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A Technical Guide to Palliative Ablation of Recurrent Cancers in the Deep Spaces of the Suprahyoid Neck

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Abstract

Treatment options for patients with recurrent head and neck cancer, whether locoregional recurrence of previously treated head and neck cancer or secondary primary malignancy, are limited. Percutaneous ablation is a minimally invasive procedure that can be used with palliative intent in the head and neck to achieve symptomatic relief and local tumor control, potentially fulfilling treatment gaps of current standard of care options. Image guidance is key when navigating the deep spaces of the neck with special attention paid to critical structures within the carotid sheath. This review article provides an overview and highlights the important nuances of performing percutaneous ablations in the head and neck. It covers general principles, ablative modalities, image guidance, procedural technique, expected outcomes, and possible complications.

Keywords
- recurrent head and neck cancer
- interventional radiology
- cryoablation
- cryoneurolysis
- percutaneous thermal ablation

Head and neck carcinoma (HNC) is the sixth most common malignancy in the world.[1] Two-thirds have locally advanced disease at the time of presentation and 50 to 60% of these patients develop locoregional recurrence (LR) within 2 years of initial curative therapy.[2,3] Additionally, this group of patients are prone to develop a secondary primary malignancy (SPM) biologically distinct from the treated index tumor due to "field cancerization" (e.g., human papillomavirus infection, smoking). The risk of developing a SPM is 2 to 4% per year and up to 30% over a 10-year period.[4,5]

Treatment options for LR and SPM are salvage surgery, palliative chemotherapy, and re-irradiation, alone or in combination. Salvage surgery, when suitable, can be effective, but often limited by lesion location and extent, and made more complex by scar tissue formation and altered field from previous surgery.[6] When performed, salvage surgery has a 16% major complication rate and 2.7% mortality rate.[7] Palliative chemotherapy is the standard option for LR but is limited by poor response rate of 15 to 45%.[8] Shin et al achieved a higher response rate of up to 59% in phase II trials with complex regimens at the cost of higher toxicity.[9,10] Re-irradiation, often in combination with chemotherapy, is potentially curative but employed cautiously in view of toxicity (to the brainstem and spinal cord) with varied success.[5] Failing these therapeutic options, this group of patients have very limited treatment alternatives with a median survival of 7 months.[11]

Percutaneous ablation is a minimally invasive procedure which entails the use of heat or cold to cause coagulative necrosis through percutaneously inserted applicators, widely used in various organs such as the liver, kidney, and lung with curative intent as an alternative to surgical resection. Percutaneous ablation also plays an important role in palliative care of cancer patients. For example, radiofrequency ablation (RFA) has been used to treat the symptoms of painful bone metastases in the spine and pelvis.[12] Less known is that percutaneous ablation has been used successfully in the head and neck with palliative intent, and the literature surrounding this technique is limited.[13–17] While performing percutaneous ablations of

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the superficial neck poses few risks, the deep structures of the suprahyoid head and neck are in close proximity and include critical neurovascular structures such as the carotid sheath and its contents. These challenges can be overcome by selecting a safe applicator trajectory, closely monitoring the ablation zone and employing protective measures when appropriate. This article discusses the pertinent principles and techniques of percutaneous ablation of recurrent head and neck carcinoma (RHNC) in the deep spaces in this region. Recurrent HNC refers to LR of previously treated HNC (including nodal recurrence) and/or SPM. Ethical review and approval were waived for this study as this is a review article.

General Principles

Each case should be discussed in a multidisciplinary team meeting and a goal-directed approach should be employed. The aims of palliative ablation of RHNC are symptomatic relief and/or local tumor control while minimizing damage to nontarget tissue/organs. Typically, these procedures are offered to patients with advanced recurrent HNC who are unsuitable for surgery and have failed chemoradiotherapy as a "last ditch" procedure to relief bulk symptoms such as pain, delay eventual airway and orodigestive tract obstruction, and the attendant tracheostomy and gastrostomy. With the primary goal of symptomatic relief and complication prevention being key in the palliative setting, subtotal ablation (without margins) is an accepted technical endpoint. A detailed history of the patient's symptoms should be taken, and a discussion of expectations and risks is vital. When pain is the predominant symptom, we employ Prologo et al's approach to interventional cryoneurolysis.[18] If the causative RHNC involves the nerve, the tumor–nerve complex is ablated (if risk of loss of motor function is acceptable). If the RHNC cannot be safely ablated, the responsible nerve is targeted (if risk of loss of motor function is acceptable). If the RHNC cannot be safely ablated and responsible nerve is not identified, regional ablation is considered.[18] Ablation of the cranial nerve that has been involved by tumor in this context is with the view that in many cases, partial and/or eventual complete palsy occurs with or without treatment. Symptoms such as bleeding may influence the ablative modality employed.

Ablative Modality and Image Guidance

Cryoablation is the modality of choice for RHNC ablation in our institution. Cryoablation is an energy-based ablation modality which utilizes rapid cooling and thawing to cause necrosis and cell death with the formation of intracellular ice crystals. The main advantage of cryoablation over heat-based ablation modalities in the head and neck is the accurate depiction of ice ball on cross-sectional imaging such as computer tomography (CT) and magnetic resonance imaging (MRI), as well as ultrasound (US).[19] This ability to visualize and monitor the ablation minimizes the risk of injury to critical structures which is crucial in the head and neck (►**Fig. 1**). Cryoablation also causes less pain compared with heat-based thermal ablation modalities due to the anesthetic effect of freezing and better tolerated by patients. Due to these advantages, cryoablation appears to have a relatively lower complication rate compared with heat-based modalities and there is a general trend toward using cryoablation in the deep spaces of the head and neck.[14,16,20]

Heat-based ablations such as RFA and microwave ablation (MWA) have also been used to treat RHNC. The main advantage of heat-based ablative modalities over cryoablation in the head and neck is its cautery effect to stop bleeding. Heat-based modalities, especially MWA, are also faster and can generate large ablation zones with a single applicator. MWA procedures are typically 2 to 8 minutes using high-powered systems, while cryoablation procedures typically last for 25 to 30 minutes.[19] The use of other ablative modalities such as irreversible electroporation and laser ablation may have a place in the treatment of RHNC, but their use in the deep head and neck has yet to be reported. Histotripsy is a new noninvasive non-heat ablative modality which uses acoustic cavitation to fractionate tissue, emulsifying tumor. This technology does not use heat and large vessels are unlikely to be injury due to its inherent high mechanical strength, making this technology safe to use around the carotid sheath, though it is still in the animal testing phase.[21]

Computed tomography (CT) guidance with CT fluoroscopy is the modality used by most operators for applicator trajectory planning and monitoring of ablation zone. CT provides three-dimensional views of the lesion and crucial structures of the head and neck and is excellent for ablation zone monitoring. Disadvantages of CT include the use of ionizing radiation in the head and neck and inferior soft-tissue contrast without the use of intravenous contrast. MRI provides excellent soft-tissue contrast, allows multiplanar applicator trajectory planning, and allows real-time monitoring of the ablation zone without the use of ionizing radiation with the added benefit of being able to monitor ablation temperatures. The downsides of MRI for RHNC ablation are limited availability, high costs, and long procedural times. Recently, the use of US with intravenous contrast alone as a guidance and monitoring modality has been reported.[22]

Ablation Technique

Ablations are performed under general anesthesia (GA) with endotracheal or endo-tracheostomy intubation to minimize discomfort. If the patient is not suitable for GA, these procedures can be done under conscious sedation with cervical plexus block.[22] Prophylactic antibiotics coverage for oral and skin organisms are recommended.[14]

Preprocedural contrast-enhanced cross-sectional imaging should be performed within a month prior to and on the day of procedure to assess for feasibility. Discussion with diagnostic radiologists familiar with the territory is helpful in trajectory planning. Many of these patients had undergone reconstructive surgery and radiation; preprocedural imaging will help determine site and extent of the target lesion as well as define the distorted anatomy and identify potentially

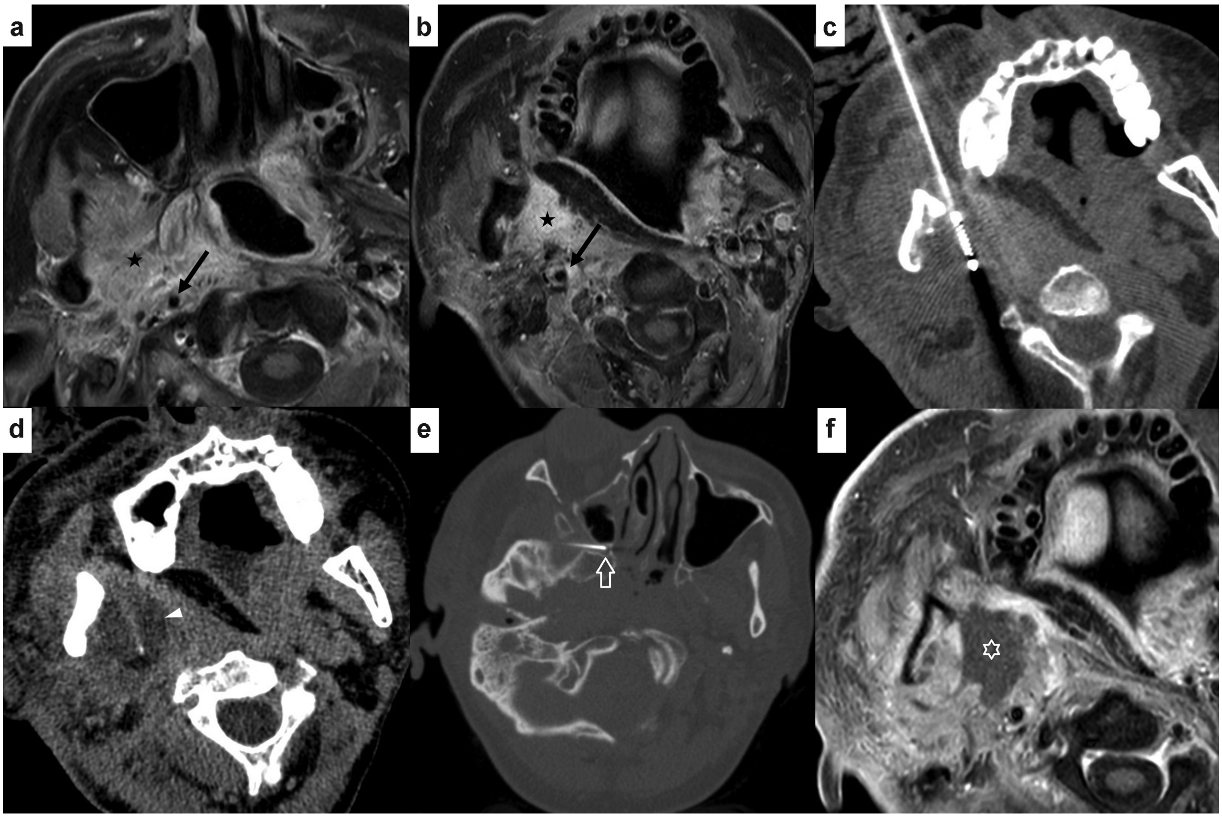

Fig. 1 Example of retromaxillary and infrazygomatic approach: a 56-year-old man with locally advanced right oropharyngeal squamous cell carcinoma underwent right oropharyngeal resection with free anterolateral thigh flap, mandibulotomy, tracheostomy, right neck dissection. He developed disease recurrence complicated by neuropathic trigeminal nerve pain secondary to malignant involvement not improving with palliative chemotherapy. (**a**, **b**) Preablation contrast-enhanced magnetic resonance imaging axial sections show an ill-defined enhancing recurrent tumor (black stars) deep to the myocutaneous flap. The main organ at risk with this approach is the carotid sheath (black arrow). (**c**) A retromaxillary approach was used and the cryoprobe (14G IcePearl cryoprobe) was advanced to the epicenter of the tumor in the slice displaying the largest cross-sectional dimensions of the tumor. (**d**) Intraprocedural computed tomography was used to monitor propagation of the ice-ball which is well-seen on unenhanced CT as an ovoid hypodense area (white arrowhead). (**e**) While symptoms improved, facial pain in the trigeminal nerve maxillary branch (V2) persisted. Decision was made by multidisciplinary team to proceed with foramen rotundum block. Unenhanced CT in the bone window shows position of the radiofrequency antenna tip (open white arrow) in the region of V2 branch of trigeminal nerve. The infrazygomatic approach was used. (**f**) Contrast-enhanced computed tomography performed 2 months after shows devascularization of the tumor (asterisk). Clinically, the patient's pain score improved from 7 to 3 on the visual analog scale (0 being no pain, 10 being unbearable pain).

useful bony landmarks such as the styloid process. Important vascular structures must be identified and assessed for involvement; critically, the ipsilateral carotid artery must be evaluated for tumor involvement and carotid blow-out syndrome (CBS). Of note, risk factors for CBS include radiotherapy (total radiation dose of $\geq$70 Gy), prior radical neck dissection, primary site of cancer at the hypopharynx or oropharynx, and malnutrition.[23] While acute CBS (type 3) presents with life-threatening bleeding, CBS may be found incidentally on imaging (type 1) or presents with transient bleeding (sentinel bleed, type 2) which aborts spontaneously or with packing. CT findings in impending/threatened CBS (types 1 and 2) are necrosis adjacent to the carotid artery, exposed artery, viable tumor, pseudoaneurysm, and contrast extravasation.[24] Regardless of type, CBS necessitates treatment and if untreated, ablation in the head and neck is contraindicated. Ablation of the tumor following treatment of CBS (typically carotid artery embolization) is feasible.

The same techniques used in CT-guided tissue biopsy can be used when inserting ablation applicator. The epicenter of the tumor should be targeted by selecting the slice with the largest axial dimensions and the applicator should be parallel to the orientation of the tumor. When using two or more applicators, typically required when performing cryoablation, the 2×1 rule applies; at the slice with the largest axial dimensions, applicators should be placed approximately 2 cm apart from one another and approximately 1 cm from the tumor margin (►**Fig. 2**). This will allow for complete ice ball coverage even in tumors which are irregular in shape.

Our approach to applicator trajectory is dependent on lesion location, size, shape, and critical nontarget structures. While the trans-oral may offer a direct path, we adopt a percutaneous approach exclusively as it provides more stability for the applicator and avoids direct contamination of the applicator by oral flora. ►**Table 1** summarizes the approaches, spaces accessed, and organs at risk in the suprahyoid neck. In craniocaudal sequence, subzygomatic, retromaxillary and retromolar trigone approaches can access lesions in the masticator, parapharyngeal, and pharyngeal mucosal spaces. Important anatomic considerations when

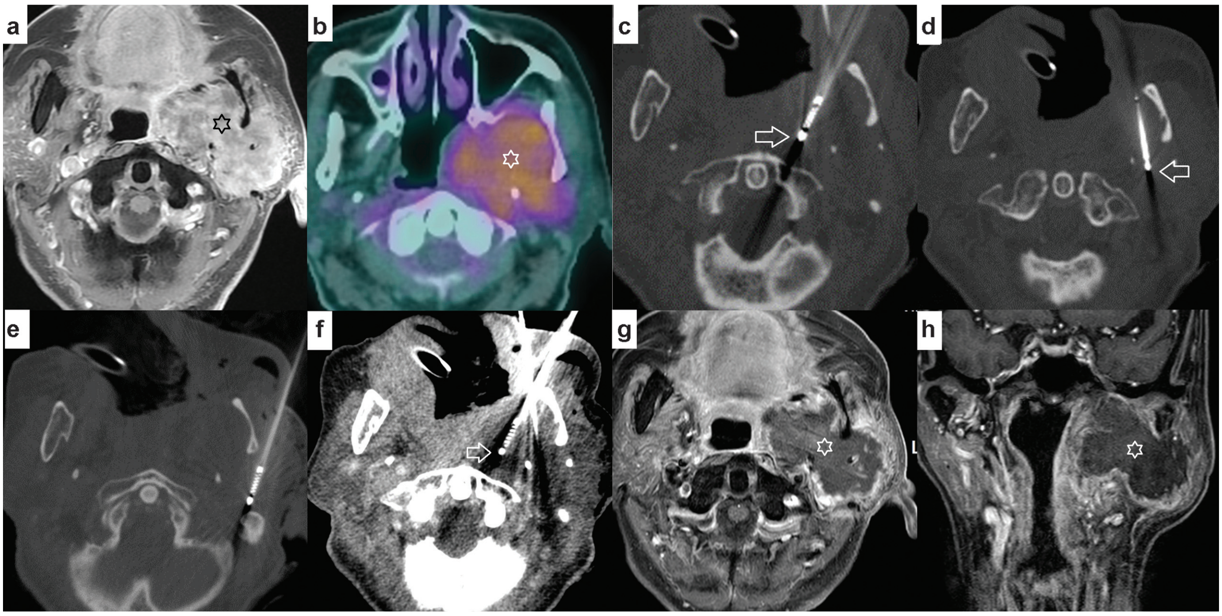

Fig. 2 Example of retromaxillary and retromandibular approach: a 76-year-old woman with metastatic deep left parotid adenoid cystic carcinoma which was refractory to radiotherapy, on best supportive care. Patient complained of tumor bulk, left facial pain, left facial nerve paralysis, and difficulty swallowing. (**a**) Contrast-enhanced MRI shows a large heterogeneously enhancing mass (asterisk), centered in the deep lobe of the parotid gland, extending to left parapharyngeal and carotid spaces; the left facial and trigeminal nerves are involved by the tumor and could not be separated from the mass. (**b**) Positron emission tomography–computed tomography shows the mass to be avid uptake (asterisk). (**c**, **d**) Two cryoprobes (arrows) were inserted with the retromaxillary (more caudal than in ►**Fig. 1**) approach in a criss-cross fashion to avoid injury of the carotid sheath. (**e**) A third cryoprobe was inserted via the retromandibular approach (arrow), targeting the superficial component of the mass. (**f**) Computed tomography axial section showing the ice-ball formation medial and lateral to the carotid sheath (arrows). (**g**, **h**) Post-ablation contrast-enhanced magnetic resonance imaging performed 2 months after shows devascularization of the mass (asterisk) and stable disease.

Table 1 Approaches, spaces accessed, and organs at risk in the suprahyoid neck

Approach	Spaces accessed	Organs at risk
Subzygomatic	Masticator Parapharyngeal Pharyngeal mucosal Retropharyngeal Prevertebral	Carotid sheath (and its contents) Maxillary artery (branch of external carotid artery) and its branches Maxillary (V2) and mandibular branches (V3) of trigeminal nerve (CN V) Pterygoid venous plexus
Retromaxillary	Masticator Parapharyngeal Pharyngeal mucosal Retropharyngeal Prevertebral	Carotid sheath (and its contents) Maxillary artery (branch of external carotid artery) and its branches Maxillary (V2) and mandibular branches (V3) of trigeminal nerve (CN V) Pterygoid venous plexus
Retromolar trigone	Parapharyngeal Pharyngeal mucosal Retropharyngeal Prevertebral	Carotid sheath (and its contents) Inferior branches of the maxillary artery Mandibular branches (V3) of trigeminal nerve (CN V) Pterygoid venous plexus
Trans-glandular (submandibular gland)	Pharyngeal mucosal Retropharyngeal Prevertebral	Carotid sheath (and its contents)
Retromandibular	Deep parotid Parapharyngeal Pharyngeal mucosal Retropharyngeal	Carotid sheath (and its contents) Retromandibular vein Facial nerve (CN VII)

Abbreviation: CN, cranial nerve.

using this approach are the carotid sheath and its contents, maxillary artery (branch of the external carotid artery) and its branches, mandibular (V2) and mandibular (V3) branches of the trigeminal nerve, and pterygoid venous plexus.

When using the subzygomatic approach, the patient's head should be secured in neck extension with chin tilt such that the body of the mandible is perpendicular to the CT table. This brings the zygomatic arch into the axial plane, allowing for easy access to the skull base. However, neck extension may be limited in patients with severe torticollis or contractures from previous treatment. The most common trajectory when using the retromaxillary approach is posterolateral to the lateral wall of the maxillary sinus. More caudally, the landmark will be a trajectory lateral to the maxillary teeth (►**Fig. 1**). Of note is the Stensen duct that runs anteriorly in the buccal fat pad which should be avoided when using the latter trajectory. Transgression through the salivary glands (parotid and submandibular) (►**Fig. 3**) is generally well tolerated without sequelae, but transgression of salivary ducts should be avoided to prevent sialocele formation. For the parotid gland, the retromandibular vein serves as a landmark for the facial nerve. For lesions in the deep parotid space, the retromandibular approach can be used with attention paid to the carotid sheath, retromandibular vein, and facial nerve. Ablations in the posterior neck such as the perivertebral space are safe as long as the vertebral artery is avoided.

Myocutaneous flaps are easily identified on the post-reconstructed neck, as they typically assume a fat signal on both CT due to its fat contents and denervated muscle. Myocutaneous flaps can be safely traversed as it is devoid of critical structures, although the pedicle artery should be avoided to avoid hemorrhage. With that said, inadvertent injury leading to thrombosis or occlusion of the pedicle artery is usually well tolerated once the flap has been successfully grafted and healed onto the recipient site.

To avoid uncontrollable hemorrhage, major vessels such as carotid and vertebral arteries must be avoided. Despite the protective "heat-sink" effect, injury of the carotid arteries has been reported.[13,25,26] In a retrospective analysis of patients who had major vascular complications after ablation, Brook et al found that the RF probe tips were within 1 cm of the carotid artery in all these patients during the ablation.[13] As such, applicators should not be within 1 cm of the carotid sheath, especially when using heat-based ablative modalities. For select cases when the expected ablation zone is close to major arteries, a pigtail catheter can be placed in the aortic root via a left trans-radial access and arterial runs using diluted contrast (bolus of 10 mL of 50% diluted contrast) may be performed during CT guidance and while ablation zone monitoring (►**Fig. 3**).

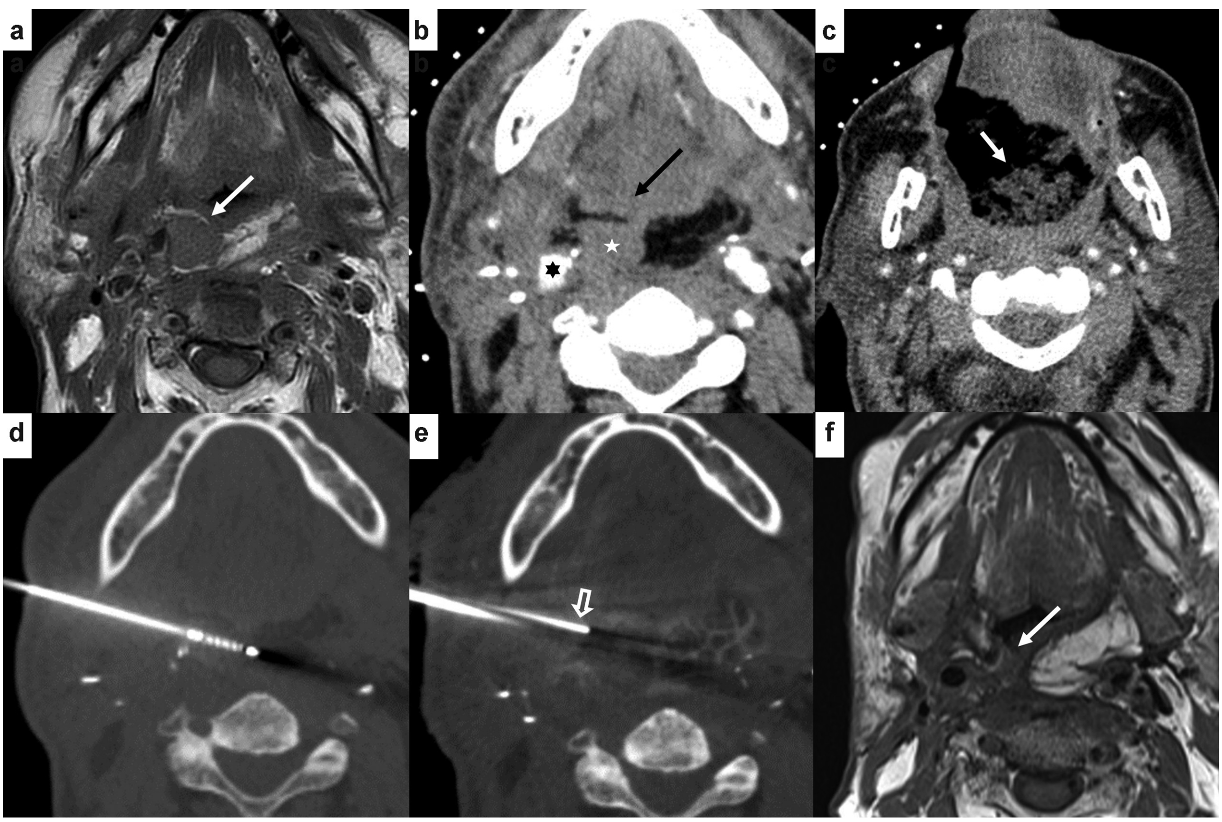

Fig. 3 Example of trans-glandular approach: a 66-year-old with locally invasive supraglottic SCC in the right aryepiglottic fold with nodal involvement underwent chemoradiotherapy followed by total pharyngolaryngectomy with bilateral neck dissection with anterolateral thigh flap and split-thickness skin graft. The margins were found to be positive on histology. (**a**) Surveillance magnetic resonance imaging performed 3 months after surgery showed local recurrence in the myocutaneous flap measuring 2.0 × 1.7 cm (white arrow). (**b**) Contrast-enhanced computed tomography performed in the arterial phase during the procedure was obtained using a pigtail catheter at the aortic root via a left trans-radial access (not shown). The right common carotid artery (black star) is identified, close to the target lesion (white star). The tongue is also seen abutting the target lesion anteriorly (black arrow). (**c**) The oral cavity was packed with gauze (white arrow), pushing the tongue away from the anticipated ice-ball formation. (**d**) Trans-glandular (submandibular) approach was used and the cryoprobe was advanced under CT guidance (14G IcePearl) avoiding the carotid sheath. (**e**) A biopsy needle was advanced in tandem with the cryoprobe. After tissue histology was obtained, the biopsy sheath (open white arrow) was used for hydrodissection to displace the mucosa for the ablation zone. (**f**) Follow-up magnetic resonance imaging shows significant size reduction of the recurrent tumor (white arrow).

Akin to ablation of other parts of the body, hydrodissection and pneumodissection should be used, when possible, to avoid nontarget injury (►Fig. 3). Thermal burns of the skin can be avoided with the use of a warmer during cryoablation. The tongue is at particular risk of thermal injury during ablations close to the oral cavity. The tongue should be displaced with the aid of a laryngoscope, McGill forceps, and oral packing with gauze (►Fig. 3).

From our experience, charts provided by manufacturers are not predictive of the ablation zone in the head and neck. This is in part due to the altered cold-sink in a postoperative neck and also the variable tissue heat capacitance. Ablation zone propagation therefore must be monitored on imaging. Ablation zone propagation is monitored every 2 to 3 minutes and freezing was terminated once the tumor was fully encompassed or if ablation zone approaches at-risk structures. Belfiore et al achieved a maximum temperature of 90 °C with a peak power of 170 to 190 W, an impedance of 60 to 80 ohms, and a peak current between 1,600 and 2,000 mA.[27] When using MWA, a lower power is used with a generator output of 30 to 45 W by Liao et al and Belfiore et al.[22,27] When using cryoablation, Gangi et al used two to eight cryoprobes and freezing time ranged between 12 and 20 minutes using the double-freeze protocol, terminating the freezing cycle prematurely if adjacent neurovascular structures were at risk.[16] At our institution, we start at 30% freezing power, increasing by 10% every 2 minutes while monitoring the propagation of the ice-ball. A double-freeze protocol (10:8:10:8 minutes) is used and the maximum power reached during the first cycle is used throughout the second cycle.

Outcomes and Complications

Palliative ablation of RHNC provides symptomatic relief. In the largest case series to date, Belfiore et al showed a significant improvement ($p < 0.001$) in quality of life (pain, swallowing, senses, speech, social eating, social contact, sexuality) between preablation and 6 months post-ablation in 22 patients with unresectable HNC lesions (17 men; mean age, 64 years; 5 MWA, 17 RFA). In 18 patients (24 lesions), Liao et al showed that US-guided MWA significantly reduced the size of RHNC (lesion volume pre-ablation vs. post-ablation, 47.45 ± 24.08 vs. 74.35 ± 46.88 cm^3; $p < 0.05$) resulting in a significant improvement in quality of life (University of Washington Head and Neck Quality of Life questionnaire score pre-ablation vs. post-ablation, 59.24 ± 11.51 vs. 69.84 ± 8.12; $p < 0.05$). Guenette et al showed that cryoablation is technically feasible with five out of seven procedures showing good imaging (involution and/or necrosis) and clinical outcomes (pain relief). Gangi et al performed cryoablation in four patients with RHNC, two patients remained disease free on imaging follow-up at 6 and 16 months, while two showed residual/recurrent disease (later underwent repeat cryoablation).

Abscopal effect was observed in cryoablation of RHNC. Abscopal effect is an uncommon phenomenon that has been observed after cryoablation and is due to systemic antitumor response triggered by the release of large amounts of cytokines and tumor-specific antigen.[28] Gangi et al reported a case of complete regression of a ground-glass nodule suspicious of pulmonary metastasis on PET-CT 4 months after cryoablation of RHNC. Chokkappan et al reported a case of abscopal effect after percutaneous cryoablation of neopharynx recurrence. A year after cryoablation, the patient experienced complete resolution of ablated neopharynx recurrence as well as near-total resolution of a non-target 4.5-cm left parotid bed tumor locoregional recurrence.[17]

Major complications related to palliative ablation of RHNC are due to ablations close to the carotid sheath and mainly observed in earlier studies which used RFA. Owen et al reported 1 carotid hemorrhage resulting in death and 2 cases of cerebrovascular accidents in 13 patients who underwent RFA. Brook et al reported a major complication of 11% (3 in 27 applications) which were cerebrovascular accident ($n = 1$), carotid blowout leading to death ($n = 1$), and threatened carotid blowout with subsequent stroke ($n = 1$).[13] In these three cases, the retractable RFA electrodes were within 1 cm of the carotid artery and the authors recommend caution when ablating close to the carotid sheath, using lower energy or adjusting the RFA electrode and tines away from the carotid sheath. Limited literature suggests cryoablation has a better safety profile compared with heat-based ablative modalities when ablating close to the carotid sheath; there were no episodes of carotid artery injury or stroke in the three cryoablation case series.[14,16,20] This is likely due to the protective heat-sink effects as well as the intrinsic collagen-preserving properties of cryoablation. Guenette et al reported one episode of intraprocedural bradycardia when performing cryoablation close to the carotid sheath.[14] This bradycardia was transient and the patient's blood pressure recovered after cryoablation paused, but the procedure was terminated, and ablation was incomplete. The authors attributed this to a vagal response due to loss of the protective "heat-sink" effect due to known ipsilateral jugular vein thrombosis. ►Fig. 4 illustrates a similar case of vagal stimulation in our institution.

Postprocedural complications include infection and damage to surrounding structures. Post-ablation, patients are at risk of developing infection. Guenette et al reported one case of neopharyngeal abscess after cryoablation requiring surgical debridement 1 week after. Cellulitis was also reported after heat-based RHNC ablation.[22,25,26] In our institution, prophylactic antibiotics coverage for oral and skin organisms is routinely given. Belfiore et al reported one case of cutaneous fistula which resolved with local therapy and one case of palate perforation that required a prosthetic replacement.[27]

Clinical and Imaging Follow-up

Patients undergoing palliative ablation of RHNC should be followed up clinically and with imaging. In our institution, each patient is assessed with the University of Washington Quality of Life (UW-QOL) scale preprocedure and postprocedure to assess for efficacy.[29] This questionnaire assesses nine domains (pain, activity, recreation, employment, disfigurement, speech, swallowing, chewing, and shoulder function) to calculate a composite score upon 100.[29] Follow-up

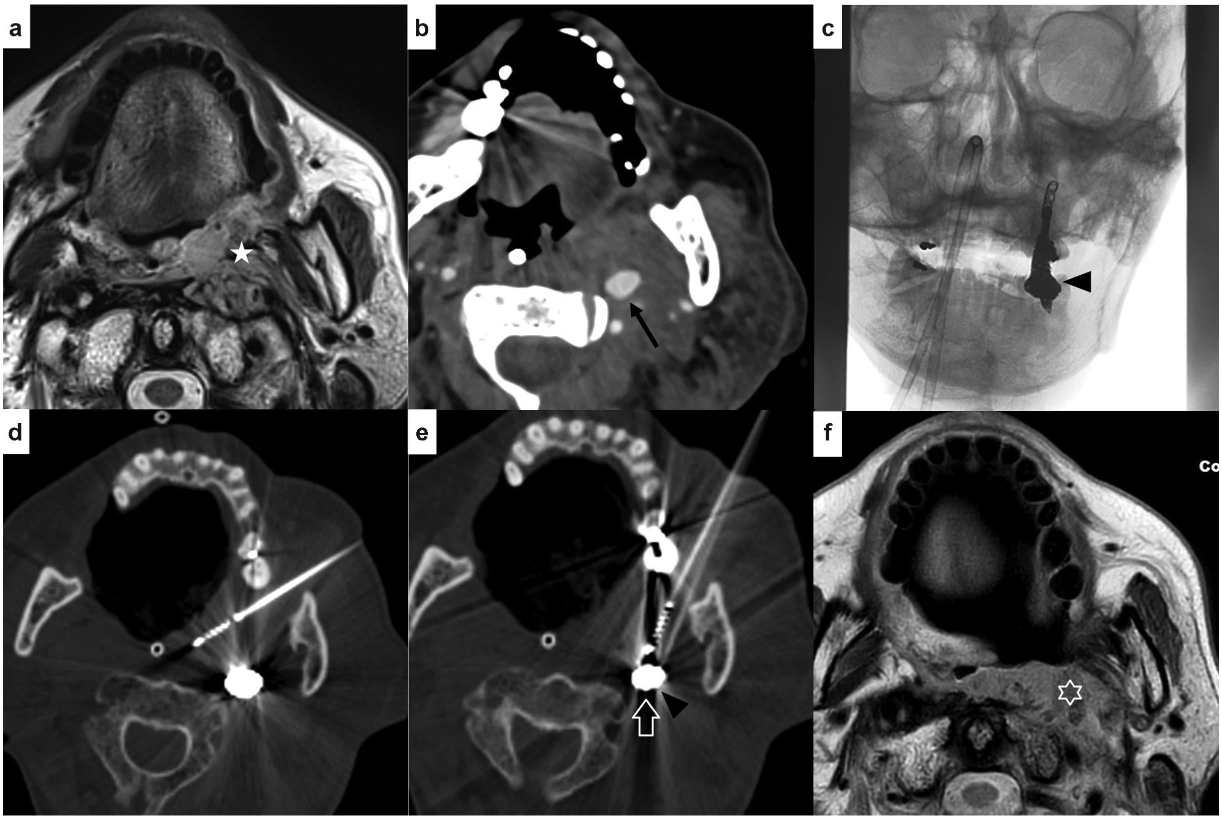

Fig. 4 Example of retro-molar trigone approach: a 64-year-old man with nasopharyngeal carcinoma underwent chemoradiotherapy followed by right neck dissection. (**a**) Surveillance magnetic resonance imaging performed 7 years after initial therapy showed a heterogeneous mass in the left retropharyngeal/prevertebral region (white star) consistent with nodal recurrence. Posterolaterally, the infiltrative mass encased the left internal carotid artery. (**b**) Prior to ablation, the patient experienced hemoptysis and underwent contrast-enhanced computed tomography angiography showing aneurysmal dilatation of the left internal carotid artery (black arrow) in keeping with type 2 carotid blow-out syndrome. (**c**) The patient underwent coil embolization (black arrowhead) of the left internal carotid artery and his hemoptysis resolved. (**d**) One month after coil embolization, the patient underwent percutaneous cryoablation of the recurrent tumor. The retro-molar trigone approach was used and the cryoprobe was inserted under CT guidance (14G IcePearl). (**e**) A second cryoprobe was inserted with the retro-molar approach and its tip close to the embolized left internal carotid artery (arrow—coils in carotid artery). Soon after activation of this probe, the patient experienced bradycardia complicated by hypotension. This was attributed to vagal nerve stimulation due to loss of protective heat sink of a patent carotid vessel as well as cold conduction through metallic coils. The patient's symptoms resolved after retraction of this probe and the ablation was completed. (**f**) Follow-up magnetic resonance imaging performed 8 months after cryoablation showed significant reduction in size of the recurrent tumor (star) and improvement of his symptoms.

imaging is performed at 6 to 8 weeks and 3 monthly intervals thereafter. The choice of follow-up imaging, whether CT or MRI, should ideally be the same as preprocedural assessment. The target lesions are assessed on imaging using the Response Evaluation Criteria in Solid Tumours criteria.

Conclusion

Percutaneous palliative ablation of RHNC represents a new area of percutaneous ablation. While the current body of literature remains limited, it represents an additional palliative treatment in patients who otherwise have limited options or exhausted current standard of care treatment options. Image guidance is crucial in achieving accurate applicator placement while avoiding critical structures such as the carotid artery.

Disclosures

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Conflict of Interest

The authors have no conflict of interest to declare.

References

1 Kamangar F, Dores GM, Anderson WF. Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world. J Clin Oncol 2006;24(14):2137–2150
2 Grégoire V, Lefebvre JL, Licitra L, Felip EEHNS-ESMO-ESTRO Guidelines Working Group. Squamous cell carcinoma of the head and neck: EHNS-ESMO-ESTRO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol 2010;21 (Suppl 5):v184–v186
3 Denaro N, Merlano MC, Russi EG. Follow-up in head and neck cancer: Do more does it mean do better? A systematic review and our proposal based on our experience. Clin Exp Otorhinolaryngol 2016;9(04):287–297
4 Sturgis EM, Miller RH. Second primary malignancies in the head and neck cancer patient. Ann Otol Rhinol Laryngol 1995;104(12): 946–954
5 Kao J, Garofalo MC, Milano MT, Chmura SJ, Citron JR, Haraf DJ. Reirradiation of recurrent and second primary head and neck

malignancies: a comprehensive review. Cancer Treat Rev 2003;29 (01):21–30
6 Hamoir M, Schmitz S, Suarez C, et al. The current role of salvage surgery in recurrent head and neck squamous cell carcinoma. Cancers (Basel) 2018;10(08):E267
7 Temam S, Koka V, Mamelle G, et al. Treatment of the N0 neck during salvage surgery after radiotherapy of head and neck squamous cell carcinoma. Head Neck 2005;27(08):653–658
8 Guidi A, Codecà C, Ferrari D. Chemotherapy and immunotherapy for recurrent and metastatic head and neck cancer: a systematic review. Med Oncol 2018;35(03):37
9 Shin DM, Glisson BS, Khuri FR, et al. Phase II trial of paclitaxel, ifosfamide, and cisplatin in patients with recurrent head and neck squamous cell carcinoma. J Clin Oncol 1998;16(04):1325–1330
10 Shin DM, Khuri FR, Glisson BS, et al. Phase II study of paclitaxel, ifosfamide, and carboplatin in patients with recurrent or metastatic head and neck squamous cell carcinoma. Cancer 2001;91 (07):1316–1323
11 Vokes EE, Weichselbaum RR, Lippman SM, Hong WK. Head and neck cancer. N Engl J Med 1993;328(03):184–194
12 Levy J, Hopkins T, Morris J, et al. Radiofrequency ablation for the palliative treatment of bone metastases: outcomes from the Multicenter OsteoCool Tumor Ablation Post-Market Study (OPuS One Study) in 100 patients. J Vasc Interv Radiol 2020;31 (11):1745–1752
13 Brook AL, Gold MM, Miller TS, et al. CT-guided radiofrequency ablation in the palliative treatment of recurrent advanced head and neck malignancies. J Vasc Interv Radiol 2008;19(05):725–735
14 Guenette JP, Tuncali K, Himes N, Shyn PB, Lee TC. Percutaneous image-guided cryoablation of head and neck tumors for local control, preservation of functional status, and pain relief. AJR Am J Roentgenol 2017;208(02):453–458
15 Quek LHH, Lim MY, Cheo T, Teo HL, Pua U. Percutaneous management of recurrent head and neck cancer: current role and evolving principles in the multidisciplinary setting. Curr Oncol Rep 2021;23(05):52
16 Gangi A, Cebula H, Cazzato RL, et al. "Keeping a cool head": percutaneous imaging-guided cryo-ablation as salvage therapy for recurrent glioblastoma and head and neck tumours. Cardiovasc Intervent Radiol 2020;43(02):172–175
17 Chokkappan K, Lim MY, Loke SC, Karandikar A, Pua U. Salvage cryoablation of recurrent squamous cell carcinoma for impending airway obstruction with abscopal effect. J Vasc Interv Radiol 2020; 31(11):1939–1942
18 Prologo JD, Edalat F, Moussa M. Interventional cryoneurolysis: an illustrative approach. Tech Vasc Interv Radiol 2020;23(04): 100698
19 Hinshaw JL, Lubner MG, Ziemlewicz TJ, Lee FT Jr, Brace CL. Percutaneous tumor ablation tools: microwave, radiofrequency, or cryoablation–what should you use and why? Radiographics 2014;34(05):1344–1362
20 Dar SA, Love Z, Prologo JD, Hsu DP. CT-guided cryoablation for palliation of secondary trigeminal neuralgia from head and neck malignancy. J Neurointerv Surg 2013;5(03):258–263
21 Longo KC, Zlevor AM, Laeseke PF, et al. Histotripsy ablations in a porcine liver model: feasibility of respiratory motion compensation by alteration of the ablation zone prescription shape. Cardiovasc Intervent Radiol 2020;43(11):1695–1701
22 Liao J, Lu M, Wu X, et al. A preliminary study on ultrasound-guided percutaneous microwave ablation for palliative treatment of advanced head and neck malignancies. Int J Hyperthermia 2021;38(01):479–487
23 Chen YJ, Wang CP, Wang CC, Jiang RS, Lin JC, Liu SA. Carotid blowout in patients with head and neck cancer: associated factors and treatment outcomes. Head Neck 2015;37(02): 265–272
24 Lee CW, Yang CY, Chen YF, Huang A, Wang YH, Liu HM. CT angiography findings in carotid blowout syndrome and its role as a predictor of 1-year survival. AJNR Am J Neuroradiol 2014;35 (03):562–567
25 Owen RP, Silver CE, Ravikumar TS, Brook A, Bello J, Breining D. Techniques for radiofrequency ablation of head and neck tumors. Arch Otolaryngol Head Neck Surg 2004;130(01):52–56
26 Owen RP, Khan SA, Negassa A, et al. Radiofrequency ablation of advanced head and neck cancer. Arch Otolaryngol Head Neck Surg 2011;137(05):493–498
27 Belfiore MP, Sciandra M, Romano F, et al. Preliminary results in unresectable head and neck cancer treated by radiofrequency and microwave ablation: feasibility, efficacy, and safety. J Vasc Interv Radiol 2015;26(08):1189–1196
28 Sabel MS. Cryo-immunology: a review of the literature and proposed mechanisms for stimulatory versus suppressive immune responses. Cryobiology 2009;58(01):1–11
29 Weymuller EA Jr, Alsarraf R, Yueh B, Deleyiannis FW, Coltrera MD. Analysis of the performance characteristics of the University of Washington Quality of Life instrument and its modification (UW-QOL-R). Arch Otolaryngol Head Neck Surg 2001;127 (05):489–493

