Microperforations of surgical gloves in urology: minimally invasive versus open surgeries

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Introduction: *Surgical glove integrity is important in preventing wound infections and reducing patient mortality. Rates of perforations have been studied in many surgical subspecialties, but glove perforations specific to urology have not been investigated previously. This study aims to determine the incidence of glove perforations during urological surgeries and to investigate differences between open, laparoscopic, and endoscopic procedures.*

Materials and methods: *A total of 180 gloves were collected from various urological procedures performed at our institution: 59 from endoscopic, 72 from laparoscopic, and 49 from open cases. The gloves were tested for defects by both the water load test and electrical conductance testing. The frequency of defects for each type of procedure along with the length of wear, surgeon experience, and glove brand was analyzed.*

Results: *Glove defects were detected in 29% of all cases. Microperforations encompassed the majority of the glove defects (23.3%) and were detected in 15.2%, 25.0 %, and 30.6% of the endoscopy, laparoscopic and open surgical cases, respectively. The frequency of perforations noted in the minimally invasive procedures was significantly different across the groups ($p < 0.01$). There was no statistical significant correlation between glove defects and operation time, surgeon experience, and glove brand.*

Conclusions: *The rates of glove perforation (29%) in urological procedures were higher than expected. Given the high rates of glove perforations found, double gloving in urological surgeries may offer a solution to the increased risk for cross contamination from microscopic perforations.*

Key Words: urology, glove perforations, minimally invasive surgery

Introduction

Surgical glove use was first pioneered by Dr. William Halstead in 1889.[1] Originally, gloves were used to protect healthcare workers from caustic disinfectants. However, it was later found that the use of gloves also prevented surgical wound infections and reduced patient mortality.[1] In the modern era, glove use is ubiquitous, and gloves standards are regulated by the FDA. However, cross contamination continues to be a significant healthcare issue as illustrated by the estimated risks for viral transmission rates amongst surgical healthcare providers.[1] Glove perforations may also contribute to transmission of contaminants from surgeons to patients.

The integrity of surgical gloves is not always maintained during a surgical procedure. It has been shown that this integrity is dependent on the duration of the procedure, the type of surgery being performed, experience of the operator, and type of glove used. The reported rate of glove perforation has been investigated in many surgical fields with rates

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varying between 5% and 50%,[2] and despite this high incidence, only 15% of the time surgeons are aware of it.[3] Another potential reason for the variation in perforation rates relates to the accuracy of the methods used to test the integrity of the gloves. Many common methods including the standard water load test can easily detect large holes but vary considerably in their detection of microscopic perforations.[4] For such subtle perforations, more sensitive tests such as those utilizing electrical impedance should be employed.[5]

Given the variability of glove perforations among surgical subtypes, it is important for the patients and the healthcare workers to have accurate knowledge of the risk of glove perforation in each of the surgical subspecialties as this information may influence the surgeons' decision to double glove. To our knowledge there is no data concerning the incidence of glove perforations in urology. This study aims to determine the incidence of glove perforations during urological surgery and to investigate differences between open, minimally invasive, and endoscopic procedures.

Materials and methods

Gloves from various urological surgical procedures performed at the Johns Hopkins Hospital were collected from June 2009 to August 2009. A total of 180 gloves were collected with the following breakdown: 59 from endoscopic, 72 from laparoscopic, and 49 from open procedures. Gloves were collected after each procedure and labeled with the type of procedure, duration of procedure, surgeon handedness, and the role of the surgeon (primary or assistant) during the procedure. The surgeon was also asked if he/she recognized a perforation and needed to change gloves, and the lengths of use of the old pair and new pair of gloves were documented if indeed there was a change. The two different glove brands used in our institution for the study included SensiCare (latex-free, powder-free made from synthetic polyisoprene) and Biogel PI (non-latex polyisoprene glove with Biogel coating). Glove sizes tested ranged from 6 to 8.

Gloves were tested for defects by both the water load test and electrical conductance testing. First, each glove was rinsed and filled with 500 mL of 0.9% saline. The opening of the glove was closed and gross leaks were evaluated by squeezing the glove for 15 seconds and examining each finger, palm and back of the glove. Any leak seen at this stage was defined as a visible leak.

Each glove was then filled with saline and immersed in a saline solution bath with one electrode inside the glove and the second electrode in the bath. A multimeter (Radioshack, Fort Worth, Texas, USA) was used to obtain electrical resistance readings. Initially, 20 unworn gloves were tested with electrical conductance as described by Sohn et al.[5] The recorded resistance of the new unused gloves was consistently greater than 40 MOhms, thus confirming the integrity of these gloves. Intact gloves therefore had resistance levels greater than 40 MOhms. Microperforations, were defined as non-visible perforations resulting in a decrease in resistance. New gloves were perforated with sequentially smaller needles starting with a 16 gauge needle until no visible leak was identified. The largest needle size that created an invisible hole was a 30 gauge which produced a decrease in measured resistance to 11 MOhms. Thus, any resistance value less than 11 MOhms without a visible leak was considered a microperforation in this study. All experiments were performed in triplicate.

The frequency of defects and types of procedures were analyzed by descriptive statistics and dichotomous data were analyzed using the chi-square test. Differences in continuous data were assessed with the t-test or one-way ANOVA with Scheffe's post hoc evaluation. A two-sided p value of < 0.05 was considered statistically significant.

Results

A total of 180 gloves were collected from endoscopic, laparoscopic and open urologic surgeries. Fifty-nine were retrieved from surgeons performing endoscopy, 72 from laparoscopy, and 49 from open. Eleven gloves had leaks detected visually (6%); none from endoscopic, five from laparoscopic, and six from open procedures. There were microperforations in 23.3% of all gloves, translating into 15.2%, 25.0 % and 30.6% of the endoscopy, laparoscopic and open surgical cases, respectively. The frequency of perforations noted in the minimally invasive procedures was significantly different across the groups ($p < 0.01$) as illustrated in Figure 1.

The 93 gloves collected from the left hand revealed eight (8.6%) with a visible leak and 19 (22.9%) with microperforations. From the 87 gloves collected from the right hand, three (3.4%) had visible leaks and 23 (26.4%) had microperforations. Twenty-nine percent of the total left handed gloves had a perforation while 29.8% of the total right handed gloves had a perforation, which was not statistically significant ($p = 0.2654$), indicating that there was not one hand which was more likely to perforate.

There was not a statistical difference in leaks or microperforations when stratified by surgeon or assistant. Similarly, we found no significant difference

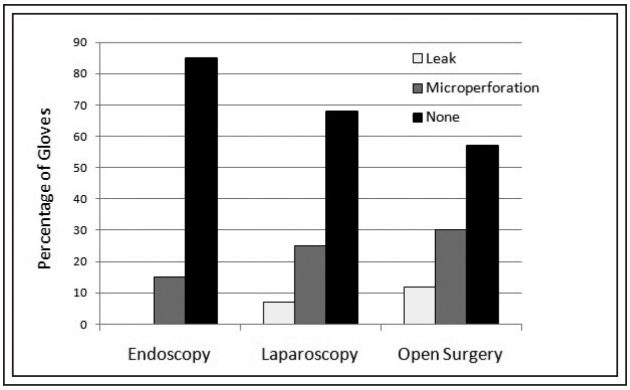

Figure 1. The frequency of perforations noted in the minimally invasive procedures was significantly different across the groups ($p < 0.01$). Microperforations were detected in 23.3% of all gloves, translating into 15.2%, 25.0 % and 30.6% of the endoscopy, laparoscopic and open surgical cases, respectively.

between the two most commonly used gloves at our institution (Sensicare, Biogel PI) in all gloves or after stratification by procedure type. Glove size did not affect the rates of leaks or microperforations.

Glove perforations were then assessed according to tertiles of operative time. Median time for the first, second, and third tertiles were 30 min, 120 min, and 210 min. There was a nonstatistically significant trend in which the longer procedures lead to an increased glove microperforation rate, which occurred in 24%, 30% and 33% across the tertiles, respectively. In addition, there was not an association with overt leaks and operative time.

Discussion

Surgical gloves function as a barrier to prevent the transmission of infection between the surgeon and the patient. Perforations or leaks in surgical gloves have been shown to be dependent on the type of glove used, duration of the procedure, and surgical subspecialty. There is no data regarding the incidence of glove perforation in the urological subspecialty. Here, we report a 23.3% incidence of microperforations for all urological cases with 30.6% for the open cases. While less common compared to microperforations, there is a 6% rate of overt leaks overall, with the most common site located at the left index finger. Interestingly, there was no difference between the right and the left with respect to microperforations.

There is clearly a risk of transmission of infection for both the surgeon and the patient when there is obvious hole in the glove. However, a recent study has also suggested that microperforations are capable of transmitting infection in a similar fashion. Hubner et al[6] demonstrated that cultures taken from surgeons wearing two gloves, with a microperoration in the outer glove, grew the same bacteria that was found in the peritoneum of laparotomy patients. This transmission rate was 54% if a microperforation was evident in the outside glove. Therefore, if a microperforation occurs in urology 23.3% of the time and roughly half of the microperforations lead to bacteria migrating through the glove, then an urologist routinely wearing single gloves would have a 12% chance of being exposed to contaminated fluids for each case. The risk for each open and laparoscopic procedure would theoretically be 15% and 12%, respectively. Endoscopic procedures seem to have the lowest rate of microperforations, but given that the average urologist would perform far more endoscopic procedures, the cumulative risk increases. No studies have shown how glove microperforations affect the transmission of viral particles. Undoubtedly, virally infected fluids would have at least similar if not increased ability to cross through microperforations.

Obvious glove tears can directly expose the patient to bacteria from the surgeon's hands, but there is a paucity of data concerning the effect of microperforations on contamination of the patient. Nonetheless, given that Hubner et al demonstrated that bacteria are able to cross and be cultured from gloves with microperforations,[6] it is highly likely that microperforations also allow bacteria from the surgeons hands to infect the patient. The implications of this are not known, but it is interesting to speculate that urologists are essentially operating with contaminated instruments 12%-15% of the time, although the burden of contamination is likely low. It is also not known how microperforations might influence wound infections. Skin closure would obviously occur at the end of the procedure when microperforation rates would be most prevalent.

The role of the surgeon, brand of glove, handedness, and the length of the procedure were all evaluated with respect to the gloves received and were not independently associated with the incidence of perforation. These results would indicate that double gloving should be recommended for surgeons at all levels of training. If one brand was more likely to be defective or weaker, then that should have been reflected in the data set; however, there was no significant difference between the two major brands used at out institution.

Other studies investigating the effect of surgery length on glove perforation have found that longer surgeries are associated with an increased rate of perforations.[7] We did not find a significant association between time of the procedure and glove perforation. This discrepancy is likely because the longer laparoscopic procedures had decreased rates of microperforations.

In conclusion, the rates of glove perforation in urological procedures were higher than expected. Single glove perforations were identified in 15%, 31%, and 43% of endoscopic, laparoscopic, and open cases, with microperforations contributing to the majority of them. Recent evidence[6] has suggested that microperforations do allow the passage of bacteria about 54% of the time indicating that urologists using single gloves may be exposed to infected fluids 16%-22% of the time for each case. Furthermore, studies have shown that wearing two pairs of gloves reduced the incidence of postoperative infection by more than 50%[8] and transmission of contaminated fluid after a needle stick.[9] Finally, Fry et al recently refuted the commonly held dogma that double gloving significantly impairs tactile sensation.[10] Therefore, given the high rates of glove perforations found and the increased risk for cross contamination from microscopic perforations, double gloving in urological surgeries may offer a solution to not only protect the patient from infections but also the operating team from patient-transmitted infectious agents. □

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