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Glove Puncture Injuries in Orthopaedics: Single versus Double Gloving

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Abstract

Background: Intact gloves provide the most important barrier between the patient and doctor to prevent cross-contamination. Identification of factors promoting glove perforation will decrease the potential risk of contamination and infection.

Method: To conduct this prospective hospital based descriptive study, specimens of gloves used in Orthopaedic Surgery were randomly selected and tested for perforation and its location. Type and duration of surgery, surgeon's handedness, the practice of double gloves wearing and ring wearing preferences were observed.

Results: 1736 gloves (1304 outer and 432 inner) used in 180 random procedures were studied. Overall glove perforation rate was 16.47 % (286/1736), inner being lesser. Perforation rates were higher for TKR 34.84 % (23/66) than spine procedures 30.43% (28/92). Larger duration procedure had higher rate of perforation. The surgeon's glove had the highest incidence. The non dominant hand (21.66%) had higher perforation rate than the dominant one (11.29%), highest in palm (28.7%) and index finger (25.80%). Emergency procedures had a higher glove perforation than elective procedures. Ring wearing increased the perforation rate.

Conclusions: Double gloving should be practiced routinely to reduce the risk of exposure to the surgeon and to prevent the risk due to possible manufacturing defect. Complex and long duration Orthopaedic procedures can have a higher incidence of glove puncture.

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Introduction:

An intact barrier between the hands of the surgeon and the patient remains the single most important factor in protection against infection for both. Glove puncture remains a major concern to health personnel in the operating theatre, as it is a definite theoretical pathway of transmitting blood borne diseases (1) glove perforation is a common problem during surgical procedures. Surgeons are at risk of contracting infectious disease from their patients if the integrity of surgical gloves is compromised (2). The risk of infection after percutaneus exposure to HIV, hepatitis B virus and hepatitis C virus varies greatly. The use of surgical gloves markedly reduces the volume of the blood inoculums present on suture needles, and double gloving is found to be more efficient than single gloving in this respect (1, 2, 3). Certain groups of individuals are at greater risk than others because of the nature of their work. Orthopaedic and trauma surgeons are thought to be at particular risk. A number of studies have shown that glove perforation is more common in Orthopaedic operations than in any other surgical specialty. In orthopedic surgery, oscillating saws are used, as well as a variety of metal instruments and implants. Manipulation of these implants and devices result in strong shear forces on the surgeon's gloved hands (1). The other reasons given for this high occurrence include: fracture surgeries frequently carried out on high-risk patients, needle injury, sharp bony fragment and the use of sharp and complex operating tools. The healthcare worker is at risk of pathogen transmission if a puncture is in the vicinity of pre-existing skin damage to hand. The average risk of infection after percutaneous injury with a contaminated sharp instrument is (4, 5): 0.3 per cent for HIV, 6 per cent to 30 per cent for Hepatitis B and 4 per cent to 10 per cent for Hepatitis C. Current surgical practices may result in more than a 50 per cent incidence of blood exposure per operation when Healthcare workers do not take any added precautions during procedures (6), with the risk of accidental exposure to blood being the greatest when procedures last more than three hours.

This prospective study is aimed to investigate glove perforation injuries at the Department of Orthopaedic Surgery, Subharti Medical College, Meerut,- with a tertiary level teaching hospital in an

attempt to determine the protective efficiency of the practice of double gloving, to identify the major Orthopaedic procedures which increase the risk, to identify the practices which can increase the probability of glove perforation and to recommend the safety norms and discipline to prevent exposure.

Material and Methods:

A total of 180 patients were included in the study from October 2007 to December 2008 conducted in the Department of Orthopaedic Surgery, Subharti Medical College, Meerut. A total of 1736 gloves were used during the surgical procedures on these study subjects. 1304 gloves were collected from single gloving practice group where as 432 gloves were from double gloving group. Operating team members included 9 surgeons, 7 resident doctors and 7 operating assistant staff. Except one resident doctor, all the operating team members were right handed. The surgeon, first assistant and assisting staff used the allocated gloves throughout the operation. These gloves were allocated randomly by the hospital, irrespective of the brand; - the brand name has been concealed for ethical reasons. After the surgery, the gloves used during operation were collected and labeled. Gloves were examined for perforations by the approved standardized water leak test method adapted from EN455-1 (European Committee for Standardization) (7) by the observer. Each glove was distended with 350 to1000ml of water and cuff end of the glove was twisted through 360 degree to increase pressure. The site of all punctures was detected by the flow of water from the puncture site (Figure 1). The location of puncture was recorded on the case record. In subtle leaks, the wearers were asked about their awareness of any perforations or blood contaminations on the hand. Records were kept of the nature

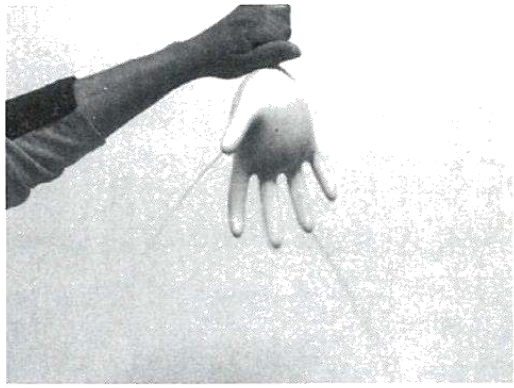

Figure 1: Water leak test method adapted from EN455-1 (European Committee for Standardization) (7).
(Povidone iodine has been added to water for better visualisation of the glove puncture site in this photograph.)

of operation, dominant hand, and team seniority of the operating person for that procedure. After the operation a proforma was completed recording the patients detail, nature and duration of each procedure.

Data was entered into Microsoft Excel and analyzed using MS Excel and Epi-info for Windows. Incidence rates were calculated as percentage (%). Discrete data was analyzed using Chi Square test for difference in proportion. In case the expected value in some cells was less than 5, Fischer's exact test was used in place of Chi-Square test. Two tailed *p*- values < 0.05 were considered significant.

Results:

A total of 1736 gloves were collected from 180 surgeries performed in the study period. A total of 212 (12.21%) gloves were found to have 286 punctures and awareness was present in 74 (25.87%) glove punctures. This gives a overall glove perforation rate of 16.47% (286/1736). For the single gloving group, 176/1304 gloves were found punctured.243 punctures were detected in single gloving with an overall puncture rate of 18.6% (243/1304). Awareness was present in 70/243 punctures. In double gloving, 432 gloves were used. 36 gloves (33 outer and 3 inner) were found to have 43 punctures (39 in outer and 4 in inner gloves). Awareness was reported in all 4 inner perforations. Overall glove perforation rate in double gloving was found to be 9.95% (43/432) [Table -1]. This was found to be statistically significant (*p* value<0.05) (chi-square value=8.07).

The180 surgeries performed under the study were categorized on the basis of duration of surgery and the glove puncture rates were calculated accordingly. 36 surgeries were of less than 1 hour duration with a puncture rate of 9.8% (29/294), 112 operations lasting for 1-2 hours had a puncture rate of 11.1% (111/996), 27% (92/340) punctured were found in 26 surgeries lasting 2-3 hours and 6 surgeries which lasted for more than 3 hours had a puncture rate of 50.9% (54/106) [Table-2]. This was found to be statistically significant (*p* value<0.05) (chi-square value=59.27).

We observed that as the duration of surgery prolonged, the percentage of glove perforation increased. Thus duration of surgery has a direct impact on the percentage of glove perforation.

The surgeries included under the study were categorized on the basis of

Table 1: Comparison of puncture characteristics in single & double gloving practice.

	No. of Gloves Used	No. of Gloves Punctured	No. of Punctures (%)	Awareness of Glove Punctures
Single Gloving	1304 (75.12%)	176 (13.49%)	243 (18.63%)	70
Double Gloving	432 (24.88%)	36 (8.33%)	43 (9.95%)	04
TOTAL	1736	212	286	74

Chi square value: 8.07, P value: 0.0004 (<.05) significant difference, d.f=1

Table 2: Comparison of glove puncture rate with duration of surgery

Duration	No. of gloves (No. of operations)	No of gloves punctured	No of punctures (%)
< 1 hr	294 (36)	21	29 (9.8%)
1 hr- 2 hr	996 (112)	91	111 (11.1%)
2 hr- 3 hr	340 (26)	77	92 (27.0%)
> 3 hr	106 (06)	23	54 (50.9%)
Total	1736 (180)	212	286 (16.49%)

Chi-Square Value: =59.27, P Value= 0.0001 (<0.05) significant difference, d.f=3

the procedure done. Procedures included K wire fixation, Plating, Nailing, PHR and DHS, THR, TKR, Spine surgeries. 34.84 % (23/66) glove puncture rate was detected in 5 TKR procedures, 30.43 % (28/92) puncture rate was detected in 10 spine surgeries. These two types of procedures had the highest glove puncture rate probably because of the long duration of surgeries. 8 THR

procedures had a puncture rate of 19.64 % (22/112) whereas 35 PHR and DHS procedures had a puncture rate of 16.66 % (58/348). 57 Nailing procedures had a puncture rate of 15.85 % (91/574). 10.61 % (45/424) puncture rate was found in 44 plating procedures. 21 K-wire fixation procedures had a puncture rate of 15.83 % (19/120) (Figure 2). This was found to be statistically significant (p value<0.05) (chi-square value=17.03).

The non dominant hand had a higher rate of glove puncture as compared to the dominant one (Table 3). On the right hand, highest number of punctures were detected in the index finger 28.57% (28/98) followed by palm 24.48% (24/98) whereas in the left hand maximum punctures were detected in the palm 30.85% (58/188) followed by the index finger 24.46% (46/188). A total of 98 punctures were detected in the right hand and 188 punctures in the left hand. Overall palm had the highest percentage of glove perforation (28.7%) followed by the index finger (25.8%). This was found to be statistically significant (p value<0.05) (chi-square value=16.85).

Out of 23 members in the operating team, 3 surgeons, 1 assistant and 2

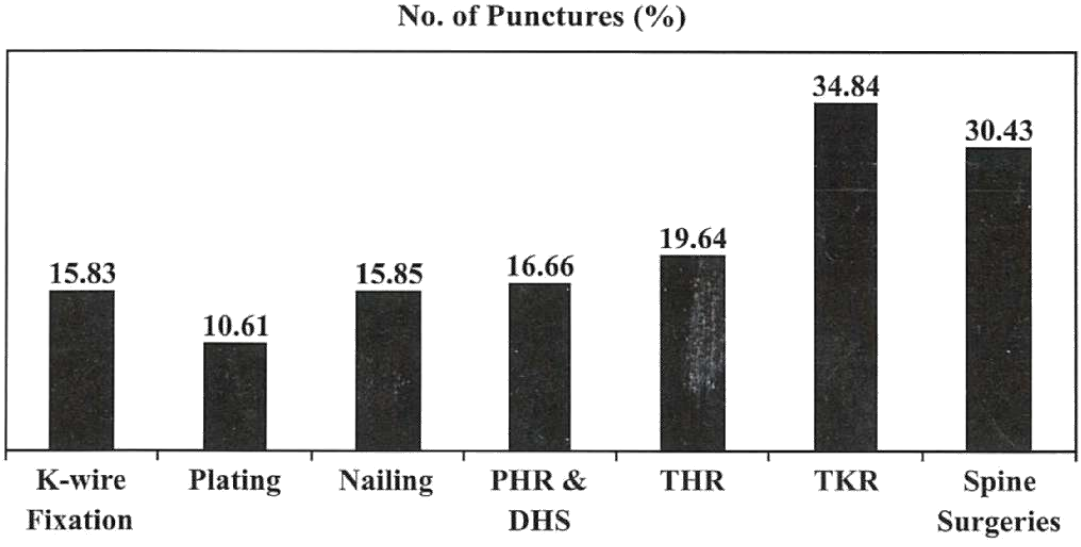

Figure 2: Comparison of surgical procedure with glove punctures *(PHR-partial hip replacement, DHS-Dynamic hip screw, THR-Total hip replacement, TKR-Total knee replacement)*

Table 3: Distribution of glove perforations in hand

	RIGHT	LEFT	TOTAL
PALM	24 (24.48%)	58 (30.85%)	82 (28.7%)
THUMB	22 (22.44%)	38 (20.21%)	60 (21.0%)
INDEX	28 (28.57%)	46 (24.46%)	74 (25.8%)
MIDDLE	12 (12.24%)	36 (19.14%)	48 (16.8%)
RING	8 (8.16%)	4 (2.13%)	12 (4.2%)
LITTLE	4 (4.08%)	6 (3.20%)	10 (3.5%)
TOTAL	**98**	**188**	**286**

assistant staff did not take off their rings during surgery. The remaining 17 members did not wear rings at the time of surgery. Most of the ring wearers wore rings in their index finger thereby contributing to increased incidence of glove puncture in index finger. Ring wearers had a glove puncture rate of 22.56 % (102/452). Non ring wearers had a puncture rate of 14.33% (184/1284). Non ring wearer had a significantly lower rate of glove puncture as compared to ring wearers. This was found to be statistically significant (p value<0.05) (chi-square value=13.26).

60 emergency procedures and 120 elective procedures were performed under the study (total 180 surgeries). Emergency procedures had a perforation rate of 21.61 %(115/532) whereas elective procedures had a puncture rate of 14.2% (171/1204). This was found to be statistically significant (p value<0.05), (chi-square value= 6.50).

Surgeons had a higher glove perforation rate as compared to the residents and the staff. Surgeons(n=9) had a perforation rate of 21.19%(128/604) whereas residents(n=7) had a puncture rate of 17.51%(103/588) and

assisting staff(n=7) with rate of 10.11%(55/544) (Table-4) (Figure 3). This was found to be statistically significant (*p* value<0.05), (chi-square value= 24.97).

Discussion:

Glove failure during surgical operations is a recognized pathway through which surgeons and operating team members could be exposed to

Table 4: Comparison of puncture rate in gloves wearers

Wearers	Number of Gloves	Number of Gloves Punctured	Number of Punctures (Puncture Rate)
Surgeon (n=9)	604	99	128 (21.19%)
Resident(n=7)	588	76	103 (17.51%)
Staff (n=7)	544	37	55 (10.11%)
Total	1736	212	286 (16.49%)

Chi-Square Value=24.97: P Value= 0.0001 (<0.05), significant difference d.f=2

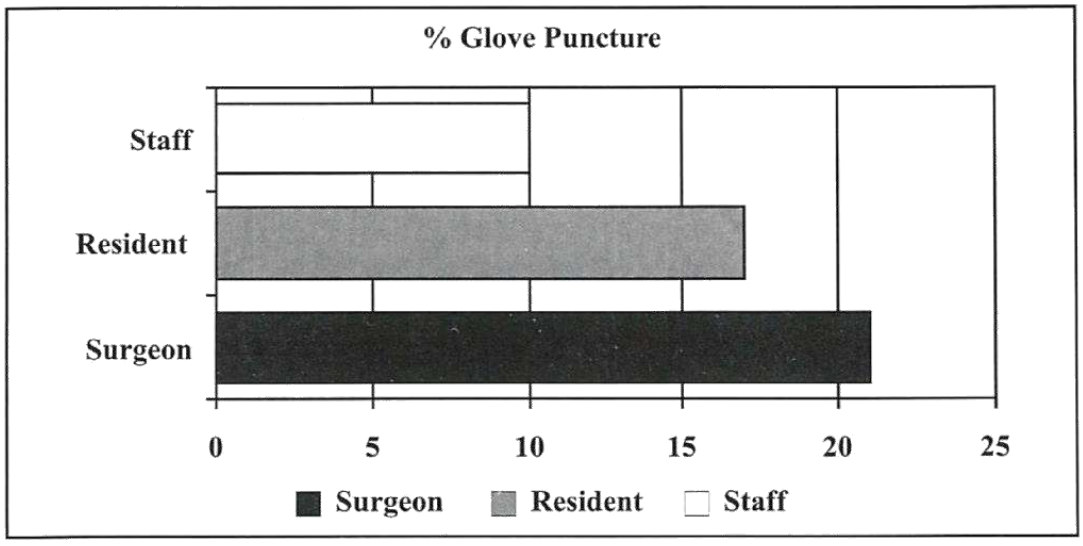

Figure 3: Comparison of puncture rate in gloves wearers

patient's blood. It is imperative that intactness of surgical gloves are make them impermeable to the HIV and the Hepatitis B virus while the perforated gloves lose the advantage (8). Although the operating team members are at risk for contracting blood borne diseases from the patients, with adequate preoperative hand preparation it has been shown that the risk gets limited (9), although, in 10% of the punctured gloves bacterial culture around the holes is positive (9). The principal route of occupationally acquired HIV infection in the surgeon is by skin perforation with a hollow needle containing HIV infected blood. The Centers for Disease Control and Prevention (CDC) in their observation in 2004 noticed that solid needle prick also transmits infection but the risk is ten times less than with a hollow needle (3). There is limited risk to the patient from surgical glove perforation regarding HIV transmission, but the risk is higher for Hepatitis B virus, which also makes double gloving highly advisable.

Studies from other surgical practices have reported variable rates of glove perforation. In gynaecological procedures, the main surgeon sustained glove perforations in 10 to 43% of procedures, in general surgery 35 to 54%, in plastic surgery in 21.4% and in thoracic surgery in 26% (1, 2, 15).

The overall glove perforation rate in our study was 16.49% which is comparable to those found in literature (1, 15, 16, 17). Ersozulu et al. included less risky procedures like arthroscopy in their study with a perforation rate of 3.6% where as major procedures like THR/TKR had a perforation rate of 21.6% (19). Their overall puncture rate was 15.8% which is comparable to our study. Yinusa et al. studied 100 operations in pediatric, spine and hand surgeries with a overall perforation rate of 8.7% (1). They have relatively low puncture rate as is being confirmed by other studies in pediatric operations in the literature. Our results are not comparable with this study because of the different nature of operations included in our study. (THR, TKR, Nailing and Plating, Adult Spine surgeries and K-wire fixation procedures). Laine et al. studied 349 operations in conventional and arthroscopic procedures (15). Their study concluded the perforation rates for conventional procedures (18.5%) which are comparable to our study. They had 5.8% puncture rate in arthroscopic procedures with an overall puncture rate of 9.25%. We did not include

arthroscopy in our study; hence puncture rates vary with their study. Nicolai et al. collected 362 gloves from THR and TKR procedures with a overall glove perforation rate of 14.6% (20).

Our study shows that double gloving offers significantly better protection than single gloving [Table-5]. We observed perforation rate of 18.6% in single gloving, where as in double gloving puncture rates for outer glove was 18.05% and for inner glove 0.9% which is significantly low. Double gloving during surgery gives an additional level of protection against blood borne infections and minimizes the hazards of glove perforation (21). When the outer glove is perforated, the inner glove will protect the surgeon's hand from contamination; subsequent visible skin contamination is also much lower with double gloves. Extensive research on this subject has been undertaken, with a number of studies strongly advocating the use of double gloving as the major risk management factor in the control of contamination in a surgical practice (22). Double gloving is the practice recommended by several organizations and standards (23).

However, double gloving should be used routinely in all surgical procedures and not limited only to those high risk cases. It has been widely stated that double gloving reduces the opportunities for perforations of the inner glove as well as hand skin exposures (6, 21). A number of studies have shown the effectiveness of this procedure in maintaining an intact barrier between the patients and the

Table 5: Distribution of glove puncture rates in single and double gloving practice in other studies as compared with our study

Study	Single gloving (% puncture rate)	Double gloving (% puncture rate)	
		Outer	Inner
Mcleods et al. (1989)	14%	19%	6%
Wright et al. (1993)	-	22.46%	14.49%
Yinusa et al. (2004)	9.6%	12.5%	0.8%
Ersozlu et al. (2007)	-	22.7%	3.7%
***Our study* (2008)**	18.6%	18.05%	0.9%

surgical staff. Among these studies is the Cochrane Library review, which concludes that 'wearing two pairs of latex gloves significantly reduces the number of perforations to the innermost glove (24). Although double gloving may not prevent a penetrating injury it may reduce the risk of disease transmission because of the wiping effect of two layers. Finally, double gloving will reduce the risk of exposure because of a possible manufacturing defect.

The use of double gloving has not been widely accepted by many. Wearers suggest that double gloving can reduce the operative feel in the hand, although others suggest the contrary. Most surgeons who switch to double gloves quickly adapt to it, even in one day (15). The commonest complaint most switchers make is the loss of sensitivity and dexterity in practicing double gloving (25). Phillips et al. reported that there is a lesser effect upon the motor functions performed under direct vision, though a significant difference in sensory function is observed (26). The decision to use double gloving should take into account factors such as discomfort, loss of sensitivity and dexterity, nature and length of the procedure and the possible risk of cross infection (26). Donning the inner glove a half size larger and the outer glove the normal size, appears to be the most comfortable method even though it may be a personal matter (6, 23).

The rate of glove perforation seems to depend upon the duration of surgery according to our observation and confirmed by other studies (15). The longer the operation time, the greater the possibilities of needle stick injuries or tears in the gloves due to the edge of sharp bone (1). Also, usually the operation is more demanding if it is longer, and thus there are more possibilities of glove perforations (15). Fatigue during long surgeries, and more importantly, the nature of operations and use of instrumentation implicate the rates of glove perforation (1, 17, 18).

Bony procedures, either because of the hard and sharp nature of the bone or higher percentage of instrumentation, tend to be associated with higher glove failure rate as compared to arthroscopic and soft tissue procedures. Moreover, the mean operative time for bony procedures is longer than that of less aggressive arthroscopic and soft tissue procedures which may also be a contributing factor for the higher incidence of glove perforation in Orthopaedic bony surgery (1). The use of instrumentation like screws, K-wires, drills and metal cutters with sharp edges or points acts as a contributing factor for glove perforation.

Manipulation of these implants and devices result in strong shear forces on the surgeon's gloved hands (1). Careless handling may cause glove punctures and lacerations.

Perforation rates are particularly high in THR, TKR and Spine operations because their mean operative time is much longer than other types of procedures. Also these procedures require use of major instrumentation. In summary, the risk factors for glove puncture include long operative time, bony procedures, and procedures with major instrumentation. However this should be pointed out that all these factors are inter-related and still there is no absolute measure that guards against glove failure (1).

Literature reveals that the index finger of the non dominant hand appears to be most prone to present glove tear or puncture (1, 15). In our study, however, the most common location was palm followed by index finger. On interview for awareness we suspected that the reason for higher perforation rates in the non dominant hand may be that the surgeon usually holds the instruments in his dominant hand and holds the tissue with the non dominant hand. Also, the needle holder is usually in the dominant hand and needle may accidentally puncture the glove of the non dominant hand controlling precision. The dominant hand is used for more elegant maneuvers during operation while the left hand is used for coarse and awkward manipulations to assist the other for precision (27). The dominant hand has a better reflex control than the non dominant hand thereby reducing accidental glove perforation.

It is natural that the surgeons more frequently had perforations in the gloves than the resident doctor or the operating assistant staff, because the assistant usually holds the tissues for a better view for the surgeon and does not use the knife or needles as much as the surgeon (19). However the frequency of glove perforation in the resident and staff is not negligible. Of course the danger of perforation is not only during their assistance in the wound but also when they handle the knives, needles and sharp instruments on the table.

Ring wearers had a higher incidence of glove puncture (22.56%) as compared to non ring wearers (14.33%). This contributed to the higher incidence of punctures in the index finger (24.47%) in the non dominant hand as most of the ring wearers wore ring in the left index finger. A similar study done by Nicolai P *et al.* (20) in 1997 showed higher

puncture rates in left ring finger (35.78%) as their operating team had members wearing wedding ring in left ring finger during operations. Thus ring wearing definitely acts as a risk factor for glove punctures and should be avoided during operations. Rings may also add to the risk of infection (20), hence should be avoided while operating.

After analysis of the result of our study and comparing this with the previous studies done by various authors we can conclude that guidelines of gloving techniques should be used to maximize protection in all situations, both high risk and low risk. Double gloving should be practiced routinely in Orthopaedic procedures because it can significantly reduce the incidence of glove perforation of the inner gloves besides reducing the risk of exposure against manufacturing defect. Technically demanding and long duration procedures have a higher incidence of glove puncture. Therefore, outer gloves must be changed at regular intervals (every one hour) in long duration surgeries to decrease the amount of blood contact. Avoid ring wearing while operating as it significantly increases the incidence of glove perforation. Emergency procedures have a higher incidence of glove puncture. So it is advisable that surgeon and his team ensure proper preoperative planning, proper instrumentation and trained operative team availability. Use of recycled gloves should be strictly avoided; practice quite common in many Indian setup.

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References

1. Yinusa W, Li YH, Chow W, Ho WY, Leong JC (2004). Glove punctures in orthopaedic surgery. *Int. Orthop.*, **28:**36-39.
2. Malhotra M, Sharma JB, Wadhwa L, Arora R (2004). Prospective study of glove perforation in obstetrical and gynecological operations: are we safe enough? *J Obstet Gynaecol Res,* **30:** 319-322
3. Bennett NT, Howard RJ (1974). Quantity of blood inoculated in a needle stick injury from suture

needles. *J Am Coll Surg*, **178:** 107-110.

4. Centers for Disease Control and Prevention (CDC). NIOSH 2004. Publication No. 2004-146.Worker Health Chart book.
5. Pattersson *et al.* (1998). Surgeon's Concern and Practices of Protection Against Blood borne Pathogens. *Annals of Surgery,* **228(2):** 266-272.
6. Clyde Smoot E (1998). Practical Precautions for Avoiding Sharp Injuries and Blood Exposure; *Plastic and Reconstructive Surgery.*
7. European Committee for Standardization. Medical gloves for single use, Part 1: requirements for testing for freedom from holes. EN 455-1:1993E
8. Dalgleish AG, Malkovsky M (1998). Surgical gloves as a mechanical barrier against human immunodeficiency viruses. *Br J Surg*, **75:** 171-172.
9. Dodds RDA,Guy PJ, Peacock AM, Duffy SR, Barker SGE, Thomas MH (1988). Surgical glove perforation, *Br J Surg,* **75:** 966-968
10. Lemaire R, Masson JB (2000). Risk of transmission of blood borne viral infection in orthopaedic and trauma surgery; *J Bone Joint Surg*; **82-B:** 313-323
11. Friedland G, Klein R (1987). Transmission of the human immunodeficiency virus. *N Engl J Med*; **317:** 1125-1135
12. McCray E (1986). Occupational risk of the acquired immunodeficiency syndrome among health care workers. *N Engl J Med*; **314:** 1127-1132.
13. Bell D (1997). Occupational risk of human immunodeficiency virus infection in healthcare workers: an overview. *Am J Med*; **102:** 9-15
14. Weiss SH, Saxinger WC, Rechtman D, Greico MH, *et al.* (1985). HTLV-III infection among health care workers. Association with needlestick injuries, *J Am Med Assn*, **254:** 2089-2093
15. Laine T, Aarnio P (2004). Glove perforation in orthopaedic and trauma surgery. A comparison between single, double indicator gloving and double gloving with two regular gloves; *J Bone Joint Surg*; **86-B:** 898-900.
16. Caillot *et al.* (1999). Electronic evaluation of the value of double gloving. *Br. J. of Surg.;* **86:** 1387-1390.

17. Maffulli N, Capasso G, Testa V (1989). Glove perforation in elective orthopedic surgery. *Acta Orthop Scand*; **60:** 565-566.

18. Maffulli N, Capasso G, Testa V (1991). Glove perforation in pediatric orthopaedic surgery. *J Pediatr Orthop*; **11:** 25-27.

19. Ersozlu S, Sahin O, Ozgur AF, Akkaya T, Tuncay C (2007). Glove punctures in major and minor orthopaedic surgery with double gloving; *Acta Orthop Belg;* **73:** 760-764.

20. Nicolai P, Aldam CH, Allen PW (1997). Increased awareness of glove perforation in major joint replacement; *J Bone Joint Surg (Br)*; **79B:** 371-3.

21. Gerberding JL *et al.* (1990). Risk of exposure of surgical personnel to patients blood during surgery at San Francisco General Hospital. *The New England Journal of Medicine,* **322(25):** 1798-1793.

22. Opinion of the Scientific Committee on Medical Products and Medical Devices on 'The protection offered by natural rubber latex devices (medical gloves and condoms) against transmissible diseases'. European Commission. Health & Consumer Protection Directorate-General. October 2003.

23. ACORN standards for Perioperative nurses. Australian College of Operating Room Nurses. 2004.

24. Tanner J, Parkinson H (2004). Double gloving to reduce surgical cross-infection (Cochrane Review). In: The Cochrane Library, Issue 3, Chichester, UK: John Wiley & Sons Ltd.

25. Matta H, Thompson AM, Rainey JB (1998). Does wearing two pairs of gloves protect operating theatre staff from skin contamination? *BMJ*; **297:** 597-8.

26. Avery CME, Gallagher P, Birnbaum W (1999). Double gloving and a glove perforation indication system during the dental treatment of HIV positive patients: are they necessary? *British Dental Journal*; **186:** 27–29.

27. Chiu KY, Fung B, Lau SK, Ng KH, Chow SP (1993). The use of double latex gloves during hip fracture operations; *J Orth Trauma;* **1:** 354-356.