CT Assessment of Woodworkers' Nasal Adenocarcinomas Confirms the Origin in the Olfactory Cleft


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CT Assessment of Woodworkers’ Nasal Adenocarcinomas Confirms the Origin in the Olfactory Cleft

BACKGROUND AND PURPOSE: Endoscopic endonasal surgery let us observe that woodworkers’ nasal adenocarcinomas originate in the olfactory cleft. Our aim was the identification of CT imaging features that corroborate the olfactory cleft as the site of origin for woodworkers’ adenocarcinoma.

MATERIALS AND METHODS: We designed a retrospective study to compare CT scans of 27 unilateral olfactory cleft adenocarcinomas with 30 cases of nasosinusal polyposis (NSP) and 33 healthy sinus controls. Enlargement of the olfactory cleft, lateralization of the ethmoidal turbinate wall, and contralateral bulging of the nasal septum were measured on coronal scans passing through crista galli and posterior half of both ocular globes. Comparisons have been performed by using analysis of variance and the Bonferroni procedure.

RESULTS: The nasal septum was significantly bulging across the midline in adenocarcinoma (4.6 ± 3 mm; range, −0.1–13.7 mm) compared with NSP (0.7 ± 1 mm; range, −2.1–2.3 mm) or healthy sinus controls (0.5 ± 1 mm; range, −1.2–2 mm) (P < .001). The olfactory cleft was significantly wider in adenocarcinoma (15.1 ± 4.5 mm; range, 8.6–25.7 mm) than in NSP (3.6 ± 0.4 mm; range, 2.8–4.6 mm) or healthy sinus controls (3.3 ± 0.7 mm; range, 1.4–4.6 mm). The ethmoidal labyrinth width was significantly smaller on the pathologic side in adenocarcinoma (7.2 ± 2.7 mm; range, 3.2–14.2 mm) than in the control groups (P < .001). Whereas the angle between the conchal lamina and vertical midline was close to zero degrees in NSP (0.03 ± 2.25°; range, −5°–3°) and healthy sinus controls (0.45 ± 2.13°; range, −5°–5°), it reached 39.76 ± 13.83° (P < .001) in adenocarcinoma.

CONCLUSIONS: Radiologists should suspect nasal adenocarcinoma on sinus CT scans showing a unilateral expanding opacity of the olfactory cavity.

Materials and Methods
We designed a retrospective study to compare the CT scans of 27 consecutive woodworkers having undergone surgery under endoscopic control on unilateral olfactory cleft adenocarcinomas between January 2004 and June 2007 with the CT scans of 30 patients having undergone surgery for nasosinusal polyposis (NSP) and 33 controls with healthy sinuses.

Patients
Adenocarcinoma Group. Adenocarcinoma diagnosis was based on preoperative biopsies. Preoperative radiologic evaluation has been based on CT scans and MR images. Patients were selected for endoscopic surgery with multidisciplinary agreement involving surgeons, radiotherapists, medical oncologists, and radiologists. Contraindications to endoscopic surgery were intracranial (2 patients), intraorbital (0 patients), or facial skin invasion (1 patient). For the sake of this study, the exceptional patients having bilateral or contralateral extension of the tumor were excluded (3 patients). The study group was composed only of men between 54 and 79 years of age (mean, 68 years). They all had been woodworkers (ie, had been exposed to wood dust during their occupational life for at least 12 cumulated months; French legal mention for Occupational Diseases2).

Control Groups. Using the last digit of each number in a table of random numbers, we collected the CT scans of 30 patients (21 men; mean age, 51 years; range, 24–77 years) among 189 patients who had...
undergone surgery for NSP without respiratory epithelial adenoma-toid harmatoma (REAH) on pathologic examination in our department between 2003 and 2005. NSP is a chronic inflammatory disease of the ethmoidal sinus mucosa leading to a protrusion of benign edematous polyps from the meatus into the nasal cavity; REAH is a benign tumor originating in the olfactory cleft, which may coexist in the setting of inflammatory polyps and may enlarge the olfactory cleft width on CT, which is characterized by a glandularlike structural proliferation lined by ciliated respiratory epithelium.

We also randomly collected 33 CT scans with normal findings of healthy patients (19 women; mean age, 36 years; range, 18–62 years) from the data base of the radiology department of our institution.

**Anatomic Terminology**

The olfactory cleft (Fig 1) is a narrow chamber opening anteriorly and inferiorly into the nasal fossa, closed laterally by the turbinic wall of the ethmoidal labyrinth and medially by the corresponding nasal septum; closed superiorly, from anterior to posterior, by the nasal and frontal bones, the cribriform plate, and the anterior process of the sphenoid roof; and closed posteriorly by the anterior wall of the sphenoid sinus.

The turbinic wall of the ethmoidal labyrinth is made of the conchal lamina and the attached middle and superior (and inconsistently the supreme) turbinates; it separates the olfactory cleft from the ethmoidal labyrinth.

Because the cribiform plate lies more caudal than the ethmoidal roof, the turbinic wall of the ethmoidal ethmoidal labyrinth is attached to the ethmoidal roof due to the lateral lamella of the intracranial olfactory groove.

**CT Assessment**

Measurements were performed by using a PACS Workstation (AGFA-Gevaert, Health Care, Mortsel, Belgium) from reformatted coronal images with a bone window (level, 200 HU; width, 200 HU).

One coronal scan passing through the crista galli and the posterior half of both ocular globes was selected. In the control groups, 1 side was selected as the "pathologic side" by using a random table of numbers (even numbers for selecting the right side). We measured the following parameters:

1. **OC**, width between the midline and the septal bulging or deviation (Fig 2).
2. **CD**, width of the olfactory cleft on the pathologic side (Fig 2).
3. **ECL**, angle between the midline \(xy\) and the conchal lamina (Fig 3).
4. **DE**, width of the ethmoidal labyrinth on the pathological side (Fig 2).
5. **AE**, naso ethmoidal cavity total width (Fig 2).

**Statistical Analysis**

Descriptive statistics are presented as means, SDs, and ranges. We used analysis of variance and the Bonferroni procedure for correction of multiple testing to compare radiologic features between adenocarcinoma, polyposis, and healthy groups. The level of type I error used to determine statistical significance in the analysis was 5%. Statistical analysis was performed by using SAS System for Windows, Version 9.01 (SAS Institute, Cary, NC).

**Results**

Descriptive results are summarized in the Table.

The **OC** distance measured a significant deviation of the nasal septum toward the contralateral side of the tumor in the adenocarcinoma group, compared with the polyposis or
Contrast-enhanced CT may, in many cases, suggest the diagnosis of malignancy but does not approach the specificity of MR imaging. Tumors appear as slow-growing tumors causing gradual expansion of the olfactory cavity by pushing onto the nasal septum and the ethmoidal turbinate wall, squeezing the olfactory cleft onto the lateral wall in the healthy nasal cavity and the ethmoidal labyrinth onto the orbital wall in the tumor nasal fossa. Endoscopic surgical dissections have shown that the nasal septum perichondrium-periosteum is an effective barrier preventing invasion of the contralateral nasal fossa; the ethmoidal turbinate wall offers the same protection against invasion of the ethmoidal labyrinth. These 2 characteristics have lead to the surgical concept of endoscopic exenteration of the olfactory cleft as the treatment of choice for removing woodworkers’ adenocarcinomas.5,10

This new knowledge about the origin and growing behavior of nasal adenocarcinoma improves the imaging diagnosis. The radiologist should now suspect the diagnosis of nasal adenocarcinoma on the sinus CT scan of woodworkers on the basis of unilateral opacity of the olfactory cleft with signs of gradual expansion of the olfactory cavity (ie, bulging of the nasal septum and lateralization of the ethmoidal turbinate wall). These characteristic features have been observed in each of our 27 cases of adenocarcinoma. This highly suggests that the remodelling of the olfactory cleft can be considered the result of a tumor originating in the olfactory cleft rather than a process originating more inferiorly in the nasal cavity and growing superiorly into the olfactory cleft secondarily. This remodelling of the olfactory cleft was not observed in our 2 control groups.

We have not checked for intra- and interobserver variability in our measurements. This lack can be considered a limitation of our study because this variability could affect the level of measurement of parameters (OC, CD, DE, AE, ECL) in each group. However, the data presented in the Table show large differences between adenocarcinoma and control groups, which are probably not very sensitive to intra- and interobserver variability.

The squeezed ethmoidal labyrinth is usually opaque, but this corresponds to mucus retention in the ethmoidal cells. When one looks closely, the bony conchal lamina, which is the upper portion of the ethmoidal turbinate wall, and the bony partitions of the ethmoidal cells remain visible despite their more-or-less severe squeezing onto the orbital wall; sometimes the inferior part of the ethmoidal labyrinth is reduced to a thin opaque layer with the tumor penetrating into the maxillary sinus through the fontanelle area or bulging onto the medial orbital wall (Fig 6A). Most interesting in large tumors, the upper part of the ethmoidal labyrinth, which lies above the line tangent to the cribiform plate and below the ethmoidal roof (Fig 1), remains, most of the time, uncursed because the slow-growing tumor originating in the olfactory cleft (below the cribiform plate) sequesters a small triangle of ethmoidal cells under the ethmoidal roof (which lies more cranially) by lateralizing (not invading) the conchal lamina. All these features are confirmed and better illustrated on MR imaging (Fig 6C, -D), which is also the imaging technique of choice in the evaluation of intracranial and intraorbital extension.

### Table: Descriptive results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Woodworkers’ Adenocarcinomas (n = 27)</th>
<th>NSP (n = 30)</th>
<th>Healthy Controls (n = 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC</td>
<td>4.58 ± 3.05 (4.0–10.0)</td>
<td>0.71 ± 1.07 (0.3–1.5)</td>
<td>0.51 ± 0.98 (0.0–1.0)</td>
</tr>
<tr>
<td>CD</td>
<td>15.12 ± 4.52 (9.6–21.0)</td>
<td>3.61 ± 0.45 (2.5–5.0)</td>
<td>3.28 ± 0.98 (2.0–5.0)</td>
</tr>
<tr>
<td>DE</td>
<td>7.16 ± 2.68 (4.0–12.0)</td>
<td>14.82 ± 0.88 (10.0–20.0)</td>
<td>13.23 ± 1.47 (9.0–18.0)</td>
</tr>
<tr>
<td>AE</td>
<td>31.03 ± 4.93 (16.0–40.0)</td>
<td>29.04 ± 2.4 (23.0–31.0)</td>
<td>29.4 ± 2.12 (20.0–30.0)</td>
</tr>
<tr>
<td>ECL (degrees)</td>
<td>39.76 ± 13.83 (14.9–74.6)</td>
<td>0.03 ± 2.25 (0.0–3.0)</td>
<td>0.45 ± 2.13 (0.0–3.0)</td>
</tr>
</tbody>
</table>

Note:—NSP indicates nasosinusal polyposis; OC, width between midline and septal bulging or deviation; CD, width of olfactory cleft on pathologic side; DE, ethmoidal labyrinth width; AE, nasoethmoidal cavity total width; ECL, angle between midline and conchal lamina.

* Mean ± SD, range.
The radiologist should, however, consider a few differential diagnoses, especially in patients who are not woodworkers. Esthesioneuroma is also a unilateral tumor originating in the olfactory cleft. This rare tumor initially expands slowly and unilaterally, allowing the bone to remodel around it. Tumoral calcification is often seen. More aggressive behavior can occur with gross intracranial extension through the cribiform plate, which is better identified on MR imaging. REAH is a pathologic entity individualized by Wenig and Heffner in 1995, presenting as a benign tumor also originating and expanding in the olfactory cleft. With the methods of measurement used in the present study, it has been shown that REAH can be suspected preoperatively on CT enlargement of the olfactory clefts. REAH may coexist in the setting of inflammatory nasosinusal polyps and may enlarge bilaterally the olfactory clefts or can also develop primarily, unilaterally, or bilaterally, favoring secretion retention in the ethmoid and other paranasal sinuses. Clinically, it might present as a differential diagnosis of nasosinusal polyposis or neoplastic lesions like an inverted papilloma or adenocarcinoma. REAH must be suspected on CT enlargement of the olfactory clefts, but the final diagnosis belongs to the pathologist.

Finally, another advantage of knowing that woodworkers’
Adenocarcinomas originate in the olfactory cleft is early diagnosis of small tumors. In 2 cases in our series of 27 adenocarcinomas, the clinical presentation was limited to loss of the sense of smell. The sinus CT revealed, in both woodworkers, a unilateral opacity limited to the olfactory cleft (Fig 6B), which led to careful endoscopy of this very narrow cavity and biopsies that revealed the diagnosis of adenocarcinoma of the olfactory cleft. The most common presentation of nasal adenocarcinomas includes nasal airway obstruction, epistaxis, nasal discharge, pain, or swelling of facial soft tissue. Only poor attention has been paid to loss of the sense of smell, probably because either patients or general practitioners do not always care about the loss in sense of smell or perhaps otorhinolaryngologists do not always perform careful endoscopic examination of the olfactory cleft or ask for CT scans in patients having lost the sense of smell. Radiologists should now search for small olfactory cleft opacities more than for ethmoidal labyrinth opacities in woodworkers with anosmia and actually in all patients with anosmia. The role of systematic endoscopic and/or CT examination of the olfactory clefts in people exposed to wood dust needs to be evaluated as a means of early detection of occupational adenocarcinoma. In conclusion, most clinicians and radiologists have paid attention to the ethmoidal labyrinth during the last 2 decades. Pathology in the adjacent olfactory cleft does, however, also exist. Woodworkers’ adenocarcinoma, an occupational malignancy, was believed, until recently, to originate in the ethmoidal labyrinth. Endoscopic endonasal surgery has recently revealed its origin in the olfactory cleft. Our study indicates that CT can prospectively suggest the diagnosis of adenocarcinoma due to remodelling features of the olfactory cleft in woodworkers.

References