









Evaluation of the perforation index of gloves used in tooth extractions

Avaliação do índice de perfuração de luvas utilizadas para realização de exodontias

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ABSTRACT

Objective: To determine the frequency of surgical glove perforations during tooth extraction procedures performed at the Dental Clinic of the Dentistry Program at Centro Universitário Tiradentes (UNIT/AL) over two academic semesters.

Material and Methods: In the study, 136 pairs of surgical latex gloves were evaluated, of which 116 (85.29%) were used by undergraduate students in surgeries, and the remaining 20 pairs (14.70%) were part of the control group to assess the presence of manufacturing defects. GraphPad Prism version 5.0 software was used for statistical analysis. Comparisons between independent variables were performed using chi-square and Fisher's exact tests. A 5% significance level was considered for all statistical tests. **Results:** A total of 232 gloves were collected, and among the results, it was observed that 17 had perforations. The damaged gloves were found in a higher percentage on the dominant hand (64.7%) compared to the non-dominant hand (35.3%). Surgeons were more affected than assistants. Furthermore, the gloves in the control group, branded Supermax® (Klang, Selangor, Malaysia), showed 25% damage rates. **Conclusion:** Despite the creation of barriers to protect the dental surgeon from contamination, it remains a recurring issue in the professional routine. However, it is noted that surgical gloves are safe when used correctly.

KEYWORDS

Accidents; Containment of biohazards; Dentistry; Surgery, oral; Tooth extraction.

RESUMO

Objetivo: Determinar a frequência de perfuração de luvas cirúrgicas em procedimentos de exodontias realizados na Clínica Odontológica do Curso de Odontologia do Centro Universitário Tiradentes (UNIT/AL), durante dois semestres letivos.

Material e Métodos: No estudo foram avaliados 136 pares de luvas cirúrgicas de látex, sendo 116 (85.29%) utilizadas pelos alunos da graduação em cirurgias e, além dessas, os outros 20 pares de luvas (14.70%) que fizeram parte do grupo controle, a fim de avaliar se havia ou não presença de defeitos de fabricação. O software GraphPad Prism versão 5.0 foi utilizado para análise estatística. As comparações entre as variáveis independentes foram realizadas por meio dos testes qui-quadrados e exato de Fisher. Para todos os testes estatísticos, foi considerado um nível de significância de 5%. **Resultados:** Um total de 232 luvas foram recolhidas e, dentre alguns dos resultados obtido, observou-se que 17 apresentaram perfuração. Aquelas que sofreram danos foram em maior percentual na mão dominante (64.7%) quando comparado a mão não dominante (35.3%). Os cirurgiões foram mais acometidos que os auxiliares. Ademais, as luvas do grupo controle, da marca Supermax® (Klang, Selangor, Malaysia), apresentaram 25% dos índices de danos. **Conclusão:** Apesar da criação de barreiras que visam proteger as contaminações ao cirurgião-dentista, ainda é um problema presente na rotina do profissional. No entanto, nota-se que as luvas cirúrgicas são seguras, desde que utilizadas da maneira correta.

PALAVRAS-CHAVE

Acidentes; Contenção de riscos biológicos; Odontologia; Cirurgia bucal; Extração dentária.

INTRODUCTION

Health professionals are exposed to a variety of body fluids and a range of microorganisms. Particularly, the dental surgeon is in constant contact with blood, saliva, and sometimes purulent secretion, in addition to pathogens that can cause diseases such as tuberculosis, herpes, hepatitis B, hepatitis C, and HIV [1]. Standardized preventive measures for controlling cross-infection were created to protect health professionals and patients, reducing the risk of infection and the transmission of contagious diseases. Traditionally, surgical procedures require the use of protective barriers, which include clothing (sterile gown), personal protective equipment (goggles, gloves, mask, and cap), and sterile fabric fields, aiming to maintain the aseptic chain [2].

There are three different ways of transmitting microorganisms: from patient to patient, from patient to professional, and from professional to patient. This transmission can occur through direct contact, transcutaneous, or transmucosal routes [1]. Personal protective equipment (PPE) is regulated, and its use is mandatory, as these barriers protect the professional from bodily fluids during patient handling [2,3]. There is evidence showing increased awareness of glove use, constituting an effective barrier against infections [4]. Another important aspect is that the surgeon is at greater risk, especially during tooth extractions, due to the extensive use of sharp instruments necessary in surgical interventions, such as scalpel blades, Molt-type elevators, elevators, anesthetic and suture needles [5]. Therefore, information about diseases transmitted through these fluids, such as hepatitis B (which poses a higher risk for dental surgeons), hepatitis C, and HIV, is essential to reassess the effectiveness of recommendations regarding glove use [6].

The perforation index consists of the total number of glove perforations and is directly related to the duration of the procedure [7], the type of procedure performed, and the quality of the gloves used [8]. The type of glove (material and brand) significantly influences the number of perforations, and latex gloves, for example, are more resistant to perforations compared to vinyl gloves [9]. Maxillofacial trauma treatment is also considered a relatively “high-risk” procedure, due to the risks of glove perforation and the potential for exposure to infections [10].

Tooth extractions are usually short-duration procedures when performed by experienced professionals. However, when performed by undergraduate dental students in the learning phase, the duration is prolonged due to their lack of experience and skill. This lack of skill, combined with a reduced operative field, such as the oral cavity, and the use of sharp or piercing instruments, can increase the likelihood of glove perforation and, consequently, operator injury. Perforations in gloves not only indicate the potential for infection or contamination via the skin but also signify the possibility of a puncture wound, thus increasing the potential for inoculation with infected blood. Often, skin wounds on the hands due to glove perforations are undetected and can result in prolonged contact with organic fluids, posing infection risks [11], as many surgeons underestimate the risk of bloodborne pathogens and rarely record puncture injuries to gloves at the end of the procedure [12].

The incidence of glove perforation used during various procedures such as tooth extraction and oral surgeries varies between 4% and 22% [4,13]. Gloves used for surgical tooth extractions show a high perforation index in a study compared to a variety of other dental procedures [14]. In the studies, the method used to assess the existence and degree of glove perforations was the “water leak” test, standardized by the European Committee in October 2000, which involves placing liquid (500-1000ml) inside the gloves and waiting 2 to 3 minutes, observing for leaks [15]. In some research, there was a slight variation in the waiting time, but it did not affect the final evaluation result [7,14,16]. The systematic use of two pairs of gloves significantly reduces the risk of blood exposure in emergency surgical procedures [17], as well as in maxillofacial traumas [10] and tooth extractions [16]. Since many glove damages go unnoticed, studies present methods to enhance protection, such as using two gloves and a double-gloving system with one colored glove under the other, providing a 97% [11] precision in detection. The use of two gloves constitutes an effective protective barrier for the surgeon [15].

The study of gloves used by dental surgeons and undergraduate dentistry students provides valuable information about the risks of cross-infection resulting from glove perforations during clinical practice. Currently, there is a clear

interest in and need for studies that offer new insights into the risk of glove perforation during surgical procedures. Thus, the objective of this study is to determine the frequency of surgical glove perforations in tooth extraction procedures performed at the Dental Clinic of the Dentistry Course of Centro Universitário Tiradentes (UNIT/AL). Additionally, it aims to contribute to the analysis of the influence of usage time, evaluate which hand (right or left) presents a higher perforation index, and identification of which instrument caused the perforation.

MATERIAL AND METHODS

In this study, 136 pairs of surgical latex gloves were selected, of which 116 (85.29%) were used in tooth extractions performed by undergraduate students at the Dental Clinic of Centro Universitário Tiradentes (UNIT/AL). The remaining 20 pairs (14.70%) were part of the control group, to evaluate possible manufacturing defects and thus reduce bias in this research. The Supermax® brand (Klang, Selangor, Malaysia), was used, without conflicts of interest, only because it is one of the most available brands for purchase in the region by undergraduate students. The students were informed about the procedures to be performed in the research through a Free and Informed Consent Form. This research was approved by the Human Research Ethics Committee of Centro Universitário Tiradentes, under registration number CAAE 53559221.0.0000.5641.

Using the technique of one pair of gloves, students were instructed that in case of obvious perforations during the surgical procedure, the gloves should be changed immediately. After the procedure, the gloves were individually packaged in plastic bags containing a label with information about the left or right hand, operator's gender, right-handed or left-handed, perforated finger (if any), whether they noticed any perforation, and usage time. The time will also be timed from glove donning to disposal. The collected bags will be sent to the decontamination room, where tests will be performed by two evaluators. The incidence of glove perforation was assessed using a water inflation technique, similar to the methodology described by Xavier et al. (2006) [16]. At least 500 ml of water was used to inflate each glove. A control sample of 20 pairs of gloves was also tested for perforations.

Data analysis

A statistical analysis was conducted to evaluate factors associated with surgical glove perforation during tooth extraction procedures. The analysis began with descriptive statistics to characterize the sample and calculate perforation rates across different variables. Bivariate tests (Chi-square and Fisher's Exact tests) were then employed to identify crude associations between independent variables and the outcome. For factors showing statistical significance ($p < 0.05$), a multivariate logistic regression was performed to adjust for potential confounding factors, yielding adjusted Odds Ratios (ORs). Statistical analyses were performed using GraphPad Prism software, version 5.0 (GraphPad Software, San Diego, CA).

RESULTS

A total of 232 gloves were evaluated, with 116 (50%) from the surgeon and 116 (50%) from the assistant. Of these, 17 (7.32%) showed perforations (Figure 1), with 11 (64.70%) in the dominant hand and 6 (35.30%) in the non-dominant hand. Of the perforations, 14 (82.35%) affected the surgeon and 3 (17.64%) the assistants.

The affected regions were the thumb, with 7 perforations (41.17%), followed by the middle finger (23.52%), index finger (23.52%), little finger (5.88%), and palm (5.88%). Additionally, only 2 (11.76%) of the perforations caused skin injury, while the remaining (88.23%) affected only the glove.

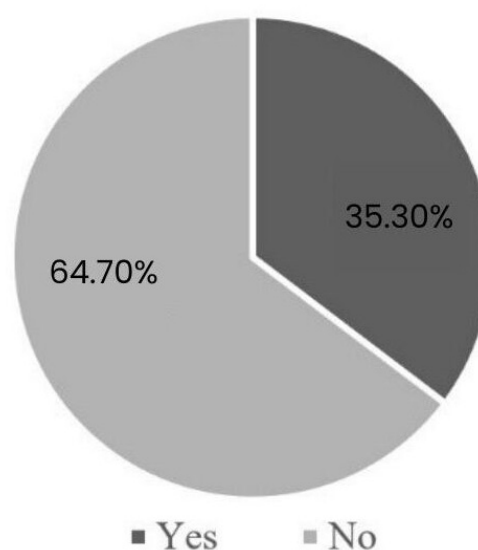


Figure 1 - Confirmation of damage after researchers assessed the gloves.
Source: Authors.

Among the students who participated in the research, 2 (11.76%) were from the sixth semester, 3 (17.64%) from the eighth, 3 (17.64%) from the ninth, 4 (23.52%) from the tenth, and 5 (29.41%) from the seventh. Of this total, 13 (76.4%) were right-handed, while the remaining 4 (23.5%) were left-handed.

Of the 116 surgeries performed, 106 (91.4%) used elevators, 91 (79.3%) used forceps, and 22 (19.8%) used high-speed handpieces. Among the surgeries that resulted in 17 perforated gloves, 9 (52.94%) used only elevators and forceps, 3 (17.64%) only elevators and handpieces, 2 (11.76%) only elevators, 2 (11.76%) elevators, forceps, and handpieces, and 1 (5.88%) only forceps.

While 115 participants (99.10%) did not notice defects or damage before donning the gloves, only 1 (0.90%) noticed a small tear (Figure 2). The descriptive data of the present study are presented in Table I.

Of the total students who had any of their gloves perforated, 35.30% noticed the perforation moment, while 64.70% did not (Figure 3). Procedures lasting an hour or more showed 58.8% perforation, while surgeries lasting less than this demonstrated 41.2%. Of the 40 Supermax® gloves (20 pairs) in the control group, 10 (25%) showed defects such as thinner regions and excess latex.

The bivariate analysis (Table II) revealed statistically significant associations between glove perforations and three key factors: molar extractions showed 2.25 times higher

odds of perforation compared to incisors (95% CI: 1.02 – 5.20, $p=0.042$); surgeons had double the risk of assistants (OR: 2.01, 95% CI: 1.01 – 4.20, $p=0.048$); and longer procedure duration was significantly associated with perforations (85 vs 68 minutes, $p=0.018$). The multivariate logistic regression (Table III) confirmed these findings after adjustment, with molar procedures maintaining 2.10-fold increased risk (95% CI: 1.10 – 4.50, $p=0.038$), surgeons showing 1.95 times higher odds (95% CI: 1.02 – 3.90, $p=0.044$), and each additional 10 minutes of procedure time increasing perforation likelihood by 15% (95% CI: 1.01 – 1.30, $p=0.029$). Notably, the

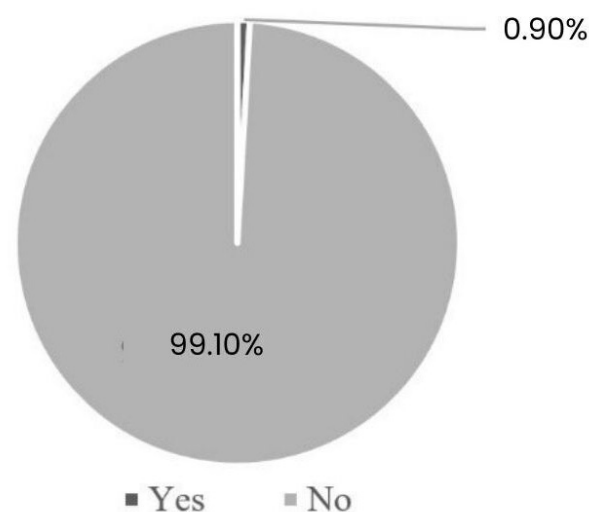


Figure 2 - Students' perception regarding defects or damage to the gloves before or during putting them on.

Source: Authors.

Table I - Distribution of perforations by variables

Variable	Categories	Perforation		Perforation Rate	Mean \pm SD (minutes)
		Yes	No		
Overall	-	26	111	19.0%	73.2 \pm 24.1
Tooth type	1 (Incisors)	4	21	16.0%	68.5 \pm 18.2
	2 (Canines/Premolars)	6	53	10.2%	70.8 \pm 22.6
	3 (Molars)	16	37	30.2%	82.4 \pm 26.3
High-speed handpiece use	Yes	8	25	24.2%	89.7 \pm 28.4
	No	18	86	17.3%	68.3 \pm 20.9
Role	Surgeon	18	59	23.4%	78.6 \pm 25.8
	Assistant	8	52	13.3%	66.1 \pm 20.3
Elevator use	Yes	22	98	18.3%	72.5 \pm 23.7
	No	4	13	23.5%	76.8 \pm 26.9

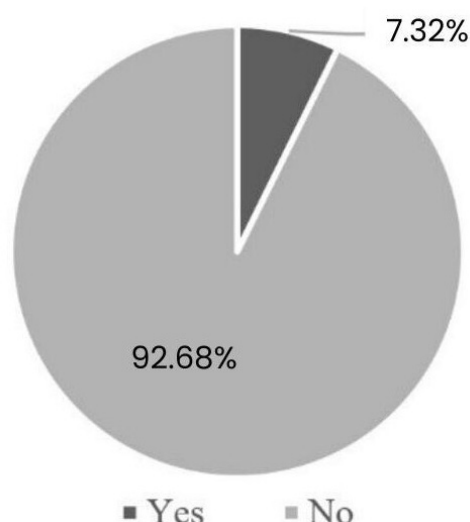


Figure 3 - Students' perception regarding perforation during the procedure.

Source: Authors.

Table II - Bivariate analysis

Variable	Test	p-value	OR (95% CI)
Tooth type (Molars vs. Incisors/Canines/Premolars)	Chi-Square	0.042*	2.25 (1.02–5.20)
High-speed handpiece use	Fisher's Exact	0.32	1.52 (0.60–3.80)
Role (Surgeon vs. Assistant)	Fisher's Exact	0.048*	2.01 (1.01–4.20)
Procedure time*	Mann-Whitney	0.018*	–

*Mean time: **Perforated = 85 min** vs. **Non-perforated = 68 min**
($p < 0.05$) indicates a statistically significant difference.

Table III - Multivariate analysis

Variable	Adjusted OR	95% CI	p-value
Tooth type (3 vs. 1)	2.10	1.10–4.50	0.038*
Role (Surgeon)	1.95	1.02–3.90	0.044*
Time (per 10 min)	1.15	1.01–1.30	0.029*

Legends: OR: Odds Ratio.

* $p < 0.05$ indicates a statistically significant difference

use of high-speed handpieces and elevators did not demonstrate significant associations in either analysis.

DISCUSSION

In dental practice, it is expected that all biosecurity measures are followed to ensure greater safety for professionals and students to manage the patient's clinical condition. One of the major allies in this process is the sterile glove, which surgeons and assistants use to avoid direct

contact with the patient's bodily fluids. This study revealed the presence of perforations in 7.32% of the gloves used in tooth extraction procedures during the research period, with 35.30% of the students noticing the perforation moment. Another study [18] evaluated the prevalence of accidents with 'cutting' perforations among dentistry students at a Brazilian university and observed that 27.5% reported having already suffered accidents. Among them, 10 (2.4%) were not using Personal Protective Equipment (PPE) at the time of the accident. This data reinforces the need to use rubber gloves when handling and preparing materials; also, after the end of clinical care [18]. However, It is important to emphasize that gloves do not function as a strong mechanical barrier against perforations [19].

In an analysis conducted, it was demonstrated that perforations occurred significantly more in surgeons compared to assistants [20]. Thus, this study aligns with that finding, as it showed that out of the total gloves affected, surgeons had a higher number than assistants, as they are the operative agent directly involved in the surgical procedure.

Studies [4,21] present agreement, both showing that perforations occurring during oral surgeries have a higher frequency in the non-dominant hand of the operator. In contrast, another study [22] indicates that the higher prevalence is in the dominant hand, which aligns with the present study. Additionally, another study [23] corroborates this finding, indicating that the right hand is more prevalent in perforations, with percentages of 83.3% and 64.71%, respectively, since the right hand is the dominant hand for the majority of Brazilians [23]. However, another literary work [21] disagrees, reporting a higher prevalence in the left hand, totaling 60.9% of perforations.

The descriptions of studies [16,20] agree on the number of professionals who noticed glove damage during the procedure, both showing that a significant minority noticed the perforation. This is consistent with the present study, which showed the same level of perception by the surgeon while operating.

A study described in the literature [16] exposes that a minimal number of professionals managed to identify which instrument used during the procedure caused the glove damage. Thus, there is agreement with the present

scientific production, which shows that most students also did not notice any type of damage. Furthermore, it was possible to evaluate that for the absolute majority, the perforation was imperceptible before donning the glove.

The current literature lacks scientific productions on the most used instruments in procedures where gloves were damaged, whether by the dental surgeon or the assistant. However, the present study obtained data on this aspect, noting that most perforations occurred in surgeries using elevators and forceps, followed by those using only the elevator and handpiece. Procedures involving only the elevator or elevator and forceps showed the same prevalence of glove damage, while the use of only forceps had the lowest damage rates.

There was agreement between studies [21,23] regarding the location of perforation, both reporting that most occurred in the index finger region, followed by the middle finger and, less frequently, the little finger. Other studies [21,22] also agree, stating that the palm is more affected than other regions, with the back of the hand being the second most affected. However, the present study disagrees with all these findings, as the highest incidence of perforation was in the thumb, totaling seven perforations (41.17%).

Two studies [22,23] demonstrated that students in more advanced periods had a higher rate of glove perforation compared to those in initial periods. The current research showed the same frequency, with students in advanced periods having more perforations, as sixth-period students had 2 (11.76%), seventh-period students 5 (29.41%), eighth-period students 3 (17.64%), ninth-period students 3 (17.64%), and tenth-period students 4 (23.52%). This may occur due to increased speed in the procedure as they are more accustomed, without emphasizing necessary precautions, as well as the increased difficulty of the procedures performed.

It was observed that the longer the surgical procedure, the higher the probability of perforation. Scientific production [23] describes that dental surgical procedures lasting over an hour are more likely to result in glove perforation. Additionally, research [24] cites that when the procedure lasted less than 2 hours, the perforation rate was 4.21%, while for procedures lasting more than 2 hours, this rate increased to 11.69%. In the present study, the approximate time of procedures varied from 25 minutes to 2 hours and 30 minutes, depending on the complexity

and number of tooth extractions. The present study agrees with this prevalence, since surgeries that took longer to perform showed a higher percentage of damage, with procedures lasting an hour or more showing 58.8% perforation, while surgeries lasting less than this showed 41.2%.

CONCLUSION

Despite the study demonstrating a considerable number of surgical glove perforations, this remains a problem that must be controlled to prevent greater harm to surgeons and assistants, as the purpose of gloves is to protect professionals during surgical procedures. The study reinforces that sterile gloves are safe when used correctly and with appropriate care. Additionally, it was noted that some gloves were already damaged from the factory, leading to inconsistencies in the perforation results during tooth extractions.

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Author's Contributions

LMMT, MESN, AJBM, JRLSJ, MABJ: Conceptualization. LMMT, AJBM, JRLSJ, MABJ: Validation. LMMT, DMBS, AJBM, HLFS, HFSN,: Writing – Original Draft Preparation. LMMT, AJBM, JRLSJ, HLFS, HFSN, MABJ: Writing – Review & Editing. DMBS, MESN, HLFS, HFSN: Data Curation. DMBS: Visualization. DMBS, HLFS, HFSN: Investigation. MESN: Methodology. MESN: Formal Analysis. LMMT, AJBM, JRLSJ, MABJ: Validation. JRLSJ, MABJ: Supervision.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjectoversight committee guidelines and

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