Application of Ultrasonic Aspirators in Rhinology and Skull Base Surgery

Dominic Vernon, MD[a], Brian C. Lobo, MD[b], Jonathan Y. Ting, MD, MS, MBA[a,*]

KEYWORDS

• Ultrasonic aspirator • Piezosurgery • Endoscopic DCR • Turbinoplasty
• Skull base surgery

KEY POINTS

- Ultrasonic aspirators can safely be used in endoscopic sinus, orbital, and endonasal skull base surgery to safely remove soft tissue and bone.
- Size, length, and angle of handpiece and working tips can limit some endoscopic dissections.
- Integrated navigation is not available at this time on ultrasonic aspirators but would be a welcome addition. Moreover, they do not significantly alter either electromagnetic (EM) or optical guidance systems.
- Much like microdebriders, these must be used with great care around vital structures, with additional caution around the external nose and upper lip.

EVOLUTION OF THE ULTRASONIC ASPIRATOR

Ultrasonic aspirators (UAs) rely on the use of ultrasonic vibration to remove both mineralized and nonmineralized tissue. This phenomenon is possible due to the piezoelectric effect, first discovered by French physicists Jacques and Pierre Curie in 1880. The Curie brothers observed that applying pressure or mechanical stress to certain materials generated an external electric field due to shifting of positive and negative charges, thus converting mechanical energy to electrical energy. Equally fascinating is that the reverse is also true. Applying an external electric field to piezoelectric

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[a] Department of Otolaryngology – Head and Neck Surgery, Indiana University School of Medicine, Indiana University, Fesler Hall, 1130 West Michigan Street, Suite 400, Indianapolis, IN 46202, USA; [b] Rhinology, Sinus & Endoscopic Skull Base Surgery, Department of Otolaryngology – Head and Neck Surgery, Cleveland Clinic Foundation, 9500 Euclid Avenue, Desk A-71, Cleveland, OH 44195, USA
* Corresponding author.
E-mail address: joting@iupui.edu

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material causes rapid compression and expansion of the material and creates ultrasonic oscillations. Harnessing this inverse piezoelectric effect is the foundation of UAs.[1–3] Although the Curie brothers demonstrated this effect using natural quartz and topaz, the overall piezoelectric effect of naturally occurring materials is relatively subtle. The development of synthetic ceramics with more powerful piezoelectric properties led to several practical applications, from simple devices, such as the cigarette lighter, to more complex medical devices, such as ultrasonic transducers and UAs.[1,2]

Using ultrasonic energy to cut bone or tissue is not new to medicine. Before the development of piezosurgery using the modern UA, the use of ultrasonic energy to cut dental tissue was described as early as 1953.[4] Ultrasonic aspiration was used to remove gingival plaques and assist in performing procedures such as root canals.[5] The harmonic scalpel, used to ligate and seal soft tissue, has been in use for the past few decades. The concept of the modern UA for what is described as piezosurgery is credited to Tomaso Vercellotti, who modified the existing technology to be more powerful and more precise.

As power and precision advanced, use of ultrasonic bone aspirators exploded in the fields of dentistry and oral maxillofacial surgery, in which ultrasonic technology was already in use. For the past 2 decades, this technology has been used for dental implant placement, Le Fort I osteotomies for midface deformities, and sagittal split osteotomies.[4,6] More recently, use of this technology by the otolaryngologic community has increased in a variety of neurotologic procedures, as well as rhinoplasty and medialization laryngoplasty.[7]

HOW THE TECHNOLOGY WORKS

As previously described, the modern UA relies on precise transformation of electrical energy to mechanical energy. The aspirator handpiece functions as the piezoelectric device, amplifying and transmitting vibrations to a variety of tips. The tips often have special coatings, including titanium and diamonds (**Fig. 1**). The frequency of device vibration can be adjusted but is most often set between 25 and 30 kHz. This is significant because it gives these devices the unique advantage of cutting mineralized bony tissue while minimizing damage to other soft tissue. These frequencies produce movements ranging from 60 to 210 μm, which cut bone but do little damage to soft tissue. Cutting soft tissue requires a frequency higher than 50 kHz, such as that seen with the

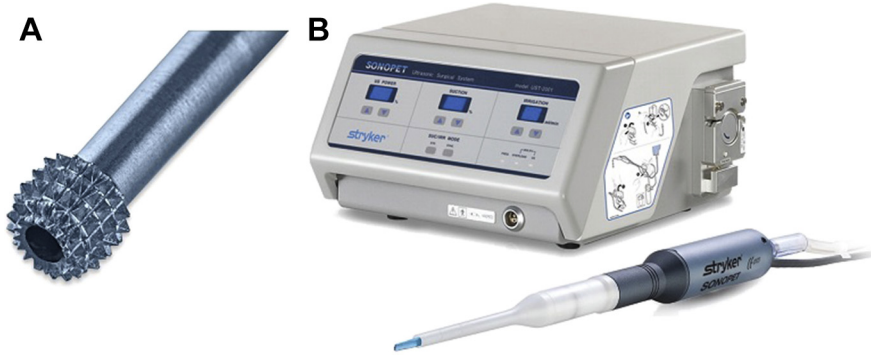

Fig. 1. Stryker Sonopet ultrasonic aspirator equipment. (*A*) Tip for ultrasonic aspirator. (*B*) Console and handpiece with integrated suction and irrigation. (*Courtesy of* Stryker, Kalamazoo, MI; with permission.)