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Role of Interventional Radiology in Head and Neck Region - A Review

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Abstract

Interventional radiology, having its origin in coronary angiograms of the 1950's and 1960's, consist of minimally invasive procedures for both diagnostic and therapeutic (treatment) purposes. These procedures can replace certain surgeries as it has faster recuperation than with surgery, usually no hospital admission required (done as an outpatient), uses local anesthetic instead of general anesthesia and is safe and effective. More recently, interventional radiology techniques have been applied to head and neck region and its implications in this region are continuing to expand. This article reviews the range of applications of interventional radiology in the extra-cranial head and neck.

Introduction

Interventional Radiology (IR), also known as Vascular and Interventional Radiology (VIR) or surgical radiology, is an independent medical specialty (previously a sub-specialty of radiology) providing minimally invasive image-guided diagnosis and treatment of diseases in every organ system. Society of interventional radiology defined it as 'the delivery of minimally invasive, targeted treatments, performed using imaging for guidance'. Charles Dotter, in 1960s used principles of angiography for the treatment of peripheral vascular disease [1] and led Dotter to say, in 1964, that 'it should be evident that the vascular catheter can be more than a tool for passive means for diagnostic observations: Used with imagination it can become an important surgical instrument' [2,3]. Thus, interventional radiology as a specialty was born. It is perhaps not surprising that the initial, and still best known, uses of interventional radiology were for the highly accessible vascular system, and for the type of non-vascular conditions that offered poor surgical access, such as in neurosurgery. More recently, interventional radiology techniques have been applied to head and neck cancer patients, initially with the use of detachable balloon occlusion in patients with laryngeal cancer and impending carotid artery rupture. Trauma victims with massive bleeding can be managed using interventional procedures. It has also aided in reaching to the diagnosis by making FNAC and biopsies of otherwise inaccessible regions possible. From this, the range of applications of interventional radiology in the extra-cranial head and neck has continued to evolve and expand. The main focus of this review is on the applications of interventional radiology in the head and neck region.

Diagnostic

Ultrasound/CT guided FNAC

FNAC performed under ultrasound guidance complements diagnostic ultrasound in the evaluation of head and neck lesions. It is a readily available, inexpensive, relatively noninvasive, well tolerated, and rapid outpatient procedure with reported diagnostic accuracy in malignant lymphadenopathy exceeding 90% [4].

Ultrasound-guided FNAC should be used along with CT and MRI to assess the primary tumor for the assessment of the neck as it is better to correlate with the exact histologic staging. A patient who reports with a clinical negative neck should be offered minimally invasive SNB or risk-level-based ENDs. An additional MRI can be done in selected cases (e.g., base of tongue cancer).

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Therapeutic

Acute hemorrhage management

Trauma: The interventional radiologist makes a tiny nick in the skin, about the size of a pencil tip, and inserts a catheter into the artery. The physician guides the catheter through the artery using the imaging and then releases clotting agents (coils, particles, gel, or foam) into the blood vessels, slowing the blood flow and stopping the hemorrhage from the inside out.

Interventional radiologists also can inflate a balloon inside the artery, just like in angioplasty, to stop the hemorrhaging and stabilize the patient so the surgeon can treat a wound, such as a gunshot wound. Often in the cases of massive bleeding, there is so much blood coming that it is impossible for the surgeon to see the wound from outside to repair it whereas an interventional radiologist, using imaging can visualize what they are doing from the inside of the vessel. They can see the blood supply and stop the bleeding. Also they can pinpoint the location of the wound for the surgeon or for embolization treatment. Often the jaw is in the way in the maxillofacial surgeries and the surgeon can't get to the injury, but the interventional radiologist can.

Epistaxis: Epistaxis is one of the most common complaints which is treated using simple techniques such as cautery and nasal packing. Surgical treatment for this is ligation of the anterior ethmoidal artery *via* a Lynch-Howarth (peri-orbital) incision or sometimes ligation of the external carotid artery or internal maxillary artery. The widespread use of endoscopes has meant that such open techniques are now reserved for the most refractory of cases, with most surgeons advocating endoscopic trans-nasal or trans-antral sphenopalatine artery ligation or endoscopic anterior ethmoidal artery ligation as a first line approach [5-7]. Selective embolization of bleeding vessels with particles or coils is an increasingly used treatment for such cases of refractory epistaxis, and has been shown by many to be safe and effective [8-13].

Carotid blowout: Carotid blowout can be defined as 'bleeding from the carotid artery or its branches'. The modern definition of carotid blowout describes a distinct syndrome that includes threatened (where there is radiological or clinical evidence to suspect future hemorrhage, such as an exposed carotid artery) and imminent (where there has been minor bleeding that has settled or been controlled) bleeding as well as acute carotid hemorrhage [14]. Carotid blowout is a well-known and much feared complication of advanced head and neck malignancy, whether treated surgically or with radiotherapy, and occurs in up to 3% to 4% of patients following neck dissection [15]. Endovascular treatment for such patients is now considered by some to be the gold standard for this group of patients. There are three main options available to the interventional radiologist. The first is Permanent Balloon Occlusion (PBO), in which a detachable balloon is placed in the common carotid artery, preventing blood flow into the bleeding vessel [14]. The second interventional technique available is selective embolization, using a variety of materials like coils, Gelfoam and glue to occlude bleeding vessels, leaving the main carotid trunks intact [17]. The third option is placement of an endovascular stent, which also allows continued cerebral blood flow, and may be used alone or in combination with embolization [16,18-20]. Successful treatment of patients with carotid blowout has led to the emergence of a new group of patients who present with recurrent hemorrhage or with delayed complications of endovascular stents [21,22]. Whether a new presentation or a recurrence, it remains important for the head and neck surgeon to work closely with the interventional radiologist, as a part of the multidisciplinary team, and where possible with the patient, in order to decide when such treatment is appropriate and will lead to a continued quality of life for the patient.

Tumors

Embolization has been used in the treatment of a wide variety of head and neck vascular tumors, including congenital hemangiomas. The aim in most cases is to devascularize the tumor prior to surgical excision, although in patients unfit for anesthetic, embolization may be used as a palliative measure. Embolization devascularize the tumor, minimizing blood loss during surgery.

Treatment of vasoformative tumors can often be challenging as complications ranging from minor bleeding and swelling to life-threatening hemorrhage and airway embarrassment may occur. Hemangiomas can regress spontaneously therefore its management may depend on their size, their location, their behavior, and the age of the patient. Management of these lesions has changed considerably with interventional radiology and use of sclerosing and medical therapy.

Interventional radiology also contributes to the treatment of malignant disease in the neck. Ultrasound-guided percutaneous ethanol ablation of neck nodal metastases from papillary thyroid carcinomas often performed. Percutaneous ethanol injections are used in other body parts, such as in Hepatocellular Carcinoma (HCC) [23], benign parathyroid adenomas, hyperfunctioning thyroid nodules [24], and cystic thyroid nodules [25]. Lewis et al. [26] was first to report the use of percutaneous ethanol injection treatment of limited cervical lymph node metastases from papillary thyroid carcinoma.

Patients suffering from neck and mediastinal malignancies often suffer from vocal cord paralysis caused by tumor infiltration of the recurrent laryngeal nerve. Medialization of the paralyzed vocal cord should be attained to treat unilateral vocal cord palsy. By bringing the paralyzed cord to midline or near-midline position the glottis competence on phonation and swallowing can be restored, with only one functional contralateral vocal cord. Transcutaneous vocal cord injection is usually the preferred treatment as it is simple but it is mostly a blind procedure as submucosal approach is used which at times can be difficult for accurate needle positioning particularly in patients with thick neck soft tissues in whom external judgment of the level of the vocal cords is difficult. Ultrasound guidance can be useful in this procedure [27].

Bui et al. [45] has also been, used Computed Tomography (CT) - guided percutaneous RFA for head and neck diseases for control of recurrent adenoid cystic carcinoma and in a series of patients with advanced head and neck cancer by Brook et al. [46] and Owen et al. [47].

Arterio-venous fistulas

These abnormal vascular connections can be congenital, spontaneous or traumatic. Treatment of congenital lesions is a challenge, as these have multiple, diffuse anastamoses with the surrounding vasculature [48]. Traumatic lesions can also be difficult to treat, in part due to the urgency of treatment required in order to prevent life-threatening hemorrhage, neurological deficit or visual complications. These lesions, such as the carotid to cavernous sinus fistula occurring after head injury, are also often inaccessible surgically.

The principle of treatment of arterio-venous fistulas is preservation of the normal vasculature where possible, while ensuring that both the distal and proximal vessels of the fistula are occluded. Various treatment modalities have been described, including embolization with detachable balloons, particles or sclerosants, using both arterial and venous approaches, as well as placement of endovascular stents [48-50]. Proper planning of treatment is the key to success, and again requires close cooperation between the interventional radiologist and the head and neck surgeon.

Trigeminal neuralgia

Onofrio [51] reported about use of fluoroscopic-guided Radiofrequency Ablation (RFA) rhizotomy for the treatment of trigeminal neuralgia in 140 patients.

Complications of Interventional Radiology

It is well recognized that interventional radiology procedures carry a risk of complications higher than that of angiography alone. Immediate complications include arterial puncture site hematoma, embolic or ischemic neurological deficits including visual disturbance and rarely, arterial rupture or contrast allergy. Later complications include delayed ischemia which may present with neurological sequelae, including cranial nerve deficit, as well as pain and skin necrosis or paresthesia [52,53]. Technological advances in the size and design of microcatheters has reduced the trauma and interruption to normal vascular flow that can be associated with interventional vascular procedures. In addition, access too much smaller vessels is now possible, allowing for highly selective vascular treatments, and reducing the incidence and severity of many of the possible complications. Infections may occur, those occurring around endovascular stents being particularly difficult to manage [54]. It must be remembered that, in many cases, similar complications can occur following surgical treatment. The treating radiologists and surgeons must therefore include the consideration of these risks in their decision-making process.

The Future

Many of the most exciting advances in interventional radiology are in the treatment of malignant diseases. These applications include intra-arterial chemotherapy, radiofrequency ablation of tumors and catheter-directed gene therapy [55].

There is currently much research into the role of endovascular carotid artery stenting in the treatment of carotid vascular disease, with comparisons to surgical carotid endarterectomy [56]. This is a controversial area, and results of further studies are awaited.

It is certain that with the continual evolution of imaging technology, improved design of microcatheters allowing increasingly selective vascular access, and the increasing availability of interventional radiology services, their use will expand [57]. As the specialty grows, it will be possible to safely offer more procedures on an outpatient basis [58]. This will require increasing cooperation between specialties, and in the future some authors predict direct referrals to interventional radiology from general practitioners [59].

Conclusion

Many conditions that once required open surgery can now be treated non-surgically by interventional radiologists. By minimizing the physical trauma to the patient, non-surgical interventions can reduce infection rates and recovery time, as well as shorten hospital stays.

Although the range of procedures performed by interventional radiologists is broad, the unifying concept behind these therapies is the use of the most modern, least invasive technique available in order to minimize risk to the patient and improve health outcomes.

Image-guided interventional procedures provide a safe way to diagnose and treat a variety of head and neck abnormalities. Most procedures can be performed on an outpatient basis as the procedure time is usually short. With close collaboration with clinical colleagues, innovative treatment for a variety of lesions can be developed by head and neck interventional radiologists.

The role of interventional radiology in the treatment of head and neck conditions is increasing, but remains controversial. In some cases, such as the treatment of the carotid blowout syndrome, endovascular treatments have been shown to be superior to surgical treatment, and are rapidly becoming the gold standard for cases where intervention is appropriate. In most cases, as in the preoperative embolization of tumors or in parathyroid venous sampling, interventional techniques and surgery can be used as complementary therapies. In some conditions, such as in the management of epistaxis, the exact role of endovascular therapies is still debated.

Head and neck surgery trainees must continue to be taught the necessary techniques to deal effectively with all of these conditions, but must also understand the role of interventional radiology in order to be able to offer the highest possible quality of care to their patients.

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