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Evaluation of the postoperative maxillary sinus with computed tomography

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ABSTRACT

Purpose : To evaluate the computed tomographic appearances of post-operative maxillary sinuses.
Materials and Methods : 33 asymptomatic cases of post-operative maxillary sinus without evidence of any pathologic changes and clinical symptoms were selected. CT images were classified as opacification, soft tissue shadow, anterior wall depression, naso-antral communication, and compartmentalization. The relationships between the CT image and the age of patients at the time of operatation, and between the CT image and the duration of time elapsed since the surgical procedure were evaluated.
Results : The most commonly presented radiological characteristics that occurred after the Caldwell-Luc procedure were opacification and soft tissue shadow. Anterior wall depression and naso-antral communication were radiographic indications that a Caldwell-Luc operation had been carried out. The age of patients when they had been first operated on, and the duration between the surgical procedure and the time of evaluation had no effect on the CT appearances of normal changes. In cases involving a longer time interval between the antral surgery and evaluation, the anterior wall depression with bony healing was more commonly observed than soft tissue healing.
Conclusion : The radiographic information regarding the normal healing state using computed tomography can distinguish post-operative changes from inflammatory and cystic disease in patients who have undergone a Caldwell-Luc type of radical maxillary antrostomy. (***Korean J Oral Maxillofac Radiol 2002; 32 : 195-200***)

KEY WORDS : tomography, x-ray computed; maxillary sinusitis

The Caldwell-Luc operation was described independently by Caldwell in the United States and Henri Luc in France in the 1890s. This operation is known to be effective for the treatment of chronic purulent inflammatory disease within the maxillary antrum. It has two basic procedures: the evacuation of the maxillary sinus and the creation of a permanent naso-antral window which usually result in a surgical cure. There are two discrete areas of assessment in radiologic findings in the maxillary sinus following Caldwell-Luc surgery - that of the "normal", quiescent, or nondiseased postoperative maxillary sinus and that of the antrum affected by continued or recurrent disease. Cable et al.[1] reported that in the radiological investigation of post-operative antra, CT was superior to hypocycloidal tomography and plain films, since it was easier to perform and more information was obtained. Unger et al.[2] reported that follow-up studies, including pluridirectional tomography and CT, could reliably differentiate pathological changes from those which were surgical sequelae. Ohba et al.[3] compared the panoramic radiographic features of the post-Caldwell-Luc maxillary sinus with the CT findings. But the detailed evaluation of the CT features of nondiseased postoperative maxillary sinus has rarely been done.

The objective of this study was to describe the normal post-operative state with the CT scan and to evaluate the relationship between the CT findings and the age of patients when they had been first operated on sinuses and between the CT findings and the duration between the first surgical procedure and the time of evaluation.

Materials and Methods

This study included 87 cases of CT scans which were obtained at the Department of Oral Radiology in Seoul National University Dental Hospital between 1994 and 2000 from patients who had operated on one or both sides of maxillary sinuses. Pathologic changes like post-operative maxillary cysts and recurrent maxillary sinusitis were excluded and 33 cases of asymptomatic post operative maxillary sinus were selected.

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These patients were 18 males and 15 females ranging in age from 27 to 65 years (mean: 48 years) and the duration between the fist surgical procedure and the time of evaluation ranged from 1 to 46 years, with an average of 19 years (Table 1, 2, 3).

All the cases were investigated by coronal and axial CT scans. The criteria for the CT evaluation of post-operative state included opacification of antrum, soft tissue shadow, anterior wall depression (Fig. 1), naso-antral communication (Fig. 2) and compartmentalization (Fig. 3). We classified opacification of antrum into three types: generalized opacification (Fig. 4), partial opacification and postero-lateral wall bony thickening, and soft tissue shadow into two types: generalized soft tissue shadow (Fig. 5) and partial soft tissue shadow, and anterior wall depression into two types: bony healing and soft tissue healing.

The relationships between the CT findings and the age of patients when they had been first operated and between the CT findings and the duration between the first surgical procedure and the time of evaluation were also evaluated.

Fig. 1. Axial projection of CT scan shows anterior wall depression. The right antrum appears normal and postoperative maxillary cyst is observed on the left antrum.

Table 1. Location and sex distribution

	Male	Female	
Right	7	10	17 (51.5%)
Left	11	5	16 (48.5%)
	18 (55%)	15 (45%)	33 (100%)

Table 2. Age of patients when they had been first operated on sinuses

Age	Male	Female	
10-19	4	4	8 (24.2%)
20-29	5	7	12 (36.4%)
30-39	3	2	5 (15.2%)
40-11	6	2	8 (24.2%)
	18 (55%)	15 (45%)	33 (100%)

Table 3. The duration between the first surgical procedure and the time of evaluation

Years	No. of cases
0-9	4 (12.1%)
10-19	14 (42.4%)
20-29	5 (15.2%)
30-39	8 (24.3%)
40-11	2 (6.0%)

Fig. 2. Coronal projection of CT scan shows the naso-antral window on the left side. The right side demonstrates postoperative maxillary cyst.

Fig. 3. Axial projection of CT scan shows compartmentalization on the right side.

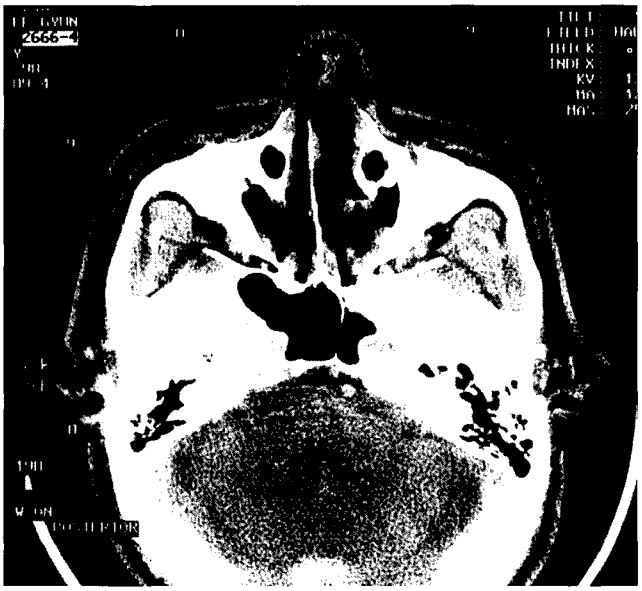

Fig. 4. Axial projection of CT scan shows generalized opacification in the left maxillary sinus. The right maxillary sinus was symptomatic due to a postoperative maxillary cyst.

Results

The opacification of the antrum was present in 32 cases (97 %) with the generalized opacification in 5 cases (15 %), the partial opacification in 6 cases (19%), and the thickening of the postero-lateral wall in 21 cases (66%). Soft tissue shadow was seen in 19 cases (58%) with the generalized soft tissue shadow in 10 cases (53%) and the partial soft tissue shadow in 9 cases (47%). Defect in the anterior wall of the antrum was detected in all cases with the bony healing in 15 cases (45%) and soft tissue healing in 18 cases (55%). Naso-antral communication was present in 18 cases (55%). The least common post-operative change was compartmentalization, which occurred in 7 cases (21%) (Table 4).

Table 4. CT appearance of the postoperative antra

CT appearance	No. of cases
Opacification	32 (97%)
generalized opacification	5 (15%)
partial opacification	6 (19%)
postero-lateral wall bony thickening	21 (66%)
Soft tissue shadow	19 (58%)
generalized soft tissue shadow	10 (53%)
partial soft tissue shadow	9 (47%)
Anterior wall depression	33 (100%)
bony healing	15 (45%)
soft tissue healing	18 (55%)
Naso-antral communication	18 (55%)
Compartmentalization	7 (21%)

Table 5 shows the distribution of the CT appearance according to the age of patients when they had been first operated on sinuses. In the patients when they had been operated in their 10s, generalized opacification was not detected and postero-lateral wall thickening was detected in 75% of cases. In the patients when they had been operated in their 20s, postero-lateral wall thickening was detected in 58% of them and partial opacification and generalized soft tissue shadow were not detected. In the patients when they had been operated in their 30s, generalized opacification and partial soft tissue shadow were not detected and generalized soft tissue shadow was detected in 80% of them. In the patients when they had been operated in their 40s and over, all kinds of CT appearance were detected and postero-lateral wall thickening was detected in 75% of them (Table 5).

Table 6 shows the distribution of the CT appearance and the

Fig. 5. Axial projection of CT scan shows generalized soft tissue shadow in the right maxillary sinus. Postoperative maxillary cyst is observed in the left antrum.

Table 5. Distribution of the CT appearance according to the operation age

CT appearance \ Operation age (years)	10-19	20-29	30-39	40-
Generalized opacification		3		2
Partial opacification	2		2	2
Postero-lateral wall thickening	6	7	3	6
Generalized soft tissue shadow	2		4	4
Partial soft tissue shadow	2	5		2
Anterior wall depression				
bony healing	4	6	2	3
soft tissue healing	4	6	3	5
Naso-antral communication	6	9	1	2
Compartmentalization	3	2		2

Table 6. Distribution of CT appearance according to the duration between the surgical procedure and the evaluation time

Duration (years) \ CT appearance	0-9	10-19	20-29	30-39	40-
Generalized opacification	1	2		2	
Partial opacification	1	2	2	1	
Postero-lateral wall thickening	2	9	3	5	2
Generalized soft tissue shadow	2	4	2	2	
Partial soft tissue shadow	1	6	1	1	
Anterior wall depression					
bony healing	1	5	3	5	1
soft tissue healing	3	9	2	3	1
Naso-xantral communication	1	8	3	4	2
Compartmentalization		4	1	1	1

duration between the surgical procedure and the time of evaluation. Soft tissue shadow was not detected in the duration ranged over 40 years, and compartmentalization was not detected in the duration ranged under 10 years. There was a tendency that the anterior wall depression with bone formation was more observed than with soft tissue healing with increasing duration.

Discussion

The main radiological appearances after a Caldwell-Luc procedure are antral radiopacity and contraction and thickening of the bony walls.[4-6] In our study the radiologic signs of post-operative sinuses were classified as opacification, soft tissue shadow, anterior wall depression, naso-antral communication and compartmentalization on CT images. This study demonstrated that true bony thickening was a common post-operative sequel. It usually occurred in the postero-lateral wall of the antrum, and did not appear to affect the operative result. Unger et al.[2] mentioned that changes seen after the Caldwell-Luc procedure were due to fibro-osseous proliferation which might produce either a thickening of the antral wall or total obliteration of the lumen. Mucosal stripping without periosteal damage is unlikely to be achieved and the area of the antrum which receives most direct pressure on the periosteum and bone is the posterior wall. Noyek and Zizmor[4] showed that approximately one-third of post-Caldwell-Luc maxillary sinuses were radiopaque on plain films. But it is not always possible to discern the bony opacification from the soft tissue shadow on plain films. In our study, 97% of the cases shows opacification and 58% of the cases shows soft tissue shadow. Fibrosis and postoperative mucosal thickening result in soft tissue shadow in antrum on CT scan. The fibrosis has been considered to be a result of post-operative resorption of blood and secretions or to relate to the degree of re-epithelialisa-

tion.[7] Asymptomatic mucosal thickening is considered to one of the pattern of surgical cure. In our study, 10 cases demonstrated generalized soft tissue shadow. It is considered that fibrosis or remaining hypertrophic mucosa may obliterate the antral lumen.

In our study, the healing pattern was not related to the age when patient had been operated and the duration between the surgical procedure and the time of evaluation. Sclerosis in the mucous membrane following Caldwell-Luc surgery may also occur. But according to our result, the types of bony healing (generalized opacification, partial opacification and posterolateral wall thickening) or soft tissue healing (generalized soft tissue shadow and partial soft tissue shadow) in the antrum might be determined by the severity of original disorder, surgical procedure, possibility of traumatizing or stripping the underlying periosteum and removal of whole lining mucosa, even normal looking mucosa. Theoretically, the diseased tissue should be removed without traumatizing or stripping the underlying periosteum. In practice this is difficult to achieve since submucosal fibrosis attached to the periosteum may be present, and even normal mucoperiosteum is often raised into folds or ridges.[8] For the patients with the duration ranged over 40 years, the soft tissue shadow in antrum was not detected in our cases. If the postoperative mucosal thickening is continued over 40 years, it is considered that mucosal thickening could be related with its inflammatory change in the sinus. This may also suggest the necessity for periodic and long-term follow-up examination.

Kaneshiro et al.[9] reported postoperative maxillary cysts 40-50 years after the initial surgery. It is not clear whether these cysts had developed soon after antral surgery from mucosal inclusions, as suggested by Kubo[10] and then gradually grew over the years, or whether they developed shortly before presentation. Mori et al.[11] reported two cases which were detected 50 years postoperatively. On the other hand, postopertive maxillary cysts that occurred only six months after the operation were reported by Odawara[12] and Mizutani et al.[13] In these cases, closure of the reopened ostium maxillare and the antral window to the nasal cavity or infection of the operated sites, or both, were considered to have caused the prompt formation of the cysts. Yamamoto et al.[14] reported that most patients were diagnosed as having a postoperative maxillary cysts in their 20s and 30s and had undergone radical maxillary surgery in their first two decades of life.

There are three areas that should be specifically examined following Caldwell-Luc surgery: that is naso-antral window, anterior antrostomy site and remaining bony walls of the maxillary sinus. The area most crucial to the success of the operative procedure is the naso-antral window, which should be kept intact for adequate drainage and free aeration of the maxillary sinus. Coronal view of CT scan is useful in demonstrating patency of naso-antral window. In the cases of CT appearance which appeared generalized opacification and generalized soft tissue shadow, mesial wall of antrum was usually depressed, and might be influenced by naso-antral window. The anterior antrostomy site in the canine fossa almost always closes; the antrostomy usually closes by new bone, or occasionally with dense scar. Our result shows slight preponderance of dense scar closure; 55% were closed by dense scar and 45% were by new bone. When the patients had been operated in their older ages, the surgical defects were closed by soft tissue scar more frequently. It may reflect individual tissue response capacity following the age when the patients had been operated. And the new bone formation was preponderance in the cases of the longer interval between the initial antral surgery and the evaluation. It may reflect the possibility of sclerotic change of soft tissue scar. The status of the remaining bony walls of the maxillary sinus are also important in the assessment of continued or recurrent disease.

Examining a succession of slices of axial cut of CT scan, incomplete compartmentalization are detected in 21% of our cases. If persistent synechia is occurred, this membrane obstructs the drainage of the lateral portion of the maxillary sinus and leads to the appearance of a postoperative antral mucocele.[15] Although the reasons for its occurrence are uncertain, it reflect an altered tissue response during the reparative healing process.

In distinguishing normal postoperative change from other inflammatory or recurrent diseases, such as postoperative maxillary cyst and recurrent maxillary sinusitis of the antrum, the status of the bony wall and the naso-antral window should be examined. On the basis of the radiologic criteria, the routine use of CT in the evaluation of post operative state of maxillary sinus is suggested.

In conlusion the radiologic information about normal healing state using computed tomography can distinguish postoperative changes from inflammatory and cystic disease in the patient who has undergone Caldwell-Luc type of radical maxillary antrostomy.

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