Original Article

Efficacy of double gloving technique in major and minor oral surgical procedures: A prospective study

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Mukul N. Padhye, Charu Girotra, Aman R. Khosla, Kavita V. Gupta
Department of Oral and Maxillofacial Surgery, Padmashree Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil University, Nerul, Navi Mumbai, India

Address for correspondence:
Dr. Aman Khosla, 701 A, Norwood Appt., Lokhandwala Complex, Andheri (West), Mumbai – 400 053, Maharashtra, India.
E-mail: arkhosla@gmail.com

ABSTRACT

Background: A prospective analysis was carried out over a 1-year period to assess gloves used during 100 major and 100 minor oral surgical procedures to test for efficacy of double gloving in oral surgical procedures. **Purpose:** The purpose of this study was to assess the efficacy of double gloving technique in preventing cross infection in both major and minor oral surgical procedures. **Materials and Methods:** Gloves used during 100 major and 100 minor oral surgical procedures were analyzed to check for glove perforations and skin punctures. 100 sterile gloves were tested as control. **Statistical Analysis Used:** Chi-square test was used to determine whether there was any difference between the expected and observed values in various categories. **Results:** A higher number of glove perforations was seen in minor oral surgical procedures compared with major surgeries, dominant hand compared with the nondominant, outer gloves compared with the inner, in procedures which took a longer duration of time to complete, in procedures involving wiring and in the index finger followed by the thumb and the palm. **Conclusion:** Double gloving technique using sterile gloves can be used as an effective means of infection control for all major and minor surgical procedures, especially high-risk procedures involving patients who maybe suffering from or carriers of blood-borne infections.

Keywords: Barrier, cross infection, double gloving, perforation

INTRODUCTION

Oral and maxillofacial surgeons are at a constant risk of contracting blood-borne diseases such as hepatitis B, hepatitis C, and AIDS while performing major and minor oral surgical procedures.[1] Restricted field of surgery (intra- or extraoral) and sharp instruments such as cutting burs further compounds the problems making the surgeon and assistant more prone to injury. Thus, oral and maxillofacial surgeons are at an increased risk of contracting blood/saliva borne diseases compared with their other surgical counterparts.

Standardized cross infection preventive measures were created for the protection of the surgeon and patient to reduce infection risk. Infection control practices, which aim to avoid direct contact of the health care professional with organic material, are indicated for all patients regardless of the presence of infectious disease.[2] This is achieved by using a protective barrier such as gloves, to prevent skin contact with blood, secretions, or mucosa.

The practice of surgical gloving has long been accepted as providing an effective barrier against the transmission of disease between the patient and surgeon and vice versa.[3,4]

Using a single glove during oral surgical procedures affords limited protection against disease transmission. The surgeon may take additional precautions such as double gloving during the treatment of all patients considered to be in the high-risk category (procedures involving wiring in patients who are infected with or carriers of blood borne disorders such as HIV)[5] to increase the protection against possible perforations and piercing wounds and help maintain operative asepsis.

MATERIALS AND METHODS

A prospective study was carried out for duration of 1 year during which the analysis of gloves used during 100 minor and 100 major oral surgical procedures was carried out.

All patients undergoing major and minor oral surgical procedures were included in the study, with no exclusion criteria. The patients were randomly distributed across all surgeons irrespective of operator experience. As only one brand of gloves was used for all the surgical procedures, blinding was not required.

Minor procedures involved were arch bar fixations, biopsy, surgical extractions, cyst enucleation, etc. carried out under local anesthesia. Procedures like treatment of maxillofacial trauma, pathology, aesthetic jaw surgery, and reconstruction carried out under general anesthesia were included in major procedures.

Double gloving technique was used in all cases using Nulife (MRK Healthcare) sterile surgical gloves. A visual inspection of the gloves was carried out preoperatively to check for any manufacturing defects. These gloves were checked for perforations postoperatively in both dominant and nondominant hand of operator as well as first assistant. Skin injuries, change of glove and subsequent perforation were also checked.

Only the outer gloves on the dominant and nondominant hand of the chief operating surgeon and first assistant were considered. In all, 100 sterile gloves were tested as control and showed no defect. The outer glove serves as a single glove and hence no control study has been carried out using single gloves.

The integrity of the gloves was tested by a "water-inflation technique"[6,7] where each gloves was fully inflated with water and the cuff twisted tight. Successive fingers were then individually distended with water and squeezed. The palm was examined in a similar pattern. The test was carried out postoperatively, unless a perforation was noticed and the glove removed and replaced immediately, in which case the test was carried out intraoperatively.

The total number of gloves perforated, number of glove perforations and skin injuries, the total time required for the procedure, site of perforation, and any change of gloves were noted. When a glove was known to be perforated, it was immediately removed and replaced with a fresh glove.

The examination was carried out by a single examiner in all cases.

Statistical Analysis

The chi-square test was used to analyze the data to determine whether there is a significant difference between the expected frequencies and the observed frequencies in various categories.

Table 1: Number of gloves perforated in major and minor oral surgical procedures

Major surgery	36
Minor surgery	50

The *null hypothesis* states that there is no significant difference between the expected and observed frequencies.

The *alternative hypothesis* states that the expected and observed frequencies are different.

Level of significance is 5% or 0.050 and a *P* value greater than 0.050 shows no association between the variables.

The Chi-square value was determined using the formula:
$\chi^2 = (O - E)^2/E$, where
O is the observed frequency in each category,
E is the expected frequency in the corresponding category,
χ^2 is the chi-square value.

RESULTS

The perforations observed during this study were found associated with major and minor oral surgical procedures, dominant and nondominant hand of surgeon and assistant, inner and outer sterile gloves, duration of the procedure, procedures involving wiring, and anatomical distribution.

Table 1 shows that the number of gloves perforated in major surgeries is 36, while that in minor oral surgical procedures is 50. Table 2 shows that there are 18 and 8 gloves perforated in dominant hand of surgeon and assistant, respectively. Six and four gloves are perforated in nondominant hand of surgeon and assistant, respectively, in major oral surgical procedures.

There is no association between surgeon and assistant and dominant and nondominant hands for number of perforations in major surgery. The *P* value is 0.598, which is greater than standard value of level of significance, i.e., 0.05 therefore it can be safely said that there is no association between surgeon and assistant and dominant and nondominant hands for number of perforations in major surgery.

Table 3 shows that 31 and 7 gloves are perforated in dominant hand of surgeon and assistant, respectively, whereas there are 7 and 5 gloves perforated in nondominant hand of surgeon and assistant, respectively, in minor oral surgical procedures. As the *P* value is 0.1002, which is greater than standard value of level of significance (0.05) it can safely concluded that there is no association between surgeon and assistant and dominant and nondominant hands for number of perforations in minor surgery [Figure 1].

Table 4 shows 24 and 6 perforations in outer and inner surgical gloves in dominant hand of surgeon, respectively, whereas

Table 2: Number of gloves perforated in dominant and nondominant hand of surgeon and assistant in major oral surgical procedures

Hand	Dominant	Nondominant	Chi square	*P* value	Degrees of freedom
Surgeon	18	06	0.277	0.598	1
Assistant	08	04			
Total	26	10			

there are 6 and 4 perforations in outer and inner surgical gloves of nondominant hand of surgeon, respectively. This table also shows that there are eight and three perforations in outer and inner surgical gloves of dominant hand of assistant, respectively, whereas there are four and one perforations in nondominant hand of assistant, respectively, in major oral surgical procedures. P = is 0.2059, which is > 0.05 confirming of absence of association between dominant and nondominant hand and outer and inner sterile gloves getting perforated in the major surgery for surgeon similarly a P of 0.755 indicates no association for surgical assistant too.

Table 5 shows that there are 36 and 4 perforations in outer and inner surgical gloves of dominant hand of surgeon, respectively, whereas there are 9 and 1 perforations in outer and inner surgical gloves of nondominant hand of surgeon, respectively. This table also shows that there are 14 and 3 perforations in outer and inner surgical gloves of dominant hand of assistant, respectively, whereas there are 9 and 1 perforations in outer and inner surgical nondominant hand of assistant, respectively, in minor oral surgical procedures. The P values of 1 and 0.5891 respectively indicate that there is no association between outer and inner sterile gloves and dominant and nondominant hand getting perforated in the minor surgery for assistant.

Table 6 shows that there are four and two skin injuries in dominant and nondominant hand of surgeon, respectively, and two skin injuries in dominant and none in nondominant hand of assistant in major surgery. This table also shows that there are two and one skin injuries in dominant and nondominant hand of surgeon, respectively, and one skin injuries in dominant and none in nondominant hand of assistant in minor surgery [Figures 2-5]. Table 7 shows that there are 14 procedures with perforations with the duration of up to 150 minutes, whereas there are 28 procedures with perforations in major oral surgical procedures with the duration of more than 150 minutes for major oral surgical procedures.

Table 8 shows that there are 20 procedures with perforations with the duration of the procedure up to 60 minutes, whereas there are 48 procedures with perforations with the duration of

Table 3: Number of gloves perforated in dominant and nondominant hand of surgeon and assistant in minor oral surgical procedures

Hand	Dominant	Nondominant	Chi square	*P* value	Degrees of freedom
Surgeon	31	07	2.702	0.1002	1
Assistant	07	05			
Total	38	12			

Table 4: Number of perforations in outer and inner gloves in major oral surgical procedures

Surgeon	Dominant	Nondominant	Degrees of freedom	Chi square	*P* value
Outer sterile	24	6	1	1.6	0.2059
Inner sterile	6	4			
Assistant					
Outer sterile	8	4	1	0.097	0.755
Inner sterile	3	1			

Table 5: Number of perforations in outer and inner gloves in minor oral surgical procedures

Surgeon	Dominant	Non-dominant	Degrees of freedom	Chi square	*P* value
Outer sterile	36	9	1	0	1
Inner sterile	4	1			
Assistant					
Outer sterile	14	9	1	0.292	0.5891
Inner sterile	3	1			

Table 6: Number of skin punctures in both major and minor oral surgical procedures

	Surgeon		Assistant		Total
Hand	Dominant	Nondominant	Dominant	Nondominant	
Major surgery	04	02	02	00	08
Minor surgery	02	01	01	00	04

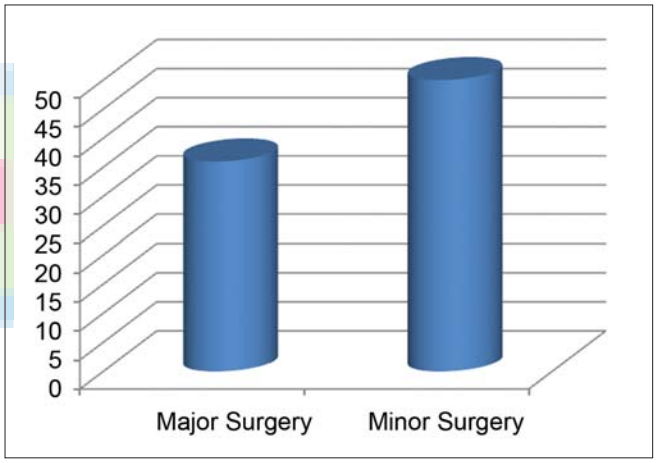

Figure 1: Cylindrical bar graph showing comparison between the number of gloves perforated in major and minor surgeries

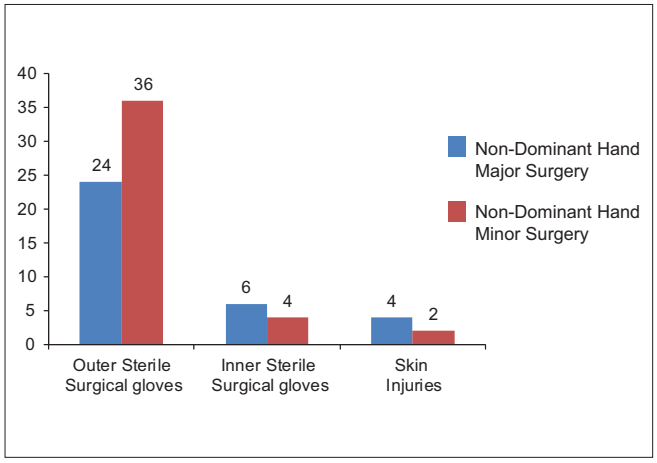

Figure 2: Comparison of number of perforations in the dominant hand of the surgeon for both major and minor oral surgical procedures

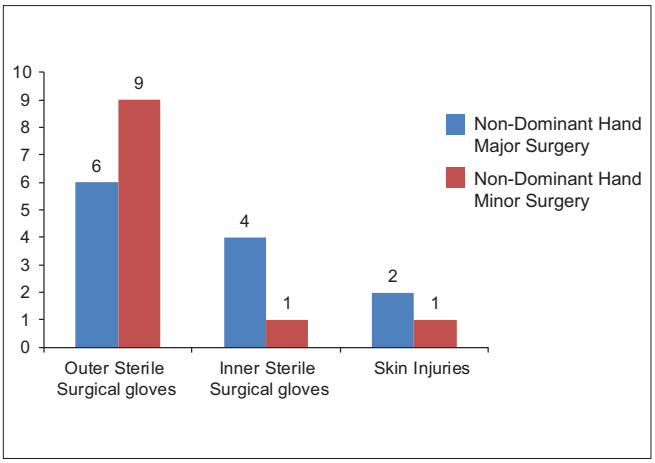

Figure 3: Comparison of number of perforations in the non-dominant hand of the surgeon for both major and minor oral surgical procedure

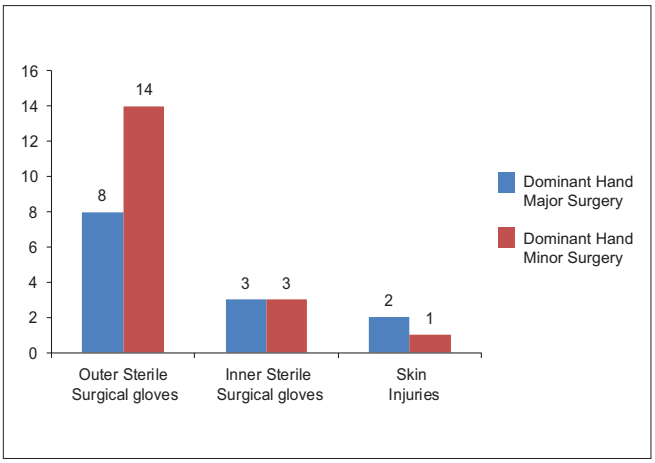

Figure 4: Comparison of number of perforations in the dominant hand of the assistant for both major and minor oral surgical procedures

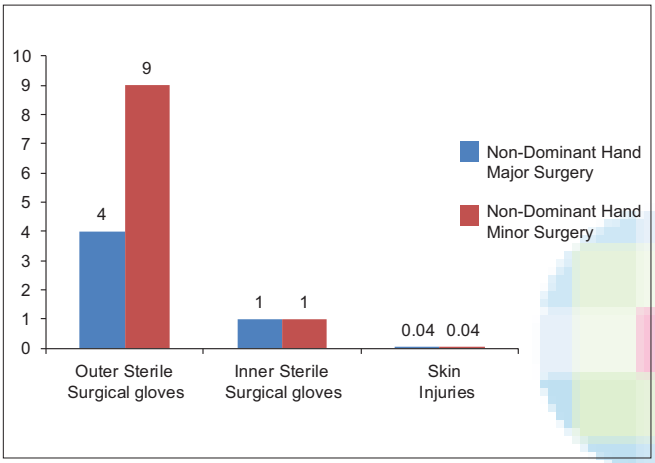

Figure 5: Comparison of number of perforations in the nondominant hand of the assistant for both major and minor oral surgical procedures

Table 7: Number of perforations compared with the duration of the procedure in major oral surgical procedures

Procedure duration	Procedures with perforations
Up to 150 minutes	14
More than 150 minutes	28

Table 8: Number of perforations compared with the duration of the procedure in minor oral surgical procedures

Procedure duration	Procedures with perforations
Up to 60 minutes	20
More than 60 minutes	48

the procedure more than 60 minutes for minor oral surgical procedures. Table 9 shows that there are 30 perforations in procedures involving wiring and 12 perforations in procedures not involving wiring in major surgery [Figure 6].

Table 10 shows that there are 44 perforations in procedures involving wiring and 24 perforations in procedures not involving wiring in minor surgery [Figure 7]. Table 11 shows that there are 20, 5, and 2 perforations in index finger, thumb and palm in dominant hand of surgeon, respectively, whereas there are 10, 3, and 2 perforations in index finger, thumb, and palm in nondominant hand of surgeon, respectively. This table also shows that there are 11, 2, and 0 perforations in index finger, thumb, and palm in dominant hand of assistant, respectively, whereas there are 1, 0, and 0 perforations in index finger, thumb, and palm in nondominant hand of assistant, respectively, in major oral surgical procedures. A p of 0.802, > 0.05 indicates that there is no association between dominant and nondominant hands and area-specific properties such as finger, thumb, and palm in the major surgery for surgeon.

Table 12 shows that there are 26, 7, and 5 perforations in index finger, thumb, and palm in dominant hand of surgeon, respectively, whereas there are 11, 2, and 1 perforations in finger, thumb, and palm in nondominant hand of surgeon, respectively. This table also shows that there are 13, 2, and 1 perforations in finger, thumb, and palm in dominant hand of assistant, respectively, whereas there are 5, 2, and 2 perforations in finger, thumb, and palm in nondominant hand of assistant, respectively, in minor oral surgical procedures.

The *P* value is 0.752 and 0.351, which is greater than standard value of level of significance, i.e., 0.05 therefore we cannot reject the null hypothesis of no association between dominant and nondominant hands and area-specific properties such as finger, thumb, and palm in the minor surgery for surgeon and assistant respectively [Figures 8-11]. We accept null hypothesis that there is no association between the variables.

DISCUSSION

Gloves are an effective barrier to prevent cross infection from patients to health care professionals. However, the integrity of the gloves should be intact from the beginning of every surgery to the end, whether it is a minor surgery or a major one.[8]

Glove perforations are commonly encountered in oral and maxillofacial surgical procedures because of restricted area of

Table 9: Perforations in procedures involving wiring compared to procedures not involving wiring in major oral surgical procedures

Perforations in procedures involving wiring	30
Perforations in procedures not involving wiring	12

Table 10: Perforations in procedures involving wiring compared to procedures not involving wiring in minor oral surgical procedures

Perforations in procedures involving wiring	44
Perforations in procedures not involving wiring	24

Table 11: Area-specific perforations in major oral surgical procedures

Surgeon	Dominant	Nondominant	Degrees of freedom	Chi square	*P* value
Index finger	20	10	2	0.441	0.802
Thumb	5	3			
Palm	2	2			
Assistant					
Index finger	11	1	2	-	
Thumb	2	0			
Palm	0	0			

Table 12: Area-specific perforations in minor oral surgical procedures

Surgeon	Dominant	Nondominant	Degrees of freedom	Chi square	*P* value
Index finger	20	10	2	0.441	0.802
Thumb	5	3			
Palm	2	2			
Assistant					
Index finger	11	1	2	-	
Thumb	2	0			
Palm	0	0			

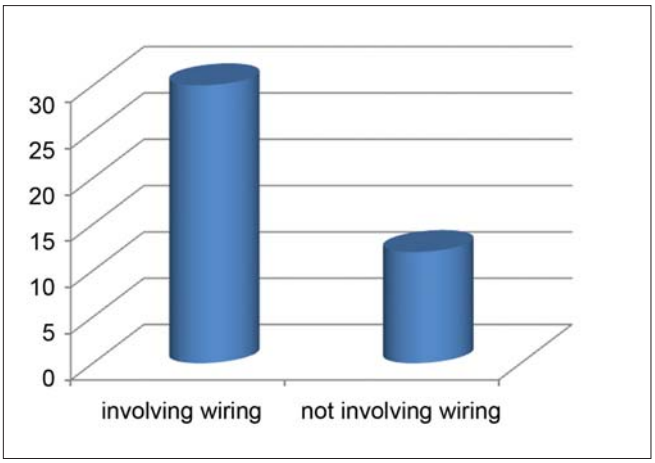

Figure 6: Cylindrical bar graph showing perforations in procedures involving wiring compared to procedures not involving wiring in major surgery

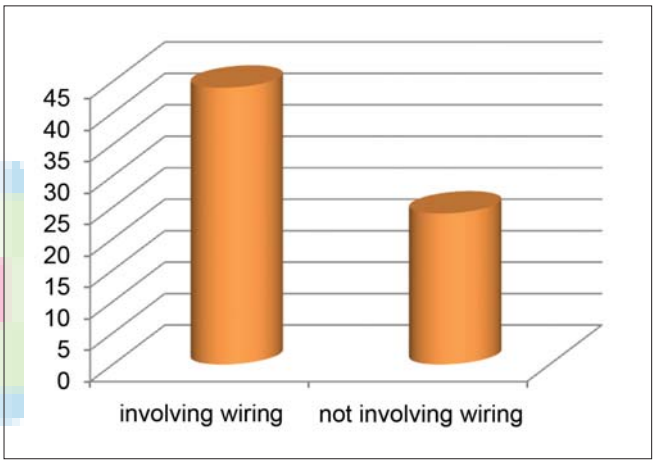

Figure 7: Cylindrical bar graph showing perforations in procedures involving wiring compared with procedures not involving wiring in minor surgery

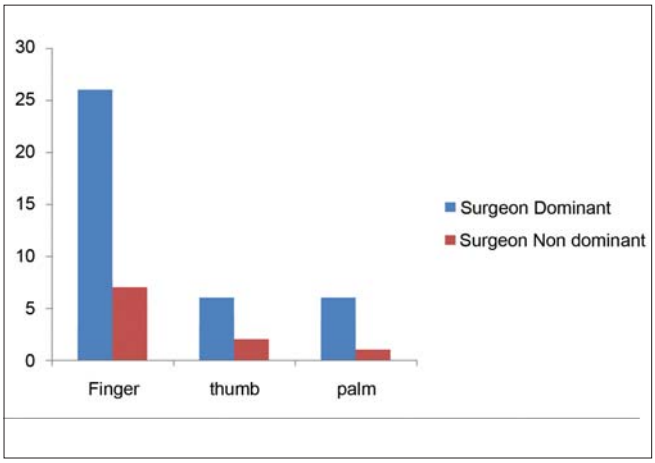

Figure 8: Graph showing area specific perforation in surgeon's hand in major oral surgical procedures

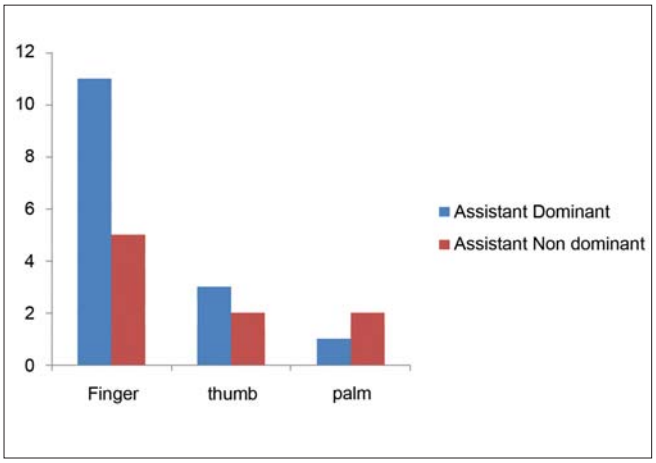

Figure 9: Graph showing area specific perforation in assistant's hand in major oral surgical procedures

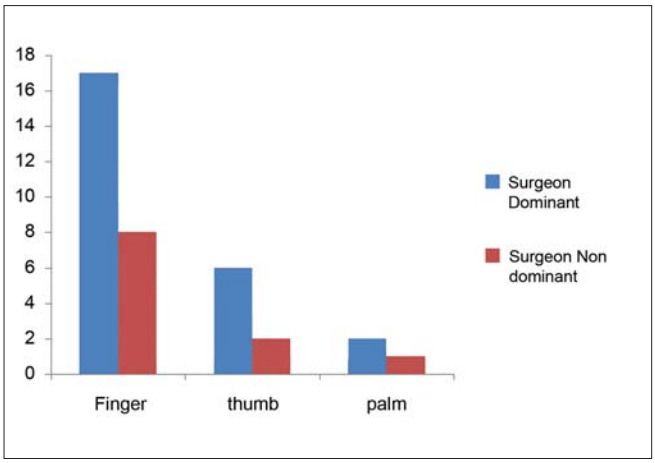

Figure 10: Graph showing area specific perforation in surgeon's hand in minor oral surgical procedures

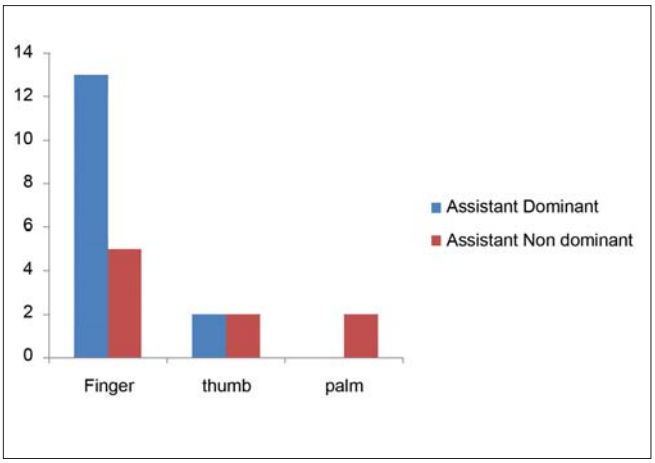

Figure 11: Graph showing area specific perforation in assistant's hand in minor oral surgical procedures

surgery (intra- or extraoral), use of sharp instruments, cuttings burs, etc. and are found to be directly related to the experience of the surgeon, type of procedure being carried out,[9] and duration of the procedure.[10] Also, certain areas are more prone to being punctured than others. Using a double gloving technique to carry out high-risk surgical procedures involving wiring in patients who are infected with or carriers of blood borne disorders such as HIV reduces the risk of cross infection significantly.[5,11]

At our institution, only sterile latex gloves are used for all major and minor oral surgical cases. Concerns about latex have led to the use of alternative, nonlatex materials for the production of surgical gloves.

Research studies have shown that[12]

1. *Latex* gloves have signifi cantly higher tear strength, intermediate abrasion resistance, and show good results for viral penetration test.
2. *Nitrile* gloves have intermediate glove strength, high abrasion resistance, and show poor result for virus penetration test (i.e., high rate of penetration of virus through the gloves)
3. *Neoprene* gloves have intermediate tear strength, high abrasion resistance, and show good result for virus penetration test (i.e., low rate of penetration of virus through gloves)
4. *Styrene-ethylene/butylene-styrene* gloves show average tear strength, intermediate abrasion resistance and average results for the viral penetration test.
5. *Vinyl* gloves have poor tear strength, low abrasion resistance, and poor results for viral penetration test.

A. This study shows the following set of attributes are independent of each other:

1. Type of operator (surgeon–assistant) and type of hand (dominant–nondominant) getting perforated in major surgery [Table 2]
2. Type of operator (surgeon–assistant) and type of hand (dominant–nondominant) getting perforated in minor surgery [Table 3]
3. Outer and inner surgical gloves and type of hand getting perforated for surgeon and assistant in major surgery [Table 4]
4. Outer and inner surgical gloves and type of hand getting perforated for surgeon and assistant in minor surgery [Table 5]
5. Type of hand (dominant–nondominant) and site of perforation (index finger, thumb, and palm) for surgeon in major surgery [Table 11]
6. Type of hand (dominant–nondominant) and site of perforation (index finger, thumb, and palm) for surgeon and assistant in minor surgery [Table 12]

B. This study shows that there is a higher rate of glove perforation (50%) seen in minor oral surgical procedures, where the operative procedure was carried out by the residents, when compared with major oral surgical procedures (36%) which were carried out by the staff [Table 1]. This shows a direct correlation between glove perforation and operator experience as more perforations were seen in the gloves of the inexperienced junior residents when compared with the experienced staff. For all minor oral surgical procedures carried out by the relatively inexperienced residents, double gloving is recommended.

C. This study shows that it was the dominant hand, of both the operator and assistant, which showed more perforations in both major and minor oral surgical procedures. This is in contradiction to most studies showing the nondominant hand to be the most prone to glove perforations[13] [Tables 2 and 3].

D. Also seen in this study, the number of perforations in the outer gloves was far more when compared with the inner gloves [Tables 4 and 5], while skin injuries were very few [Table 6] for surgeon and assistant in major surgery and minor surgery. Majority of the skin injuries were due to wire stick injury, while a few were attributed to needle stick injury. This demonstrates the effectiveness of using a double gloving technique for all major and minor oral surgical procedures, in reducing the risk of cross infection when compared with single gloving. This view is supported by various studies which demonstrated that single gloving increased the risk of hand contamination with blood and possibly the number of wire stick or needle stick injuries sustained.[14]

E. The number of perforations was also seen to be directly proportional to the duration of the procedure. Major oral surgical procedures which took over 150 minutes to complete and minor oral surgical procedures which took over 60 minutes to complete showed a higher number of perforations (2 and 2.4 times, respectively) than procedures which took a shorter duration of time to complete [Tables 7 and 8]. Results from this study suggest that gloves be changed at shorter intervals (90 minutes), for major surgery irrespective of their status, especially while carrying out high-risk procedures, while some authors recommend that gloves be changed every 120 minutes.[15,16]

F. A higher number of perforations (2.5 and 1.8 times, respectively) was seen in procedures which involved wiring (arch bar application, ivy loops application, IMF wiring, etc.) in both major and minor oral surgical procedures when compared with procedures which did not involve wiring [Tables 9 and 10]. Handling of sharp instruments such as Erich arch bars increases the risk of glove perforation so drastically that perforations could be found within a few minutes of starting the procedure. Wearing double gloves in procedures involving wiring provides an effective barrier and affords greater protection. It is also recommended to change the outer pair of gloves after arch bar placement for each arch. Taping of all fingers with sticking plaster/tape before donning of surgical gloves is recommended for all surgical procedures involving wiring. A change of outer sterile gloves following placement of arch bar in one arch is recommended, before proceeding with placement of the arch bars in the remaining arch.

G. In this study, none of the patients involved in skin injuries via needlestick/sharps injury was HIV or HBsAG positive.

Wounds and skin sites that have been in contact with blood or body fluids should be washed with soap and water, while mucous membranes should be flushed with water.

Studies of the occupational risk of HIV infection to dental practitioners indicate that the risk of transmission is very low.

Prospective studies of HIV transmission from patients to health care workers after a percutaneous exposure to HIV infected blood indicate an average risk of transmission of 0.4%.[14]

The risk of hepatitis B transmission under similar circumstances is much greater and is approximately 20%.[14]

The risk of seroconversion following wire stick injury is far less than needle prick injury.[14]

In case of a HIV-positive patient, the following postexposure prophylaxis[16] using antiretrovirals must be followed, preferably within 24 horrs of exposure:

Basic regimen:
1. Zidovudine 300 mg twice a day + Lamivudine 150 mg twice a day for 4 weeks, or
2. Zidovudine (as above) + Emtricitabine 200 mg capsule once a day for 4 weeks, or
3. Tenofovir 300 mg once daily + Lamivudine 150 mg twice daily for 4 weeks.

Expanded regimen:
Basic regimen + Indinavir 800 mg thrice a day for 4 weeks.

In case of a hepatitis B-positive patient, the following postexposure prophylaxis[17,18] must be followed, preferably within 24 hours of exposure-

In case of an unvaccinated operator, administer hepatitis B vaccine series, and hepatitis B immune globulin.

In case of a vaccinated operator, administer hepatitis B vaccine booster dose.

H. When the anatomical distribution of the perforations was noted, it was seen that the highest number of perforations was recorded in the index finger followed by the thumb and lastly in the palm region for both major and minor oral surgical procedures [Tables 11 and 12]. In a majority of the cases, these glove perforations go unnoticed by the operator and can be assumed to be an *unnoticed sharps injury*.

Thus, it is seen that operator experience, duration of the procedure, and type of procedure are factors to be kept in mind while considering glove perforations, while performing both major and minor oral surgical procedures.

Strengths of this study include diversity of patients as well as operators for major and minor oral surgical procedures, large sample size, randomization, observation of strict controls to maintain data purity (all gloves were checked immediately postoperatively), and no reduction of manual dexterity reported by any of the operators using double gloving.

Limitations include no high-risk patients in the sample for study, testing of only latex gloves as it is most frequently used at our institute. Testing of gloves by way of water inflation has been used in our study to check for perforations, as it was easy to perform for a large sample size. Other tests such as conductivity test and microbiological assessment can be used.

This study is aimed at operator care and provides evidence to change the policy from single to double gloving in both major and minor oral surgical procedures.

A controversy raised by this study is that the dominant hand of both operator and assistant was more frequently perforated than nondominant hand for both major and minor surgical procedures, while most studies show that the nondominant hand is more frequently perforated.

Future research studies could be undertaken involving high-risk patients in the study group, and materials other than latex like neoprene and nitrile could be tested and compared.

CONCLUSION

A single glove offers little protection against a penetrating wire or

a needle stick injury. Double gloving has been shown to be an effective barrier to microorganisms and other infectious agents to or from the wearer, without affecting the dexterity and maintaining comfort of the wearer.

However, certain factors such as puncture resistance, operator experience, and time of the procedure must be considered while examining for perforations.

Double gloving technique using sterile gloves can be used as an effective means of infection control for all major and minor surgical procedures, especially high-risk procedures involving patients who maybe suffering from or carriers of blood-borne infections.

As type of hand (dominant–nondominant) was found to have no association with the type of operator (surgeon–assistant), site of perforation, and outer and inner surgical gloves in both major and minor surgery, it is concluded that double gloving will be required in both hands in all the operators and across the anatomical distribution.

As perforations were noted in both major and minor oral surgical procedures both involving and not involving wiring, donning of double gloves is recommended for all surgical procedures.

For procedures involving wiring, taping up of the fingers using sticking plaster/tape is recommended. The outer pair of gloves must be changed after arch bar application for each arch.

A change of outer sterile gloves following placement of arch bar in one arch is recommended, before proceeding with placement of the arch bars in the remaining arch.

Also, it is recommended to change the outer pair of gloves after every 90 minutes for major surgical procedures to reduce the risk of glove perforations.

Although most perforations go unnoticed, as soon as the operator becomes aware of it, he must immediately discard the glove and replace it with a new sterile one to minimize the risk of cross infection.

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