41.7%). Glove perforation occurred more frequently in consultant surgeons (28.8%) than in residents (20.9%) (P = 0.021), in surgeons with more years of surgical experience (P = 0.003) and longer procedure duration (P < 0.001). Most glove perforations were identified in the left hand (64.1%), while 23.1% were in the right hand and 12.8% in both hands. 51.2% occurred in thumb and index finger. Differences in the patterns of glove perforation were observed among the different surgical procedures.

Conclusions: Our findings provide insights into the risk of glove perforation during selected surgical procedures and the need for prevention strategies to reduce adverse consequences of glove perforation in patients and healthcare workers.

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Introduction

The use of gloves during surgical procedures aims at preventing surgical site infections and to protect healthcare workers against blood and other body fluid exposure, especially those related to the transmission of blood borne pathogens.
The use of double gloves and the frequent change of the outer one is recommended by various organisations but underused in routine practice, raising concerns about the perception of the risk of blood borne infection exposure and the need for protection among healthcare workers [1–4].

Surgical glove perforation constitutes a risk for the maintenance of aseptic technique, for surgical site infection in patients and occupational exposure to blood borne pathogens among users. Published studies have found perforations frequency and tears up to 78% of gloves during surgical procedures. [5–14] These studies have highlighted the duration and type of surgical procedures, user experience, and glove quality as factors related to glove perforation.

In Cuba, the use of double gloving is not routine practice, while glove replacement at selected instances of the surgical procedures (for example in long duration procedures or before suturing) or when there is evidence of rupture is common practice. There are no previous studies describing the frequency of perforation of surgical gloves in Cuba. We aimed to identify the frequency of glove perforation within selected surgical procedures.

**Methods**

A cross-sectional descriptive observational study was carried out in surgical units of the Joaquin Albarrán Hospital (La Habana, Cuba) during the period September–December 2019. The hospital is a 380-bed teaching facility that provides secondary medical and surgical care to a population living in the western area of La Habana.

**Table I**

Factors associated with glove perforation

| Variables      | No. Gloves | No. Gloves (%) | Yes. Gloves (%) |
|----------------|------------|----------------|-----------------|
| Specialty      |            |                |                 |
| Vascular       | 34         | 17 (50.0)      | 17 (50.0)       |
| General        | 337        | 249 (73.9)     | 88 (26.1)       |
| Maxillofacial  | 4          | 4 (100)        | 0               |
| ENT            | 149        | 120 (80.5)     | 29 (19.5)       |
| T & O          | 16         | 13 (81.3)      | 3 (18.8)        |
| Proctology     | 58         | 36 (62.1)      | 22 (37.9)       |
| Rheumatology   | 52         | 46 (88.5)      | 6 (11.5)        |
| Urology        | 107        | 77 (72.0)      | 30 (28.0)       |
| Category       |            |                |                 |
| Surgeon resident | 291    | 230 (79.1)     | 61 (20.9)       |
| Staff surgeon  | 466        | 332 (71.2)     | 134 (28.8)**    |
| Role           |            |                |                 |
| Assistant surgeon | 422  | 324 (76.8)     | 98 (23.2)       |
| Principal surgeon | 335  | 238 (71.0)     | 97 (29.0)       |
| Procedure      |            |                |                 |
| Open adenomectomy | 9     | 4 (44.4)       | 5 (55.6)        |
| Testicular     | 11         | 8 (72.7)       | 3 (27.3)        |
| Percutaneous nephrolithotomy | 12 | 10 (83.3) | 2 (16.7) |
| Endourological | 33         | 29 (87.9)      | 4 (12.1)        |
| Open radical nephrectomy | 16 | 2 (12.5) | 14 (87.5) |
| Other urological procedures | 26 | 24 (92.3) | 2 (7.7) |
| Saphenectomy   | 7          | 3 (42.9)       | 4 (57.1)        |
| Limb amputation | 26         | 14 (53.8)      | 12 (46.2)       |
| Hysterectomy   | 36         | 21 (58.3)      | 15 (41.7)       |
| Herniorrhaphy  | 114        | 80 (70.2)      | 34 (29.8)       |
| Laparotomy     | 18         | 13 (72.2)      | 5 (27.8)        |
| Other general surgery** | 50 | 38 (76,0) | 12 (24,0) |
| Thyroidectomy  | 14         | 11 (78,6)      | 3 (21,4)        |
| Breast         | 34         | 28 (82,4)      | 6 (17,6)        |
| Cholecystectomy | 70       | 56 (80,0)      | 14 (20,0)       |
| Anal           | 58         | 36 (62,1)      | 22 (37,9)       |
| T & O          | 16         | 13 (81,3)      | 3 (18,8)        |
| Arthroscopy    | 52         | 46 (88,5)      | 6 (11,5)        |
| Head and neck  | 111        | 91 (82,0)      | 20 (18,0)       |
| Other ENT procedures | 44 | 35 (79,5) | 9 (20,5) |
| Experience as surgeon (year) (mean ± SD) | 13.0 (13.3) | 16.2 (13.0)** |
| Procedure duration (minutes)) (mean ± SD) | 62.3 (41.8) | 78.2 (54.1)** |

*Data presents as No (%) unless specified ** other surgery includes stomach, appendix, gynecology and colon surgeries *** P < 0.005.

ENT- Ear, nose and throat surgery; T & O Trauma and Orthopaedic.
Gloves used by surgeons in major urgent or elective surgeries were collected. The surgeons’ specialties, category (staff surgeon or resident), years of experience as a surgeon, procedures performed, surgeon role (principal or assistant), and the duration of the procedure were recorded. The gloves were collected immediately after completion of procedures in separate plastic bags for either the ones used by the principal or assistant surgeons. Then, bags were sealed and labelled.

The detection of perforations was carried out according to the method described in standard ISO EN 455–1:200011. [15] The gloves were filled with 1000 ml of water at room temperature and twisted 360 degrees. Gloves were observed for a maximum of 3 minutes to detect perforations or tears, which, if identified, the affected gloves were recorded as right or left as well as the tearing location (finger, palm, or back). Gloves torn during the procedure due to mishandling were excluded from the study.

| Procedure                  | Right | Left |
|----------------------------|-------|------|
| Hernia surgery             |       |      |
| Head and neck surgery      |       |      |
| Cholecystectomy            |       |      |
| Anal surgery               |       |      |
| Arthroscopy                |       |      |
| Hysterectomy               |       |      |
| Limb amputation            |       |      |
| Nephrectomy                |       |      |
|                             | >23%  | 20-29.9% |
|                             | 10-19.9% |      |
|                             | 0.1-9.9% | 0 |

*Figure 1. Distribution of glove perforations according to procedures (per 100 perforations).*
Only one commercial brand of gloves was used in the hospital during the study period.

Ethics

The surgical staff were informed about the objectives of the study. The names of surgeons were coded with consecutive alphanumerical characters based on the glove collection order. The study was approved by the Scientific Committee of the Joaquín Albarrán Hospital.

Analysis

The information was registered in an Excel 2016 database (Microsoft Corporation) analysed in SPSS version 22 (IBM Corporation New York, USA). Statistical technique of frequency distribution analysis was used. To demonstrate an association between the presence of perforations and study variables the chi-square test and t-students test were used with a significance threshold of 5%.

Results

757 gloves worn by 149 surgeons from 8 surgical specialties were collected. Perforations were found in 195 gloves (25.8%), with a higher frequency in vascular surgery (50.0%), followed by proctology (37.9%), urology (28.0%) and general surgery (26.1%) with lower frequencies for the other specialties. Among the selected surgical procedures, the perforation rate was higher for open radical nephrectomy (87.5%), saphenectomy (57.1%), open adenomectomy (55.6%), limb amputation (46.2%), and hysterectomy (41.7%) (Table I).

Glove perforation occurred significantly more frequently in surgeons (28.8%) than in residents (20.9%) (P = 0.021), in surgeons with more years of experience (P = 0.003) and in procedures with a longer duration (P = <0.001). 29.0% of gloves used by the principal surgeon and 23.2% by assistant surgeons had perforations (P = 0.89). Most perforations were identified in the left hand (64.1%), while 23.1% were in the right hand; and 12.8% in both hands (Table I).

The frequency of perforations according to location was: 18.8% in thumb, 42.4% index finger, 15.5% middle finger, 3.0% ring finger, 2.0% little finger and 9.2% for both the palm and the back of the hand. Figure 1 shows the perforation frequency for eight surgical procedures. The highest perforation frequency occurred in the thumb and index finger, with a lower incidence in other fingers, palm, and back of the hand. A higher frequency of index finger perforations of the right hand was observed in hernia surgery and limb amputations. In hysterectomies, glove perforations in the index and ring finger of the right hand were more frequent. In anal surgery, perforations in the right-hand-middle-finger were most frequent. In nephrectomies, the highest perforation frequency occurred in the left hand, including the index and ring, middle fingers, and the palm and back of the left hand.

Discussion

The frequency of glove perforation identified was significantly higher in vascular, proctology, urology and general surgery and in some selected surgical procedures. In addition, a higher frequency of perforation was identified among consultant surgeons compared to residents, in surgeons with more years of surgical experience and in procedures of longer duration.

The higher frequency of glove perforation in consultant surgeons compared with other members of the surgical team, including residents, has been reported previously. For consultant surgeons, Bekele et al. reported perforation in 40.4% and 60.1% in elective and emergency surgeries [16,17]. Tlili et al. reported perforation in 48.9% of different surgical procedures [5], and Lee et al. in 37% of orthopaedic surgeries [13]. The higher frequency of perforation in more experienced surgeons does not have a clear explanation. Besides their role during surgical procedures, practice issues during surgical procedures and the risk perception could play a role that requires further research.

Tlili et al. [5] demonstrated a higher frequency in procedures over 90 minutes’ duration and in urological procedures, compared to general and maxillofacial procedures. These results are similar to our research findings. Other studies have shown a high frequency in orthopaedic or trauma surgery and cardiac surgery. [6–11,13] The frequency of perforations among surgical procedures could be related to specific procedure characteristics, instruments, and human factors. Therefore, we suggest that the use of double gloving, recommended for the prevention of glove perforation, should become a routine practice in the country, despite the limited resources of the healthcare system in a low-income country. [1,16].

The high frequency of perforations in the thumb and index finger has been described in previous reports. [5,11] Our findings provide some clues about the distribution of punctures according to procedures, and that this is likely to be related to surgical techniques. The distribution of glove perforations in nephrectomies is likely to be related to the open (non-laparoscopic) approach used in all cases.

In conclusion, our findings provide insight into the risk of glove perforation during selected surgical procedures and the need for preventive strategies to reduce adverse outcomes for patients and healthcare workers.

Authors’ contributions

Study design: HGG, FGG. Data acquisition: AGV, LGA, GFS, KK, YMF. Data analysis: HGG, FGG, AGV, LGA, GFS, KK, YMF Manuscript writing: HGG, FGG. Critical review and major scientific input: HGG, FGG, AGV, LGA, GFS, KK, YMF.

Conflict of interest statement

None to declare for all authors.

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