

Associated Factors of Surgical Glove Damages in Orthopedic Surgeries

Ahmad Ghadami¹, Mohammadreza Zarei², Jaber Zabihi Rad³,
Saeed Jazini Dorcheh⁴, Khalilullah Nazem⁵

¹Assistant Professor, PhD in Nursing, Ulcer Repair Research Center, Department of Operating Room, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, ²Department of Operating Room, Student Research Committee, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, ³Department of Operating Room, Student Research Committee, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, ⁴Department of Operating Room, Surgical Technologist of Operation Room of HojjatEbnal-Hassan Asgari Hospital of Isfahan, Isfahan, Iran, ⁵Department of Orthopedic Surgery Specialist, Knee Operation Fellowship, Medical Sciences University, Isfahan Branch, Isfahan, Iran

Abstract

Background: Sterile surgical gloves protect patients from the surgical team members' microbial flora of the hands, and mutually, the members of the surgical team from pathogens of the patient's body. Damage of surgical gloves during each surgical procedure is one of the major concerns. There are a lot of risk factors and related issues associated with the damage of gloves that the results of other studies about them in some cases are consistent and in some cases inconsistent with each other. The aim of this study was to investigate the rate of surgical glove damages based on various factors in orthopedic surgery. **Materials and Methods:** In this descriptive-analytic study, 384 surgical gloves (192 pairs) were the study samples. The gloves were all made of the same material, and they were consisted of two layers. The gloves were selected based on a simple sampling study method. The study environment was the orthopedic and nerve operating room in Kashani Hospital associated with Isfahan's Medical Sciences University. The study population included the gloves wore by the scrubbed individuals during foot and hand orthopedic plating operations. Data collection tools were comprised of questionnaires and checklists all constructed by the researcher. Questionnaire contained demographic information, surgery type, and the operation team members, and the checklists covered items pertaining to the surgical glove damages. The present study made use of Water Leak Test to evaluate whether the gloves have been damaged or not. To analyze the data, descriptive statistics tests and analytical statistical tests were applied, and the data were further inspected in the SPSS software, ver. 22. **Results:** The results of this study showed that there was a significant relationship between the type of surgery, the role of people in procedure, the gender of the surgical team, the location of damage on the gloves, the glove layer, the dominant hand of people, and the rate of damage of the surgical gloves, among different issues ($*P < 0.05$), and factors such as the number of scrubbed staff in surgery, the surgical team experience, and the size of surgical gloves did not have a significant relationship with the rate of surgical glove damages ($*P > 0.05$). **Discuss and Conclusion:** Considering to risk factors that damage to surgical gloves by the surgical team, can reduce the number of needle sticks or transmission of infection between patients and them. According to the results, it is suggested that the surgical team during surgery should seek more attention to their dominant hands and in the areas contacting with the surgical instruments and the patient's body, including the thumb and index finger. Furthermore, due to the higher rate of surgical gloves damages in implanting plates into the femur, it is recommended to put on two layers gloves or routine changing of them during these surgical procedures.

Key words: Operating room, orthopedic procedures, surgical gloves

BACKGROUND

So far, many efforts have been made to create a microbe-free environment for surgical procedures. Despite these efforts, the risk of infection still exists. Although several factors are responsible for surgical infections, the dispersal and transmission of infection from the surgical team members (including surgeons, surgeon's assistants, and scrubbed nurses) to the

Address for correspondence:

Saeed Jazini Dorcheh, Department of Operating Room, Surgical Technologist of Operation Room of HojjatEbnal-Hassan Asgari Hospital of Isfahan, Isfahan, Iran.
E-mail: saeedjazinid@yahoo.com

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operating environment are recognized as the most important factor among other factors. Therefore, preventing of surgical site infections by surgical team hands and wearing the sterile gloves in the surgical site by them is very important.^[1] Sterile surgical gloves play a dual role during surgeries including protecting patients against microbial flora of the surgical team members' hands and vice versa protecting the members of the surgical team against patients' blood pathogens and their body fluids, including HIV virus and the hepatitis C virus (HCV).^[2,3] However, the damage of surgical gloves during any surgical procedure is a concern as it increases the risk of transmitting pathogenic agents between patients and among personnel and contaminating the field of surgery. Several studies stated the rate of surgical glove damage of orthopedic surgeries between 3.6% and 26%.^[4] Studies have shown that frequent use of piercing devices such as nails, wires, saws, or needles during orthopedic surgeries increases the transmission of blood infections such as HIV, hepatitis B virus, and HCV.^[5] However, there are many risk factors and related issues associated with glove damage, such as the age, body mass index, operating time, the amount of bleeding, patient gender, the individuals' roles in surgery, the type of gloves, and the dominant hand.^[6,7] The results of studies about the rate of surgical glove damage and its classification are consistent in some cases, and in some cases, contradictory with each other.^[8,9] According to the review of similar studies in relation to surgical glove damages and related factors, it seems that many studies have been carried out in this regard of the country, but in our country, there are very few studies on this issue. The purpose of this study is investigating the rate of surgical glove damages in orthopedic surgeries according to the associated factors with this issue.

MATERIALS AND METHODS

The current research paper has been carried out based on a descriptive-analytical method in 2016 in an orthopedic and nerve operating room in Ayatollah Kashani Hospital associated with Isfahan's Medical Sciences and Treatment Services University.

The study sample volume included 384 gloves that had been worn by the scrubbed individuals present in hand and foot plating operations. Of the 384 gloves, 192 ones were used in hand plating and 192 ones were used in foot plating operations. In each of these two sets of surgeries, 64 gloves belonged to the surgeons, 64 ones to the assistant surgeons, and 64 others were from the scrubbed individuals. A total of 12 samples were taken from each surgery, of which four belonged to the surgeons, four to the assistant surgeons, and four to the scrubbed individuals. The four samples belonging to each of the individuals included the inner right gloves, the inner left gloves, the outer right gloves, and the outer left gloves. The entire gloves were made of two layers, and all had the same material. After each one of the gloves was taken off, the reason and the time of the glove removal were recorded. However,

only the outer layer of the gloves was replaced during the operation, and the new gloves were not taken into consideration for further investigation. Data collection tool was comprised of researcher-made questionnaire and checklist.

Questionnaire included the demographic information pertaining to the surgery as well as to the operation team members and the checklist embraced items pertaining to the surgical glove damages. The questionnaire contained items regarding the type of the surgery, the number of the scrubbed individuals present during the operation, dominant hand, gender, and the individuals' work history. Checklist contained items pertaining to the gloves' damages such as the roles of the surgical team, gloves orientation (left or right), inner & outer gloves and their sizes; also, including the shape (perforation or rupture), damage location in hand, the number of the damaged points on the gloves and the time the damage had occurred.

The gloves were labeled after being discarded by the individuals, and they were transferred to outside the operating room for the purpose of undergoing Water Leak Test which is a standard method for analyzing the surgical gloves around the globe.^[10]

The study inclusion scales were the shortness of the operation team members' nails, the presence of the operation team members from the very beginning, the elective nature of the surgeries, not manually working with tools damaging the gloves, and use of identical materials in the entire gloves. Study exclusion scales were the illegibility of the glove labels, the imperfect preparation of the data pertaining to each of the gloves, and conducting processes other than what had been specified for the main intervention that was to be carried out on the patient during the surgery.

To analyze the data, the following statistical tests were undertaken: Pearson's Chi-square test, Fisher's exact test, and *t*-tests for two independent samples and the data were analyzed by means of SPSS software, version 22.

RESULTS

In the study, 384 (192 pairs) gloves put on by the scrubbed surgical team (surgeon, first surgeon assistant, and scrub) were studied according to the entering criteria of the study. Among 384 examined gloves, 192 gloves (50%) were related to implanting plate of hand (16 operations) and 192 gloves (50%) associated with foot implanting plate surgery (16 operations); among the 16 operations related to upper limb implanting plate, 8 (50%) were related to the arm plate and 8 (50%) were the forearm plate; and among 16 lower limb operations, 7 (43.8%) were related to femur plate and 9 (56.2%) were related to tibia plates. The average number of scrubbed staff in 32 orthopedic surgeries of lower and upper limbs was 3.66 ± 0.139 , whereas the average number of

scrubbed staff in the 16 operations of lower limb was 3.94 ± 0.123 , and in 16 operations of upper limb, it was 3.35 ± 0.155 . The results of the frequency distribution of demographic characteristics of the surgical team scrubbed staff (surgeon, assistant, and scrub), according to 32 orthopedic surgeries, have been shown in Table 1.

The overall rate of surgical glove damages was 26.8% (103/384). The results of the investigation of the relationship between the damage and the types of operation, the role of the individual in the surgical team, the gender of individual in the surgical team, and the inner and outer layers of the gloves are shown in Table 2. It was observed that there was a significant

Table 1: Frequency distribution of demographic characteristics of orthopedic surgical team and patients

Characteristics of surgical team-related factors to gloves damaging	Sex n (%)		Total
	Male	Female	
Role			
Surgeon	32 (100.0)	0 (0.0)	32 (100.0)
Assistance	32 (100.0)	0 (0.0)	32 (100.0)
Scrub	11 (34.4)	21 (65.6)	32 (100.0)
Total	75 (78.1)	21 (21.9)	96 (100.0)
Sex	n (%)		
Male	21 (65.6)		
Female	11 (34.4)		
Total	32 (100.0)		
Work history	Role	Mean±SEM	
	Surgeon (n=32)	6.38±1.22	
	Assistance (n=32)	2.28±0.144	
	Scrub (n=32)	12.53±2.14	

SEM: Standard error of mean

Table 2: Determination of frequency distribution of glove damages based on various surgical factors in upper and lower plating surgery

Characteristics of surgical team-related factors to gloves damaging	Damage		Total	P
	No	Yes		
Surgery				
Femur	43 (51.2)	41 (48.8)	84 (100.0)	
Tibia	82 (75.9)	26 (24.1)	108 (100.0)	
Arm	68 (70.8)	28 (29.2)	96 (100.0)	0.002*
Forearm	88 (91.7)	8 (8.3)	96 (100.0)	
Total	281 (73.2)	103 (26.8)	384 (100.0)	
Role				
Surgeon	89 (69.5)	39 (30.5)	128 (100.0)	
Assistance	80 (62.5)	48 (37.5)	128 (100.0)	0.001*
Scrub	112 (87.5)	16 (12.5)	128 (100.0)	
Total	281 (73.2)	103 (26.8)	384 (100.0)	
Sex				
Male	206 (68.7)	94 (31.3)	300 (100.0)	
Female	75 (89.3)	9 (10.7)	84 (100.0)	0.003*
Total	281 (73.2)	103 (26.8)	384 (100.0)	
Layer				
Outer	117 (60.9)	75 (39.1)	192 (100.0)	0.001*
Inner	164 (85.4)	28 (14.6)	192 (100.0)	
Total	281 (73.2)	103 (26.8)	384 (100.0)	

P* < 0.05 was considered as significant level (the results are based on Chi-square test)

Table 3: Determination of the frequency distribution of glove damages based on the number of scrubbed individuals of the surgical team

Characteristics of surgical team-related factors to gloves damaging	Damage		Total	P
	No	Yes		
Number of scrub				
3	150 (73.5)	54 (26.5)	204 (100.0)	0.848
4	77 (71.3)	31 (28.7)	108 (100.0)	
5	54 (75.0)	18 (25.0)	72 (100.0)	
Total	281 (73.2)	103 (26.8)	384 (100.0)	

$P^* < 0.05$ was considered as a significant level (the results are based on Chi-square test)

correlation between the damage of the gloves and all of the above factors ($P < 0.05$) so that the incidence of damages in femur plate operation (48.8%) was significantly higher than tibia plate surgery (26%), arm plate (29.2%), and forearm plate (8.3%). The incidence of damages among the scrub members of team (12.5%) was significantly lower than surgeons (30.5%) and assistant (37.5%), and also in men (31.3%), the incidence of damages was significantly higher than women (10.7%) (the risk of damage in men was 3.8 times higher than women); ultimately, the damage of the outer layer of the gloves (39.1%) was significantly higher than the inner layer (14.6%) (the risk of damage in the outer layer was 3.75 times higher than the internal layer). There was no significant difference in the mean time of the personnel work history in the surgical team based on perforated and healthy gloves (P -value = $0.094 > 0.05$), although the average work experience of people with perforated gloves was 5.89 ± 0.765 years less than those with healthy gloves (7.49 ± 0.555 years). It is noteworthy that the incidence of glove damage in the dominant hand than the other hand was significantly different (P -value = $0.004 < 0.05$) so that, of 103 glove damage in upper and lower limb surgeries, 66 cases related to the dominant hand (64.1%) and 37 cases (35.9%) were related to the other hand.

According to Table 3, there was no significant difference in the incidence of glove damages in terms of the number of scrubbed individuals (P -value = $0.848 > 0.05$).

It was observed that the incidence of damage increases as the size of the gloves increases (correlation coefficient ETA is equal to 0.195) so that glove damage with a size > 7.5 (54.4%) was more than gloves with a size < 7.5 (45.6%), but the difference was not significant (P -value = $0.890 > 0.05$). It was observed that, regarding the location of damage, the highest incidence rate was related to thumb (45.6%) and then to the index finger (42.7%), according to the test results, distribution frequency of the damage based on location was significantly different (P -value = $0.001 < 0.05$) [Figure 1].

DISCUSSION

In this study, there was a significant difference in total rates of surgical glove damages according to different types of

surgical procedures, which was along with the results by Thanni and Yinusa and Solda *et al.*, Yinusa *et al.* which sows the importance of surgery type in surgical glove damages.^[11-13]

The difference in the rate of damage in various surgical plating procedures (femur, tibia, forearm, and arm) can be due to differences in tools, tissue type, tissue depth, or in general, the difference in overall conditions of these operations. The results of the study by Choudhari and Padia which has examined surgical glove damages in various orthopedic surgical procedures of upper and lower limbs, also in line with this study, shows the different percentages of the damage in different types of orthopedic surgeries.^[9] Other studies also have shown that the rate of glove damage varies according to different types of surgical procedures.^[14]

In this study, the rate of damage according to the individuals' roles in surgery (surgeon, assistance, and scrub) was significantly different, which is consistent with the results of the study by Han *et al.* and Solda *et al.*^[6,12] and contrary to the study by Guo *et al.*^[15] The percentage of surgical glove damages in upper and lower limb surgery cases was the highest in surgeons' assistance and it was the lowest in scrubs. Less damage in scrubs seems to be because of their low activity and involvement in surgery. The higher percentage of damages in surgeons' assistant than the surgeons in this study is also consistent with the results of the study by D'Souza *et al.*, which the percentage of glove damages in surgeon assistants wearing two layers gloves was more than surgeons, in the inner layer.^[16] Of course, most other studies,^[8,17] contrary to this study, have shown more percentage of injuries in surgeons than in other groups. The higher rate of the damage in surgeons' assistance in this study can be because of their greater responsibility during surgery in this educational and treatment center, their longer presence during orthopedic surgeries, and the task of suture which they should do at the final stages of the surgery.

In this study, there was a significant difference between the rate of damages among women and men, which is consistent with the results by Han *et al.*^[6] The greater rate of damages in men can be due to the fact that all surgeons and surgeons assistants were men, and according to their more active role in surgery (the role of the surgeon and the surgeon's assistants

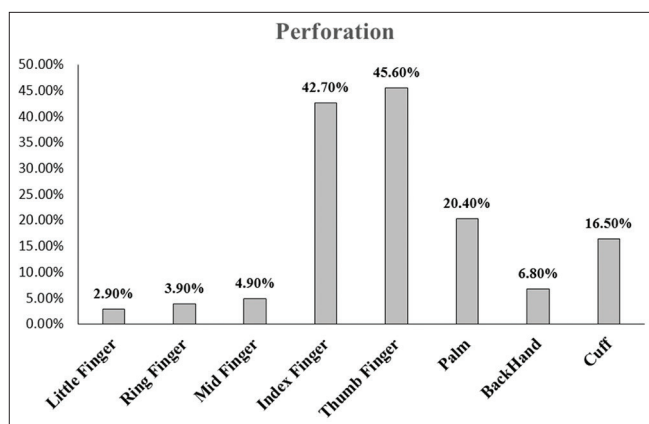


Figure 1: Frequency percentage chart of perforated gloves based on damage location

in this study), the rate of damage in men differed significantly in proportion to the number of women.

The results of this study showed that there was a significant relationship between the dominant hand and surgical glove damages, which is in line with the results of the study by Han *et al.*^[6] and contrary to the study by Kaya *et al.* In this study, in both groups of upper and lower limb plating surgeries, the frequency of damage was higher in the dominant hand than in the non-dominant hand, which is in line with the results of the study by Choudhari and Padia.^[9] and the opposite of the results of the study by Pie and Dhar.^[8,18-19] It seems that the higher rate of damages in the dominant hand is due to more activities such as exposure, suture, tissue separation, and the use of tools and, in general, being more active than the non-dominant hand.

Statistical analysis showed a significant difference between the inner and outer layers in the surgical gloves, which is consistent with studies by Avery *et al.*^[20] and Guo *et al.*^[15]. The results showed that the rate of damage in the outer layer of gloves in both groups of upper and lower limb surgeries is higher than the inner layer, which suggests the usefulness of wearing a double-layer gloves. This problem is consistent according to the results of the study by D'Souza *et al.* in which the study of the external layer damage of the surgical gloves was 11.9% and the inner layer was equal to 2.38%.^[16] The greater the damage in the surgical gloves outer layer can be due to their greater contact with damaging agents. On the other hand, it is clear that the outer layer of gloves protects the glove inner layer (below).

Regarding the location of damages in gloves, the results showed that, in upper and lower limbs surgery, damage in the area of the thumb and index finger was more than other points. Comparison of different places of damages on surgical gloves showed a significant difference in different points. The results of the damage in different points of surgical gloves in both categories of these operations were in line with the results of the study by Sanaullah *et al.*^[5] The greater damage in these areas of surgical gloves can be due to the increased

use of these areas and the greater involvement of them with damaging and sharp agents and more contact with patients' tissues and bones.

The results of the average time of perforated and healthy gloves showed that there was no significant difference between time and damage of surgical gloves, which was contrary to the studies by Latef and Yinusa,^[13] Han *et al.*, and Yinusa *et al.*^[6,11,13] Of course, the results of a study by Dhar^[19] in accordance with this study show that as the time increases, the damage does not increase and it is different or maybe less, in different intervals after the start of the procedure,^[18] which seems to be due to the difference between the type of surgery and the study environment in that research.

In terms of damages of surgical gloves according to the size of the gloves, the rate of glove damage was higher in both sizes of 8 and 7.5, but a comparison of the frequency of damages between the sizes of 7.5 and higher and the sizes below 7.5 was not significantly different. The damages of the sizes of 7/5 and 8, according to the researcher's opinion, are due to the greater use of these sizes of gloves between surgeons and surgeons' assistants and naturally increased damages in these sizes. This was because all the surgeons and surgeons' assistants were men and most scrubs were women, and this has caused a difference in the glove damages in these sizes.

The results showed that there was no significant relationship between the number of scrubs and the average work experience with surgical glove damages.

FINAL CONCLUSION

Due to the high rate of damage in orthopedic plating surgery, rechecking and replacement of surgical gloves during this surgical procedure are necessary. Considering the significant difference in the rate of damage between the inner and outer layers of gloves, it seems that wearing two layers of gloves is a useful method to reduce the damage to the undercoat of the glove and reduce the probability of needle stick and the transmission of dangerous infections. Regarding the different risk factors of the glove damage, it is recommended that the surgical team more often seek the damage in their dominant hands and in the areas affected by the surgical instruments and the body of patients such as the thumb and index fingers, during the operation. Considering the higher risk of surgical glove damage in femur plating surgeries, it is recommended to wear two layers gloves or replace them routinely during these surgeries with greater sensitivity.

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