EDITORIAL

Maximizing Surgeon Safety During Excimer Laser Photorefractive Procedures

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THIS YEAR, IT HAS BEEN ESTIMATED THAT MORE than 1 million excimer laser procedures will be performed in the United States alone. A number of viral pathogens have been identified in tears and the ocular surface.[1] This raises the possibility that viral particles[2,3] or subcomponents[4,5] may become part of the airborne contaminants of the laser that are ejected into the air at supersonic speed during excimer laser ablation. A number of laboratory studies have been designed and executed to test this hypothesis.[2–5]

Dr. Michael Taravella and co-workers have recently demonstrated that infectious poliovirus can be amplified in tissue culture from the plume of an Food and Drug Administration-approved excimer laser.[2] This finding is in contrast to their earlier studies of varicella-zoster virus,[4] which was not detected in an infectious state in the excimer plume. This pertinent negative result with varicella zoster may relate to the larger size of the virion; the lipid envelope surrounding the herpes family of viruses, which may be easily disrupted (thereby inactivating the virus); and the cell-associated nature of varicella zoster virus which makes it more difficult to propagate in vitro. The result is also in contrast to poliovirus, a 30-nm picornavirus that is remarkably stable to many forms of inactivation. The finding serves to emphasize that the 193-nm ultraviolet light of the excimer laser should not be viewed as "disinfecting" the ocular surface.

The new findings of Taravella and associates regarding live poliovirus adds to the list of aerosolized viruses that have been detected under experimental conditions after excimer laser ablation, including herpes simplex and adenovirus.[3] The ocular surface may harbor nonviral microbial pathogens, as well as other viruses, such as hepatitis C, human immunodeficiency virus type 1, and hepatitis B. As stated in the American National Standard for Safe Use of Lasers in Health Care Facilities,[6] "analysis of the laser airborne contaminants produced during laser surgical procedures has shown the presence of gaseous toxic compounds, bioaerosols, dead and live cellular material, and viruses." As a result, the laser plume should be considered a potential biohazard, and it warrants the use of universal precautions.

What are the appropriate measures a surgeon can take to control laser airborne contaminants?

Health care personnel must rely on appropriate local exhaust ventilation techniques as the first line of protection against occupational exposure to laser-generated airborne contaminants. At present, there is no suitable surgical mask or surgical laser mask that will exclude all laser-generated plume particulates, bacteria, viruses, or other irritants.[5] The efficacy of such a mask depends heavily on its fit over the nose and mouth, which decreases as such a mask becomes moist. During clinical use, there is no airtight seal that holds the mask in place. The significant space that exists between the skin and mask therefore becomes the actual particle filtration size. Surgical masks are intended to protect the patient from the surgeon's contaminated nasal or oral droplets and were not designed to provide protection from plume contents.

The VisX Star 52 (Santa Clara, CA) laser system has a smoke evacuator and a high-efficiency particulate air filter that has been estimated to remove approximately 90% of the plume. The efficacy of such smoke evacuators depends on volumetric airflow, the angle of the evacuator tube, close proximity to the point of laser smoke production, and the local velocities of the room air. Local exhaust ventilation must be accomplished without altering surgical effectiveness, such as causing excessive drying of corneal tissue, in the case of the excimer laser for corneal surgery. The filter should be periodically replaced to ensure efficacy, and the evacuator tube should be disinfected regularly. External smoke evacuator systems should be used with other laser systems that do not have this important safety feature which is inherent in the VisX Star S2 laser.

Studies by Moreira and colleagues[3] using herpes simplex and adenovirus revealed that the virus was more commonly detected in close proximity to the lased site, with directional spread toward the vacuum nozzle and away

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from the surgeon. The vertical spread of the virus from the shock wave when particles are released at supersonic speed was not assessed. These data suggest that viral particles could easily settle on the surgeon's hands, which may be close to the ablation field. If the surgeon's hands become contaminated in such a manner, it could result in other potential routes of transmission or autoinoculation, exclusive of airborne pathways. This leads to a second recommendation: the need to wear gloves during excimer laser surgery and to wash hands between procedures, which complies with Occupational Safety and Health Administration's standards.[7]

Despite active surveillance by the Centers for Disease Control and Prevention, it is reassuring that there have been no reported cases of infectious disease transmission associated with excimer laser surgery. Moreira and colleagues[3] demonstrated that the detection of viruses in the excimer plume related directly to the titer of the virus present in the tissue culture plate during lasing. Most of the studies of viruses in excimer laser plumes have used tissue culture plates containing viral titers that are logarithmically higher than those present on the ocular surface. The lack of reported cases of viral transmission after excimer laser surgery in the clinical setting may relate to this difference. However, as mentioned earlier, the ocular surface has been shown to be capable of harboring hepatitis B virus.[8] Therefore, prudence would dictate that the surgeon and health care workers in the laser facility be vaccinated against hepatitis B.

Dr. Taravella and associates have provided important new information regarding the potential for the presence of live virus in excimer laser plumes.[2] In a disconcerning precedent, skin[9] and laryngeal[10] papilloma have been reported in surgeons using a carbon dioxide laser to treat human papillomavirus lesions. Adherence to the guidelines outlined will further promote the safety of surgeons and health care workers who are involved in excimer laser surgery.

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