Blood spatter in oral surgery
Prevalence and risk factors

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ABSTRACT

Background. Oral surgeons are exposed to blood spatter. The authors evaluated the prevalence of and risk factors for blood spatter in facial masks during oral surgery procedures.

Methods. The authors evaluated facial masks and caps of oral surgeons and assistants for blood spatter using the Kastle-Meyer test after different oral surgery procedures. The authors correlated the presence of blood spatter to the clinician, type of surgery, surgery time, and self-awareness of blood spatter, using $\chi^2$ and $t$ tests.

Results. The authors analyzed a total of 202 samples and detected blood particles in 46% of the samples in both operators and assistants. The authors observed blood contamination in all types of procedures, and in 4% of the cases, the internal part of the visor was also affected. Clinicians were unaware of the presence of blood spatter in 40% of the cases.

Conclusions. The risk of clinician contamination with blood during tooth extraction and implant placement was 46%. The risk increased with the use of high-speed instruments and longer surgery time.

Practical Implications. The use of facial protective devices should be mandatory during oral surgery procedures to avoid blood contamination, especially when rotary devices are used. In many cases, imperceptible blood spatter is present.

Key Words. Cross infection; occupational exposure; personal protective equipment; eye protective devices; respiratory protective devices; blood spatter; oral surgery; dental implants; Kastle-Meyer test.

Dentists are exposed to multiple occupational infectious diseases. Many dental procedures produce aerosols and fluid splashes, which contain blood or saliva. In oral surgery, owing to the constant use of rotary instruments and irrigation, both the operator and assistant are exposed to contaminated aerosols and blood spatters, with the inherent risk of experiencing transmission of infectious diseases. Hepatitis B virus (HBV), hepatitis C virus (HCV), and HIV are some of the most common concerns, although the transmission of pathogens via blood is infrequent in the dental field. The risk of experiencing HIV seroconversion after professional exposure to blood is 0.2% through 0.3% in the case of parenteral exposures and 0.1% or less in the case of mucous membrane exposures. Despite this low risk of experiencing disease transmission through contact with mucous membranes, other infectious diseases such as influenza might put clinicians and patients at risk. Moreover, HBV and HCV can persist and survive on surfaces and devices contaminated with blood for at least 1 and 6 weeks, respectively. The use of protective measures and devices such as gloves, masks, eye protection, HBV vaccination, hygienic handwashing, and disinfection and sterilization of dental equipment should be mandatory to optimize safety and avoid any kind of transmission, as specified in the Occupational Safety and Health Administration Bloodborne Pathogens Standard and in the Centers for Disease Control and Prevention recommendations. Also, precautions should be taken when removing facial protective devices.
In medicine, the need for operators and assistants to use facial protection during surgery owing to
the presence of blood in safety devices, especially those protecting the eyes, has been
confirmed. Ocular protection and masks significantly reduce mucosal exposure, although without
fully eliminating it. Knowledge of the degree of protection provided by the different devices allows
for better selection of the best option in safety terms.

Owing to the lack of information on this topic in regard to oral surgery, we conducted a study
with the aim of determining the prevalence of blood particles on masks with visors and surgical caps
in oral surgery procedures and establishing the main risk factors for blood spatter.

METHODS
From March through May 2019, we screened a total of 108 surgical procedures performed by res-
dients in the master's degree program in oral surgery and orofacial implantology at the University of
Barcelona in Barcelona, Spain, for blood spatter on the faces of the surgeon and assistant. The
institutional review board of the Dental Hospital of the University of Barcelona approved this study
(protocol 2017/30). We selected oral surgery procedures performed in this center under local
anesthesia and requiring the use of rotary instruments. Before each surgery, the surgeon and assistant
received a new facial mask with a visor and disposable cap (Figure 1). After fitting the masks, the
surgeons scrubbed their hands and arms and dried them with sterile towels. After that, they put on
sterile disposable surgical gowns and gloves. Once the surgical procedure was finished, both the
surgeon and the assistant changed their gloves for new clean ones before removing the facial
protective devices and handed them to a single investigator (L.A.-D.), who inspected the devices
using nonsterile clean gloves. The same investigator retrieved the following data:

- arterial hypertension, antplatelet, or anticoagulant therapy;
- the use of rotary instruments (for tooth extraction, high-speed air-turbine handpiece with water
cooling or low-speed electric straight handpiece with external cooling using a syringe; for implant
placement, electric contra-angled handpiece with saline cooling incorporated in the handpiece);
- type of procedure (extraction of impacted or erupted teeth or dental implant placement);
- duration of the procedure, excluding the anesthesia onset time.

Both the surgeons and assistants were asked whether they were aware of receiving any blood
spatter during the surgical procedure.

The same investigator visually screened the masks and the caps for the presence of blood and
counted the number of splashes at each site. Only red droplets were considered to exclude other
types of spatters.

Once visually inspected, the investigator used the Kastle-Meyer test to detect blood. The Kastle-
Meyer test is a forensic test that uses phenolphthalein to detect the presence of hemoglobin.
Positive detection is evidenced by a bright pink color. Figure 2 shows a paper filter with a positive
Kastle-Meyer test result. Studies comparing different systems to reveal blood have found that
phenolphthalein is one of the best tests to use to detect blood spots. It is positive at a dilution of

Figure 1. Facial mask with visor and a disposable cap used by the surgeons and assistants during the study.

ABBREVIATION
KEY
HBV: Hepatitis B virus.
HCV: Hepatitis C virus.
1:100,000 and can be used with dry blood, as its sensitivity does not differ between wet and dry blood samples. The investigator rubbed the inner and outer sides of the facial masks and the outer side of the caps with a paper filter. Then the investigator applied 2 drops of Kastle-Meyer reagent to the paper filter and, after 5 seconds, added 2 drops of 6% hydrogen peroxide. The immediate presence of bright pink was observed if there was blood. Once analyzed, the samples were properly discarded.

To validate the Kastle-Meyer test, the investigator tested 2 clean paper filter with the Kastle-Meyer procedure before starting as negative controls.

Statistical analysis

We performed a bivariate analysis using $\chi^2$ tests and $t$ tests. We performed a nonconditional binary logistic regression analysis to assess the effects of pre- and intraoperative variables on spatter risk. We considered a $P$ value of less than .05 as statistically significant.

RESULTS

We collected a total of 216 sets of caps and facial masks (from 108 surgeons and 108 assistants) from 108 procedures. We analyzed 14 sets from 7 surgeries separately because those procedures did not require the use of any rotary instruments. Of the remaining 202 samples, 93 (46%) proved positive for blood. Table 1 summarizes the presence of blood and the mean number of droplets in each part of the samples with visual inspection and with the Kastle-Meyer test. Visual inspection revealed greater blood spatters on the external part of the visors, followed by the masks and minimal splashes on the caps (Figure 3). The Kastle-Meyer test detected blood in 28% of the samples (95% confidence interval [CI], 25.1% to 30.6%) that were classified as negative via visual inspection. In 8 samples (3.96%), the test detected blood in the internal part of the visor, 4 of them linked to the use of a high-speed air-turbine handpiece (3 samples from surgeons and 1 sample from an assistant) and the other 4 linked to the use of a low-speed electric straight handpiece (all of them from surgeons). Preoperative and intraoperative variables and their association to blood detection are summarized in Table 2. We found blood splashes more often from surgeons, although assistants also had positive samples. The use of a high-speed air-turbine handpiece produced the highest percentage of blood splash (77.3%), followed by a low-speed electric straight handpiece (45.6%), and a contra-angle handpiece 20:1 for implant placement (31.8%). Procedures beyond 30 minutes were more prone to have blood contamination. Forty percent of the clinicians were unaware of blood spatters. The percentage risk of experiencing contamination was not significantly higher in patients receiving antiplatelet or anticoagulant therapy (50%; 95% CI, 46.6% to 53.4%; $P = .910$) or in patients with arterial hypertension (65%; 95% CI, 61.9% to 68.1%; $P = .073$).
Seven extractions did not require rotary instruments and were not included in the analysis, although we processed them in the same way as the rest. In these extractions, we detected blood in 3 of 14 sets (21.43%, 95% CI, 19.1% to 23.8%).

**DISCUSSION**

The presence of blood spatter during oral surgery procedures with rotary instruments implies a risk of experiencing accidental exposure to blood among dentists. Our study aimed to evaluate
the risk of experiencing blood spatter in the masks, the external and the internal part of the visors, and the caps of clinicians after surgical tooth extractions and dental implant placement. We found blood contamination in almost one-half of the cases (46%; 95% CI, 52.9% to 39.2%), with surgeons' being more exposed. However, one-quarter of the assistants also tested positive for blood splashes, which underscores the need for all clinicians involved in oral surgery to wear appropriate protective devices and cover their entire faces and hair properly. Facial masks and caps considerably reduce the risk of experiencing blood contamination but do not totally exclude the possibility of blood particles reaching the face of the professionals. Our study revealed that the use of a visor did not seem to guarantee total eye protection, as 8 samples (4%) had blood contamination in the internal part of the visor. These data are similar to those obtained from dermatologic surgery. On the basis of this finding, it would be advisable to reduce the gap between the forehead and the visor with a flange or to wear hermetic surgical glasses.

The external part of the visors and the masks had the highest amount of blood spatter, being slightly greater in the ocular area. In our study, 38% of the visors were contaminated. Edmunds and Rawlison found similar blood contamination in dentist glasses in periodontal treatments. However, 33% of the masks had blood spatters, although in approximately one-half of the cases, these were only observed after using the Kastle-Meyer test. Surgical masks were originally developed to contain and filter droplets expelled from the mouth and nasopharynx of health care workers to protect the patient. Dental professionals should ensure that their surgical masks are resistant to fluids and that they are changed after each surgery or earlier if they get wet. Failure to do so means an increased risk of experiencing cross contamination. Considering that 8% of the caps in our study had blood spatters and that some viruses can persist and survive for a long time on contaminated devices, the use of disposable caps seems advisable.

The Kastle-Meyer test was the forensic test we used to identify undetected blood. It has been used in previous studies in the dental field to evaluate the effectiveness of cleaning and disinfection protocols for instruments and surfaces after their clinical use but for facial protective devices in oral surgery. The use of this test allowed us to identify blood particles that were unnoticeable in simple visual assessment in 28% of the samples.

Both surgical tooth extractions and implant surgery were associated with a high risk of experiencing blood contamination. Air-turbine handpieces produced the most widespread and frequent blood splash (77.3%), probably owing to the air and water that form an aerosol. This outcome is particularly relevant because such instruments are commonly used in many dental treatments. Low-speed electric straight handpieces caused blood spatter in 46% of the impacted tooth extractions. Ishihama and colleagues performed impacted mandibular third-molar extractions with a low-speed handpiece in 25 patients and found blood contamination in almost 90% of the procedures. This rate is higher than that recorded in our sample, probably because Ishihama and colleagues tested not only the masks but also the surgical gowns. We found that implant surgery was significantly cleaner than tooth extractions. This was probably related to the low working speed and the fact that external irrigation was incorporated in the handpiece, whereas low-speed straight handpieces used in tooth extraction were irrigated externally with a syringe, thus increasing the risk of creating spatter. Another variable that should be included in future studies is the position of the patient during surgery, because this might increase or decrease the risk of experiencing blood contamination.

Forty percent of the clinicians with positive blood contamination did not notice the intraoperative blood spatter, which means that clinicians might be underestimating the risk of experiencing contamination.

The analysis of 14 simple tooth extraction samples also revealed some blood particles (21%). This probably indicates that spatter was not only a consequence of the use of rotary devices. Other surgical steps like luxation and curettage can also cause spatter, so face and eye protection are mandatory in all types of surgical procedures.

Finally, taking into account the risk of developing mucocutaneous infectious diseases in oral surgery, the use of protective barriers serves to reduce occupational exposure. It is critical to intensify education in the field of prevention of occupational hazards in the context of the dental degree, because there is a higher prevalence of accidental occupational exposure among dental students compared with more experienced dentists and surgeons.
CONCLUSIONS

Surgical tooth extractions and implant placement frequently produce blood spatter that can affect surgeons and assistants. The risk of experiencing blood contamination increases with the use of air-turbine handpieces and in surgeries that take more than 30 minutes. Masks with a visor do not guarantee total eye protection, given that some samples had blood in the internal part of the visor.

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