SCIENTIFIC ARTICLE

Incidence of Glove Perforation During Hand Surgical Procedures

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Purpose To determine the rate of glove perforation during hand surgery.

Methods We prospectively examined the rate of glove perforations among 10 fellowship-trained hand surgeons at our institution during a 6 week period. Gloves were tested for perforation using a water-fill technique at the conclusion of each surgical procedure. Surgeons recorded the presence of any glove perforations.

Results Eleven perforations were identified in 10 gloves among 600 surgical procedures during the study period. The perforation rate per case was 1.5% (95% confidence interval, 0.78% to 2.8%). Forty percent of perforations (n = 4) occurred during fracture surgery. Other holes occurred during isolated carpal tunnel release (n = 3) or combined carpal tunnel and trigger finger release (n = 3). The perforation was noticed intraoperatively in only 2 gloves. The difference in perforation rate between single- and double-gloved procedures was not significant. There were no perforations in the inner glove of surgeons who double gloved. A total of 73% of holes (8 of 11) occurred on surgeons' index finger; 75% of these were on the dominant hand. The dominant thumb, non-dominant ring and nondominant little fingers each had a single perforation.

Conclusions The rate of glove perforation during hand surgery is low. Holes can occur even during soft tissue procedures of short duration. The dominant index finger appears to be at greatest risk for perforation. When they do occur, most often holes are not noticed by the operating surgeon. The baseline glove perforation rate is unknown.

Clinical relevance A high level of vigilance is required to maintain sterile technique. *(J Hand Surg Am. 2017;■(■):1.e1-e5. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Glove perforation.

Online Exclusive

The use of surgical gloves dates to the late 19th century. Caroline Hampton, the scrub nurse in the operating room of William Stewart Halsted, developed contact dermatitis in her hands from phenol and mercuric chloride, commonly used as surgical disinfectants. To address the problem, Dr. Halsted, chief of surgery at Johns Hopkins Hospital, commissioned the Goodyear Rubber Company to create thin rubber gloves to protect his nurse. The use of surgical gloves became commonplace among

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other nurses, and eventually surgeons adopted the practice. Joseph Bloodgood, one of Dr. Halsted's protégés, reported a near 100% drop in infection rate in over 450 hernia surgeries with the use of gloves in 1899. In light of this success, Dr. Halsted and many of his contemporaries adopted the routine use of gloves during surgical procedures.[1]

For the hands of the surgeon, the surgical glove provides a barrier to isolate the skin surface of the surgical team from the patient. Glove perforation results in a break in this barrier, which can potentially result in wound contamination and expose the surgeon and patient to pathogens. In 1991, Maffulli et al[2] examined the rate of latex glove perforation in hand surgical cases and found a rate of 19%. Most of these perforations were not detected by the operating surgeon during the procedure. This rate of glove perforation seems high, given that our anecdotal experience suggested that glove perforations are rare during hand surgery. However, based on the experience of Maffulli et al and others,[3] holes may occur much more frequently than we are aware, and even close intraoperative inspection of a potentially compromised glove may be inadequate to detect a perforation.

Surgical practice has changed considerably since the report of Maffulli et al[2] nearly 25 years ago. Procedures such as volar plating of distal radius fractures have become far more common[4] whereas implants have become more refined with features including smooth, tapered edges and precontours[5] that may be less likely to cause perforations. Many surgeons have adopted wide-awake local anesthesia with no tourniquet, which can result in a bloodier surgical field.[6] Many surgical procedures such as carpal tunnel release (CTR) and cubital tunnel release are being performed through more minimally invasive and/or endoscopic approaches, and glove manufacturing techniques and quality control measures have been modified over the past quarter century.[7] Therefore, the purpose of our study was to evaluate the rate of surgical glove perforation during common hand surgical procedures. We hypothesized that these changes would result overall in a lower rate of glove perforation than previously reported.

MATERIALS AND METHODS

With institutional review board approval, we prospectively examined the rate of glove perforations among 10 hand surgery fellowship-trained orthopedic surgeons at our institution who performed consecutive elective surgery over a 6 week period. We believed that excluding trauma patients would eliminate some degree of variability, because these surgeries are often performed at off hours, with an unfamiliar team, and in an uncontrolled setting. During this time, surgeons recorded the presence of any glove perforations noted during the surgical procedure. If a perforation was noticed during the procedure, the location (side, digit, and outer/inner glove) was recorded.

If no perforation was noted during the procedure, the surgeon tested each of the outer and inner gloves for perforations at the conclusion of surgery. The method used to detect holes was a water-fill technique identical to that used by Maffulli et al[2] and described by McCue et al,[8] which is validated for determining holes equivalent to the size of a 26-gauge needle and larger. Each glove was overfilled with water and then squeezed, both at the base of the glove to pressurize the palm and along each digit. A perforation was noted as a stream of water. For surgeons who used double gloves, the same analysis was performed for both the inner and outer gloves. The gloves of surgical assistants were not tested.

Surgeons also recorded the following variables: type of procedure, type of anesthesia, surgical or tourniquet time, glove type, and use of single or double gloves. Surgical technique was per the surgeon's usual routine, as was the type of glove and use of single or double gloves. Use of latex-free gloves was also noted when these were worn by the surgeon.

Gloves used by surgeons in the study were manufactured by 4 companies: Cardinal Health (Dublin, OH), Ansell (Iselin, NJ), Mölnlycke (Norcross, GA), and Medline (Mundelein, IL). In 47 cases, latex gloves were used (these were manufactured by either Medline or Ansell); the remainder were synthetic. For surgeons who double gloved, the same manufacturer made both pairs of gloves.

Surgical cases were categorized as soft tissue only (ie, trigger finger release [TF], tendon repairs, ganglion excisions), nerve releases (ie, CTR and cubital tunnel releases), fracture surgery, reconstructive (ie, thumb basal joint arthroplasty, proximal row carpectomy, and arthrodesis), and arthroscopy. Table 1 summarizes the distribution of surgical case types.

Because our data had a non-normal distribution, we calculated 95% confidence intervals and estimated sample size using a bootstrap method with an attempted 1,000 replications using SPSS statistical software (IBM, Armonk, NY).[9] The bootstrap method models observations by assuming a variety of distributions. We performed 1,000 simulations to see whether these replications led to a different result