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# A Suggested New Classification System for the Anatomic Variations of the Sigmoid Sinus: A Preliminary Study

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**Objective;** It is very important for otology surgeons to know all the sigmoid sinus variations and their relationship to the adjacent structures for performing such surgical procedures as antrostomy, mastoidectomy and thrombectomy for the transverse sinus thrombosis. This is because the sigmoid sinus has too many variations in its shape, size and location in the temporal bone. Several classification systems of the sigmoid sinus have been developed, but there is currently no classification system that has clinical significance for otology surgeons.

**Materials & Methods;** One hundred high resolution computed tomograms of the temporal bone were reviewed retrospectively. To evaluate any variations, CTs of a pneumatic mastoid as well as those of a sclerotic mastoid were included in this study. Three reference lines were selected, which should be surgically significant and easily found. For verification, our classification system was compared with those of Ichijo H et al and Han SJ et al.

**Results;** The three reference lines were defined as one line extending through the posterior semicircular canal, the second line extending through the malleal-incudal axis and the third line extending through the tympanic segment of the facial nerve. Based on these reference lines, the position of the sigmoid sinus was classified into 4 groups.

**Conclusion;** This classification system was correlated with those of Ichijo H et al and Han SJ et al. Compared with these other systems, this system has its own merit as it reflects the clinical significance of the sigmoid sinus as a surgical landmark.

The sigmoid sinus is one of the venous spaces that drain the blood from the brain.

It possesses an endothelium lining without valves or muscle in its walls, and it is situated between the two layers of the dura mater. It continues with the transverse sinus at the point where the latter leaves the tentorium cerebeli. It curves downwards and medially in a deep groove on the mastoid part of the temporal bone named the sigmoid sulcus. The sigmoid sinus crosses the jugular process of the occipital bone and then it turns forwards and forms a genu to continue with the superior bulb of the jugular vein.

Although wide variability in the anatomical positions of the sigmoid sinus has been accepted clinically, the exact causes of such variability have not been established. The relationship between mastoid pneumatization and sigmoid sinus variations remain a subject of debate. In a previous study, one of the authors (Lee D.H.) demonstrated that the location of surgically-important structures, including the sigmoid sinus, in the middle and inner ear was rarely influenced by the sclerotic change.[1]

The location of the sigmoid sinus within the temporal bone is highly variable. Therefore, advances in

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otologic surgery necessitate a complete reassessment of the sigmoid sinus and this is important for the planning and execution of surgery within the mastoid cavity. The variations in its shape and position can cause problems during the surgical approach to the tympanic cavity, mastoid antrum and membranous labyrinth.

The aim of this study was to establish a new classification system of the sigmoid sinus variations, which is well-correlated with the surgical findings, as well as this new system has surgical significance for otologic surgeons.

## Materials & Methods

This retrospective study reviewed 100 high resolution computed tomograms (HRCT) of the temporal bone retrospectively. All the cases of pneumatic mastoid as well as the cases of sclerotic mastoid were included into the study. The cases of the temporal bone fractures that were only fractured, but not displaced were also included. However, the cases that showed severe fracture-dislocation of the temporal bone were excluded. Those cases that showed dislocation or destruction of the ossicles were also excluded. Additionally those patients who underwent tympanomastoidectomy, ossiculoplasty or other mastoid surgeries were excluded. The temporal bone HRCT scans (Somatom sensation16, Siemens, Erlangen, Germany) were taken with a 1.0 mm slice thickness, 120 kV and 100 mA.

*1) Selection of the reference images and the appropriate lines for classification of the sigmoid sinus*

Two or three axial images that satisfied the following terms were chosen as the reference images; 1) axial section where the common crus of the posterior semicircular canal (PSCC) is just joined into the vestibule; 2) axial section that shows the longest tympanic segment of the facial nerve; and 3) axial section that shows the ice cream cone shape of the malleal-incudal joint clearly.

Three imaginary line that satisfied the following terms were chosen as the reference lines on the above chosen images;

1) line 1 = the posteriorly-extended line that joins the common crus of the PSCC to the PSCC ;
2) line 2 = the posteriorly-extended line of the tympanic segment of the facial nerve; and
3) line 3 = the posteriorly-extended line of the malleal-incudal axis (Figure 1).
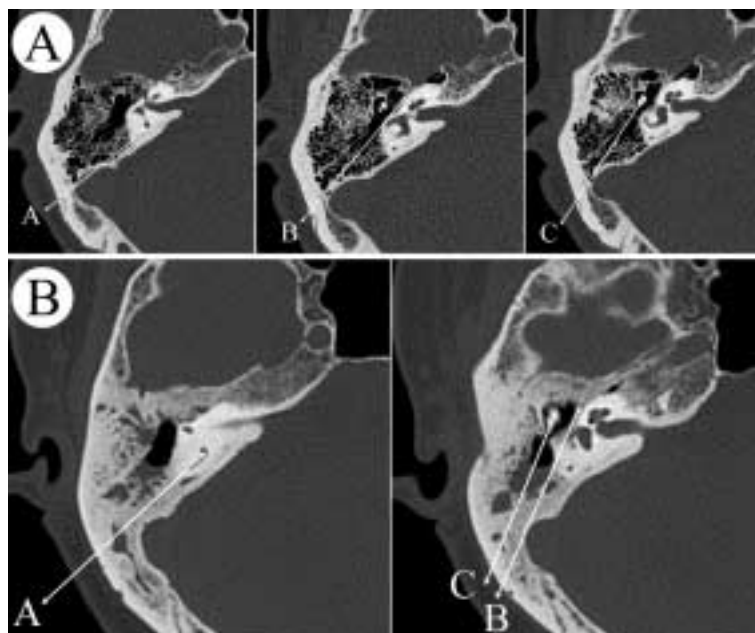


**Figure 1.** The three reference lines that are used in this study. (A) Each line is demonstrated on one axial image. (B) In some cases, lines B and C are demonstrated on one axial image.

*2) Suggestion for a new classification system of the sigmoid sinus*

Based on the three reference lines, the sigmoid sinus was categorized into four types; type 1, the most protruding portion of the sigmoid sinus is medial or posterior to line 1;

type 2, the most protruding portion of the sigmoid sinus is located between line 1 and line 2;

type 3, the most protruding portion of the sigmoid sinus is located between line 2 and line 3; and

type 4, the most protruding portion of the sigmoid sinus is lateral or anterior to line 3.

*3) Verification of the suggested new classification system*

All the images were evaluated and recorded independently by two investigators. When the evaluation by two investigators was different, the final evaluation was made by the two investigators reviewing the scan together.

To verify the usefulness of the suggested new classification system, this proposed classification system was compared with two preexisting systems; those described by Ichijo H et al and Han SJ et al.[2,3] The former categorized the sigmoid sinus into 3 groups and the latter into 4 groups.

Chi-square tests and Pearson's correlation tests were performed using the SPSS software programs (SPSS Inc., Chicago, IL), and a P value < 0.05 was considered significant.

**Results**

A total of 200 images of 100 patients were included into the study. There were 35 male patients and 65 female patients. Their mean age was 46.1 years-old (standard deviation = 14.2 years-old). The number of pneumatic mastoids were 125 and there were 75 sclerotic mastoids.

According to this new classification system, there were 104 cases of the type 1 sigmoid sinus, 35 cases of type 2, 21 cases of type 3 and 40 cases of type 4. According to the classification system of Ichijo et al, there were 112 cases of the protrusive type, 44 cases of the half-moon type and 44 cases of the saucer type. Due to the classification system described by Han SJ et al, group 1 was 54 cases, group 2 was 64 cases, group 3 was 48 cases and group 4 was 34 cases.

This study's classification system was significantly correlated with those systems of Ichijo H et al and of Han SJ et al. A moderate positive correlation was shown between this classification system and that of Ichijo H et al. The more protruded sigmoid sinus was in this new classification system, and the more protrusive type of sigmoid sinus was found. But, there was weak negative correlation between this new classification system and that of Han SJ et al. The more protruded a sigmoid sinus was in this new classification system, the less pneumatized was the mastoid bone (Table 1).

**Table 1.** Comparison of our new classification system with the other two classification systems.

|  |  | versus Ichijo H et al [2] | versus Han SJ et al [3] |
|---|---|---|---|
| **Chi-square test** | Total (n=200) | p = 0.000 | p = 0.000 |
|  | Pneumatic (n=125) | p = 0.000 | p = 0.001 |
|  | Sclerotic (n=75) | p = 0.000 | p = 0.024 |
| **Pearson's correlation coefficient** | Total (n=200) | 0.493 | - 0.293 |
|  | Pneumatic (n=125) | 0.426 | - 0.296 |
|  | Sclerotic (n=75) | 0.564 | - 0.262 |

## Discussion

Our classification system can categorize the sigmoid sinus into 4 types by using 3 reference lines. The reference lines used in this classification system are a posteriorly-extended line that joins the common crus of the PSCC to the PSCC, a posteriorly-extended line of the tympanic segment of the facial nerve and a posteriorly-extended line of the malleal-incudal axis.

The reference lines were selected by considering that this classification system should have surgical significance and the sigmoid sinus should be easily categorized on HRCT scans. Line 1 (a posteriorly-extended line that joins the common crus of the PSCC to the PSCC) can reflect the location of the periantral air cells of the mastoid bone and the posterior cranial plate of the posterior cranial fossa. Line 2 (a posteriorly-extended line of the tympanic segment of the facial nerve) may guide the accessibility for performing posterior tympanomtomy. Finally, line 3 (a posteriorly-extended line of the malleal-incudal axis) may guide the accessibility to the attic through performing posterior epitympanotomy.

There have been several classification systems of the sigmoid sinus in the literature.[2,3,4,5] (Figure 2) The classification system of Ichijo H et al is based only on the shape of the sigmoid sinus,[2] and it cannot present any information about the location of the sigmoid sinus within the mastoid bone nor does it have any surgical significance to otologic surgeons. For the otologic surgeon who will perform surgical procedures such as antrostomy or mastoidectomy, it is more important how easily the lesion is accessed and exposed. Kayahoglu G et al investigated the whole course of the sigmoid sinus within the temporal bone and they classified the sigmoid sinus variations into 5 groups from an anatomical point of view.[4] However, because two-dimensional CT cannot evaluate the three-dimensional course of the sigmoid sinus, it is impossible to clinically apply this classification system. In addition, only the shape of the sigmoid sinus within the temporal bone cannot present any information about the surgical accessibility for otologic surgeons. The classification system of Sarmiento PB et al is feasible to evaluate only after cortical mastoidectomy is completed.[5] The
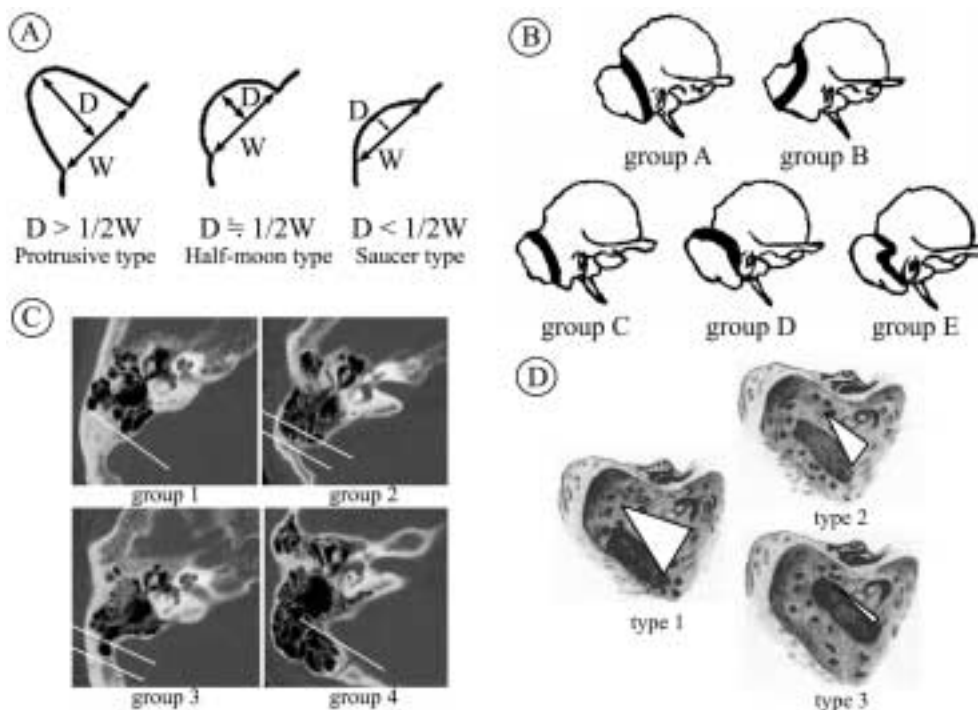


**Figure 2.** Classification systems of the sigmoid sinus in the literature. (A) Ichijo H et al (1993), (B) Kayahoglu G et al (1996), (C) Han SJ et al (2007) and (D) Sarmiento PB et al (2004).

classification system of Han SJ et al is a classification of mastoid pneumatization rather than that of the sigmoid sinus.[3]

We expect that this new classification system may help otologic surgeons predict how easily the lesion will be accessed or how difficult an operation will be. In addition, this new classification system may help them plan the method of exposure, the approach and the surgical technique.

However, this is a preliminary study. Further study must be done, that will evaluate the correlation between this classification system and the real operative findings. Several problems were also found in this preliminary study; this classification system cannot be applied to cases in which the mastoid bone, including the ossicles, is destroyed. In addition, it is confusing to classify the sigmoid sinus in cases that the 3 references lines are overlapped.

## Acknowledgments

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