



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 Septiem, Katerine Cardenás Goulet, Yelina Matos Figueroa, Francisco Gutiérrez García

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

ARTICLE INFO

Article history:

Received 11 March 2022

Accepted 25 June 2022

Available online 2 August 2022

Keywords:

Glove perforation
Surgical procedures
Surgeons
Healthcare workers



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 Joaquín 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.

© 2022 Published by Elsevier Ltd on behalf of The Healthcare Infection Society.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

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.

* Corresponding author. Address: Hospital Epidemiology Department. Hospital Joaquín Albarrán, Avenida 26, La Habana, Cuba. Tel.: +97466028896, +5355013515.

E-mail address: humbertoguanhegarcell@yahoo.es (H. Guanche Garcell).

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 Joaquín 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 1
Factors associated with glove perforation

Variables	No. Gloves	Glove perforation		
		No No. (%)	Yes No. (%)	
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 (39,8)
	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.

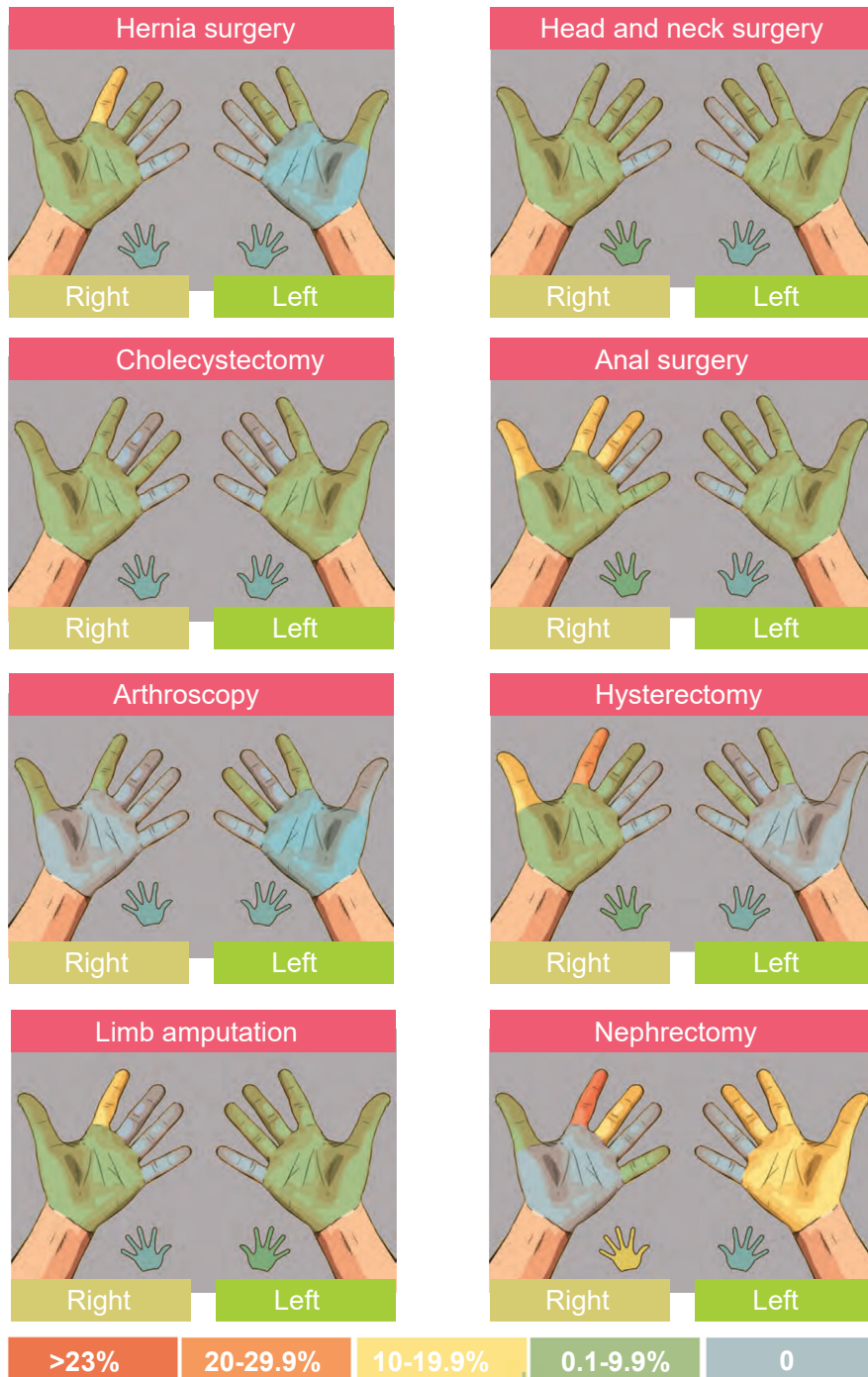


Figure 1. Distribution of glove perforations according to procedures (per 100 perforations).

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.

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 alphanumeric 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 adenectomy (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, KKG, YMF. Data analysis: HGG, FGG, AGV, LGA, GFS, KKG, YMF. Manuscript writing: HGG, FGG. Critical review and major scientific input: HGG, FGG, AGV, LGA, GFS, KKG, YMF.

Conflict of interest statement

None to declare for all authors.

Funding statement

No financial support was received to conduct the study.

Acknowledgments

We want to thank the contribution of Mr. Yasser Correa during the study conduction, Mr. Arturo Folgueira García for figure design and, Prof. Alexis Gonzalez Velázquez for proof-reading of the manuscript.

References

- [1] Tanner J, Parkinson H. Double gloving to reduce surgical cross-infection. *Cochrane Database Syst Rev* 2006 Jul 19;2006(3):CD003087. <https://doi.org/10.1002/14651858.CD003087.pub2>.
- [2] Revised statement on sharps safety. American College of Surgeons. Revised 2016 Oct. 1. Available: <https://www.facs.org/about-acs/statements/94-sharps-safety> (accessed 4 May 2022).
- [3] Childs T. Use of double gloving to reduce surgical personnel's risk of exposure to bloodborne pathogens: an integrative review. *AORN J* 2013 Dec;98(6):585–96. <https://doi.org/10.1016/j.aorn.2013.10.004>. e6.
- [4] Lipson ME, Deardon R, Switzer NJ, de Gara C, Ball CG, Grondin SC. Practice and attitudes regarding double gloving among staff surgeons and surgical trainees. *Can J Surg* 2018 Aug;61(4):244–50. <https://doi.org/10.1503/cjs.013616>.
- [5] Tlili MA, Belgacem A, Sridi H, Akouri M, Aouicha W, Soussi S, et al. Evaluation of surgical glove integrity and factors associated with glove defect. *Am J Infect Control* 2018 Jan;46(1):30–3. <https://doi.org/10.1016/j.ajic.2017.07.016>.
- [6] Demircay E, Unay K, Bilgili MG, Alataca G. Glove perforation in hip and knee arthroplasty. *J Orthop Sci* 2010 Nov;15(6):790–4. <https://doi.org/10.1007/s00776-010-1547-0>.
- [7] Li X, Li M, Li J, Gong W, Sun Y, Tang J, et al. Glove perforation and contamination in fracture fixation surgeries. *Am J Infect Control* 2017 Apr 1;45(4):458–60. <https://doi.org/10.1016/j.ajic.2016.07.024>.
- [8] Beldame J, Lagrave B, Lievain L, Lefebvre B, Frebourg N, Dujardin F. Surgical glove bacterial contamination and perforation during total hip arthroplasty implantation: when gloves should be changed. *Orthop Traumatol Surg Res* 2012 Jun;98(4):432–40. <https://doi.org/10.1016/j.otsr.2011.10.015>.
- [9] Kumar D, Shantanu K, Kumar M, Kumar A, Sharma V. A Cross-sectional Analysis of Glove Perforation in Primary and Revision Total Hip Arthroplasty. *Malays Orthop J* 2016 Nov;10(3):31–5. <https://doi.org/10.5704/MOJ.1611.010>.
- [10] Tao LX, Basnet DK. Study of Glove Perforation during Hip Replacement Arthroplasty: Its Frequency, Location, and Timing. *Int Sch Res Notices* 2014 Oct 29;2014:129561. <https://doi.org/10.1155/2014/129561>.
- [11] Becerra V, Fernández AL, Adrio B, Rubio J, Sierra J, García J, et al. Perforación de los guantes e infección de la herida de esternotomía en cirugía cardíaca con circulación extracorpórea. *Cirugía Cardiovasc* 2015;22(1):25–30. <https://doi.org/10.1016/j.circv.2014.01.008>.
- [12] Hübner NO, Goerdts AM, Stanislawski N, Assadian O, Heidecke CD, Kramer A, et al. Bacterial migration through punctured surgical gloves under real surgical conditions. *BMC Infect Dis* 2010 Jul 1;10:192. <https://doi.org/10.1186/1471-2334-10-192>.
- [13] Lee SW, Cho MR, Lee HH, Choi WK, Lee JH. Perforation of Surgical Gloves during Lower Extremity Fracture Surgery and Hip Joint Replacement Surgery. *Hip Pelvis* 2015 Mar;27(1):17–22. <https://doi.org/10.5371/hp.2015.27.1.17>.
- [14] Zaatreh S, Enz A, Klinder A, König T, Mittelmeier L, Kundt G, et al. Prospective data collection and analysis of perforations and tears of latex surgical gloves during primary endoprosthetic surgeries. *GMS Hyg Infect Control* 2016 Dec 20;11. <https://doi.org/10.3205/dgkh000285>. Doc25.
- [15] European Committee for Standardization. Medical gloves for single use. Part 1: requirements and testing for freedom from holes English version of DIN EN 455-1. Brussels: European Committee for Standardization; January 2001. Ref. No. DIN EN 455-1 : 2001-01.
- [16] Bekele A, Makonnen N, Tesfaye L, Taye M. Incidence and patterns of surgical glove perforations: experience from Addis Ababa, Ethiopia. *BMC Surg* 2017 Mar 20;17(1):26. <https://doi.org/10.1186/s12893-017-0228-8>.
- [17] Zhang Z, Gao X, Ruan X, Zheng B. Effectiveness of double-gloving method on prevention of surgical glove perforations and blood contamination: A systematic review and meta-analysis. *J Adv Nurs* 2021 Sep;77(9):3630–43. <https://doi.org/10.1111/jan.14824>.