Original Article

Evaluation of Surgical Glove Perforation and Sharps Injury in Oral and Maxillofacial Surgery

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Abstract

Introduction: The risk of exposure to infections during surgery is partly mitigated by gloving. However, perforation can reduce the effectiveness of gloving as a barrier to exposure. This study aimed at investigating the frequency of surgical glove perforation and factors predictive of these in our oral and maxillofacial surgical practice. **Materials and Methods:** The study was carried out at the National Hospital and the University of Abuja Teaching Hospital, Abuja, Nigeria. Consenting patients requiring oral surgical interventions were consecutively recruited into the study. Similarly, surgeons and their assistants who consented to the study were also enlisted in the study. At the end of every surgical procedure, gloves used by the surgeons and the assistants were tested for perforation. Variables investigated included the rate of perforations, the influence of the type of gloving, single versus double gloving, type of anaesthesia, and duration of surgery on rates. **Results:** At a minimum of three operators per procedure, a total of 154 participants were involved in the study and 895 gloves were used. The number of glove perforations was 117(13.1%) with 82 (70.1%) involving the surgeons. There were 58/117 (49.6%) cases of perforation involving the dominant hand. Forefinger glove perforation accounted for 62 (52.9%) cases. Wire-related perforations were 72 (61.5%). Overall, nine cases of percutaneous injury were recorded. Duration of operation and double gloving were the predictive factors for perforations. **Conclusion:** Risk of sharps injury was relatively high due to the high incidence of glove perforation.

Keywords: *Glove perforation, oral maxillofacial surgery, sharps injury*

Introduction

A sharp injury (SI) is defined as "parenteral introduction into the body of a health-care worker, during the performance of his duties, of blood or other potentially infectious material by a hollow-bore needle or sharp instrument, including but not limited to needles, lancets, scalpels and contaminated broken glass."[1] Although gloves can be used to mitigate the risks associated with SI, they are often damaged during the course of a procedure and damage may not always be readily apparent, thereby placing the surgeon and patient at risk of infection. Determining the risk factors for glove perforation in the specialty and the relative risk associated with a specific procedure amongst other variables can aid the surgeon in deciding when a glove change is advisable.[2] Oral and maxillofacial surgery, with regular use of wires, needles, power drills and saws, is one of the surgical specialties that is likely to predispose practitioners to glove perforation and sharps injury. Previous reports confirm this to be the case,[3,4] although rates could differ, based on the environment of practice and the specific surgical procedure. The scope and pattern of surgical glove perforation in oral surgery has not been investigated in our practice; a limited-resourced environment, where the use of wires, arch bar and similar items, which have been replaced in other parts of the world are still in high use. Therefore, this study was carried out to determine the rates of glove perforation associated with wire and non-wire-related procedures and the factors associated with perforation. This could serve as a way of estimating the risk of sharps-related injuries and possible infection exposure hazard in oral and maxillofacial surgery.

Materials and Methods

This cross-sectional study was conducted at the National Hospital and University of Abuja Teaching Hospital, Abuja. The participants were consecutive consenting

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individuals who presented for oral and maxillofacial surgery in the two hospitals, the managing consultants, senior residents, and attending nurses. Surgical glove perforation among surgeons and their assistants during wire-based procedures such as fracture fixation and non-wire-based procedures, like, third molar surgery and biopsies were determined. Surgical gloves (Neogloves) manufactured by Neomedic Limited, were used in the study. Rate of perforations due to manufacturing or storage errors was determined by randomly selecting 5% of the gloves used for the study for pretesting. All glove testing was done using Water Inflation Technique and Electro-conductivity tests.[5] In addition, the Hosmer and Lemeshow goodness of fit tests were carried out to determine the fitness of the model for the study.

Simple descriptive analysis of surgical variables and demographic information using appropriate tools was carried out. All data processing was executed using the Statistical Package for Social Sciences (SPSS) version 20.0. The confidence level was set at 95% and a value was considered statistically significant when $P < 0.05$.

Results

In this study, a total of 895 gloves were used, of which 564 were in wire-based procedures and 331 utilised for non-wire-based procedures. In the wire-based group, surgeons used 337 gloves, whereas assistants used 227 gloves, while in the non-wire-based group, 173 and 158 gloves were utilised by surgeons and assistants, respectively. The number of glove perforations was 117(13.1%) with 82 (70.1%) involving the surgeon. Wire-related perforations were 72/117 (61.5%). Overall, there were 58/117(49.6%) cases of perforation involving the dominant hand [Table 1]. Forefinger glove perforation was reported in 62 (52.9%) cases. Also, for the dominant hand, the forefinger was the most frequently affected by perforations among both surgeons and their assistants in both wire and non-wire-based groups [Table 2]. In both wire-based and non-wire-based groups, double gloving and duration of surgery were risk factors for glove perforation; double gloving accounted for 81 (69.2%) of cases of perforation, surgeons who were double gloved accounted for 55(66.7%) cases [Table 3]. The risk of perforation was also associated with duration of surgery. Operation duration equalling or more than 61 min (odds ratio 4.9; 95% confidence interval [CI]) was significantly associated with glove perforation [Table 4]. Considering the total number of glove perforations encountered during wire-based procedures in this study, the probability of percutaneous injury, affecting either the surgeon or assistant, was estimated to be 8.4%. The surgeon had a higher probability (9.7%) of being affected.

Table 1: Analysis of glove utilisation and perforations

	Surgeon	Operating personnel assistant	Surgeon	Assistant	Total
	wire		Nonwire		
Number of gloves used	337	227	173	158	895
Number of perforated gloves	72	35	10	0	117
Gloved hand with perforation					
Dominant	34	17	7	–	58
Nondominant	38	18	3	–	59

Table 2: Analysis of glove perforations according to fingers affected during procedures

Variables	Working hand						Total *n* (%)
	T *n* (%)	F *n* (%)	M *n* (%)	R *n* (%)	L *n* (%)	O *n* (%)	
Surgeon	9(26.5)	18(52.9)	2(5.9)	0(0.0)	0(0.0)	5(14.7)	34(100.0)
Assistant	1(5.9)	9(52.9)	5(29.4)	0(0.0)	0(0.0)	2(11.8)	17(100.0)
	Nonworking hand						
	T	F	M	R	L	O	
Surgeon	4(10.4)	22(57.9)	5(13.2)	1(2.6)	0(0.0)	6(15.8)	38(100.0)
Assistant	1(5.6)	13(72.2)	2(11.1)	0(0.0)	0(0.0)	2(11.1)	18(100.0)

T = thumb, F = forefinger, M = middle finger, R = ring finger, L = little finger, O = other parts of the hand

Table 3: Glove perforations and percutaneous injuries in relation to method of gloving by operating personnel

Method of gloving	Glove perforations		
	Surgeon *n* (%)	Assistant *n* (%)	Total *n* (%)
Single gloving	27(33.3)	9(25.7)	36(30.8)
Double gloving	55(66.7)	26(74.3)	81(69.2)
Total	82(100.0)	35(100.0)	117(100.0)

Table 4: Bivariate analysis of association between glove perforation and duration of operation

Operating team	Factors	*n* (%)	OR	χ^2	*P* Value
Surgeon	*Duration of operation*				
	≥ 61min	57(74.0%)			
	≤ 60 min	20(26.0%)	1,52	18.84	0.009*
	Gloving method				
	Single gloving	71(92.0%)			
	Double gloving	6 (8.0%)	1.01	23.101	0.006*
Assistant	*Duration of operation*				
	≥ 61min	57(74.0%)			
	≤ 60 min	20(26.0%)	1.02	21.21	0.002*
	Gloving method				
	Single gloving	77(100.0%)			
	Double gloving	0.0(0.0%)	–	–	–

The Hosmer and Lemeshow goodness of fit test carried out to determine the fitness of the model for the study was non-significant (surgeons, $P = 0.654$; assistants, $P = 0.821$), indicating that the models were not significantly different from the observed data. Consequently, the models derived from this study can predict glove perforation among surgeons and their assistants in the real world well. The model for surgeons accounts for 56.2% (Nagelkerke R-Square = 0.562) of the variance in glove perforation among surgeons. It was a similar profile found among assistants; their model accounts for 53.9% (Nagelkerke R-Square = 0.539) of the variance in glove perforation.

Discussion

Although the use of gloves during surgical procedures is routine, the effectiveness of this practice in preventing exposure to potentially infectious agents in blood and other body fluids is diminished by damage through perforations. Some literature reported incidence of glove perforation during a variety of minor dental and oral surgical procedures as ranging from 4% to 23%.[6-8] However, we recorded 13.1% glove perforation rates in this study. Glove perforation risks are also influenced by the specific procedures; procedures associated with significant use of sharps and manoeuvres, for example, intermaxillary fixation in fractures and orthognathic surgery, as against soft tissue procedures. The rates were higher in the wire-based group in our study than overall, 21.4% and 15.4% among the surgeons and assistants, respectively, in the wire-based group. No perforation occurred amongst the assistants in non-wire-based group but a 6.8% perforation rate was recorded among the surgeons. Although the overall rate is comparable to the studies above and those of a more recent study,[9] the figures for wire-based procedures are significantly lower than that by Pigadas *et al.*,[10] and the 50.5% incidence recorded during intermaxillary fixation of mandibular fractures in a much earlier study reported by Avery *et al.*[11] Our study, however, corroborates the fact that wire-based procedures are associated with high chances of glove perforation and consequent risk of patients, surgeons, and assistants being exposed to infections. Non-wire-based procedures are much less likely to be associated with perforation but the risk must still be appreciated, especially among surgeons.

In terms of risk to individual personnel, some authors,[12,13] reported that the scrub nurse has the highest risk of glove perforation incidence, whereas in the study by Thanni and Yinusa,[14] assistant surgeons were noted with the highest glove perforation rate. On the contrary, Ersozlu *et al.*[15] asserted that surgeons naturally have the highest risk of glove failure rate since they handle the knife, needles and other sharp instruments more than the scrub nurse and assistant. In their study of minor and major orthopaedic surgical procedures, the highest incidence of 25.2% was associated with surgeons, far above 8.3% for the assistant and 8.6% for the scrub nurse. In this study, the difference in glove perforation rate between the surgeon (21.4%) and assistant (15.4%) observed in the wire-based procedures (perhaps similar to orthopaedic surgery) was not as wide as in the study by Ersozlu *et al.*, although places the surgeon ahead of the assistant. This implies greater risk for oral surgeon assistants during wiring procedures, relative to orthopaedic surgeons' assistant, probably because of greater participation within a very limited surgical field; the oral cavity.

In this study, the non-dominant hand had slightly more perforations in wire-based procedures than the dominant hand, an observation that corroborates earlier reports in a study of orthopaedic surgeries,[2,15,16] and in oral surgery procedures.[6,9,17] This is apparently logical, considering that the dominant hand is technically protected from sharps because of the instrument it holds and manipulates, whereas the non-dominant hand is often used to manoeuvre wire ends and needles during surgical operations. Overall, the forefingers of the dominant and non-dominant hands were most frequently affected by glove perforation for both the surgeons and assistants. This finding agrees with the report of previous investigators who conveyed similar observations.[3,9,18] Hence, there might be need for specially

designed gloves, whereby the most susceptible fingers are specially protected by glove reinforcement.

Sharp Injuries are a serious occupational hazard for surgeons and other members of the operating team. The use of wires in a surgical procedure is regarded as an exposure-prone process to blood-borne viruses which can be transmitted when there is occurrence of injury.[1,17] In this study, there were 11/117 (9.7%) obvious sharps injury recorded by surgeons and 7(5.7%) by assistants out of 117 perforations. Compared with Cassina *et al.*,[19] who reported an incidence of 3.5% for surgeons, the incidence in this study would seem high, but considering the high risk associated with the use of wire in our cases and the peculiarities of oral and maxillofacial surgery, the rate is explainable. It is also most probable, that rates may be underestimated, as all cases of sharp injuries may not have been immediately obvious, or may have remained unknown to participants. In an earlier study,[18] authors reported a 23% percutaneous injury rate during intermaxillary fixation. Percutaneous injuries in non-wire-based procedures usually result from suture needles, syringes and other sharp instruments, these tools are often also used during wire-based procedures. The additional use of wires therefore certainly increases the exposure to high-risk objects in the surgical field. The relatively high rate of glove perforation reported in this study points to the possibility of equally high rate of percutaneous injury, particularly in wire-based procedures. Also, in a resource-limited environment like ours, where wire-based intermaxillary fixation is still commonplace, the use of standard kits containing appropriate instruments for holding, bending, guiding and looping wire must be standard practice. By adopting the non-touch technique[20] of needle and wire handling, using appropriate instrumentation, the incidence of glove perforation may be significantly reduced.

This study showed that the risk of glove perforation is relatively high with double gloving as previously reported.[9,21,22] The tendency of the glove to perforate in double-gloved personnel is probably due to the diminished tactile sensation resulting from the double layer covering of the skin.[22,23] Although a study,[24] appeared to have controverted this, it is known that, depending on the size of the outer glove, some degree of bagginess often results from reduced fitness at the tip of the fingers which make the outer glove to easily catch on sharp objects within the operation field.[22,23] In the prospective randomised study by Thomas *et al.*,[25] 32 perforations and 19 perforations were associated with double gloving and single gloving, respectively. However, only 5/32 (15.6%) of the perforations in the double gloving group led to visible hand contamination as against 8/19 (42.1%) in the single gloving group. This is similar to the observation from the present study whereby greater percutaneous injuries were associated with single gloving technique in spite of its comparatively lower perforation rate. Other researchers have also reported the protective effects of double gloving in other procedures.[26,27] Therefore, considering the higher predisposition of single gloving to SI, the use of double gloves for high-risk surgical operations such as arthroplasty and trauma,[9,25,27] fixations with wires, is highly recommended. Double gloving for the non-dominant hand might also serve to avoid the sensitivity issue associated with double gloving while protecting the hand more at risk of perforation and sharps injury.

Duration of operation and gloving method (single versus double gloving) were the two significant independent variables that predisposed to glove perforations in the present study. Procedures exceeding 61 min significantly increased the likelihood of glove perforation; 77.5% of perforations. An earlier study documented 13.7% glove perforation rates in procedures that lasted longer than 20 min during emergency periods.[28] Also, glove defects as high as 56% were recorded for surgeries that lasted more than 2 h compared to 20% for surgeries that lasted less than 2 h.[29] Twomey *et al.*[30] noted that the risk of glove perforation increases 1.12 times for every 10 min of surgical times. These findings support the assertion that glove performance decreases with the increased length of time the gloves are worn.[30,31] In this present study, procedures that lasted longer than 61 min and above were 5.6 times (OR) at higher risk of surgeon's glove perforations than those performed 60 min and below, just as double gloving increased the likelihood of perforation; OR=11.4, $P = 0.001$ for surgeon and OR = 2.1 times $P = 0.006$ for assistant.

Duration of operation and gloving method were significantly associated with glove perforation in this study. However, if surgery includes the use of wire, the odds of the surgeon having glove perforation increases; it was about 32 times more than surgery that did not include the use of wire.

Conclusion

There is a high risk of sharps injury associated with maxillofacial procedures based on the frequency of glove perforation reported in this study. Double gloving and change in glove when procedure is longer than 1 h is recommended. Further studies are needed to ascertain other likely factors associated with glove perforation as well as sharps injuries with a view to mitigating them.

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Conflicts of interest

There are no conflicts of interest.

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