Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Practice Points

Visualization of droplets produced by dental air turbines that require infection control measured during coronavirus 2019 outbreaks

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The current global pandemic of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led to nosocomial infections in many medical settings [1]. Consequently, there is a growing interest in protection against droplets and aerosols generated by medical procedures. In particular, dental treatment is a source of droplets and aerosols in the oral cavity that may contain SARS-CoV-2, and infection control measures during these procedures require special attention. Because SARS-CoV-2 RNA has been detected in environments where patients infected with coronavirus 2019 (COVID-19) have received dental treatment, analysis of aerosol dynamics in dental treatment facilities is crucial to provide safe dental care [2].

High-speed rotary cutting instruments are commonly used in dentistry to grind teeth and bones and to adjust and remove dental restorations. An air turbine is a high-speed rotary cutting instrument that uses compressed air to drive a turbine rotor mounted in the head of the handpiece to rotate a cutting bar. The heat generated in the cutting area is cooled from the head to the cutting bar by a water jet.

In this study, we used a high-speed camera to film the cutting of a human tooth with an air turbine and a laser beam. In addition to the cooling water, a portion of the compressed air was injected through a gap in the press-button chuck on the back of the turbine head, causing the surrounding water droplets to fly up at high speed.

This study was approved by the Ethical Review Committee of Yokohama City University Hospital (approval number: B20100000), and the experiment was performed in a private room in the outpatient clinic of the Department of Dentistry, Oral and Maxillofacial Surgery and Orthodontics of Yokohama City University Hospital. An Osada fine joint head turbine (OFJ-TZL(P); Osada, Tokyo, Japan) was used with a rotation speed of 350,000 rpm and a cooling water flow rate of 60 mL/min. The cutting target was an extracted human molar. A red laser sheet (5 W, 638 nm wavelength; Katokoken Co. Ltd, Kanagawa, Japan) was irradiated at a distance of ~75 cm from the tooth to be cut, perpendicular to the ground and passing through the tooth. Since SARS-CoV-2 is contained in droplets >2.5 μm in diameter, the water droplets could be visualized on the laser sheet [3]. A summary of the system used is available at https://www.youtube.com/watch?v=8IH9RqJNoik. The images were captured using a high-speed camera (HX-7s, 10,000 frame/s; NAC Image Technology, Tokyo, Japan) that was set up perpendicular to the laser sheet and placed ~75 cm from the tooth to be cut.

Images of water droplets sprayed from the turbine head to cool the cutting area and of water droplets generated by the exhaust from the back of the turbine head were captured. The average vector of the droplets every 1000 frames (100 ms) was

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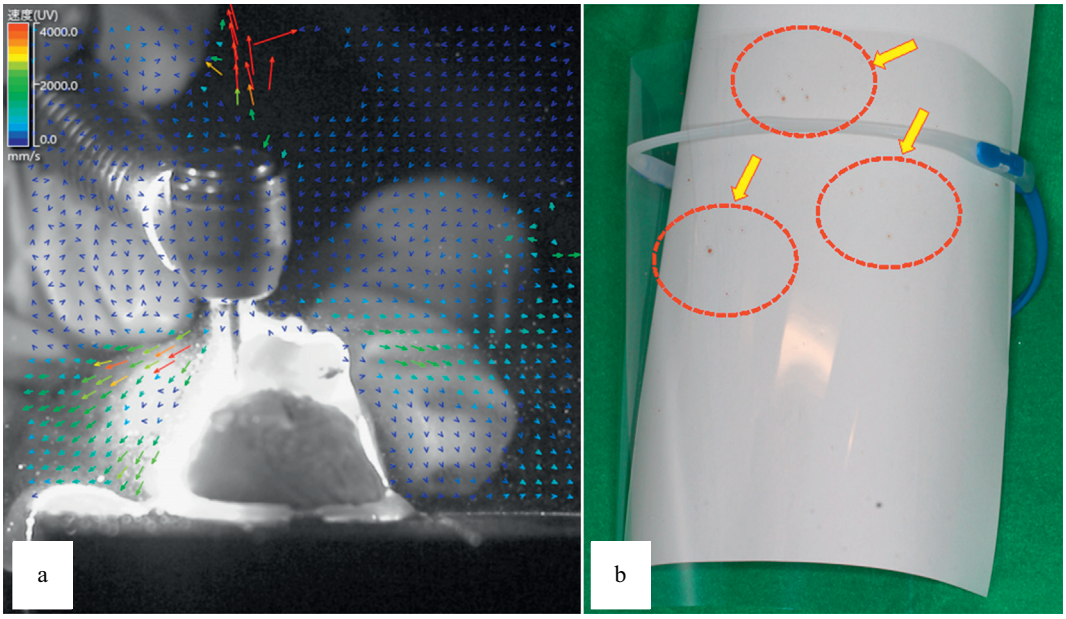

Figure 1. Results from cutting of a human tooth with an air turbine using a high-speed camera and a laser beam to determine droplet spread. (a) Average vector of droplets captured every 1000 frames by the high-speed camera while the air turbine was cutting the molar tooth with a laser beam. The cooling water from the turbine head and the droplets generated by the high-speed exhaust from the back of the turbine head both have a velocity >4 m/s. (b) Face shield after use in a dental procedure. A high-speed rotary cutting tool was used to split the tooth. Many droplets contain blood and are visible to the naked eye on the face shield (inside the dashed red circles).

determined. The droplets coming from the back of the turbine head were at a high velocity of 4 m/s (Figure 1a). Such high-velocity droplets could be directly sprayed on to the face of the surgeon or caregiver or generate aerosols and float far away. SARS-CoV-2 infection may occur when virus particles contained in an aerosol are inhaled or when they adhere to mucous membranes [4,5]. The main risk factor for COVID-19 transmission is the total amount of virus to which healthcare workers are exposed [6]. Therefore, the World Health Organization has emphasized the need for enhanced personal protective equipment (PPE), and our findings confirm the importance of such equipment [7]. Even relatively large aerosols containing droplets of ~100 μm in diameter can pose a risk of remaining airborne for about 5 min [8]. In fact, many blood droplets are often found on face shields when a patient's tooth is split with a high-speed rotating cutting tool (Figure 1b).

In conclusion, it is essential to wear enhanced PPE, including N95 mask and eye protection such as face shields and goggles, when performing dental treatment with an air turbine during an epidemic where the infectious particles can be spread by droplets, such as COVID-19.

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Author contributions

T. Ohya: study concept or design, data acquisition, analysis or interpretation of the data, and drafting/revising the manuscript. K. Nakagawa: data acquisition, analysis or interpretation of the data, and drafting/revising the manuscript. Y. Arai: data acquisition, analysis or interpretation of the data, and drafting/revising the manuscript. H. Kato: data acquisition, analysis or interpretation of the data, and drafting/revising the manuscript.

Conflict of interest statement

None declared.

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