Ultrasonic Technology and HARMONIC® Instruments: Advances in Surgery for Carotid Artery Disease

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Introduction
Various tools—including lasers, cryosurgery, radiofrequency devices, vascular clips, surgical knots, and monopolar and bipolar electrocautery devices—are employed to cut, dissect, and coagulate sensitive tissues. However, no one technology is perfect for all scenarios. For example, while the ability to cut and seal vessels to control surgical bleeding has contributed to the increased use of electrocautery devices, the application of extremely high heat can cause lateral thermal tissue damage.

Ultrasonic-powered devices were developed to provide surgeons with an alternative for dissections while minimizing the hazards of electrosurgery. In ultrasonic devices, piezoelectric ceramic discs convert externally provided electrical energy into mechanical motion via an ultrasonic, vibrating blade which acts on patient tissue. Thus, no electricity passes to or through the patient. The HARMONIC FOCUS®, curved shears with a tapered tip that vibrates longitudinally at 55.5 kHz, is specifically designed to perform fine and delicate surgical procedures, as well as seal vessels up to 5 mm and lymphatics (Figure 1).1,5

HARMONIC® technology has been applied in various open and closed surgical procedures, and has become a popular alternative to electrosurgery techniques.1 This success has led to its exploration in carotid artery surgery, for which the FOCUS® may be of benefit owing to the nature of the carotid and surrounding structures.

Carotid Artery Surgery
Surgery on the carotid artery commonly is necessitated by either injury (e.g., gunshot, stabbing, or other neck-penetrating wounds) or disease caused by atherosclerosis. Both carotid injury and disease are associated with increased morbidity and mortality.2,3 Although carotid artery trauma is relatively rare,2 carotid artery atherosclerosis is more common, particularly as the population ages.3 Atherosclerosis is associated with an increased risk for stroke, which is the third leading cause of mortality in the United States and an important cause of long-term disability.4 Most of these patients have numerous comorbidities that include atherosclerosis, poorly controlled hypertension, and diabetes. Most of them are also obese,5 said John H. Matsuura, MD, FACS, vascular surgeon at the Iowa Clinic, Cardiovascular Services, in West Des Moines.

Procedure
Typically, restoring carotid artery blood flow begins with an electrocautery incision on the side of neck adjacent to the sternocleidomastoid muscle, according to E. Anthony Murphy, MD, vascular surgeon at Suncoast Medical Clinic in St. Petersburg, Florida, and Dr. Matsuura (Figure 2). Once the subcutaneous tissue has been reached, both Drs. Murphy and Matsuura use the HARMONIC FOCUS® to expose the carotid sheath. Then, the internal carotid artery is carefully identified, from the common carotid artery to beyond the bifurcation of the internal and external carotid artery, according to both surgeons.

"I generally tie the facial vein if it’s of any significant size. But, you can use a HARMONIC® [device] on vessels up to 5 mm," Dr. Murphy said. "I basically follow the dissection up across the carotid bifurcation and then isolate up enough of the internal carotid up to where you can see the plaque." Due to the minimal thermal spread associated with the FOCUS®, "we feel we can get effective hemostasis and dissect in proximity to the carotid sheath," he said.

"The biggest concern that we had with electrocautery was transfer of electrical energy or damage to the surrounding structures, in particular the vagus nerve. In my experience, I worry less about that with the HARMONIC FOCUS®," Dr. Matsuura noted. "In terms of having a dry, bloodless field and working with the lymphatic vessels in the head and neck, the FOCUS® offers a very effective tool to expose the carotid artery with ease without experiencing the problems with small vessel bleeding that we saw with electrosurgery."2

Surgical Complications and Benefits Of HARMONIC® Technology
According to both surgeons, neck incisions typically heal without incident, even with electrocautery; infection in this area is rare. However, if vessels are not properly sealed, patients run the risk for bleeding or developing a hematoma.5

"In carotid artery surgery, redo patients typically have a higher rate of hematomas because of the abundance of scar tissue, and they can benefit from this technology," Dr. Murphy said. "Also, the small vessels around the superior portion of the internal carotid are most vulnerable to bleeding and now I use the FOCUS® to seal these. The HARMONIC® [device] may also help to reduce the incidence of seroma, swelling, and drainage volume in this area."

The main concern with older patients is wound healing. "There are advantages to less thermal spread," Dr. Matsuura said. "With the HARMONIC® devices, I see less desiccated and charred flesh. Overall, we are quite pleased with the healing rate of these patients, particularly around skin and subcutaneous tissue." Minimal thermal spread also may decrease the risk for injuring nerves found in the neck. "Without HARMONIC®, you may have to tie or clip the vessels individually, a process that can be quite time-consuming. With HARMONIC®, however, when you come close to

Figure 1. HARMONIC FOCUS® Long Curved Shears.
Image courtesy of Ethicon Endo-Surgery.

*Data on file at Ethicon Endo-Surgery, Inc. Based on preclinical testing of lymphatic vessels up to and including 1 mm in diameter.
As HARMONIC® technology does not involve electrical transmission to or through the patient, pacemakers are not susceptible to electrical stimulation and electromagnetic interference it may cause. *With the HARMONIC® tool, I was able to operate in proximity to the defibrillator device without compromising patient safety. This increased my interest in the effectiveness of hemostasis with this tool and ultimately led to my using it in other vascular operations,* Dr. Matsuura added.

**Learning Curve**

For surgeons with previous experience with HARMONIC® shears, the FOCUS® should be readily mastered. However, those who are new to the technology may find a steeper learning curve. "Newcomers usually require anywhere from 5 to 10 cases to get comfortable with the device," Dr. Murphy said. "However, once they learn to use the HARMONIC FOCUS®, surgeons will find that the device is much more efficient than other types of surgical instruments."

**References**