

TABLE 4. ENERGY SETTINGS AND CHOICE OF RADIOFREQUENCY ABLATION ELECTRODE ACTIVE TIP SIZE

RF power (W)	Active tip size (cm)
RF power according to active tip size	
5–15	0.38
10–30	0.5
20–40	0.7
30–80	1.0
50–90	1.5

RF, radiofrequency.

Safety of energy delivery is facilitated by the computer-driven nature of this treatment, which utilizes a laser beam to detect neck movement and immediately stop US wave delivery. The ablation begins at 280 J/pulse and the power is gradually increased until hyperechoic marks appear at the focal point, then that level of energy is maintained throughout the entire treatment cycle. The treatment cycle is semi-automated with the treatment head moving slowly across the entire nodule until it is ablated in its entirety.

Techniques to optimize peri-procedural safety

Anesthesia

During the procedure, optimizing the safety of proximate anatomic structures is paramount. With local anesthesia, the patient is fully awake and able to vocalize to ensure intact laryngeal nerve function and provide feedback regarding discomfort, which is immediately relayed to and can be acted on by the operator. Conscious sedation may minimize patient anxiety; however, timely communication and recognition of concerns or side effects can be less reliable depending on the depth of sedation.³⁹

The most common approach for local anesthesia injection utilizes a small gauge (27–30 G) needle to inject the anesthesia subcutaneously in the midline neck. Subsequently, a wider bore needle (25–27 G) connected to a syringe containing additional local anesthetic is inserted through this anesthetized

area, directed to the thyroid capsule, and advanced between capsule and muscle to bathe the capsule in anesthetic.

Anesthesia volume is determined by nodule size and patient weight. Lidocaine 1% is a commonly used anesthetic. Doppler interrogation of superficial neck structures must be done before needle insertion to identify and avoid injury to the anterior jugular veins and thyroid vessels. If a vessel is punctured, a hematoma may result on needle withdrawal. Firm neck pressure over the puncture site usually controls any bleeding and allows for safe continuation of the ablation procedure.

Trans-isthmic approach and moving shot technique

The trans-isthmic approach offers distinct safety advantages for operators treating patients with RFA and MWA. First, the operator can monitor the association between the applicator, target nodule, and RLN, which is situated between the trachea and thyroid gland. In the upper neck, near the cricothyroid joint, the RLN can be protected by applying the concept of a “danger triangle” as previously described.^{6,8,31,36}

At the level of the mid-cervical trachea and below, the concept of the “danger triangle” for RLN safety becomes less reliable, particularly on the right side where the nerve can run 1–2 cm lateral to the tracheoesophageal groove.⁴⁰ At these lower cervical levels, the entire posterior capsule should be considered a “danger zone” and precautions taken to minimize heat transmission to this region (Fig. 2).

Second, the normal isthmic parenchyma between the target nodule and the applicator (i.e., electrode with RFA, antenna with MWA) insertion site prevents the leakage of hot ablated fluid to the perithyroidal area, which could otherwise cause pain and tissue damage. Finally, the applicator position remains stable even when a patient talks or coughs, thereby minimizing the risk of injury to surrounding structures.³⁶

The moving-shot technique divides the nodule into multiple small ablation units.⁶ These ablation units can be treated individually and systematically. To prevent limitation of the acoustic window by gas bubbles, the applicator tip should be initially positioned in the deepest and most remote portion of the nodule, with subsequent retraction to more superficial areas. The location of the applicator tip should be continuously

FIG. 2. The danger triangle concept is applicable to ablation at the level of the upper tracheal rings and cricothyroid joint. In the lower neck, the concept of a “danger zone” is more appropriate as the recurrent laryngeal nerve is often laterally placed at these levels, especially on the right. CCA, common carotid artery; TR, trachea.

