JACC Vol. 14, No. 6
November 15, 1989:1527–9

Damage to Physicians' Gloves During "Routine" Cardiac Catheterization: An Underappreciated Occurrence

JOHN M. PALMISANO, RRT, JON N. MELIONES, MD

Ann Arbor, Michigan

Recently, concern for the protection of health care employees and health care recipients has led to increasing awareness of transmitted infections. However, it is evident that damage of barrier methods of controlling infection can occur and go undetected. In a prospective study conducted from January 13, 1989 through February 15, 1989, 100 sequential pairs of gloves (200 gloves) worn during routine pediatric cardiac catheterizations were evaluated for punctures. A control group of 25 pairs of unused physicians' gloves was also evaluated for the presence of spontaneous leakage.

In the 25 pairs of unused gloves (50 gloves), no punctures were detected, whereas in the 200 gloves worn during the catheterization procedures, punctures were found in 38 gloves or 19% ($p < 0.001$). When comparing the frequency of punctures with respect to the digits, 81% of the punctures were detected within the thumb and index finger of the gloves. In the majority of instances, physicians describe stopcock manipulation as the cause of the punctures. Implication of the stopcock as a possible mechanism for glove damage can be isolated to the stop mechanism on the stopcock pivot.

Although surgeons' gloves are worn in many procedures besides surgery, no previous studies have defined the incidence of glove punctures during these procedures. Recommendations include a redesign of the stopcock as a protective measure and immediate change of latex surgeons' gloves whenever damage is suspected.

(J Am Coll Cardiol 1989;14:1527–9)

Recently, health care workers have become increasingly aware of the need to establish adequate protective measures against the transmission of infectious diseases. These measures have included the wearing of goggles, gowns, masks and gloves. However, unrecognized defects in these barrier methods may limit their protective effect. Brough et al. (1) found an overall incidence rate of perforation of latex surgeons' gloves during surgical procedures of 37.5% per pair. Because most of these punctures were not appreciated during the surgical procedure, gloves were not changed. Our study was undertaken to ascertain the incidence of glove puncture during cardiac catheterization and to identify maneuvers associated with them.

From the Department of Pediatrics, C.S. Mott Children's Hospital, Cardiac Catheterization Laboratory, University of Michigan Medical Center, Ann Arbor, Michigan.

Manuscript received March 27, 1989; revised manuscript received May 24, 1989, accepted June 7, 1989.

Address for reprints: John M. Palmisano, RRT, C.S. Mott Children's Hospital, University of Michigan Medical Center, 1500 East Medical Center Drive, Room F-1131, Box 0204, Ann Arbor, Michigan 48109-0204.

Methods

Glove examinations. In a prospective study from January 13, 1989 through February 15, 1989, 100 sequential pairs of gloves (200 gloves) worn during routine pediatric cardiac catheterizations were evaluated. A control group of 25 pairs of unused physicians' gloves was also evaluated for the presence of spontaneous leakage. All gloves were sterile latex surgeons' gloves (Travenol Laboratories, Inc., Becton Dickinson, Smith and Nephew Medical). The gloves were tested by a modification of the technique previously reported by Church and Sanderson (2). A standard filling volume of 500 ml was used after it was demonstrated that a hand (size 7 glove) displaced approximately 500 ml of water during total immersion within a container. Each glove was initially inspected visually for obvious damage and was noted to have been worn by either the staff physician or the catheterization fellow. It was then filled with 500 ml of water, the cuff occluded, and the glove suspended for observation of leakage and the number of punctures and their location. To improve the accuracy of our detection method, each finger and the palm were individually squeezed at both a proximal and a distal location.

0735-1097/89/$3.50

JACC Vol. 14, No. 6
November 15, 1989:1527–9

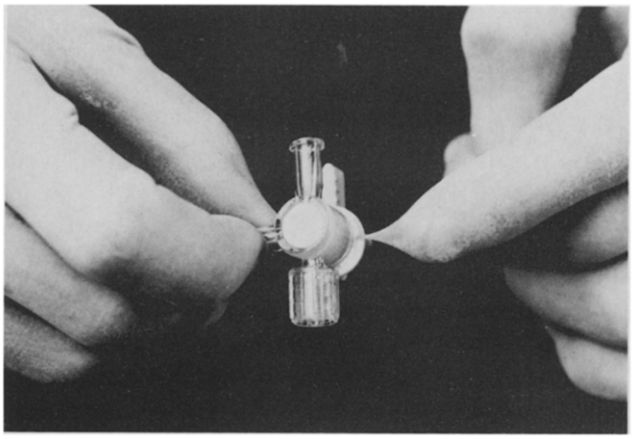

Figure 1. Photograph demonstrating a glove caught in the typical location (in the pivot mechanism) after stopcock manipulation.

Sensitivity of glove testing technique. To determine the sensitivity of our water distension test in detecting punctures, unused gloves were purposely punctured at various locations with a 25 or a 23 gauge needle. These gloves were then tested by an observer who did not know the location, size or number of needle punctures. With our technique, the 50 holes caused by a 23 gauge needle and the 50 holes caused by a 25 gauge needle were identified. Therefore, our method was 100% sensitive for holes equal to or larger than those caused by a 25 gauge needle. Our results are similar to those reported by Brough et al. (1) although our technique was somewhat more sensitive in detecting punctures created by a 25 gauge needle (versus 80%). The most likely explanation for this difference is the amount of pressure generated by squeezing at both a distal and a proximal location on the gloves.

Protocol. The gloves (100 pairs) from 11 pediatric cardiologists, 5 staff physicians and 6 catheterization fellows were sequentially obtained immediately after "routine" cardiac catheterization. All physicians had prior knowledge of the study and were aware that their gloves would be collected and reviewed after the procedure. One pair of gloves was excluded from study because of accidental contamination during donning of the gloves. After the catheterization, each individual glove was then carefully inspected for damage, filled with water and observed for the presence of punctures by the previously described process. If a hole was detected, the physician was immediately questioned and asked to recall a circumstance or manuever that might have caused it.

Stopcocks. Three-way stopcocks (2FLL-MLL-L) from various manufacturers (Abbott Critical Care, Cook, Medex Inc.) were examined as the potential mechanism of damage to surgeons' gloves. The stopcocks were manipulated by investigators wearing gloves and were found to catch consistently at a specific location on the stopcock (Fig. 1).

Table 1. Incidence of Punctures in Unused Gloves and in Gloves Worn During Pediatric Cardiac Catheterization

	Gloves (no.)		
Total	Without Punctures	With Punctures	Total Gloves
Worn 200	162	38	(19%)*
Unused 50	50	0	(0%)

*$p < 0.001$ by chi square analysis.

Statistical analysis. Statistical analysis was performed with the chi-square test.

Results

Perforations detected. No punctures were detected in the 25 pairs of unused gloves (50 gloves); in contrast, punctures were found in 38 gloves (19%) of the 200 gloves worn during the catheterization procedure ($p < 0.001$, Table 1). Of the 38 gloves with punctures, 23 were right gloves and 15 were left gloves; a total of 43 punctures were noted in these gloves. The 23 right gloves had 27 punctures with 3 gloves having multiple punctures (2 having 2 punctures and 1 having 3 punctures). The 15 left gloves had 16 punctures with 1 multiple puncture (2 punctures). Only one glove had visible damage that was attributed to the X-ray badge worn on the damaged glove finger.

Among the 38 punctured gloves, there were seven instances in which both the right and the left glove were confirmed to have punctures. Therefore, 31% of the physicians had at least one glove punctured during the cardiac catheterization procedure.

The thumb and index finger were frequent sites of puncture; 81% of punctures occurred in these two digits (Table 2). In addition, 95% (41 of 43) punctures occurred at the distal portion of each glove.

The six catheterization fellows had a higher incidence of glove puncture than did the five staff physicians (15 of 101 gloves (a 14.8% puncture rate versus 23 of 99 gloves, a 23% puncture rate). The most likely explanation for this difference is that the fellows are more likely to be involved with stopcock manipulation.

Mechanism of perforation. When asked, all physicians identified a situation that might have caused the punctures.

Table 2. Hand and Digit Location of Punctures Noted in Gloves Worn During Pediatric Cardiac Catheterization

Left Hand (n = 100 gloves)					Right Hand (n = 100 gloves)				
Little	Ring	Middle	Index	Thumb	Little	Ring	Middle	Index	Thumb
0	1*	2	9	4	0	3†	2	9	13

*Diamond ring puncture; †X-ray badge puncture (n = 1).

In the majority of instances, they described a point during stopcock manipulation when they believed a puncture could have occurred. During our testing, we consistently isolated the stop mechanism on the stopcock pivot as the area on which the gloves caught. Because the process of maneuvering the stopcock pivot primarily involves the use of the thumb and index finger, these would be the most likely location for punctures. Our data support this theory because 81% of the punctures occurred in these digits. In describing further difficulties, the physicians often commented that contrast agents caused their gloves to adhere to the stopcock, which often led to difficulties with manipulation.

Although not mentioned, the use of medical instrumentation, an accidental needle puncture, excessive torque applied to the catheter and primary right-handedness of the physicians are legitimate explanations for glove punctures. During these studies no physician changed gloves because of a presumed puncture.

Discussion

Frequency of glove punctures. The safety of barrier methods depends on the integrity of the barrier for protection. When this method of protection falters, the transmission of disease from patient to physician or from physician to patient is possible. Gloves have frequently been touted as an important mechanism for protection against the transmission of communicable disease. Previous studies (1,2) have found a glove perforation rate between 11.5%/glove to 37.5%/pair of gloves during surgical procedures. Although surgeons' gloves are worn in many nonsurgical procedures, no previous studies have defined the incidence of glove puncture during such procedures. Our study shows the frequency of glove puncture during routine pediatric cardiac catheterizations is 19% of 200 gloves or 31% of the glove pairs.

Etiology. In the present study, the most likely cause of glove puncture appeared to be related to stopcock manipulation. Only three-way stopcocks were evaluated because these were the only stopcocks used during our study. During the process of turning the stopcock pivot, the distal portion of the gloves is frequently caught and puncture results.

Recommendations. Glove damage during cardiac catheterization is frequent and not readily detectable. The primary source of damage to the gloves is related to the manipulation of the stopcock. Recommendations to help reduce glove perforations include redesign of the stopcock pivot and reinforcement of the distal portion of gloves. Finally, because unrecognized glove puncture is common during cardiac catheterization, strict adherence to handwashing guidelines is essential and direct contact with open fluids (flush solutions and blood) should be minimized.

Future studies. This study involved a pediatric cardiac catheterization laboratory and a similar study should be performed in an adult laboratory to evaluate the puncture rate in that setting. Although no obvious clinical consequences were appreciated in either patients or physicians, a careful prospective study is now being conducted to evaluate this more fully.

We thank the staff physicians, fellows and technical staff of the catheterization laboratory for assistance during this study.

References

1. Brough SJ, Hunt TM, Barrie WW. Surgical glove perforations. Br J Surg 1988;75:317.
2. Church J, Sanderson P. Surgical glove punctures (letter). J Hosp Infect 1980;1:84.