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Malignant Tumors of the Sinuses

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Background

The location of the nasal cavity and the paranasal sinuses make them extremely close to vital structures. Sinonasal malignancies (SNM) can grow to considerable size before presentation, and aggressive therapy may be needed in areas close to the skull base, orbits, cranial nerves, and vital blood vessels.

Problem

Although rare, sinonasal malignancies (SNM) can be lesions of immense importance. They produce few if any signs while the tumor is in its early stages. This problem is exacerbated by the fact that the initial manifestations (eg, unilateral epistaxis, nasal obstruction) mimic signs and symptoms of many common but less serious conditions. Therefore, the patient and clinician often ignore or minimize the initial presentation of these tumors and treat early-stage malignancy as a benign sinonasal disorder.

By the time ominous signs and symptoms (such as severe intractable headache, visual disturbance, or cranial neuropathy) occur, the neoplasm is often advanced. The anatomy of the nasal cavity and paranasal sinuses cause these tumors to manifest in advanced stages and complicate their treatment. They are located adjacent to important structures such as the skull base, orbits, cranial nerves, and vital vascular structures. The obvious morbidity and complications associated with surgical resection of such tumors can be severe.

Treatment of sinonasal malignancies (SNM) is best accomplished through a multidisciplinary team. Optimally, this includes a head and neck oncologic surgeon, reconstructive surgeon, maxillofacial prosthodontist, radiation oncologist, medical oncologist, neuroradiologist, pathologist, neurosurgeon, and the patient.

Epidemiology

Frequency

Sinonasal malignancies (SNM) are rare. They are more common in Asia and Africa than in the United States, where about 2000 Americans develop these malignancies each year. In parts of Asia, sinonasal malignancies (SNM) are the second most common head and neck cancer behind nasopharyngeal carcinoma. Men are affected 1.5 times more often than women, and 80% of these tumors occur in people aged 45-85 years.[1]

Approximately 60-70% of sinonasal malignancies (SNM) occur in the maxillary sinus and 20-30% occur in the nasal cavity itself. An estimated 10-15% occur in the ethmoid air cells (sinuses), with the remaining minority of neoplasms found in the frontal and sphenoid sinuses.[2, 3, 4]

Etiology

Risk factors for sinonasal malignancies (SNM) have been extensively investigated. They are complicated, multifactorial, and somewhat controversial. The idea that squamous cell carcinoma (SCCA) and adenocarcinoma in this area are associated with exposure to nickel dust, mustard gas, thorotrast, isopropyl oil, chromium, or dichlorodiethyl sulfide is well established. Wood dust exposure, in particular, is found to increase the risk of SCCA 21 times and the risk of adenocarcinoma 874 times.[5] Many of these products are found in the furniture-making industry, the leather industry, and the textile industry. A careful social and employment history should be asked of all patients presenting with symptoms concerning for sinonasal malignancies (SNM).[6, 7]

Viral infections and their relationship to malignancy is an interesting area that has not received sufficient investigation. Preliminary studies show that epidermal growth factor receptor (EGFR) and transforming growth factor-alpha (TGF-alpha) in elevated levels of expression may be associated with early events in inverting papilloma (IP) carcinogenesis. Human papillomavirus (HPV) and Epstein-Barr virus (EBV) infection may also be an early event in a multistep process of malignant transformation of inverting papilloma (IP).[8, 9, 10]

Pathophysiology

Inverted papilloma

Although inverted papilloma (IP) is a benign lesion in most cases, it can be a locally aggressive tumor with malignant potential, and for this reason the authors have included it in the discussion.

Gross examination reveals a red-to-tan mass in the nasal cavity. As opposed to benign reactive nasal polyps, inverted papilloma (IP) is commonly unilateral. Therefore, whenever a surgeon encounters a patient with a unilateral polypoid mass, the surgeon should have a high index of suspicion for inverted papilloma (IP). More than 90% of inverted papilloma (IP) are attached to the lateral wall, although they can also arise in the maxillary, frontal, or ethmoid sinuses. Full extent of the lesion can often not be determined without radiographic imaging. Biopsy is ultimately necessary. Approximately 10% of inverted papillomas (IP) harbor squamous cell carcinoma. Histologic evaluation demonstrates hyperplastic multilayered squamous-to-columnar epithelium with or without atypia.[11, 12]

Treatment of inverted papilloma (IP) is wide surgical resection, usually a medial maxillectomy, but the specific method of excision has evolved over the past several decades from open procedures to endoscopic surgery. Endoscopic approaches have the advantage of no visible scar, less pain, reduced epiphora, and, in most cases, less blood loss. Multiple studies have shown similar safety and recurrence rates between endoscopic resection and open approaches.[13, 14, 15, 16] Not all lesions, however, are amenable to endoscopic resection. Oikawa (2007) studied recurrence rates in endoscopically resected inverted papilloma (IP) and recommended external surgery for inverted papilloma (IP) that extends into the frontal sinus, supraorbital recess, or outside the paranasal sinuses, regions that are difficult to access endoscopically.[17]

Cannady (2007) further recommended a modification of the Krause staging for IP as follows:

- Modified Krause staging
    - A – Inverted papilloma (IP) confined to the nasal cavity, ethmoid sinus, or medial maxillary wall
    - B – Inverted papilloma (IP) with involvement of any maxillary wall (other than the medial wall) or frontal sinus or sphenoid sinus
    - C – Inverted papilloma (IP) with extension beyond the paranasal sinuses

These authors found that tumors in group A were amenable to complete endoscopic resection and low recurrence rates (RR) of (3%). Those tumors in group B could be resected endoscopically but often required adjunctive procedures (Caldwell-Luc approaches or osteoplastic frontal sinusotomy, respectively) for removal and RR of 20%. Those tumors in group C always required open approaches, and RR were closer to 35%.[18]

Squamous cell carcinoma

Squamous cell carcinoma (SCCA) constitutes over 80% of all malignancies that arise in the nasal cavity and paranasal sinuses. Approximately 70% occurs in the maxillary sinus, 12% in the nasal cavity, and the remainder in the nasal vestibule and remaining sinuses.[19]

Several variants of carcinoma are often considered variants of squamous cell carcinoma of the nasal cavity and paranasal sinuses. These include verrucous carcinoma, basaloid squamous cell carcinoma, spindle cell carcinoma, and transitional or cylindrical cell carcinoma. The unqualified term squamous cell carcinoma is used to indicate malignancies that have the standard features widely understood to represent that entity.[20]

The presentation is, as with all of the entities described here, extremely varied and may include a nasal mass or obstruction, rhinorrhea, epistaxis, cranial neuropathies, or pain. Long-standing lesions may alter the patient's facial features in a detectable manner, causing asymmetry or proptosis. Visual disturbances and paresthesias are not uncommon. On occasion, malocclusive phenomenon occurs with a notable mass effect arising from the floor of the maxilla and hard palate.

On clinical evaluation, the appearance is a function of the stage of the tumor. At first, it may be little more than a mass or small ulcer. With advanced disease, large ulceration, necrosis, heaped edges, and bone and soft-tissue invasion may be observed. Biopsy is necessary to classify any lesion. Wegener granulomatosis and other nonneoplastic diseases may simulate the signs, symptoms, and appearance of SCCA. Histologic examination reveals sheets, ribbons, and individual squamous, polyhedral, or round-to-ovoid cells with various degrees of keratinization.

Prognosis is improved in those patients presenting with ethmoid primaries, early lesions treated with both radiation and surgery, and with history of inverted papilloma.[21] Unlike other SCCA of the head and neck, lymph node involvement is rare and selective lymph node dissection is not advocated. The overall 5-year survival rate is 60-64%, and the recurrence rate is estimated at 31%.[19, 22, 23, 24]

Adenoid cystic carcinoma

Adenoid cystic carcinoma (ACC) is of salivary origin and is the second most common sinonasal malignancy, accounting for 10% of cases. Three histological subtypes are based on growth patters: tubular, cribriform, and solid. These subtype distinctions are important because the solid form portends a much worse prognosis than either cribriform or tubular.

Cervical lymph node involvement is rare and elective neck dissection is not indicated in most cases. Perineural invasion is common and is present in 40-60% of cases. Late recurrence and distant metastasis are frequent and can occur decades after initial presentation.

Surgery is the mainstay of therapy with postoperative radiation reserved for advanced disease, perineural involvement, or positive margins. Chemotherapy does not currently have a role in treatment. Although no scientific studies specifically address neutron beam radiotherapy for ACC of the sinonasal region, studies involving ACC in other areas of the head and neck have shown improved local control rates over traditional radiation. No overall survival benefit has been shown.[25, 26, 27] Recurrence is common, occurring in up to 55% of cases. Overall disease-specific 5-year survival rates were respectively 63% and 70% in the MD Anderson experience.[28]

Adenocarcinoma and its variants

Adenocarcinoma of the nasal cavity and paranasal sinuses is historically important and is associated with specific risk factors including exposure to wood dust, lacquers, and other organic compounds.

Both low- and high-grade adenocarcinoma can cause obstructive symptoms, rhinorrhea, or epistaxis. However, pain, paresthesias, and oral ulceration are far more common in the high-grade, poorly differentiated tumors. Regardless of grade, local destruction of the orbits and skull base is frequently seen.

Distant metastases are rare. When they do occur, the lung, liver, and bone are the sites most often involved. Metastases to the cervical lymph nodes are uncommon, even with poorly differentiated tumors.

Treatment is surgical excision with wide margins and postoperative radiotherapy for advanced disease or positive margins. One study evaluated the outcome and prognosis of 44 patients treated for sinonasal adenocarcinoma with endoscopic resection followed by radiotherapy. After 5-year follow-up, the overall survival rate was 63%, the disease-specific survival rate was 82%, and the recurrence-free survival rate was 60%. These results add support to the assertion that endoscopic resection is a valid treatment option to the open resection technique.[29] The rarity of lymph node metastasis makes elective neck dissection unnecessary.

The prognosis for low-grade adenocarcinoma is far better than that for high-grade tumors of the sinonasal area. High-grade adenocarcinomas have a reported survival rate of less than 35% at 3 years, while low-grade adenocarcinoma has a 5-year survival rate of approximately 80%.[30, 31, 32]

Malignant melanoma

Malignant melanoma is a rare disorder of the nasal cavity and paranasal sinus mucosa. It accounts for less than 1% of all malignant melanomas and less than 4% of nasal malignancies. In general, mucosal melanoma of the head and neck accounts for 55% of all mucosal melanomas; 80% are found within the nasal vault and 20% in the sinuses. Melanoma rarely metastasizes to this anatomic region; however, a careful clinical search is still indicated to rule out metastatic disease. Positive LAD is found in over 26% of patients on presentation.[33]

Clinical appearance of the lesion is that of a firm, gray-white or pink-to-black, ulcerated mass. Black coloration is a rarity, and its absence does not rule out melanoma without biopsy. Histologically, mucosal melanoma can be extraordinarily variable in appearance. Immunohistochemistry often plays an important role and is often positive for S-100, HMB-45, Melan-A, Tyrosinase, or pigment epithelium–derived factor.

The primary therapeutic modality is surgical resection with wide local margins. Although no formal randomized trials have shown benefit to radiation therapy in sinonasal melanoma, large retrospective studies demonstrate improved locoregional control. Postoperative radiation is therefore often recommended for advanced disease. Chemotherapy is currently only used for disseminated disease and palliation.[34, 35] Despite optimal therapy, median survival is less than 2 years. Beyond the typical negative risk factors of large size, deep thickness, and large volume, a review from the Mayo clinic found statistically significant survival benefit from location of the primary on the nasal septum, compared with the sinuses or lateral nasal wall.[36, 37]

Sinonasal neuroendocrine tumors

Sinonasal neuroendocrine tumors are a unique and often confusing group of sinonasal malignancies (SNM) including esthesioneuroblastoma (ENB), sinonasal undifferentiated carcinoma (SNUC), neuroendocrine carcinoma (NEC), and small cell carcinoma (SmCC). Although important histologic differences exist between these tumors, most experts agree that the largest distinction should be made between ENB and non-ENB types because of the much more favorable clinical outcome of ENB compared with the other 3.[38] Part of the confusion comes from the multiple names given to each of these tumors and the histological overlap between the tumors. Recent immunohistochemical stainings have shown these tumors to be distinct entities.

M.D. Anderson Cancer Center compared their findings of 72 patients with sinonasal endocrine tumors over a 20-year period and found the overall survival of ENB was 93% at 5 years, compared with 62%, 64%, and 28% for SNUC, NEC, and SmCC, respectively. These results occurred despite the fact that most patients with ENB were treated with local therapy alone (surgery and/or radiotherapy) versus more aggressive approaches for non-ENB tumors, including surgery, radiation, chemotherapy, and treatment of the regional lymph nodes.[39, 40, 41]

Esthesioneuroblastoma

Esthesioneuroblastoma (ENB), frequently called olfactory neuroblastoma, is an uncommon but frequently studied tumor of the sinonasal tract. It constitutes 3% of all endonasal tumors. Its presentation is similar to other sinonasal malignancies (SNM); nasal obstruction and epistaxis being the most common presenting symptoms. Most patients present in the fifth decade of life. ENB most commonly originates from olfactory cells near the cribriform plate.

ENB commonly manifests at an advanced stage, possibly because early symptoms in this location are either not

present or ambiguous. Levine and colleagues at the University of Virginia have one of the longest and most consistent single institution series of patients with ENB, and 64% of their patients present with stage C disease. A retrospective literature review by Broich et al of 945 patients found 18% of patient presenting with Kadish stage A, 32% with stage B, and 50% presenting with stage C.

Treatment of ENB changed dramatically in the 1970s with the advent of the craniofacial resection (CFR), which significantly increased 5-year survival. In the review by Broich, survival rates at 5 years were 72%, 62%, and 53%, respectively, for Kadish Stage A, B, and C tumors.[42] A meta-analysis by Dulguerov et al of publications between 1990 and 2000 compared surgery alone, radiation alone, and surgery combined with postoperative radiation and found a statistically significant benefit to combined surgery and radiation; the 5-year survival was 65%, 48%, and 37% for combined therapy, surgery, and XRT, respectively.[43]

Levine and colleagues advocate similar treatment for stage A and B tumors with the addition of chemotherapy for stage C tumors. This is based on the belief that ENB shares certain biological characteristics with other chemosensitive endocrine tumors. Chemotherapy effectiveness at Mayo Clinic was reviewed in 10 stage C patients and the best tumor response was in high-grade tumors, while minimal response was found in low-grade tumors.[44]

Despite good 5- and 10-year disease-free survival rates, late recurrence is common, occurring in approximately one third of cases, with a mean time to recurrence of 6 years. Despite a 34% recurrence rate, Levine reported 5- and 15-year survival rates after treatment for recurrent disease of 89% and 86%, respectively.

Cervical lymph node metastasis at the time of presentation is less than 5%, but long-term cervical involvement ranges from 15-30%. Prophylactic treatment of the N0 neck is recommended in “select cases” by Levine and Dulguerov, but no further guidance has been given. A similar retrospective review by Diaz et al from M.D. Anderson of 30 patients found 100% regional recurrence of stage C tumors at 10 years, but 77% overall survival rate despite the high recurrence rate.[45, 46, 47]

Sinonasal undifferentiated carcinoma

Sinonasal undifferentiated carcinoma (SNUC) is an uncommon neoplasm of the sinonasal region. The name is derived from the lack of clear-cut distinguishing histologic features of this lesion. Given the aggressive nature of this tumor, the location and frequent advanced stage of the tumor at presentation, it is rarely treated with resection alone. Studies show the 5-year survival rate is closer to 43-63%. Unlike ENB, early recurrence is common and response to re-treatment is poor. For this reason, 2-year disease-free survival is similar to 5-year survival. A study of 10 patients treated at one institution over a 10-year period found that surgery should usually only be considered when residual resectable disease is found after neoadjuvant chemotherapy.[48]

Another study by Chen et al of 21 patients with SNUC found surgery followed by postoperation XRT and chemotherapy to be effective when complete surgical margins could be obtained, increasing local control rates from 24% to 74% at 5 years. Overall survival was also increased from 40% to 50% at 5 years.[49, 50, 51, 52]

Small cell neuroendocrine carcinoma

Small cell neuroendocrine carcinoma (SmCC), similar to oat-cell carcinoma of the lungs, is reported to arise in the nasal cavity and paranasal sinuses in patients ranging aged 26-77 years. The fact that the tumor is almost always in an advanced stage by the time it comes to attention reflects it aggressive nature. Several sinuses are nearly always involved. Cervical lymph nodes and pulmonary metastases may also be involved.

Treatment is multimodal, including regiment combinations of surgery, chemotherapy, and radiation therapy. Despite maximal efforts and individualized therapy, the prognosis is poor. Median survival, as extrapolated from several studies, is less than 2 years.

Verrucous carcinoma

Verrucous carcinoma is a type of squamous carcinoma grossly characterized by a fungating appearance with complex papillary infoldings.

On histologic examination, this low-grade malignant neoplasm is composed of well-differentiated, keratinized squamous epithelium with a hyperplastic, or abundantly cellular, appearance.

An important issue related to verrucous carcinoma is the potential to progress to the more aggressive traditional squamous cell carcinoma. Verrucous carcinomas cause damage by local invasion but do not metastasize unless they contain a component of squamous cell carcinoma. On extensive examination, 20% of these lesions have demonstrated classical squamous cell carcinoma in at least one area. The rate of local invasion is also slower than with that usually observed with squamous cell carcinoma.[53]

One important and often overlooked feature of verrucous carcinoma of the head and neck is their frequent association with synchronous or metachronous tumors. These take the form of epithelial malignancies or premalignancies in the upper aerodigestive tract, with a rate as high as 37%. This association must always be considered during patient follow-up.

Lymphomas and related conditions

This category of malignant neoplasia of the sinuses and nasal cavity is complicated, poorly understood, evolving, controversial, and extensive.

In general, non-Hodgkin lymphomas are primarily found in patients in their 60s and 70s and manifest with symptoms of obstruction. Rhinorrhea and epistaxis may also be present. After the type of tumor is established, treatment is usually radiation therapy and chemotherapy, as established by protocol. The prognosis in general is variable for patients with non-Hodgkin lymphoma and, depending on the type and stage ranges, median survival ranges from less than 1 year to close to 80% at 5 years.[54]

Another controversial type of malignant lymphoid tumor is T-cell/natural killer–cell lymphoma. It has had numerous names throughout its history, including lethal midline granuloma, midline malignant reticulosis, lymphomatoid granulomatosis, angiocentric lymphoproliferative lesion, and T-cell/natural killer–cell lymphoma. Given the current knowledge, this lesion is probably best categorized as a T-cell/natural killer–cell lymphoma.[55, 56]

The tumor is a destructive sinonasal lesion associated with obstructive symptoms, bone and soft-tissue destruction, and hemorrhage. It is strongly associated with the Epstein-Barr virus and is most common in Asia and Latin America, with a patient age at presentation of 13-80 years.

Treatment has included radiation with or without chemotherapy. The chemotherapeutic regimen often includes combinations of cyclophosphamide, doxorubicin, vincristine, and prednisone. Because of past confusion about to how to categorize this disease, scientifically rigid data to ascertain the prognosis are not available. At present, the prognosis must still be considered poor, and the 5-year survival rate is less than 70% at best.

Salivary-type neoplasms

Pleomorphic adenomas, mucoepidermoid carcinoma, and other salivary gland neoplasms may arise in the nasal cavity and paranasal sinuses. On gross and histologic evaluation, they are similar to the corresponding salivary gland tumors found elsewhere.

Pleomorphic adenomas are excised with wide margins if feasible. Recurrences are re-excised, often to good effect. The behavior of mucoepidermoid carcinoma is a function of the stage, grade, size, and resection margins of the tumor. High-grade mucoepidermoid is similar to squamous cell carcinoma because it is mostly epithelia in content.

Sarcoma

Sarcomas of the sinonasal tract are rare. Given that the nasal cavity and paranasal sinuses contain nerves, blood vessels, lymphatics, smooth and skeletal muscle, fibrous tissue, bone and fat, malignant mesenchymal tumors occasionally develop. Fibrosarcomas, leiomyosarcomas, rhabdomyosarcomas, liposarcoma, malignant peripheral nerve-sheath tumors, and other lesions have been reported. Of these tumors, rhabdomyosarcoma deserves special consideration because it is one of the more frequent sinonasal malignancies in children, although it has also been reported in adults.[57, 58]

The symptoms are similar to those of other tumors in this area and sarcoma is usually in an advanced stage at the time of presentation. Bone and extensive soft-tissue destruction is not unusual.

Rhabdomyosarcomas may be classified into several subtypes. Therapy is controversial and has included a strong reliance on a combination of radiation therapy and chemotherapy. Despite current optimal therapy, 50% of patients die from this disease.[59]

Pediatric sinonasal tumors are most commonly sarcomas and have a 70% response rate to multimodal therapy.[60]

Metastatic tumors

Metastatic tumors to the nasal cavity and paranasal sinuses are well documented but uncommon. As expected, tumors that most frequently metastasize to this bony region are those that are well known to metastasize to other bones. These are the traditional metastatic tumors that seem to home in on bone and include prostate, breast, kidney, lung, and thyroid.[61]

In addition, melanomas, GI adenocarcinoma, and hepatocellular carcinoma are all reported to metastasize to the head and neck region. Whenever one suspects such a malignancy, performing an appropriate evaluation to search for a primary is imperative.[62]

Of particular importance are 2 metastatic lesions that may cause confusion. The first is the clear-cell variant of renal cell carcinoma. Its appearance can be similar to the clear-cell variant of a mucoepidermoid carcinoma. Although the pathologist should be able to distinguish these lesions, special studies, such as immunohistochemical studies and possible electron microscopy, may be required. The second metastatic neoplasm that may become problematic for the diagnostician is colorectal adenocarcinoma. This lesion may be indistinguishable from the colonic variant of primary sinus adenocarcinoma.

Recognizing the presence of a colonic or intestinal type of primary adenocarcinoma should automatically lead to an intelligent clinical and radiologic evaluation to distinguish a primary sinonasal tumor from a metastatic colorectal neoplasm.

Presentation

Initial presenting symptoms include epistaxis, nasal obstruction, recurrent sinusitis, cranial neuropathy, sinus pain, facial paresthesia, proptosis, diplopia, or an asymptomatic neck mass. Often, these mimic signs of conditions more common and less serious than malignant tumors of the sinuses. The patient often ignores early symptoms, or the clinician may minimize them, treating early-stage malignancies as infectious diseases. By the time ominous signs and symptoms (eg, severe intractable headache, visual disturbances) occur, the neoplasms are advanced and require complex management.

In addition to malignant neoplasms causing local destruction of the tissues, infectious diseases of the sinuses (eg, mucormycosis in diabetes) can cause similar destruction. In addition, certain autoimmune diseases (eg, Wegener granulomatosis) can also manifest with new growth and malignant behavior.

Finally, benign growths from outside the sinonasal tract in adjacent areas may lead to aggressive signs and symptoms and require radical and destructive therapy. Meningiomas may grow into the sinuses, and orbital tumors may extend into adjacent paranasal sinuses. Even benign conditions, such as juvenile angiofibromas or nasal gliomas, may lead to death if not recognized and appropriately treated.

This article limits itself to sinonasal malignancies (SNM) that arise from host tissues and are considered locally invasive, destructive, and possibly metastatic.

Relevant Anatomy

As with all areas of the head and neck, the relevant anatomy is extremely complex, and the various important structures are close to each other. The fine details of the anatomy of the nasal cavity and paranasal sinuses are beyond the scope of this article. However, the most important anatomic and geometric relationships of these

regions are discussed below. These regions include the nasal cavity, the frontal sinuses, the sphenoid sinuses, the maxillary sinuses, and the ethmoid sinuses.

Nasal cavity

The cribriform plate of the ethmoid bone forms the superior aspect of the nasal sinus. Branches of the olfactory nerves pierce through this plate as they enter the nasal cavity. The inferior aspect is the superior surface of the hard palate. The lateral walls are formed by portions of the ethmoid, maxilla, palatine, lacrimal, and medial pterygoid plates of the sphenoid, nasal, and inferior turbinate bones. The walls are covered with highly vascular pseudo erectile tissue with immense capacity for serious hemorrhage.

The anterior aspect is an ill-defined area artificially separated from the external nose by the upper and lower lateral cartilages and the nares. The posterior aspect is defined as the posterior choanae, where the soft palate and hard palate join. Anything posterior to this is considered the nasopharynx.

Frontal sinuses

The frontal sinuses are usually paired, but may show focal fusion. In fact, the frontal sinuses are remarkable for their size and shape variations. On average they are each approximately 7 mL in volume and conical to funnel shaped, with the apex oriented superiorly; asymmetry is common.

The superior aspect is an ill-defined stopping point of the cavity in the frontal bone. The inferior aspect is variable but almost always covers some portion of the ipsilateral orbital roof. The lateral aspects of the sinus or cavity gradually fade into more or less porous aspects of the frontal bone. The anterior aspect is bounded by the frontal bone. The posterior border is made by a table of bone separating the frontal sinus from the anterior cranial fossas.

Sphenoid sinuses

The sphenoid sinuses are unique among the paranasal sinuses because they do not arise as invaginations of the nasal cavity. Instead, they originate from embryonic rests in the nasal capsule. They are not discernible on imaging studies or autopsy until an individual is aged 2-4 years. The sinuses are full size at the age of 20 years. At this age, they each have a volume of approximately 8 mL. Orientation, geometry, position, and extent of the sinus vary so greatly that any generalization of fixed borders can give a wrong impression.

The sphenoid sinus lies immediately beneath and often anterior to the sella turcica, which encases the pituitary gland. Impressions from the carotid arteries inferiorly along the lateral sinus walls and the optic nerve superiorly can be found within the sphenoid sinus. The bony walls, floor, or ceiling of the sphenoid sinus may be dehiscent, exposing the optic nerve or carotid arteries.

Maxillary sinuses

These are paired sinuses located anteriorly on either side of the nose just below the orbits. The structure is that of a pyramid with the base located at the nasal wall. They each have a volume of 10-20 mL.

The orbital floor including the infraorbital nerve constitutes the roof or superior aspect of the maxillary sinus. The floor of the maxillary sinus is initially at the level of the nasal floor. As time passes and as the sinus undergoes progressive pneumatization, it approaches the apex of the maxillary canine tooth. In fact, extraction of the canine tooth sometimes results in an oroantral window. The nasal cavity is at the most medial aspect of the maxillary sinus. Thin bone with rich vascular turbinate tissue lines the maxillary sinus at the most medial border.

The anterior aspect is the anterior wall of the maxilla is simply the thin bony plate running from the root of the canine to the floor of the orbit. The posterior aspect of the maxillary sinus is where the converging walls of the lateral, inferior, medial, and superior walls meet below the orbits.

Ethmoid sinuses

The ethmoid sinuses are the most variable of all the paranasal sinuses. For this reason, imaging must be performed in any individual before any operation involving this area is undertaken. The ethmoid sinuses are a series

of variably interconnected air cells within bone. On average, 10 such air cells compose each of the paired ethmoid sinuses.

Portions of the superior aspect of the ethmoid sinus lie directly below the anterior cranial fossa. Regarding the inferior aspect, the orbits lie directly beneath these structures over much of their extent. They can extend into the superior wall of the maxillary sinus. In terms of the medial aspect, the lateral boney wall of the nasal cavity and the middle turbinate are the medial wall of the ethmoid. The lateral aspect of the ethmoid air cells varies in thickness. It is the medial wall of the orbit; because of its extremely thin dimension, it is called the lamina papyracea (ie, paper plate).

The anterior-most air cells of the ethmoid are actually bone perforated with an opening that is so curved it is called the hiatus semilunaris. This opening drains the frontal sinus and the maxillary sinus. The sphenoid sinus lies posteriorly over the middle aspect of the ethmoid bone.

Lymph node drainage

The lymphatic drainage of the sinuses and nasal cavity include levels I-III. In addition, the retropharyngeal lymph nodes can be site of drainage for the posterior ethmoids, posterior nasal cavity, and sphenoid sinuses.

Treatment of the N0 neck in sinonasal malignancy (SNM) is typically not recommended. A retrospective study of 704 patients with sinonasal malignancies (SNMs) of the ethmoid and maxillary sinus by Cantu (2008) found only a 1.6% lymph node involvement of the ethmoid sinuses at presentation and 8.3% in the maxillary sinus. They did note, however, that undifferentiated carcinoma had a much higher metastasis rate and tumors of the floor of the maxillary sinus also metastasized more frequently (hypothesized to be caused by its rich lymphatic supply, similar to the mouth).[63] They also found a much higher lymph node (LN) metastasis rate in T2 versus T3 and T4 tumors. A study of SCCA of the maxillary sinus by Tiwari (2000) also found a relatively low incidence of neck disease at 4.1%.[19]

In the N0 neck, judgment should be used by the tumor board in deciding appropriate treatment. Patients with the following criteria would likely benefit from selective lymph node dissection (LND): aggressive histologic types (SCCA and undifferentiated carcinoma); T2 or greater tumors; tumors of rich lymph supply, including the nasal vault and floor of maxillary sinus.

Contraindications

Therapy of sinus and nasal cavity malignancy is often multimodal. Radiation therapy, surgery, and chemotherapy are usually administered in combination. The location of the anatomic structures in question may make the outcome of surgery intolerable to some patients. These locations are adjacent and connected to the orbits, brain, skull base, hard palate, and the carotid sheath. Careful discussion with the patient and family is important before any therapeutic procedure is undertaken.

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