Metrical Differential Diagnosis Based on Location
Differential Diagnosis among Various Cysts

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Key words: differential diagnosis, cyst, metrical data, panoramic radiograph

Abstract
An attempt was made to quantify the location of oral lesions. Panoramic radiographs of non-odontogenic cysts (13 globulomaxillary cysts, 8 median maxillary cysts, 8 nasopalatine cysts, 5 nasoalveolar cysts and 11 simple bone cysts) and odontogenic cysts (37 radicular cysts, 13 radicular granulomas, 68 dentigerous cysts and 40 odontogenic keratocysts) were examined.

Metrical data (integers) were obtained from a conversion table and the abscissa values (to the first decimal place) were obtained from the centroid of the cysts. Differential diagnosis among these lesions revealed the following:
1. In the maxilla, it was possible to differentiate median maxillary cysts and nasopalatine cysts from globulomaxillary cysts, nasoalveolar cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts.
2. In the mandible, it was difficult to differentiate simple bone cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts from one another.

The present findings revealed that data on lesion location can be changed into metrical data for differential diagnosis of cysts.

Introduction
Basic data for differential diagnosis of various lesions in the oral region can be classified primarily into metrical (quantitative) data expressed numerically, and non-metrical (qualitative) data[1,2]. Metric data include the age of patients, the size of lesions (area or volume) and radiographic density. However, the location of lesions has not previously been dealt with metrically, but rather is generally expressed in the form of dentition or dental formula, including size[3].

For improving the accuracy of metric differential diagnosis, it is important to have a large volume of various forms of data[4].

In the belief that the location of lesions, as one form of metrical data, should be studied for the purpose of improving the accuracy of future differential diagnosis, the author prepared a numerical conversion table in advance as a preliminary stage for achieving this aim, and attempted a quantitative study[5,6].

Materials and Methods
As materials for lesion location, panoramic radiographs of both non-odontogenic and odontogenic cysts diagnosed histo-pathologically at this hospital between 1976 and 1988 were used. The non-odontogenic cysts studied were 13 globulomaxillary cysts, 8 median maxillary cysts, 8 nasopalatine cysts, 5 nasoalveolar cysts and 11 simple bone cysts. The odontogenic cysts used were 37 radicular cysts, 13 radicular granulomas, 68 dentigerous cysts and 40 odontogenic keratocysts. Cases of edentulous jaw, cases of missing teeth in the area of the cyst, and cases involving cysts with unclear contours were excluded.

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Integers and decimal numbers were obtained separately. First, a numerical conversion table was prepared for quantifying the above diseases (Fig. 1). This table lists continuous numerals (classified according to the maxilla and mandible) indicating each contact point on the left side of each tooth. The numerals for teeth at the location of the centroid\(^7,8\), which was determined by the following method, were used as data for integers.

The centroid for each disease was determined by tracing the cyst and the tooth adjacent to the cyst in the panoramic radiograph, and in order to determine the coordinates of the point extracted from the contour section of the cyst, the author plotted the line passing through the mesial/distal contact point of the tooth adjacent to the cyst on the X-axis, and then plotted the contact point on the left side of the tooth so that it was located at the intersection point of the X and Y axes. Next, the coordinate points of the cyst contour section (approximately 10 - 63 points) were extracted. Through the application of spline interpolation\(^9\) to the extracted points, the contour of the cyst was reproduced, and the centroid was determined from this contour. The X coordinate value of this centroid was divided by the distance between the mesial and distal contact points of the tooth, and the product of this division was used as the numeral in the decimal position. The integer mentioned previously and the decimal value were used as one item of data (Fig. 2).

The data included numerals reduced to the first decimal place.

For comparing numerals, the mean values (corresponding to predilection) and standard deviations for each case group (globulomaxillary cyst, median maxillary cyst, nasopalatine cyst, nasoalveolar cyst, simple bone cyst, radicular cyst, radicular granuloma, dentigerous cyst and odontogenic keratocyst groups) were calculated (Tables 1 and 2), and the right and left side values for each case were totaled (for the maxilla, 10 was deducted from the left side value, and the right and left side values were totaled; for the mandible, 20 was deducted from the right side value, and the right and left side values were totaled). Thus, differentiation was achieved through the use of the maxillary and mandibular values.

### Table 1  Location of non-odontogenic cyst

<table>
<thead>
<tr>
<th></th>
<th>Mean (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
</tr>
<tr>
<td>Globulomaxillary Cyst</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>22.0 (1.0)</td>
</tr>
<tr>
<td>Man.</td>
<td>-</td>
</tr>
<tr>
<td>Median Maxillary Cyst</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>20.4 (0.3)</td>
</tr>
<tr>
<td>Man.</td>
<td>-</td>
</tr>
<tr>
<td>Nasopalatine Cyst</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>20.5 (0.4)</td>
</tr>
<tr>
<td>Man.</td>
<td>-</td>
</tr>
<tr>
<td>Nasoalveolar Cyst</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>-</td>
</tr>
<tr>
<td>Man.</td>
<td>-</td>
</tr>
<tr>
<td>Simple Bone Cyst</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>-</td>
</tr>
<tr>
<td>Man.</td>
<td>35.8 (2.1)</td>
</tr>
</tbody>
</table>

S.D.:standard deviation  
Max.:maxilla  
Man.:mandible
Table 2  Location of odontogenic cyst

<table>
<thead>
<tr>
<th></th>
<th>Mean(S.D.)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
<td></td>
</tr>
<tr>
<td>Radicular Cyst</td>
<td>Max.</td>
<td>22.8 (±2.0)</td>
<td>13.0 (2.1)</td>
</tr>
<tr>
<td></td>
<td>Man.</td>
<td>35.2 (1.8)</td>
<td>55.4 (0.9)</td>
</tr>
<tr>
<td>Radicular Granuloma</td>
<td>Max.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Man.</td>
<td>33.3 (2.8)</td>
<td>55.7 (1.7)</td>
</tr>
<tr>
<td>Dentigerous Cyst</td>
<td>Max.</td>
<td>22.7 (2.5)</td>
<td>12.6 (1.9)</td>
</tr>
<tr>
<td></td>
<td>Man.</td>
<td>36.8 (1.2)</td>
<td>56.4 (2.5)</td>
</tr>
<tr>
<td>Odontogenic Keratocyst</td>
<td>Max.</td>
<td>26.0 (1.9)</td>
<td>14.1 (2.5)</td>
</tr>
<tr>
<td></td>
<td>Man.</td>
<td>35.8 (3.1)</td>
<td>57.1 (1.9)</td>
</tr>
</tbody>
</table>

S.D.: standard deviation
Max.: maxilla
Man.: mandible

Fig. 1  A conversion table for location

Maxilla

|     | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | M |
|-----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
|     |    |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   | M |
| M   | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | 1  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 61~58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 38~41 |

M Mandible

|     | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | M |
|-----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
|     |    |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |
| M   | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | 1  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 61~58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 38~41 |

Fig. 2  A sample of quantification obtained from the centroid

Centroid (x, y)

Contact Point of Left Side (0, 0)

a = Distance between left and right contact point

Integers were obtained from the conversion table (Fig. 1). Decimal number is \( x_a \) and rounded down to the second decimal place.

Fig. 2  A sample of quantification obtained from the centroid
Results

With regard to the analytical method for the quantified mean values of lesion location, the degree of coincidence was evaluated through comparison with Figs. 3 to 11, which revealed variance among individual cases. The results of this evaluation are given below.

The non-odontogenic cysts examined in this study included globulomaxillary cysts, median maxillary cysts, nasopalatine cysts, nasoalveolar cysts and simple bone cysts.

With regard to globulomaxillary cysts, shown in Table 1, the mean value (standard deviation) of location was maxillary left side 22.0 (1.0), which corresponds to the predilection shown in Fig. 3. For median maxillary cysts, shown in Table 1, the mean value of location was maxillary right side 20.4 (0.3), which corresponds to the predilection shown in Fig. 4.

For nasopalatine cysts, shown in Table 1, the mean value of location was maxillary left side 20.5 (0.4) and maxillary right side 10.3 (0.1), corresponding to the predilection shown in Fig. 5. For nasoalveolar cysts, shown in Table 1, the mean value of location was 12.1 (0.7), corresponding to the predilection shown in Fig. 6. For simple bone cysts, shown in Table 1, the mean value of location was mandibular left side 35.8 (2.1) and mandibular right side 56.8 (2.2), corresponding to the predilection shown in Fig. 7.

With regard to odontogenic cysts, the author studied radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts. For radicular cysts, shown in Table 2, for the maxilla, the mean value (standard deviation) of location was left side 22.8 (2.0) and right side 13.0 (2.1); for the mandible, the corresponding values were left side 35.2 (1.8) and right side 55.4 (0.9). Agreement with the predilection shown in Fig. 8 was seen in the maxillary left side and the mandible.

Concerning radicular granulomas, however, the mean value of location was left side 33.3 (2.8) and right side 55.7 (1.7) in the mandible shown in Table 2, which did not correspond to the predilection shown in Fig. 9.

Also with regard to dentigerous cysts, shown in Table 2, the mean value of location was left side 22.7 (2.5) and right side 12.6 (1.9) in the maxilla, and left side 36.8 (1.2) and right side 56.4 (2.5) in the mandible, which did not agree with the predilection shown in Fig. 10.

Furthermore, with regard to odontogenic keratocysts, the mean value of location was left side 26.0 (1.9) and right side 14.1 (2.5) in the maxilla, and left side 35.8 (3.1) and right side 57.1 (1.9) in the mandible. Thus, the mandibular right side corresponded to the predilection shown in Fig. 11.

From Fig. 12, which shows the mean values and standard deviations of each cyst group, median maxillary cysts and nasopalatine cysts can be differentiated from globulomaxillary cysts, nasoalveolar cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts. In addition, globulomaxillary cysts and nasoalveolar cysts can be differentiated from odontogenic keratocysts.

On the other hand, in the mandible, it is difficult to differentiate simple bone cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts from one another.
Fig. 4 Location of median maxillary cyst

Fig. 5 Location of nasopalatine cyst

Fig. 6 Location of nasoalveolar cyst
Fig. 7  Location of simple bone cyst

Fig. 8  Location of radicular cyst

Fig. 9  Location of radicular granuloma
Fig. 10  Location of dentigerous cyst

Fig. 11  Location of odontogenic keratocyst

Fig. 12  Location of each cyst
Discussion

In this study, an attempt was made to quantify the location of lesions, prompted by the WHO numbering system for tooth identification, in the anticipation that location could be expressed by this type of continuous variate.

Samples covering a large number of lesions in various locations were used. Non-odontogenic cysts included globulomaxillary cysts, median maxillary cysts, nasopalatine cysts, nasoalveolar cysts and simple bone cysts. Odontogenic cysts included radicular cysts, radicular granulomas, dentigerous cysts, and odontogenic keratocysts.

Median mandibular cysts and aneurysmal bone cysts were excluded from the non-odontogenic cysts because the number of such cases was small. Primordial cysts and postoperative maxillary cysts were also excluded from the odontogenic cysts because data on these cysts were unprocessed, even though the number of these cases was sufficient.

The numerical conversion table prepared for this study was based on the WHO numbering system for tooth differentiation. As shown in Fig. 1, the maxilla and mandible were considered as independent continuous numerical series. The maxillary median right-side third molar was assigned numbers 10-18, and the median left-side third molar numbers 20-28. On the other hand, the mandible median right-side third molar was assigned numbers 30-38, and the median right-side third molar numbers 50-58. From measurements made from radiographs taken by the author, the right and left mandibular ramus regions corresponded to the width of three molars. The left side mandibular ramus region was assigned numbers 38-41, and the right mandibular ramus region numbers 58-61.

Although the processing method used in the previous study was based on the idea of a cyst center, in this study the centroid was considered a more appropriate parameter because of the somewhat rounded form of the cyst. Consequently, various given points in the cyst contour region were extracted, and then the outline section was reproduced through spline interpolation and the centroid of the cysts calculated. Using as a reference the portion of the contact point on the left side of the tooth where the centroid was located, data were expressed as numerals rounded down to the second decimal place. In other words, the integers of the data were obtained from the conversion table in Fig. 1. Numerals in the decimal position were obtained by dividing the X coordinate of the centroid of the tooth at which the centroid was located (as in Fig. 2) by the distance between the right and left contact points. This numeral is a continuous variate, and the centroid was expressed as a ratio; consequently, there was no apparent problem in calculating the basic statistics.

The centroid was expressed as numerals down to the first decimal place because, despite the fact that the mesial/distal width of each tooth is approximately 1 cm, the above centroid can be obtained in millimeters, and numerals down to the first decimal place can be calculated for the sake of precision. However, more precise numerals would be preferable.

With regard to spline interpolation, the number of extracted points to be used for the interpolation is important. A larger number of points result in more accurate reproduction. Therefore, for large cysts, spline interpolation was performed using as many extracted points as possible; there were limits to this process for small cysts.

As a result, through the use of calculated mean values and standard deviations, median maxillary cysts and nasopalatine cysts in the maxilla could be differentiated from globulomaxillary cysts, nasoalveolar cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts. In addition, globulomaxillary cysts and nasoalveolar cysts could be differentiated from odontogenic keratocysts.

On the other hand, in the mandible, it was difficult to differentiate simple bone cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts from each other.

In comparing these results with those obtained by Furumoto et al. and Ishikawa et al. for non-odontogenic cysts, globulomaxillary cysts were reportedly observed between the maxillary lateral incisor and the canine. In the present study, this tendency was observed on the maxillary left side, and also in the totals for the right and left sides.
It is reported that median maxillary cysts and nasopalatine cysts are observed in the median maxillary region\(^{[12,14]}\), and this tendency was confirmed in the present study. A similar tendency was also observed after totaling the right and left sides.

Nasoalveolar cysts show features of pressure bone resorption in the region neighboring the nose wing\(^{[14]}\). This tendency was recognized on the maxillary right side in this study.

It is reported that simple bone cysts occur in the mandibular bone region (anterior and posterior regions)\(^{[12,14]}\). This tendency was observed in the present study, and also after totaling the right and left sides.

With regard to odontogenic cysts, it is reported that radicular cysts are found most frequently in the maxillary lateral incisors, followed by the central incisors, the maxillary and mandibular second premolars, and the first molars\(^{[13]}\). In this study, a similar tendency was also observed on the maxillary left side and in the mandible, but not on the maxillary right side. After totaling the right and left sides in the maxilla, cysts were frequently found in the canine, whereas in the mandible, they occurred most frequently in the first molar region. The mandible showed the same tendency.

Radicular granulomas are reported to occur most frequently in maxillary and mandibular first molars, followed by second molars and second premolars\(^{[13]}\). In this study, only the mandibular left side revealed this tendency. After totaling the right and left sides in the maxilla, radicular granulomas were found most frequently in the first premolar region, whereas in the mandible they occurred most frequently in the second premolar region. Thus, the mandible revealed a similar tendency.

It has been reported that in the maxilla, dentigerous cysts are found primarily in the third molar region, followed by the premolar region; in the mandible, such cysts are found most frequently in the canine region and the third molar region\(^{[14]}\). In this study, the mandible showed such a tendency, but the numerals for the maxilla did not. After totaling the right and left sides for the maxilla, cysts were found most frequently in the canine region, whereas in the mandible they were most frequent in the second molar region. Thus, the mandible revealed a similar tendency.

Half of all odontogenic keratocysts occur in the region from the mandibular third molar to the mandibular ramus. The remainder are found in the maxillary third molar region, the mandibular posterior region, and the maxillary canine region\(^{[14]}\). In this study, the mandible revealed this tendency. After totaling the right and left sides in the maxilla, cysts were found most frequently in the second premolar region, whereas in the mandible they were most frequent in the second molar region. Thus, the mandible revealed a similar tendency.

The mean values (predilection) and standard deviations of locations quantified for each disease shown here indicate the characteristics of the lesions, and reveal that these values can be utilized for the differential diagnosis of cysts.

Since present analyses were based only on panoramic radiographs, satisfactory differentiation was impossible for globulomaxillary cysts, median maxillary cysts, nasopalatine cysts, nasoalveolar cysts, simple bone cysts and radicular cysts because of the small number of such cases. For this reason, it will be necessary to widen the range of cases subjected to oblique position imaging, which would enable the entire cyst to be observed.

According to the distribution of data, the locations expressed through dental formulae, as well as the location quantified were expressed in a variety of ways (in other words, the right side for globulomaxillary cysts, median maxillary cysts, nasopalatine cysts, nasoalveolar cysts, simple bone cysts and radicular cysts because of the small number of such cases. For this reason, it will be necessary to widen the range of cases subjected to oblique position imaging, which would enable the entire cyst to be observed.

Although some problems currently remain unsolved, it is clear that the metric data obtained will be applicable for differentiation of lesions in the future.
Conclusion

The centroids of cysts were calculated from traced panoramic radiographs of 13 globulomaxillary cysts, 8 median maxillary cysts, 8 nasopalatine cysts, 5 nasoalveolar cysts and 11 simple bone cysts (non-odontogenic cysts). The centroids were also calculated for 37 radicular cysts, 13 radicular granulomas, 68 dentigerous cysts and 40 odontogenic keratocysts (odontogenic cysts). All of these patients visited this hospital, and their diagnoses were determined histopathologically. The location of the lesions was quantified from the X-axis of the centroid and a numerical conversion table. The values were then compared with those in other reports, and each of the diseases was differentiated from the others.

1) In the maxilla, median maxillary cysts and nasopalatine cysts were differentiated from globulomaxillary cysts, nasoalveolar cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts. Furthermore, globulomaxillary cysts and nasoalveolar cysts were differentiated from odontogenic keratocysts.

2) In the mandible, it was difficult to differentiate simple bone cysts, radicular cysts, radicular granulomas, dentigerous cysts and odontogenic keratocysts from one another.

These findings indicate that the location of lesions can be analyzed numerically.

In concluding this paper, the author expresses his deep appreciation to Dr. Keiichi Nishikawa, Department of Dental Radiology, Tokyo Dental College, for kind cooperation in the program used for this study, which was conducted with the aid of a 1992 Nihon University Research Grant.

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References