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CORR Insights®: High Risk of Surgical Glove Perforation From Surgical Rotatory Instruments

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Where Are We Now?

The German surgeon Paul Leopold first used rubber surgical gloves in the late 1800s, and William Halstead popularized the use of sterile medical gloves at Johns Hopkins around 1894 [11]. Since their introduction, surgical gloves have had one of the most fundamental roles in

modern healthcare: To protect the patient from surgical wound contamination. In more recent years, they have fulfilled another important purpose: To protect medical personnel from exposure to blood borne pathogens like human immunodeficiency virus and hepatitis B and C viruses.

Although surgical gloves are generally considered a crucial component of universal precautions [11], many papers suggest that intraoperative surgical glove holes, punctures, and/or tears commonly occur among all members of the surgical team [3, 6–8, 13].

Aside from the unsettling mere prospect that these highly regarded modern medical tools of quality and safety may fail to fulfill their intended purpose, the

prevalence of surgical glove perforation has been reported to be as high as 43%–64% [10, 14]. Even more disturbing, up to 73% of perforations are not recognized until the completion of the surgical procedure [11]. Furthermore, investigators have reported this issue to be particularly pervasive in orthopaedic surgical cases, which have consistently demonstrated the highest risk of glove perforations among all major surgical specialties [8, 10, 11], accounting for up to 61% of all surgical glove perforations [12].

Our current knowledge suggests that surgical glove perforations are apt to occur in the nondominant hand, more specifically in the index finger followed by the thumb, and then middle digit [10, 11]. These perforations usually involve the gloves of the operating surgeon (77%), but surgical assistants (13%), and scrub nurses (10%) are also at risk [4]. Furthermore, the risk of glove perforations appears to increase with increased duration of a surgical procedure [3, 9, 14], in bony versus soft-tissue procedures [14], and during the manipulation of complex instrumentation or implants in deep

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wounds [10]. There are good data to suggest that double gloving may prevent the complete loss of this protective barrier [6]; however, utilizing double gloves, alone, does not reliably prevent both outer and inner glove perforations [14]. Finally, the nature and/or type of surgical procedure may also significantly impact the risk for glove perforation [3].

Despite the clear potential implications of these previous findings, many surgeons continue to overestimate the security surgical gloves actually provide, and, thereby, lack the caution required to make these implements more effective.

Where Do We Need To Go?

Surgical glove holes are so common that they should be considered an expected risk of almost any orthopaedic operation. However, the actual impact of these perforations on patients and providers, although hypothetically harrowing, remains elusive. Consequently, it is imperative that we more-conclusively establish the actual patient/surgeon surgical site contamination and/or disease transmission risks that may be associated with these perforations. The evidence regarding glove perforation risks to the patient's wound has been conflicting. Dodds and

colleagues [5] have suggested that glove perforations pose a limited threat for surgical site infections due to the current emphasis on improved preoperative hand preparation. By contrast, Misteli and colleagues [9] concluded that surgical glove perforations were a risk factor for surgical site infection and recommended extended antibiotic prophylaxis as a precaution.

In terms of risk to medical personnel, we do not know what the real risk of disease transmission is following a surgical glove breach. Although several hundred healthcare workers die from hepatitis B, are exposed to hepatitis C, or contract HIV each year, it is difficult to confirm disease transmission as the result of occupational exposure, let alone intraoperative contact [2].

Until the aforementioned concerns have been clarified, an evidence-based approach should be implemented that includes all reasonable and readily available steps to decrease the risk of surgical glove perforation or increase the likelihood of its early intraoperative detection. All members of the surgical team should double glove, routinely change gloves during long procedures or after high-risk portions of the case, and employ sound surgical techniques (like "no touch" techniques for bony fragments manipulation or wound retraction and closure). In

accordance to their role, members of the surgical team should become more cognizant of the types and nature of surgical cases that increase the risk for glove perforation (as highlighted in the present study), and take particular precautions during these specific stages of the procedure.

One can assume that in the foreseeable future glove perforations will not be entirely eliminated, so in addition to preventive measures, further diligence must be given to the early detection of perforations when they occur. Surgical gloves should be regularly inspected throughout the case, standard practice must include double-gloving systems with perforation indicators, and surgeons should always change their gloves after the extremely high-risk aspects of any procedure (such as gloves caught in rotatory instruments). Lastly, all operative personnel should briefly check all of their gloves for perforations at the end of each case as opposed to simply discarding them. An immediate post-operative glove check could provide vital feedback for each member of the surgical team and keep everyone mindful of the challenges associated with surgical glove perforations, their prevention, or detection.

Despite the substantial advances in modern day surgical glove materials (latex, neoprene, or vinyl nitrile rubber) or design standards (as established

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by the American Society for Testing and Materials and enforced by the FDA and Occupational Safety and Health Administration), continued efforts must be made to enhance the perforation resistance of the surgical glove. Because surgeons have long accepted the limitations of existing gloves, many may not consider continued innovation in this area to be truly cost-effective. However, our ultimate objective should always be the development of surgical gloves that reliably and effectively protect the patient and the surgeon.

How Do We Get There?

Although regulatory requirements for surgical glove materials and design are currently being met, the medical community and patients are ethically obliged to demand higher standards and actively work with manufacturers to develop and test surgical gloves that are intrinsically more resistant to shear and puncture while maintaining an effective level of user sensitivity and dexterity [12]. In light of the variable risk of surgical glove perforation, depending on the healthcare providers' role or the nature of a particular operative procedure, future advances should consider the development of more "role-" or "case-" specific gloves.

Clinical studies like the current paper by Goldman and colleagues consist primarily of prospective single-center observational studies intended to establish the prevalence of glove perforation or its detection. Large, well-controlled multicenter long-term prospective clinical studies directed by large national or international orthopaedic or subspecialty societies are needed to verify the real effect of surgical glove perforations on healthcare quality and safety. Additional prospective, multicenter randomized clinical trials are needed to explore the protective or detection merits of single- versus double-gloving, existing surgical glove types, commonly proposed perforation prevention strategies such as periodically changing gloves during longer operative cases, or how specific members of the operative team might minimize the risks to themselves and the patient.

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