A Comparison between Coronal and Axial Scans in PNS CT

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ABSTRACT

Background and Objectives A coronal section computerized tomography (CT) is essential for the diagnosis of paranasal sinusitis, especially in the evaluation of the ostiomeatal unit. Although the coronal scan is preferred to the axial scan, the role of the axial scan during endoscopic sinus surgery has not been thoroughly examined. The aim of this study is to compare the advantages and disadvantages of coronal and axial scans in the paranasal sinuses. Materials and Methods Selected for study were the coronal and axial scans of 30 preoperative sinus CTs showing minimal sinus pathology. The rates of detecting 15 anatomic structures in the coronal and axial sections were analyzed across 60 sides. Results The coronal scan was superior to the axial scan in detecting eight normal structures, including the anterior ethmoid artery, the opening of the maxillary sinus and the superior meatus \( p<0.05 \). The axial scan was useful in showing the vertical portion of the 3rd basal lamella and the opening and the anterior wall of the sphenoid sinus \( p<0.05 \). Conclusion The coronal scan is more informative than the axial scan but has limitations in showing the structures lying on the coronal plane. The axial scan plays a complementary role in covering this limitation. Together, the coronal and axial sections of a sinus CT can help the surgeon to understand the three dimensional structure of the paranasal sinus before endoscopic sinus surgery.

KEY WORDS Paranasal sinus CT · Coronal scan · Axial scan.

INTRODUCTION

Radiological examination is extremely important when diagnosing chronic or acute paranasal sinusitis. Since the introduction of FESS (functional endoscopic sinus surgery), the importance of coronal computerized tomography (CT) has increased further due to the need for a clear view of the ostiomeatal unit (OMU). A coronal scan of the paranasal sinus has become a basic requirement for endoscopic sinus surgeries, because it provides images that show the surgical view more accurately than an axial scan and yields more anatomic information. But with endoscopic surgery now expanding to the entire paranasal sinuses and not just the OMU, where FESS focused, a coronal scan has been found to provide only limited information about the structures parallel to the coronal scan, such as the basal lamella. The necessity of the axial scan has thus emerged.

Maffee et al., after comparing axial and coronal scans, report that the former is better for observing the posterior wall of the frontal sinus, the bony wall between the sphenoid sinus and the posterior ethmoid sinus, the pterygomaxillary fissure and the pterygopalatine fossa. But to date there has been no report that compares the benefits and weaknesses of both scans under the actual conditions of endoscopic sinus surgery. The authors evaluated the normal structures in the coronal and axial scans of preoperative sinus CTs.

SUBJECTS AND METHODS

Subjects

Selected for study were 30 preoperative sinus CTs showing minimal pathology, which allowed for easy observation of the anatomic structures. The sample was selected from CTs performed on patients who were suspected of suffering from chronic paranasal sinusitis from March 1996 to September 1999 at Samsung Medical Center. The CTs of patients who had undergone paranasal sinus surgery in the past, who displayed anomalies in the head or face or who were under the age of 20 were
excluded. The gender ratio between male and female was 17\(\div\)13, and the patients’ ages ranged from 20 to 81 years and averaged 37 years.

**Method**

The paranasal sinus CTs included both coronal and axial scans using the bone algorithm. The coronal scans were taken of an area running from the anterior wall of the frontal sinus to the posterior margins of the sphenoid sinus, while the axial scans encompassed an area running from the frontal sinus to the floor of the maxillary sinus. Both the coronal and axial scans were taken continuously with 3 mm thickness.

The 30 paranasal sinus CTs were divided into left and right sides and the 60 sides of the coronal and axial scans were analyzed using PACS (Picture Archiving and Communication System). A total of 15 anatomic structures of the nasal cavities and paranasal sinuses were examined on the coronal and axial scans (the uncinate process, the infundibulum, the ethmoid bulla, the supraorbital recess, the agger nasi cell, the nasolacrimal duct, the olfactory groove, the anterior ethmoid artery, the horizontal and vertical portions of the 3rd basal lamella, the ostium of the maxillary sinus, the superior meatus, the anterior wall of the sphenoid sinus, and the optic nerve. Also analyzed were the opening of the conchal cell, the accessory opening the maxillary sinus, the Haller cell and the Onodi cell as anatomic variations.

Analysis of each anatomic structure was conducted by two otolaryngology doctors independently and those cases that were confirmed by the both were classified as “Able to Confirm”, while cases that were not confirmed by the both were classified as “Not Able to Confirm”. The differences between the coronal and axial scans were analyzed using the chi-square test. The acceptable level of significance was set at p<0.05.

**RESULTS**

**Analyses of 15 normal anatomic structures (Table 1)**

The nasolacrimal duct, the olfactory groove and the optic nerve could be fully observed in both the coronal and axial scans. The uncinate process, the infundibulum, and the ethmoid bulla could be observed in more than 80% of the coronal and axial scans, with the former being more informative than the latter. The anterior ethmoid artery, the horizontal portion of the 3rd basal lamella, the ostium of the maxillary sinus and the superior meatus were easily observable on the coronal scans while observation of these structures on the axial scans was possible in less than 30% of cases (p<0.05) (Fig. 1, 2, 3, 4).

Structures that could be observed better in the axial scans were the vertical portion of the 3rd basal lamella, the ostium and the anterior wall of the sphenoid sinus (p<0.05) (Fig. 4, 5).

The agger nasi cell was similarly observable in both coronal and axial scans, in 80% and 83.3%, respectively (p>0.05).

**Analysis of other anatomic variations**

The conchal cell was observed in nine cases while the opening was observed easily in the axial scans. The accessory opening of the maxillary sinus was observed in five cases while the Haller cell, which appeared in eight cases, was observed in the coronal scans. The Onodi cell, which was observed in six cases, could be identified exactly when both scans were combined. These structures, however, were excluded from the statistical analysis due to small numbers.

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**Table 1. The detection rate (%) of normal anatomic structures in coronal and axial CTs of the paranasal sinuses**

<table>
<thead>
<tr>
<th>Anatomic Structure</th>
<th>Coronal Section (n=60)</th>
<th>Axial Section (n=60)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP(^*)</td>
<td>100</td>
<td>88.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Infundibulum</td>
<td>100</td>
<td>83.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Ethmoid bulla</td>
<td>95</td>
<td>80</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>SR(^1)</td>
<td>88.3</td>
<td>55.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>AN(^1) cell</td>
<td>80</td>
<td>83.3</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>NLD(^2)</td>
<td>100</td>
<td>100</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Olfactory groove</td>
<td>100</td>
<td>100</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Ant. Ethmoid a.</td>
<td>91.7</td>
<td>18.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>3rd basal lamella, vertical portion</td>
<td>38.3</td>
<td>75.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>3rd basal lamella, horizontal portion</td>
<td>100</td>
<td>0.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Maxillary ostium</td>
<td>100</td>
<td>20.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Sup. Meatus</td>
<td>88.3</td>
<td>21.7</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>SS(^3) opening</td>
<td>23.3</td>
<td>73.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Anterior wall of SS(^4)</td>
<td>15.0</td>
<td>98.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Optic nerve</td>
<td>100</td>
<td>100</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>
DISCUSSION

In the endoscopic sinus surgery, the coronal scan is generally preferred to the axial scan and has become a basic preoperative examination, because it provides images that is similar to the views of the surgical field, thus allowing easy comparisons between the operative view and the scan with regards to the order of the uncinate process, the ethmoid bulla, the 3rd basal lamella and the sphenoid sinus. At times, however, the coronal scans may contain the radial blurring from the dental prosthesis or amalgams.

In CTs, each scan shows all of the information obtained from the scanned area on an average, so a structure that is thinner than the section thickness presents a partial volume effect. Accordingly, structures that are at a right angle to the section plane are shown clearly while those that are parallel to the section plane are hard to identify. Due to these problems, structures that are parallel to the coronal plane are seen more clearly in the axial scan. Most of the structures that separate the paranasal sinuses such as the basal lamellas including the 3rd basal lamella and the anterior wall of the sphenoid sinus are located in coronal plane.

The nasolacrimal duct, the olfactory groove, and the optic nerve were observed in both sections, making it impossible to distinguish the difference between the two sections. Of the remaining structures, observation was possible in more than 70% of cases for nine structures in the coronal scans, while seven structures were observable in more than 70% of cases in the axial scans.

The structures that were observable in more than 80% of cases in both sections were the uncinate process, the infundibulum and the ethmoid bulla. Although these structures were more observable in the coronal scans, the clinical significance was considered to be minimal. The structures that were more easily observable in the coronal...
scans than in the axial scan were the anterior ethmoid artery, the opening of the maxillary sinus, the superior meatus and the horizontal portion of the 3rd basal lamella. The anterior ethmoid artery was more visible in the coronal scan than in the axial scan because it runs anterior from the lamina papyracea to the medial wall of the ethmoid sinus. A number of coronal scans showed the anterior ethmoid canal and especially the point at which the artery entered the lamina papyracea. There have been report that a 1 mm thickness scan of the axial section allows 100% observation of the anterior ethmoid artery, but it would be difficult to scan the paranasal sinus at a 1 mm thickness under ordinary clinical conditions. The opening of a maxillary sinus that has a tubular structure is observed in a single section of coronal scan, especially the area that is connected to the infundibulum, which is located between the ethmoid bulla and the uncinate process. In an axial scan, it is difficult to observe unless a single image covers the entire area running from the infundibulum to the opening of the maxillary sinus.

Structures that were more visible in the axial scans included the middle vertical portion of the 3rd basal lamella, the anterior wall and the opening of the sphenoid sinus. In particular, the middle portion of the 3rd basal lamella was present in 100% of axial scans, while its detection rate as the 3rd basal lamella was only 75%, when it was traced along with the middle turbinate. In the remaining 25% of cases, it was difficult distinguish the 3rd basal lamella. The detection rate of the anterior wall of the sphenoid sinus was 73.3% in axial scans and 23.3% in coronal scans. Although it is named the “anterior wall”, it is properly called the anterior superior wall when the large sphenoehtmoid cell is present. In 10% of cases where the sphenoehtmoid cell existed, the anterior wall was visible also in the coronal scan, suggesting that observation of both scans is necessary to understand the relationship between the posterior ethmoid and the sphenoid sinus. The opening of the sphenoid sinus was mostly observed in the axial scans. In the coronal scans, its existence was observed in 15% of cases as a circular shape and appeared as a semicircle in the remaining 85%, thus giving information only about its location (Fig. 5).

The agger nasi cell was detected in 80% of both scans, but in most cases it was hard to distinguish from the adjacent ethmoid bulla. The uncinate process was also easily observed in both scans, but only the coronal scans provided enough information to determine whether the attached area was the skull base-type or lamina papyracea-type.

Even if a structure is easily observed in both scans, each scan shows different portion of the structures because of their three-dimensional quality. For example, the ethmoid bulla’s upper and lower walls appear in the coronal scan but it is its anterior and posterior walls that are visible the axial scan. Therefore, the axial scan is preferable to the coronal scan when seeking a relation between the 3rd basal lamella and the posterior wall of the ethmoid bulla. In other words, the axial scan is better for identifying the adherence of the posterior wall of the ethmoid bulla and the 3rd basal lamella or the opening in the posterior area of the ethmoid bulla. That is to say, determining the type of scan should be based on the purpose of the analysis.

To make up for the limitations of the coronal scan and arrive at a proper diagnosis, there have been attempts to add one or two axial scans to the number of coronal scans. These small number of axial scans may be helpful for diagnosis but such discontinuous scans may not be used as a roadmap for operations.

The accessory opening of the maxillary sinus was well observed in both scans, when the opening was patent. The Haller cell which is known to cause obstructions of the osteomeatal unit in 9–5% of cases was confirmed in 8 coronal scans, while its existence was hard to confirm in the axial scans. Concha bullosa, which is known to cause obstruction of the osteomeatal unit in 20–31% of cases was also observed in both scans. But the opening of the concha bullosa was observed mainly in the axial scans. The supraorbital cell expands from the ethmoid sinus to above the superior wall of the orbit, which is reported to be found in 21% of Europeans and 61% of Asians. Its existence was clearly visible in the coronal scans, but when deeply pneumatized into the frontal bone, it was more easily observable in the axial scans.

The results of this study suggest that coronal scans are more informative than axial scans and are more helpful for operations. But those areas that coronal scans cannot show can be covered by axial scans.

**CONCLUSION**

In general, the coronal scans were better than the axial scans in detecting the anatomic structures of the paranasal sinus, especially the anterior ethmoid artery, the superior meatus, and the opening of the maxillary sinus,
which were hard to observe in the axial scans. But in the case of structures that exist on the coronal plane, such as the vertical portion of the 3rd basal lamella, the anterior wall and the opening of the sphenoid sinus, the axial scans demonstrated some advantages. Because structures that are parallel to each scan plane are hard to observe, performing both scans would be useful in understanding the three-dimensional structure.

REFERENCES