Original Article

The Efficacy of an Extraoral Suction Apparatus on Reduction of Splatter Contamination during Impacted Lower Third Molar Surgical Procedure: An Observational Study

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Abstract

Background: The COVID-19 pandemic has affected the delivery of dental care globally. Air contamination during aerosol and splatter-generating procedures is of great concern to dental healthcare provider during these times. Extra oral suction (EOS) apparatus has been shown to be effective in preventing infection by control of aerosol. But very limited data is available regarding the efficacy of the apparatus in preventing splatter contamination. **Objectives of the Study:** To assess the efficacy of EOS apparatus in reducing frequency and mean intensity of splatter contamination at clinician, assistant, patient sites during lower third molar surgical procedures. **Materials and Methods:** Patients who required surgical removal of an impacted lower third molar were divided into two groups (EOS and non-EOS) with 20 patients each. Universal indicating paper (UIP) was placed in specific locations on the surgeon, patient, and assistant. Colour changes after the settling of splatter on the UIP were analyzed to calculate the percentage intensity of splatter contamination. **Results:** The use of an EOS device has shown an overall reduction in the total number of contaminated sites, with a difference of 6.36%. Surgeon, patient, and assistant sites showed reductions of 6.25, 10%, and 1.66%, respectively. The apparatus has showed statistically significant reduction of splatter frequency and intensity at the patient's chest and left shoulder regions respectively, during surgical removal of the impacted 48. **Conclusion:**The magnitude of splatter contamination during minor dentoalveolar surgical procedures is inevitable. Therefore, to achieve a better working environment, usage of an EOS apparatus is advocated.

Keywords: *Aerosol-generating procedures, aerosols, extraoral suction apparatus, infection control, SARS-CoV-2, splatters*

Introduction

The COVID-19 pandemic has affected the delivery of dental care globally and has prompted the clinicians to re-evaluate the infection control protocols and bring about changes. Air contamination during aerosol and splatter-generating procedures is of great concern to patients, dental health-care providers, and others.[1] Dental aerosols are extremely fine airborne particles that are liquid, solid, or combinations of both. Splatters, in comparison, are larger in size and projectile in nature. Aerosols are generally considered more hazardous than splatters because they are more likely to remain airborne.[2,3]

The literature is still uncertain regarding the probability of transmission of viruses such as SARS-CoV-2 via an airborne route. The medical community is concerned about the possibility of iatrogenic disease transmission via aerosols and splatters during surgical procedures. It is practically difficult to avoid completely the generation of large amounts of droplets and aerosol in a dental clinic,[4] during dental restorative procedures,[5] oral prophylaxis,[6] and dentoalveolar surgical procedures such as impacted tooth removal and implant surgery.[7]

In order to prevent the contamination that occurs in the immediate vicinity, various methods, such as the use of personal protective equipment (PPE) like masks, gloves, and eye protection,[8,9] strict adherence to aseptic protocol,[10] high-level sterilization,[11] and the use of air filters,[12] are reported in the literature to reduce or eliminate the threat caused by aerosols.

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Recently extraoral suction (EOS) apparatus emerged as a novel method for preventing the spread of infection. This device is placed adjacent to the surgical field and employs negative pressure to suck in the atmospheric air along with the aerosol and splatter particles. Its proponents claim that the usage of this advanced suction apparatus significantly reduces the total aerosol count and splatter intensity during the aerosol-generating procedures.[13,14] All EOS devices feature a vacuum motor, an arm with articulation with the ability to bring the vacuum close to the operative site, and a built-in, high-power blower that pushes air through a series of filtration units including HEPA filtration, and some have included UVC lighting for air sterilization. Therefore, the use of these suction apparatus in minor dentoalveolar procedures can effectively limit airborne contamination that results from the operating field.[15,16] However, there is a scarcity of literature regarding the efficacy of extraoral suction (EOS) apparatus in preventing splatter contamination. This study was undertaken to assess the efficacy of an extraoral suction device on the reduction of splatter contamination during impacted lower third molar surgical removal procedures in a closed setting.

Materials and Methods

This was a prospective, single-center study conducted in a tertiary health-care university in Kerala, India. This study conforms to the Declaration of Helsinki on medical protocol and ethics and was approved by the Institutional Ethics Committee (ECASM-AIMS-2021-196/23-02-2021).

This study evaluated the exposure to contaminated splatter at various operatory sites during an impacted lower third molar surgical procedure. A larger sample size was not achievable because of the pandemic. Hence a small sample size of 40 patients who required surgical removal of impacted lower third molar, were selected for the study. They were allocated randomly (envelope method) to Group A (EOS) and Group B (non-EOS). All surgical procedures were carried out using citric acid (10%) added to the irrigating solution (normal saline, 0.9%), with universal indicating paper (UIP) fixed on the following 11 specific locations in the operatory sites: surgeon (surgeon head, surgeon visor, surgeon chest, and surgeon L shoulder), patient (patient head, patient chest [PC], patient R shoulder, and patient L shoulder), and assistant sites (assistant visor, assistant chest [AC], and assistant abdomen). For the Group A cases, the EOS apparatus was used throughout the procedures. The device was consistently placed in the 4 o'clock position, 15–20 cm from the central incisors, with the arm of the device positioned between the patient and the assistant [Figure 1]. The EOS machine was not used in group B.

All the contaminated, chromatically changed UIP papers were removed and transferred for image analysis (color thresholding in MATLAB software) without delay [Figure 2]. Maximum intensity (the highest percentage coverage of a single UIP), mean intensity (average coverage of all contaminated UIPs), and frequency (n = number of contaminated UIPs) were recorded. Statistical analysis was done by IBM Statistical Package for the Social Sciences (SPSS) software version 20 (Armonk, New York). The percentage intensity between the groups was compared using Mann–Whitney test. The reduction in frequency of splatter contamination at various operatory sites between the groups was compared using Chi-square tests.

Results

Among 40 patients, 22 were female and 18 were male, with a mean age of 32.25 ± 11.57 years in the case group (A) and 29.25 ± 6.41 years in the control group (B). Out of 220 sites in the control group, 69 sites were contaminated (31 [80] surgeon sites, 28 [80] patient sites, and 10 [60] assistant sites). The corresponding value for the case group was 55 out of 220 sites (26 [80] surgeon sites, 20 [80] patient sites, and 9[60] assistant sites). The use of an EOS device has shown an overall reduction in the total number of contaminated sites, with a difference of 6.36%. Surgeon, patient, and assistant sites showed reductions of 6.25, 10%, and 1.66%, respectively [Table 1].

Figure 1: Operatory site with extraoral suction apparatus

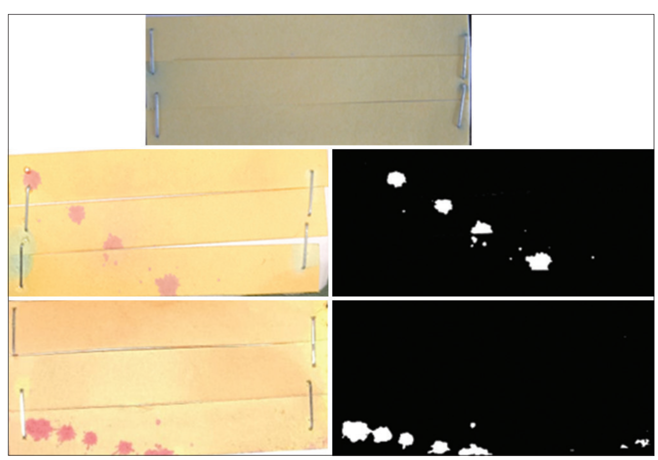

Figure 2: Contaminated universal indicating paper's and image analysis

Table 1: Percentage mean difference in frequency of contamination between procedures with and without extraoral suction

Result for each site	Without EOS	With EOS	Difference	Reduction (%)
Mean frequency of surgeon sites contaminated (*n*)	31 (80)	26 (80)	5	6.25
Mean frequency of patient sites contaminated (*n*)	28 (80)	20 (80)	8	10
Mean frequency of assistant sites contaminated (*n*)	10 (60)	9 (60)	1	1.66
Total sites contaminated	69 (220)	55 (220)	14	6.36

EOS: Extraoral suction

Table 2: Frequency, mean intensity, and maximum intensity of vulnerable sites

	Vulnerable site	Frequency (%)		Mean intensity (% coverage)		Maximum intensity (%)	
		Case	Control	Case	Control	Case	Control
Surgeon	Chest	40	55	0.73±1.35	0.60±1.44	4.8	6.1
Patient	Chest	30	65	0.72±1.17	2.3±5.09	2.9	22.1
Assistant	Abdomen	20	30	0.02±0.06	0.19±0.50	0.24	2.18

Table 3: Maximum splatter intensity site wise

	UIP location	Maximum intensity (Control group) (%)	Maximum intensity (Case group) (%)
Surgeon	Head	1.16	4.6
	Visor	26.7	17
	Chest	6.1	4.8
	Left shoulder	26.02	4.13
Patient	Head	0.77	5.59
	Chest	22.1	2.9
	Right shoulder	2.96	4.9
	Left shoulder	1.94	0.72
Assistant	Visor	0.93	0.12
	Chest	0.70	4.9
	Abdomen	2.18	0.24

UIP: Universal indicating paper

Surgeon's chest is the most vulnerable site for splatter contamination (40% in the case group and 55% in the control group). In the case group, the mean intensity was 0.73 ± 1.35% and the maximum intensity was 4.8%. The corresponding figure infers that – In the control group, the mean intensity of splatter contamination on the surgeon's chest was 0.60 ± 1.44% and maximum intensity was 6.1% [Table 2].

The surgeon's head and visor were the next most splatter-prone areas, with a frequency of 35% each in the case groups. The splatter contamination in the surgeon's head region had a mean intensity of 0.55% ±1.21% in the case group and 0.26% ±0.39% in the control group, while the visor region had a mean intensity of 2.26% ±5.02% in the case group and 1.89% ±6.13% in the control group. Assistant sites were the least contaminated, with the AC region showing the highest intensity of 4.9% in the case group and 2.18% in the control group [Table 3].

Considering $P < 0.05$ to be statistically significant, analysis of the splatter contamination indicated that there was a statistically significant reduction ($P = 0.027$) in the frequency of contamination in the patient's chest region and a mean intensity reduction in splatter at the patient's chest and left shoulder during surgical removal of the impacted 48 with the EOS device; however, the numerical and percentage difference in various other sites was not statistically significant.

Discussion

Many routine dental health-care procedures involve the use of high-speed rotary devices which are employed for trimming, shaping, or removal of hard tooth material (enamel and dentin) or alveolar bone. The contact of these high-speed instruments with hard tissue creates a large amount of heat, necessitating the use of coolant solution to minimize the potential thermal damage to adjacent vital tissues (pulp, periodontal ligament, and alveolar bone). The continuous irrigation of those coolants in the highly dynamic field creates droplets containing saliva, blood, and irrigating solution. Depending on the size of the droplet and the type of spread into the air, these droplet groups have described as aerosol and splatter. Typically ultra-speed airotor device (>100,000 rpm) used for cutting enamel and dentin, produce very tiny particles, creating an aerosol.[17] The low-speed micromotor devices (25,000–40,000 rpm) utilized for bone removal and tooth sectioning, produce a large size practices known as splatters.

Medical professionals get exposed to blood-borne illnesses due to splatter contamination during the various surgical procedures. Depending on the surgical specialization, the prevalence rate of these occupational infections ranges from a few percent in general surgery to over 30% in the disciplines of gynecology and orthopedic surgery.[18,19] An investigation done by Collins *et al*., on orthopedic procedures using high-speed instruments revealed that 86% of the surgeons had blood on their visor masks.[20] High-speed rotary instruments are crucial for oral and maxillofacial surgery techniques, such as placing osteotomy cuts, in fracture fixation, and tumor removal involving the jaw, in addition to orthopedic surgery. They are also used in cases of minor oral surgery, like the outpatient dentoalveolar procedures such as removal of an impacted mandibular third molar, implant surgeries, etc.[21]

This is the first known clinical study to evaluate the efficacy of an EOS apparatus' on the reduction of splatter contamination during minor oral surgery. We have added citric acid (10%) to the irrigating solution (normal saline, 0.9%), during impacted lower third molar surgical procedure, with UIP placed in specific locations in the operatory. We evaluated the frequency and intensity of splatter/droplet creation during the procedure, for assessing the use of the EOS device. In our study, all procedures were done by under strict aseptic surgical protocols. This included sterile reusable gown, sterile gloves, visor, goggles, head cap, and shoe cover for the oral surgeon, and the dental assistant. The patients wore a head cap and chest drape. The total time taken during the procedure was 42.95 ± 5.577 for the EOS group and 40.75 ± 8.168 for the non-EOS group. (P = 0.415), even though no statistically significant difference was noted between the groups, in all the procedures the time exceeded more than 20 min, hence a greater amount of splatter was noted in both groups and the chance of contamination increased. Ishihama *et al*. have noticed that even if the procedure required < 10 min to carry out, the surgeon was potentially exposed to blood. In our study, both group's surgeon and patient received varying levels of contamination during the procedure, whereas the number of contaminated regions in the assistants is very low in both groups.[21]

Surgeon's chest is the most vulnerable site for splatter contamination (40% in the case group and 55% in the control group) in our study, with a mean intensity of 0.729 ± 1.347% in the case group and 0.605 ± 1.441% in the control, with a maximum intensity of 4.8%, 6.1% in the case and control groups, respectively. These findings are consistent with a stimulatory study[14] where the clinician's chest was the most commonly contaminated site (n = 27) at an average distance of 0.3 m, with a mean intensity of 3.72% and a maximum intensity of 24.52% during surgical sectioning of the 37 and 38 compared to any other procedure. The surgeon's head and visor were the next-most often splatter-prone areas, with the frequency of (35% in case group [forehead region], 40% in control group, and 35% in case group [front visor region], 30% in control group). Assistant sites were the least contaminated, with the AC region showing the highest intensity of 4.9% in the case group and 2.18% in the control group. In the simulatory study,[14] the front of the visor was the second-most frequent site.

Data from the splatter contamination indicated that there was a numerical reduction in the frequency of contamination in patient's chest and percentage reduction in splatter at PC and left shoulder during surgical removal of impacted 48 with the EOS device; however, the numerical and percentage difference in various other sites was not statistically significant. The factors such as patient compliance, inclination of the teeth, side of the teeth, and expertise of the operator and experience of the assistant affect the total duration of the procedure, especially the bur time (time spent on cutting or trimming hard tissue). In this study, the bur time remained almost the same for both groups. Since the same set of operators and assistants have performed the procedure in both groups, the variations get nullified. The positioning of the EOS device (4 o'clock), the side of the impacted tooth removal (right), and the direction of irrigation by the assistant could have affected the reduction in the mean intensity of splatter at the patient's chest and left shoulder.

The frequency and mean intensity of splatter contamination at various sites (surgeon, patient, and assistant sites) were not statistically significant between the groups. These results support the first *in vivo* study conducted by Desarda *et al*.[22] evaluating the effectiveness of a high-volume evacuator in a piezoelectric ultrasonic scaling procedure without any modification to simulate the clinical scenario. Previous experiments on the EOS machine for oral surgical procedures[14] were conducted entirely in a simulation setup, where patient factors such as saliva, soft tissues, etc., don't exist.

The limitation of this study is that only splatter contamination has been evaluated at this stage with no aerosol detection (quantity of aerosol generation in environment) or microbial counts (bacterial contamination). Furthermore, the color of the non-contaminated UIP may have contained different shades of red that may or may not have been detected during analysis. Other minor oral surgical procedures, such as the surgical removal of broken root stumps, implant osteotomies, and multiple other impacted tooth procedures, have not been compared in this study. It is also to be taken into consideration that surgeons and assistants would adopt various positions for various patients under various operating circumstances. Due to the particles parabolic nature of the larger particles, it is also noted that the height at which the patient was lying down may have an effect on how far they traveled.

The findings of this investigation made it quite evident that no major benefit is accrued by the use of EOS for control of splatter. Due to its high kinetic energy and the fact that it moves against the air stream, splatter pollutes the environment and cannot be effectively removed by an extraoral device. As a result, in addition to general barrier measures, other strategies for reducing splatter contamination should be taken into account.

The increase in number of samples and sites of UIP paper, documentation of environmental aerosol counts after various oral surgical procedures in open and closed practices, findings of microbial growth (colony forming unit) in various sites of operatory, use of various other commercially available EOS devices could provide us with extensive solid data and benefit the society in future.

Conclusion

The magnitude of splatter contamination during minor dentoalveolar surgical procedures is inevitable and is determined mainly by the speed of rotary devices, amount of irrigation, duration of the procedure. The EOS devices in the market reduce the splatter contamination to a certain extent. Therefore, to achieve a better working environment in these COVID-19 times, along with PPE, strict aseptic protocol, and advanced sterilization, proper usage of an advanced EOS apparatus is advocated. It is advisable to design an equipment which is simple, affordable, and effective alternative for reducing splatter contamination.

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Conflicts of interest

There are no conflicts of interest.

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