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What's new for the clinician– summaries of recently published papers

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Prof V Yengopal, Dean, Faculty of Dentistry, University of the Western Cape

1. Simulated and clinical aerosol spread in common periodontal aerosol-generating procedures (AGPs)

Particles, particularly aerosols, and splatter generated during routine dental procedures have been shown to have the potential to transmit the SARS-CoV-2 virus to patients. Thus, controlling the spread of aerosolized particles has become one of the core strategies for reducing occupationally acquired infections with the SARS-CoV-2 virus[1]. The World Health Organization (WHO) defines splatter as particles greater than 100 µm in size, droplets as particles between 5 and 100 µm in size, and aerosols as particles smaller than 5 µm. [1]

Dental procedures generate particles that are a mixture of saliva, blood, water coolant, plaque, gingival crevicular fluid, tooth hard tissue debris, calculus, and dental restorative materials that generate potential hazards to dental professionals.[1]The extent and spread pattern of common dental AGPs need to be identified before applying mitigating strategies.

Some prevention measures have been are proven to significantly reduce splatter or aerosol spread such as medium-volume suction (159 L/min), high volume suction (HVS) [>250 L/min] and mechanical extraction.

Puljich and colleagues (2022)1 reported on a study that sought assess the distribution of particles following common dental AGPs in an in vitro setting with and without HVS and determine the particles spread during non-surgical periodontal treatment for 19 patients using an ultrasonic scaler in a clinical setting.

MATERIALS AND METHODS

This study explored the generation and spread of particles created by dental AGPs in both simulated laboratory and clinical environments.

The Simulation study was carried out in a 25 m^2 room which had 7 air changes per hour and was located within a PC2 laboratory. A phantom head mannequin containing typodont teeth in both jaws was used. Mock dental procedures were performed on the mandibular right central incisor (tooth 41). Fluorescein sodium salt was added to the water coolant reservoirs of dental devices at a final concentration of 1 mg/mL (approximately 3.0 mMol/L) as a tracer dye to track particle travel. To prevent bias, one periodontist trainee performed all the simulated and clinical experiments.

The following dental devices were used for the mock periodontal AGPs:

- An ultrasonic piezoelectric scaler (EMS Piezon) was used at intensity setting 10 and water flow rate at 48 mL/min, with a scaler tip of type PS. For the experimental protocol, the scaler tip was positioned adjacent to the lingual surface of tooth 41.
- An air polisher device (EMS Air Flow Prophylaxis Master), was used at an air pressure setting of 3 (1.9 Bar), with a water flow setting of 70% at 53 mL/min. The abrasive particles were 14-µm erythritol powder. The tip of the air-polishing device was located 3–5 mm from the buccal aspect of tooth 41, at an angle of approximately 45 degrees, with the spray aimed towards the incisal edge.
- A 2.2-mm diameter dental implant osteotomy drill (Straumann) was used in a 20:1 reduction handpiece at 200 revolutions per minute. The water coolant flow rate was 100 mL/min. For this experiment, tooth 41 was removed from the typodont model and the implant drill was placed at 2 mm along the imaginary line joining the incisal edges of the 31 and 42 teeth.

Each device was tested without suction to establish baseline data and then once again using intra-oral high-volume evacuation (Aspi-Jet 6) with an airflow of approximately 325 L/min. The suction used was comparable to HVS used in the clinical setting. The evacuation tip was held approximately 10 mm from tooth 41, favouring the left side of the mannequin. For the ultrasonic handpiece, the procedure was carried out for 10 min, while the air-polishing and implant surgical drill procedures lasted 2 min each to mimic a real clinical scenario. For the air-polishing device, the suction tip was placed adjacent to the point on the tooth where the powder made contact. Each AGP was

Prof V Yengopal: *BChD, BScHons, MChD, PhD*, Dean, Faculty of Dentistry, University of the Western Cape, South Africa.
ORCID Number: 0000-0003-4284-3367
Email: vyengopal@uwc.ac.za

repeated 10 times for each scenario (without or with HVS). Before each procedure, pieces of filter paper measuring approximately 150 mm × 150 mm were placed in five different locations around the phantom head. Location 1 represented the dentist's position located 20 cm away from the center of the mouth in the longitudinal plane. Location 2 was located 15 cm away from the mouth, at a 90° angle to the left, to mimic a dental assistant. Location 3 was 22 cm in front of the mouth mimicking the patient's chest, while location 4 was mimicking a location further along the patient body at 60 cm away from the mouth. Location 5 was mimicking a distant site away from the procedure 120 cm away from the center of the mouth on the left side of the patient at a 60° angle. Immediately after each cycle, the filter paper was imaged for splatter, droplets, and aerosols. The filter paper locations were cleaned thoroughly at the end of each testing run, and a minimum waiting period of 30 min used between testing cycles to prevent residual effects of airborne contamination.

The five locations of the filter paper strips were used to collect in vitro splatter, droplets, and aerosols in a laboratory setting with and without HVS. Location 1 reflects the dentist's upper chest and face mask, location 2 reflects the dental assistants' forearms and body, location 3 represents the upper portion of the patient's chest, location 4 represents the patient's body, location 5 represents the dental chair/suction unit.

Filter paper sheets were scanned using a fluorescence imaging system. Images were analyzed using Fiji-ImageJ software to determine the diameter of the tracer particles.

For the clinical component of the study, a total of 19 patients attending the postgraduate specialist periodontal clinic were invited to participate in the study. Written consent was obtained from the participants with the following inclusion criteria:

1. ≥ 18 years old;
2. able to provide consent for enrolment in the study;
3. self-reported stable general systemic health;
4. ≥ 20 teeth (excluding third molars);
5. patients requiring supragingival debridement with an ultrasonic scaler.

Exclusion criteria were (1) immunosuppression; (2) antibiotic therapy within the proceeding three months; (3) uncontrolled medical conditions; and (4) long-term use of anti-inflammatory medications.

The study was performed by one periodontist trainee in three dental operatories each measuring approximately 15 m^2 with 7 air changes per hour. Each room had delivery air outlets and return air collection on the ceiling. Prior to each patient appointment, all hard surfaces on the dental chair and throughout the operatory were cleaned as part of standard infection control procedures.

Approximately 1 mL of unstimulated whole saliva was collected at the beginning of the appointment by asking the patients to expectorate pooled resting saliva into a sterile Falcon tube. Following the Australian Dental Association guidelines for the COVID-19 pandemic, pre-procedure mouth rinse and high-volume suction were applied to all visiting dental patients. Fifteen millilitres of hydrogen peroxide 1.5% w/v (Colgate Peroxyl) was used for each patient to rinse for 30 s prior to the ultrasonic scaling. Aerosols, droplets, and splatter generated during the ultrasonic scaling were collected on pieces of filter paper that were placed at nine locations: Two on the patient protective sheet, either side of the midline in the upper chest area; Two on the dentist, on either side of the midline in the upper chest area; Two on the dental assistant, on either side of the midline in the upper chest area;

One on the dental bracket tray table attached to the dental chair; One on the suction unit of the dental chair; One on the bench, approximately 1.5 m to the right of the patient; Negative control (NC): one filter paper was not exposed during the appointment and acted as a negative control. Thus, each patient has their own NC as a background to compare; and Whole saliva from each patient was used as a positive control.

Each patient underwent supragingival ultrasonic scaling for 10 min using the piezoelectric scaler built into the dental unit. The scaler was operated on a power setting of 9 with 80 mL/min of water flow rate, using a fine ultrasonic scaler tip.

After this time, the filter paper strips were collected using fresh gloves and placed into tubes. Within 10 min, the strips were placed in a – 80°C freezer located in an adjacent PC2/BSL2 laboratory and then kept frozen. At the end of the clinical procedure, hard surfaces on the dental chair and throughout the operatory were again decontaminated using standard infection control procedures. There was a minimum of 60 min between patient appointments, which allowed for 7 air changes in the room. The dental team donned new protective gowns, masks, and gloves for each patient.

The protein content of each filter paper was determined from samples incubated at 37°C for 30 min with the test reagent. There were two aspects of data analysis: (a) bioaerosol contamination at each location for each patient was estimated based upon the protein quantity at that location and the protein concentration of the patients' original whole saliva sample; (b) the values higher than their NC background were considered to represent contamination.

RESULTS

In vitro simulated splatter generation with and without HVS
During 10 min of using the ultrasonic scaler on a mandibular incisor tooth, HVS reduced splatter particles for all three types of devices. Locations 2 and, to a lesser extent 1 were the most spread sites for all three equipment types. The 2-min air polisher generated more splatter particles compared to a 10-min ultrasonic scaler procedure, while the 2-min implant drill led to the least splatter liquid particles. The number of particle numbers was quantified by measuring the percentage of the total area of each filter paper. HVS reduced the extent of spread for all three dental AGPs. The distribution of particle size at the five locations exhibited median values larger than 200 µm, consistent with splatter spread (large droplets). Particle numbers and distributions were measured for each location. A significant benefit for the use of HVS was seen with all devices at location 2, as well as for the ultrasonic scaler at location 4. Particle histogram patterns at all five locations demonstrated that HVS did not alter the median size of splatter particles.

Aerosol and droplet particles at 120 cm away from the source with and without HVS – in vitro

The aerosols and droplets that were retained on filter paper fibers were captured at 120 cm from the source (location 5) after 10 min of the ultrasonic scaler and 2 min of air polisher and implant drill (Fig. 4a). Small particles (0.7 to 100 µm in diameter) were detected, whether or not HVS was used, indicating a mixture of aerosols and droplets (Fig. 4b). The ultrasonic scaler produced the highest number of particles that were 5 µm in median diameter or less. The use of HVS reduced particle quantity for all three devices.

Analysis of the average particle count and the percentage coverage of the total area for a mixture of aerosol and droplets revealed that HVS significantly reduced 82.6% and 93.8% of small particles at location 5 for both the ultrasonic scaler and the air polisher. The same was found for a separate analysis of aerosol and droplet particles.

Taken together, the in vitro simulated studies demonstrated that the air polisher generated most splatter particles and the use of HVS significantly reduced the spread of splatter, droplets, and aerosols for ultrasonic scaler and air polisher.

Bioaerosol contamination in a clinical setting during routine periodontal supragingival scaling

Whether bioaerosol spread can generate hazards to dental health professionals in a clinical setting was examined. A total of 19 patients (1 healthy – BOP < 10%; 3 gingivitis - BOP > 10 % and 15 periodontitis – 2 × stage 1, 10 × stage 3, 3× stage 4) requiring supragingival calculus removal as part of their dental care were recruited, thus generating a total of 190 clinical (filter paper) samples and 19 saliva samples.

The clinical study included 9 females and 10 males, aged 63.3 ± 13.2 years old (ranging from 35 to 80 years old) with one smoker. The average PPD for all patients ranged from 2.34 to 3.27 mm, with an average of BOP of 18% ± 12.2% (ranging from 4 to 44%) and PI of 22.9% ± 11.3 % (ranging from 2 to 42%). For periodontitis patients, 2.42 ± 3.06 sites had a deep periodontal pocket that is ≥ 5 mm (ranging from 0 to 13).

Samples were eluted from filter paper strips placed at 9 different locations. Compared to each patient's background (NC filter paper), protein quantification at each location showed that only 10.5–21.1% of patients generated bioaerosol protein contamination beyond the relevant negative control sample for each patient. The extent of protein contamination at each location varied between patients and was not influenced by periodontal health status.

CONCLUSIONS

The in vitro simulated component of the study showed that the air polisher produced the largest amount of splatter particles, while the ultrasonic scaler generated the largest amount of aerosol and droplet particles at 1.2 m away from the source. The use of HVS reduced up to 96 % of splatters and 93% of aerosol and droplets spread. Additionally, supragingival ultrasonic scaling did not produce significant amounts of bioaerosol contamination in the majority of clinical cases.

Implications for practice

the importance of using HVS during AGPs was highlighted by the results of this study

REFERENCE

1. Simulated and clinical aerosol spread in common periodontal aerosol-generating procedures

2. Influence of radiotherapy on dental implants placed in individuals before they were diagnosed with head and neck cancer

More than 700 000 people are diagnosed with Head and neck cancer (HNC) every year[1]. Common modes of treatment include surgery, radiotherapy (RT) and chemotherapy which is used alone, in combination or concurrently. Both surgery and RT have side effects that often result in changes in the anatomy of the oral and maxillofacial region, which makes it difficult to repair dentition defects or to substitute missing teeth using conventional restorations. To further complicate this problem, most HNC patients require dental restoration replacement due to tumor resection or tooth extraction prior to radiation therapy1. Importantly, dental implants and prosthetic restorations are an effective way to rehabilitate teeth defects and missing dentition, and these interventions can substantially improve oral health and the quality of life of HNC patients. [1]

Published studies of dental implants placed in irradiated bone have reported success rates as high as 100% success after 1–5 years of placement. However little is currently known about the influence of radiation on dental implants placed before HNC diagnosis.

Modern radiotherapy techniques can treat the individual target volume with a high conformal dose distribution and a steep dosage gradient, which means the radiation dose varies substantially across organs and tissues of interest. [1] Li and colleagues from China (2022)1 reported on a study that sought to investigate the influence of implant-bed-specific radiation dose on dental implants and to evaluate the impact of these implants on radiation dosimetry among patients who had dental implants and were later diagnosed with HNC.

MATERIALS AND METHODS

A retrospective study was conducted with 8931 patients who had received radiation therapy (RT) over the previous 10 years between 2011 and 2020. Patients who had dental implants and who had radiotherapy at the study hospital in China between January 2011 and December 2020 were included. Patients who had dental implants placed after the radiotherapy treatments were excluded.

Information collected included demographic variables (sex, age) and health status (tumor location, tumor site dose, and chemotherapy treatment). Implant information per patient included the total number of implants and the implant site.

To accurately evaluate the implant-bed-specific irradiation doses for each implant, the researchers used the treatment planning systems Monaco® and ARIA® to import and register each scan. In all patients, the contouring and planning details, including radiotherapy, fractionation, total dose, oral cavity dose, mandible dose, and parotid doses, were retrospectively reviewed.

The implant-bed dose was estimated by (1) contouring 58 available 3-dimensional radiation plans and (2) subsequently verifying the implant-bed by imaging until an exact match was found for each particular implant. In this way, an implant-specific radiation dose for 58 patients with 151 implants was recorded. Patients with no implants matching tumor site and stage served as a control group (n = 58). The radiation hot spots, the cavity dose, mandible dose, and parotid doses were assessed.

In all cases, the marginal bone status was evaluated using CT images taken 3–4 weeks before RT (baseline) and 1 and 3 years after RT. Acquisition CT data were acquired on GE Discovery CT scanners. The first step was to superimpose two different CT images taken at different time points using a digital gauge to ensure the same site was evaluated. Specifically, the researchers superimposed baseline images and 1-year images after RT to test the marginal bone status 1 year after RT; similar steps were used to test the marginal bone status 3 years after RT. By measuring the distance from the bottom of the implant to the most apical point of contact with the implant, they measured the marginal bone levels at the mesially, distally, buccally, and lingually. Bone level changes were calculated by subtracting the 1-and 3-year marginal bone values from the initial after RT value. This was done separately for mesial and distal sites. Radiological implant success was also assessed.

RESULTS

A total of 8931 HNC patients received RT between 2011 and 2020. Of these, 1865 patients received dental restorations (20.9%) before RT, of which 66 cases (3.5%) were implant restorations.

This study comprised 58 irradiated HNC patients (38 male and 20 females; median age 59 years, range 53–68 years) who had received dental implants prior to RT, including 72 (47.7%) and 79 (52.3%) implants located in the upper and lower jaws, respectively, as well as 79 (52.3%) and 72 (47.7%) implants located in the anterior and posterior jaws.

All patients had completed radiotherapy with a median dose of 62.4 Gy (range 62.2–67.7 Gy), 4 of which as definitive (6.9%) and 54 as adjuvant (93.1%). A total of 9 patients (15.5%) received chemotherapy in addition to radiotherapy. In addition, 16 (27.6%) patients received modulating radiation techniques IMRT and 42 (72.4%) received VMAT. `The researchers were able to measure the exact irradiation dose of the implant bed in 58 patients with 151 implants. There were differences in implant-bed-specific doses as a function of implantation site. The median radiation dose was 40.3 Gy, ranging from 30.7 to 49.7 Gy. Implants inserted anteriorly in the oral cavity received a cumulative mean dose of 35.7 Gy, which was significantly lower than the estimated 45.3 Gy of the posterior oral cavity region ($P < 0.001$). Implants inserted in the maxilla received a cumulative median dose of 35.0 Gy compared to the 45.9 Gy of those inserted in the mandible ($P < 0.05$). All implants were inserted into the native jawbone, and no patients developed osteoradionecrosis following radiotherapy.

Furthermore, the median hot spot was also similar in the two groups, with 112.5% (62.4 Gy) observed in the implant group versus 112.3% (63.1 Gy) in the control (i.e., non-implant) group. For patients with dental implants, the median oral cavity dose was 38.2 Gy, which is slightly higher than the 36.2 Gy measured in the non-implant control group. Similarly, the radiation dose in the mandible and parotid, in both the implant group, (45.6 Gy and 25.8 Gy, respectively) and the non-implant group (47.6 Gy and 24.2 Gy, respectively) were not significantly different.

The survival rates across the 151 implants following radiotherapy were 99.94% and 97.4% after 1 and 3 years, respectively. In terms of peri-implant bone resorption, the median marginal bone losses after 1 and 3 years respectively, 0.3 were 8 mm and 1.14 mm mesial side, 0.43 mm and 1.14 mm distal side, 0.17 mm and 1.20 mm buccal side, and 0.29 mm and 0.35 mm lingual side.

CONCLUSIONS

The researchers concluded that Implant-bed-specific dosage significantly differs depending on primary tumor location, and more than 40 Gy seems to be a risk factor for peri-implant bone resorption, In addition, implants did not affect the radiation dosimetry in this study indicating that radiation oncologists did not need to worry about the impact of implants on radiotherapy.

Implications for practice

The results of this study further illustrate that dialogue between dentists and radiation oncologists could contribute to the long-term success of implant restorations in HNC patients.

REFERENCE

1. Influence of radiotherapy on dental implants placed in individuals before diagnosed with head and neck cancer: focus on implant-bed-specific radiation dosage

CPD questionnaire on page 564

The Continuous Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.