Radio-opacity of the paranasal sinuses. Conventional views and CT*

T. Iinuma[1], Y. Hirota[1], Y. Kase[2]

[1] Department of Otolaryngology, Saitama Medical College, Saitama, Japan
[2] Department of Otolaryngology, Tokyo University Branch Hospital, Tokyo, Japan

SUMMARY

In order to examine the reliability of conventional views in predicting the degree of radio-opacity, irrespective of soft tissue or fluid seen in chronic sinusitis in adults, a comparison has been made between the results of evaluations by two routine views (Caldwell's and Waters') and by CT in axial scans. Ninety-seven sides (61 case) were included in the study. The radio-opacity was classified into three groups according to the degree of aeration or radiolucency. The diagnosis of plain films were classified into three categories (matched diagnosis, over-diagnosis, and under-diagnosis) in comparison to the radio-opacity depicted by corresponding CT scans. The incidences of matched diagnosis are, in the order of percentages: maxillary sinus (78.4%), frontal sinus (71.1%), nasofrontal area (66.0%), anterior ethmoidal cells (52.6%), and posterior ethmoidal cells (52.6%). The incidence of over-diagnosis is highest in the posterior ethmoidal cells (52.6%) and lowest in the maxillary sinus (20.6%). The incidence of under-diagnosis is highest in the anterior ethmoidal cells (24.7%) and lowest in the maxillary sinus (1.0%).

Key words: paranasal sinuses, radiography, computed tomography, plain radiographs

INTRODUCTION

We always thought it remarkable that, while the discussion about the information obtained by CT and/or MRI have been and will be florid, only scattered reports are available for the reliabilty of conventional views for paranasal sinus lesions by comparing these views either with CT or MRI. Apart from a remote future when the conventional views will be replaced by safe and non-invasive modalities such as MRI, the convention-al views will continue to be obtained. A comparison was made between the findings of conventional views and CT by the or-bital wall fractures in our previous report (Iinuma et al., 1994). The aim of the present study was to examine the reliability of conventional views in predicting the degree of radio-opacity seen in chronic sinusitis in adults. A comparison was made between the results of evaluations by two routine views (Caldwell's and Waters') and by CT in axial scans.

METHODS

The present study was limited to adult patients, 17 years or older, with the indications for sinusectomies. Ninety-seven sides (61 cases) were first evaluated by two routine views of Caldwell (occipito-frontal) and Waters (occipito-mental). CT was performed to look for details of surgical anatomy and disease, within two weeks after the evaluations by plain films. Conventional views were taken in a recumbent position with face down, and CT was performed with a Toshiba TCT 60A/60. Slice thickness was 5 mm, and the images were processed both by soft tissue and bone settings. For the evaluation of radio-opacity, a bone window setting of window width 800–900 and window level 10–50 was used.

The radiographic anatomy of paranasal sinuses is shown in Figure 1. Although the radiographic anatomy of the anterior and posterior ethmoidal cells is arbitrary, the radiographical are-as as indicated in Figure 1 correspond to the radiographic ana-tomy of the medial orbital walls and are approximately ade-quate for the practical purposes. The anterior ethmoidal cells are medial to the anterior portion of the medial orbital wall, and the posterior ethmoidal cells are medial to the posterior portion of the medial orbital wall and superio-medial to the ethmoid-maxillary plate. The radio-opacity, i.e. a soft-tissue density irres-pective of fluid or mucosa, was classified into three groups according to the degree of aeration or radiolucency of the sinu-ses in Figure 2. The area for the corresponding sinus was rough-ly evaluated in three degrees of aeration. In Group I the degree
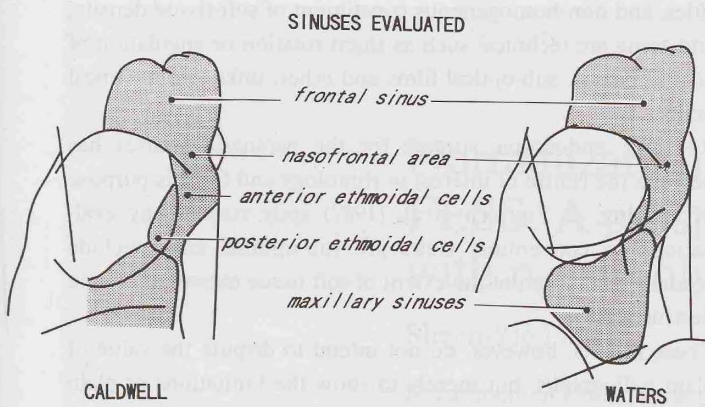
SINUSES EVALUATED

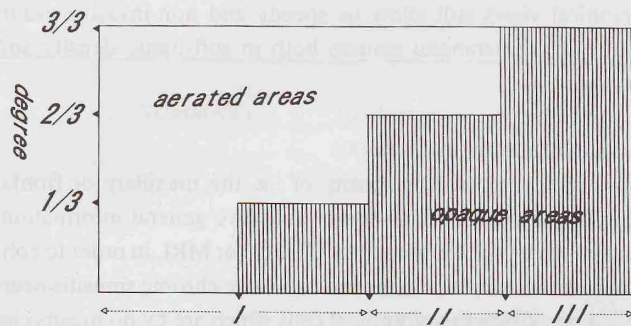Figure 1.   Radiographical anatomy of the paranasal sinuses.

Figure 2.   Classification of radiolucency into three groups.

of aeration is from 3/3 to 2/3, in Group II from less than 2/3 to 1/3, and in Group III from less than 1/3 to 0/3. The opaque or non-aerated area increases from I to III.

A CT slice in which the corresponding sinus shows maximal dimensions was chosen for the evaluation. The assumption was made that axial scans accurately depict radio-opacity of the sinuses. To minimize variations among observers the evaluations were done by the senior author alone. The two plain films of Caldwell's and Waters' views were first evaluated all through the cases without the benefit of CT. On independent occasions, CT scans were interpreted.

RESULTS

The results of comparisons between the plain films and the axial CT scans are seen in Table 1. The diagnosis by plain films was classified into three categories: matched diagnosis (the result by plain films matched that of CT according to the classification of Figure 2), over-diagnosis (the results of plain films overestimated the radio-opacity), and under-diagnosis (the results of plain films underestimated the radio-opacity). The incidences of matched diagnosis are, in the order of percentages: maxillary sinus (78.4%), frontal sinus (71.1%), nasofrontal area (66.0%), anterior ethmoidal cells (52.6%), and posterior ethmoidal cells (45.4%). The incidence of over-diagnosis is highest in the posterior ethmoidal cells (52.6%) and lowest in the maxillary sinus (20.6%). The incidence of under-diagnosis is highest in anterior ethmoidal cells and lowest in maxillary sinus. As an average, the matched diagnosis is seen in 62.7%, the over-diagnosis in 28.4%, and the under-diagnosis in 9.9%. The results allow us roughly to state that the two sets of routine plain films will demonstrate the radio-opacity of paranasal sinuses by the following incidences: 60% of proper estimation, 30% of overestimation, and 10% of underestimation.

In Table 2 the incidences of the matched diagnosis in the various sinuses are shown according to the groups by degrees of aeration as depicted by axial CT scans. For example, Group I frontal sinuses comprised 63 sides in CT and matched diagnosis was obtained in 48 sides, thus the incidence for matched diagnosis in this case is 76.2%. The distribution of matched diagnosis by degree of aeration differs from sinus to sinus. In Figure 3, the distribution is shown schematically. Both the frontal sinus and nasofrontal area show a notched type of distribution, and the matched diagnosis is poor in Group II. The anterior ethmoidal cell shows a sloping-down distribution, and the matched diagnosis is poor in Groups II and III. The posterior ethmoidal cells show sloping-up distribution, and the matched diagnosis is poor in Group I. The maxillary sinus shows a slight tendency of sloping-up distribution, but the matched diagnosis is even in all the three groups.

Table 1.   Diagnosis of radio-opacity by conventional views.

	FS	NFA	AEC	PEC	MS	average
matched diagnosis	69 (71.1%)	64 (66.0%)	51 (52.6%)	44 (45.4%)	76 (78.4%)	62.7%
over-diagnosis	23 (23.7%)	21 (21.6%)	22 (22.7%)	51 (52.6%)	20 (20.6%)	28.4%
under-diagnosis	5 (5.2%)	12 (12.4%)	24 (24.7%)	2 (2.1%)	1 (1.0%)	9.9%

FS: frontal sinus; NFA: nasofrontal area; AEC: anterior ethmoidal cells; PEC: posterior ethmoidal cells; MS: maxillary sinus

Table 2.   Distribution of matched diagnosis by degree of aeration (Matched diagnosis by convential views/number of I, II and III).

group	FS	NFA	AEC	PEC	MS
I	48/63 (76.2%)	40/57 (70.2%)	34/56 (60.7%)	15/56 (26.8%)	36/49 (73.5%)
II	2/13 (15.4%)	8/16 (50.0%)	6/14 (42.9%)	16/27 (59.3%)	7/25 (68.0%)
III	19/21 (90.5%)	16/24 (66.7%)	11/27 (40.7%)	13/14 (92.9%)	23/23 (100%)

FS: frontal sinus; NFA: nasofrontal area; AEC: anterior ethmoidal cells; PEC: posterior ethmoidal cells; MS: maxillary sinus
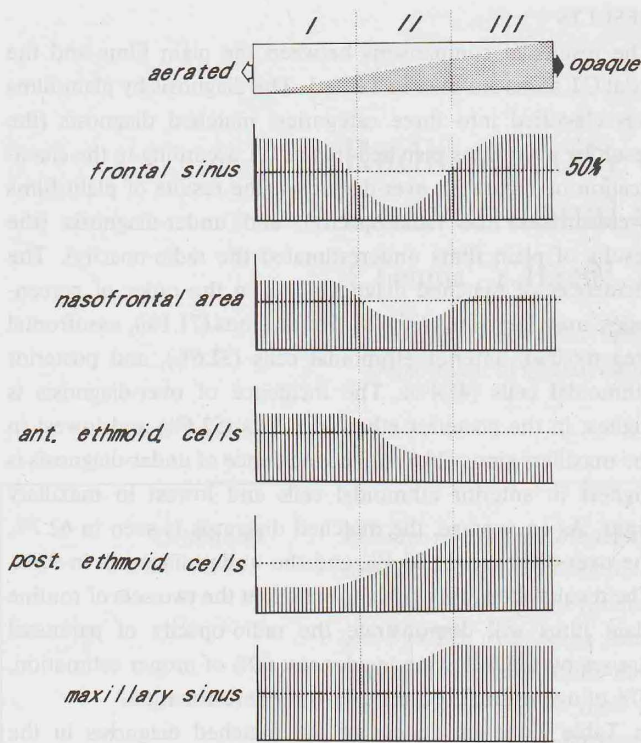
Figure 3. Degree of aeration and matched diagnosis.

DISCUSSION

The so-called standard projections for the nose and paranasal sinuses differ both in institutions and in generations. The advent of CT and MRI, in particular, poses limitations upon the number of standard projections. Axelsson et al. (1974) recommend two projections of the occiptio-mental and occipito-frontal, whereas Hayward et al. (1990) recommend only the occipito-mental. Our practice in the past 10 years has been to use two routine projections of occipito-mental (Waters') and occipito-frontal (Caldwell's) in adults and one projection of Waters' in children from 4-7 years old. The radiolological inaccuracy has been the subject of discussion in two ways: to compare the results of plain films and sinoscopy (Illum et al., 1972; Pfleider et al., 1986), and to compare the results of plain films and CT (McAlister et al., 1989). Illum et al. (1972) reported that the results of the plain films were in agreement with those of antroscopy in 62.5%. Pfleider et al. (1986) reported matched diagnosis in 44%, false-positive results in 35%, and false-negative results in 9%. McAlister et al. (1989), in a study similar to ours but using coronal scans in infants and children instead, demonstrated the discrepancies between the results of plain films of Caldwell's, Waters', and lateral views, and CT scans as follows: frontal sinus 15.6%; ethmoidal cells 29.3%; maxillary sinus 22.9%; and sphenoidal sinus 31.0%. No exact comparisons among the results of these reports including ours are possible since the modes of studies are dissimilar only to allow us to compare tendencies. The reasons for this radiological inaccuracy are manifold, some are inherent such as superimposition of structures other than sinuses, sloping sinus walls, irregular dimensions of sinuses, asymmetry between two sides, and non-homogeneous constituent of soft-tissue density, and some are technical such as slight rotation or angulation of central beams, sub-optical films and other, unknown technical faults.

Recently, endoscopic surgery for the paranasal sinuses has become the centre of interest in rhinology and for this purpose of imaging, as Zinreich et al. (1987) aptly state, many evaluations by conventinal views are sub-optimal and preclude accurate evaluation of the extent of soft tissue masses and bone destruction.

These reports, however, do not intend to dispute the value of plain radiographs, but merely to show the limitations of plain radiographs. With these limitations in mind and dispensing non-contributing numbers of projections, the standard radiographical views still allow us speedy and non-invasive evaluation of the paranasal sinuses both in soft-tissue density and bones.

CONCLUSION

In chronic sinusitis an opacity of i.a. the maxillary or frontal sinuses on conventional X-rays only give general information, and has to be supplemented by CT and/or MRI, in order to confirm the extent of the inflammation since chronic sinusitis nearly always afflicts the ethmoidal cells which are by no means clearly enough visualized by plain radiographs.

REFERENCES

1. Axelsson A, Jensen C (1974) The roentgenologic demonstration of sinusitis. AJR 122: 621–627.
2. Hayward MWJ, Lyons K, Ennis WP, Bees J (1990) Radiography of the paranasal sinuses. One or three views? Clin Radiol 41: 163–164.
3. Iinuma T, Hirota Y, Ishio K (1994) Orbital wall fractures. Conventional views and CT. Rhinology 32: 81–83.
4. Illum P, Jeppsen F, Langebaek E (1972) X-ray examination and sinoscopy in maxillary sinus disease. Acta Otolaryngol (Stockh) 74: 287–292.
5. McAlister WH, Lusk B, Kuntz HK (1989) Comparison of plain radiographs and coronal CT scans in infants and children with recurrent sinusitis. AJR 153: 1259–1264.
6. Pfleider AG, Croft CB, Lloyd GAS (1986) Antroscopy: its place in clinical practice. A comparison of antroscopic findings with radiographic appearances of the maxillary sinus. Clin Otolaryngol 11: 455–461.
7. Zinreich SJ, Kennedy DW, Rosenbaum AE, Gayler BW, Kumar AJ, Stammberger H (1987) Paranasal sinuses: CT imaging requirements for endoscopic surgery. Radiology 163: 769–775.

T. Iinuma, M.D.
Department of Otolaryngology
Saitama Medical College
Morohongo 38
Moroyama-machi
Iruma-gun
Saitama-ken
Japan 350-04