

# Study the Incidence of Surgical Glove Perforation during Surgery and Evaluation for the Risk of Perforation and Risk of Surgical Site Infection

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## To cite this article:

Brajesh Kumar, Saurov Ghose, Gaurav Pandey, Manashi Ghosh. Study the Incidence of Surgical Glove Perforation during Surgery and Evaluation for the Risk of Perforation and Risk of Surgical Site Infection. *Journal of Surgery*. Vol. 6, No. 5, 2018, pp. 140-145.

doi: 10.11648/j.js.20180605.16

**Received:** September 22, 2018; **Accepted:** October 8, 2018; **Published:** October 30, 2018

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**Abstract:** In a surgical setting there is always a possibility of cross infection between patient and surgeon and surgical gloves act as an important barrier to prevent this infection. Use of double gloves provides more effective barrier for transfer of pathogens from surgical team to patient and vice versa. This study compares the benefit of using double gloves versus single gloves in various departments and its role in preventing Surgical Site Infection (SSI). This study was conducted at Army Hospital (R&R) where surgical gloves used by the operating surgeon were checked for any perforation in outer and inner gloves. In case of perforation was detected, culture of both gloves and surgical part were taken and examined for any cross infection. This study reveals that simultaneous perforation rate of both outer and inner gloves was very less and hence chances of cross infection between patient and surgeon was less when compared to single glove use. Also, the rate of perforation was less in laparoscopic surgery compared to open surgery however this is controversial as various studies which shows more perforation in laparoscopic surgery. The departments where surgeries were complex and were of longer duration had more perforation rate of gloves and consequently SSI. This study concludes that the use of double surgical gloves has got low chances of cross infection between patient and surgeon and hence low rate of Surgical Site Infection and hence should be encouraged.

**Keywords:** Double Surgical Gloves, Perforation Rate, Surgical Site Infection (SSI), Dominant Hand, Non-Dominant Hand

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## 1. Introduction

The invasive nature of surgery means that during surgery there is a high risk of transfer of pathogens. Pathogens can be transferred from the surgical team to their patients and from patients [1, 2] to the surgical team [3, 4]. This transfer may occur through a number of routes including contact with skin or blood. In surgical settings skin borne pathogens are particularly susceptible to get transferred. For the patient, this transfer of pathogen can result in a surgical wound infection which may compromise the success of their surgery, prolong their hospital stay or may become life threatening. The

surgical team is also at risk with surgeries, for example, surgeons have three times the incidence rate of Hepatitis B compared with the general public [5]. Consequently, all surgical staff members wear sterile gloves [6, 7] as a protective barrier to prevent hand-to-wound contamination during operations.

With the growing awareness among operating room staff of the risk of exposure to disease from patients, primarily Human Immunodeficiency Virus and Hepatitis Virus [8, 9] gloves have begun to be regarded as a requirement for their own protection. But when the gloves are perforated, the barrier breaks down and germs are transferred. The risk of perforation increases with the duration of operating time

significantly so after 02 hours [10, 11] and occurs more often when gloves do not fit properly [12]. The factors favoring gloves perforation include, most commonly, punctures by needles, spiked bone fragments, or sharp surfaces on complex instruments [13, 14]. The frequency of glove perforation during surgery has been extensively studied and found to be in range from 8% to 50% [15-21].

The gloves which were used in laparoscopic surgery is found to be higher perforation rate when it is compared to the conventional open surgery [22, 23]. However, this remains controversial, as some of the studies suggest that laparoscopic surgeries have lesser perforation rate compared to the open surgeries [24, 25]

The gloves worn on the non- dominant hand were more commonly perforated [26].

Double gloving offers significantly better protection than single gloving, as the inner gloves gives protection when the outer gloves is perforated [27]. As the majority of glove perforation go unnoticed, use of double gloves helps in protecting cross infection specially when the duration of surgery is expected to be more than one hour.

There are various studies which show that glove perforation is a risk factor for Surgical Site Infection (SSI) [28]. Efforts to decrease the frequency of glove perforation, such as double gloving and routine changing of gloves during lengthy procedures are encouraged. The use of double gloves is an important step to control cross infection.

Currently, in the United States, SSI account for almost 40% of hospital acquired infection among surgical patients [29]. The surgical wound encompasses the area of the body, internally and externally that involves the entire operative site.

The decision to use additional glove protection is influenced by a variety of factors such as the surgical procedure involved, prior knowledge of the risk status of the surgical patient, abrasions on the hands of the surgical team and personal preferences. For example, orthopedic surgery is considered to have a high risk of glove perforation due to the nature of the surgery which usually involves sawing, drilling and contact with sharp objects such as bone. The risk status of a surgical patient is also influential: if a patient is known or considered to be a high risk for pathogens then double gloving is one of the precautionary practices instituted.

In present scenario the role of double gloving to prevent surgical site infection particularly after prolonged surgeries is not very clear. Hence this present study was aimed to detect the rate of surgical gloves perforation in various surgeries and the effect of perforation on the development of surgical site infection

## 2. Objectives of This Study

- (i) To evaluate the risk of surgical gloves perforation during surgical procedures.
- (ii) To evaluate the risk of surgical gloves perforation in various department.
- (iii) To correlate the risk of perforation with type and

duration of surgery.

- (iv) To evaluate the difference in perforation between dominant and non- dominant hand.
- (v) To assess the association between surgical gloves perforation and development of Surgical Site Infection (SSI).
- (vi) To compare the results of single versus double gloves perforation and development of SSI.

## 3. Methods

This prospective study was carried out in operation theatres of Army Hospital (Research & Referral). All eligible patient and their procedural characteristics were recorded which included age, sex, underlying disease, additional diagnosis, type of procedure performed, division of surgical specialty, duration of surgery with special emphasis on the type of surgery. Total 1614 gloves were examined in the study. 100 gloves were examined pre operatively to look for any manufacturing defect. Total 1514 gloves (500 surgeries) from various departments were analyzed for perforation at the end of surgery with respect to time duration. All the gloves used by the surgeon were of same quality and same manufacturer (Medi Grip). The choice of single gloves or double gloves was surgeon's own preference.

The procedures were divided into laparoscopic (biliary surgery, nephrectomy and hernia repair) and conventional methods. The conventional methods were again divided into major (> 60 min surgery) or minor (< 60 min surgery) based on the time involved in the surgery.

The operating room nurses or assistants were responsible for detecting and recording breaches of asepsis when the perforation/ leakage was obvious. During the surgery, the surgical team use to look for visible perforation or breach in continuity of the surgical gloves. If any perforation was detected, the time of perforation with respect to the duration of surgery was noted.

At the end of surgery, the surgeon's hand was looked for any blood staining. The gloves which were used by the surgeon were collected and was checked for any perforation by water load test (WLT) [30]. The sensitivity of this method is less compared to other methods like electrical conductance test (ECT). Since, only the facility of Water Load Test was available in this hospital it was used for detecting surgical gloves perforations. This was done by filling the gloves with 500 ml of sterile water and was checked for any leakage of water for next 03 minutes after gentle milking. In case of no perforation were detected the gloves were discarded and gloves were not sent for culture. In such cases no swab culture was taken from the surgical site.

In case perforation were detected in the gloves, the affected part of glove was sent for culture to show any growth of microorganisms. Simultaneously swab culture were taken from the site of surgery and were sent for culture. In case growth from both the sites were positive for the same organism, it confirmed the transmission of pathogens after perforation of gloves from surgeon's hand to operative site or

vice versa.

In case of double gloves were used by the surgeon, inner gloves were also checked for perforation by same method and in case if it were found positive for perforation it was further checked similarly as described earlier.

Post operatively the patients were followed for development of signs and symptoms of Surgical Site Infections specially for the cases where gloves perforation was detected.

## 4. Data Interpretation

All statistical analyses were performed with the help of an experienced statistician using SPSS 16. The data was expressed and summarized in term of frequency and percentage. Categorical data were analyzed using Chi-Square test and Fisher's Exact Test. A p value of less than 0.05 was considered statistically significant.

## 5. Results

**Table 1.** Total no of perforation in single/ double gloves.

	No gloves used	Perforation detected	Percent (%)
Single	498	21	4.21%
Double	1016	39	3.83%

A total of 500 cases and 1514 gloves were used in the study. Surgeons used single gloves (498 gloves) or double

**Table 3.** Perforation rate in Laparoscopic and Conventional Procedures.

	No of surgeries	No of gloves used	No of perforation	Percentage
Laparoscopic	152	418	06	1.43%
Conventional	348	996	54	5.42%

Total 418 gloves were examined which were used in 152 laparoscopic surgeries. Total 06 (1.43%) perforation were detected. While in conventional surgeries total 996 gloves were examined which were used. Total number of 54 (5.42%) perforation was detected in the gloves used in

gloves (1014 gloves) according to their preference. Out of 498 single glove 21 (4.21%) perforation were detected and out of 1014 double glove 39 (3.83%) perforation were detected. 04 surgeries has both outer and inner gloves perforation in same finger (0.79%). Though the percentages of perforation in single gloves was more than double gloves it was statistically not significant ( $p = 0.06$ )

**Table 2.** Department wise gloves use and perforation.

Department	No of gloves used	No of perforations	Percent (%)
CTVS	08	01	12.5
Gen Surgery	744	17	2.28
GI Surgery	84	06	7.14
Neurosurgery	178	12	6.74
Onco Surgery	126	07	5.55
Pediatric Surgery	42	05	11.09
Reconstructive Surgery	24	Nil	-
Urology	254	07	2.75
Vascular Surgery	54	05	9.25

The incidence of surgical gloves perforation was least in reconstructive surgery (Nil). Perforation rate detected in urology department were also very less (2.75%). In gen surgery department again, the perforation rate was less (2.28%) as most of the surgeries were of short duration. In most of the other departments the perforation rate of gloves was high as the duration of surgery was very complex and of very long duration.

conventional surgery. Low perforation rate in laparoscopic surgeries was probably because of less use of sharp instruments. The difference of perforation between laparoscopic and conventional procedures was statistically significant ( $p = 0.04$ )

**Table 4.** Perforation depending on time of surgery.

Time duration	No of surgeries	No of gloves	No of perforations	Percent (%)
Upto 60 min	160	440	Nil	-
>60 upto 90 min	140	516	17	3.29%
>90 min	200	658	43	6.53%

In first group, the duration of surgery considered were up to 60 min, in which total 440 gloves were considered and no perforations were found in this group. The second group was for the surgery, where gloves wearing time was more than 60 min and up to 90 min. In this group total 516 gloves were examined and 17 (3.29%) perforations were found. In the last group, surgeries more than 90 minutes duration were considered. In this group 658 glove were checked and 43 (6.53%) perforations were found. The difference in perforation rate with respect to time was statistically significant ( $p = 0.046$ )

**Table 5.** Distribution of Perforation in fingers.

Finger	Total no perforations	Percent (%)
Left Index finger	32	53.33%
Left Middle finger	10	16.67%
Left Ring finger	05	8.33%
Left Thumb	05	8.33%
Right Index finger	05	8.33%
Right Middle finger	03	5.00%

The maximum number of perforations were detected in left index finger (53.33%) and least in right middle finger (5.00%). left middle finger had 16.67% perforation. left hand

which was the non- dominant hand had more perforation (86.66%) than the dominant hand (13.33%). Though the

perforation was high in non -dominant hand compared to dominant hand it was statistically insignificant ( $p = 0.06$ )

**Table 6.** Distribution of SSI in gloves after perforation.

	No of perforation	Development of SSI	Percent (%)
Single gloves	21	05	23.80%
Double (outer gloves perforation)	35	00	-
Double ( both outer and inner gloves perforation)	04	02	50%

In case of single glove were used by the surgeon, 21 perforations were detected and out of these 05 patients (23.80%) developed SSI. In case of double gloves were used the by surgeon, total 35 perforations were detected in outer gloves only and none of the patients developed SSI. In 04 surgeries, both the outer and inner gloves were perforated and 02 patients (50.00%) developed SSI. The difference in SSI rate between single and double gloves was statistically significant ( $p = 0.049$ )

## 6. Discussion

This study was conducted in operation theatre of Army Hospital (R & R). Total 1614 gloves were examined in the study. 100 gloves were examined pre operatively to look for any manufacturing defect. Total 1514 gloves (500 surgeries) from various departments were analyzed for perforation at the end of surgery with respect to time duration. All the gloves which were used by the surgeon, were of same quality and same manufacturer. The choice of single gloves or double gloves was surgeon's own preference.

A prospective randomized study was performed by S thomas et al [31] which included surgeries lasting more than one hour. After surgery, both inner and outer gloves were tested for perforations A total of 396 gloves were included in the study. In the double gloving pattern, out of the 32 perforations observed, 22 (68.8%) were noticed in the outer glove and 10 (31.3%) in the inner glove. Out of the 22 perforations in the outer gloves four cases (18%) had matching inner glove perforation: this indicates that in 82% of cases when the outer glove is perforated the inner glove will protect the surgeon's hand from contamination.

In this study total 1614 gloves were examined out of which 100 gloves were used for evaluation of manufacturing defect. Total 1514 gloves were used during 500 surgery. Total 60 perforations (3.967%) were found. Out of 1514, 498 gloves were used as single glove in which 21 (4.21%) perforation was found. Rest 1016 gloves were used as double gloves and 39 (3.83%) perforations were detected. In 04 (0.79%) surgeries both outer and inner gloves were perforated and these perforations were in the same finger of outer and inner gloves.

In this study the incidence of surgical gloves perforation was least in reconstructive surgery (Nil). Perforation rate detected in urology department were also very less (2.75%) because most of the surgeries were video assisted. In Gen Surgery Department again the perforation rate was less (2.28%) as most of the surgeries were of short duration. In

most departments the perforation rate of gloves was high as the duration of surgery was very complex and of very long duration.

In this study the incidence of surgical gloves perforation was significantly less in laparoscopic surgeries (1.43%) as compared to the conventional open surgeries (5.42%).

In this study, the surgeries were divided into three categories depending on the total duration of surgery. In first group the duration of surgery considered was up to 60 min. In this group total 440 gloves were considered and no perforations were found in this group. The second group was for the surgery where gloves wearing time was more than 60 min and up to 90 min. In this group total 516 gloves were examined and 17 (3.29%) perforations were found. In the last group surgeries more than 90 minutes duration was considered. In this group 658 gloves were checked and 43 (6.53%) perforations were found.

A prospective study was conducted by Lara Ivo Partecke Et al [ 32], from May 2005 through January 2006, all surgical gloves worn in the department of general surgery at the Ernst - Moritz - Arndt University, Greifswald, Germany, were collected and examined (898 pairs of gloves).

The distribution of perforations on the left hand was as follows: index finger, 55 (32.2%); palm, 21 (12.3%); middle finger, 16 (9.4%); thumb, 14 (8.2%); ring finger, 5 (2.9%); and little finger, 3 (1.8%). On the right hand, where 57 (33.3%) of the perforations occurred, the perforations were distributed as follows: middle finger, 20 (11.7%); thumb, 12 (7.0%); index finger, 11 (6.4%); palm, 8 (4.7%); ring finger, 3 (1.8%); and little finger, 3 (1.8%).

In this study maximum number of perforations were detected in left index finger, 32 (53.33%) and least in right middle finger, 03 (5.00%). Left middle finger had 10 (16.67%) perforation. Left Hand which was the non-dominant hand had more perforation 52 (86.66%) than the dominant hand 08 (13.33%)

In a study conducted by Heldi Misteli et al [28] to measure the surgical glove perforation and the risk of Surgical Site Infection SSI. It was found that in the absence of surgical antimicrobial prophylaxis ( $n = 914$ ), glove leakage was associated with an SSI rate of 12.7%, as opposed to 2.9% when asepsis was not breached. The most effective method for lowering the frequency of leakage is double gloving, which reduces glove failure significantly from rates as high as 51% with single gloves to as low as 7% of inner glove puncture when 2 pairs are used.

In this study it was found that in case of single glove use by the surgeon, 21 perforation were detected and out of these

05 patients (23.80%) developed SSI. In double gloves use by surgeon, total 35 perforations were detected in outer gloves only and none of the patients developed SSI. In 04 surgeries both the outer and inner gloves were perforated and 02 patients (50.00%) developed SSI.

## 7. Conclusion

A prospective non-randomized study regarding evaluation for the risk of surgical glove perforation during surgery and the risk for surgical site infection was taken at Department of Surgery Army Hospital Research & Referral.

Total 60 perforations (average 3.96%) were found. 21 (4.21%) perforations were found in single gloved surgeries which was higher than double gloved surgeries, where 39 (3.83%) perforations were detected. In 04 (0.79%) surgeries both outer and inner gloves were perforated and these perforations were in the same finger of outer and inner gloves.

In this study the incidence of Surgical Gloves Perforation was least in Reconstructive Surgery (Nil). Perforation rate detected in urology department was also very less (2.75%). In Gen Surgery Department again the perforation rate was less (2.28%). In most departments the perforation rate of gloves was high (Vascular Surgery- 9.25%, Pediatric Surgery- 11.09%, CTVS- 12.5%).

Perforation rate was significantly in laparoscopic surgeries compared to open surgeries.

No perforation was detected in surgeries which were less than 60 min duration. 17 (3.29%) perforations were found in surgery where gloves wearing time was more than 60 min and up to 90 min. Maximum perforation were found in surgeries more than 90 minutes <43 (6.53%)>.

In this study Left Hand, which was the non-dominant hand had more perforation (86.66%) than the dominant hand (13.33). Maximum number of perforations were detected in Left index finger (53.33%) and least in Right Middle finger (5.00%). Left middle finger had 16.67% perforation.

In this study, it was found that in case of single glove use by the surgeon, 21 perforation were detected and out of these 05 patients (23.80%) developed SSI. In case of use of double gloves by surgeon, total 35 perforations were detected in outer gloves only and none of the patients developed SSI. In 04 surgeries both the outer and inner gloves were perforated and 02 patients (50.00%) developed SSI.

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