

Dental proportion chart to summarize change of mesiodistal and buccolingual crown diameters, crown module and crown index in different tooth classes

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Abstract

It is difficult to simultaneously visualize tooth size and shape changes in dental characteristics on a single chart. A chart that includes scales for mesiodistal crown diameter, buccolingual crown diameter, crown module and crown index on a single chart is proposed – the Dental Proportion Chart. The development and use of the chart are described.

1. Introduction

Mesiodistal and buccolingual crown diameters are primary measurements in odontometric studies [1] [2]. The measurements are often expressed as indices (crown module and crown index, etc.) aimed at summarizing occlusal form and deriving shape variables. The crown module is the average diameter of the crown in a particular tooth, and the crown index is buccolingual crown diameter expressed as a percentage of mesiodistal crown diameter [3]. To evaluate tooth class changes of dental characteristics, charts used ordinarily include two coordinates, tooth class as the x-coordinate and a dental characteristic (mesiodistal and buccolingual crown diameters, root length, etc.) as the y-coordinate in common. If more dental characteristics need to be illustrated graphically in a single chart, an alternative chart may be necessary.

In this context, a Dental Proportion Chart (DPC) was developed to evaluate tooth class changes in size and shape [4]. The DPC includes scales for size (mesiodistal and buccolingual crown diameters, crown module) and shape (crown index) on a single chart and shows both the magnitudes and proportions of the dental characteristics simultaneously. The basic concept of the DPC has already been adopted in a chart to evaluate body proportion [5]. The present paper describes the development and application of the DPC.

2. Preparation of the Dental Proportion Chart

Several steps are involved in preparation of the DPC. Mesiodistal crown diameter and buccolingual crown diameter are plotted as x- and y-coordinates, respectively (Figure 1). The coordinate for the crown module is the sum of mesiodistal and buccolingual crown diameters divided by 2 (Figure 2). For example,

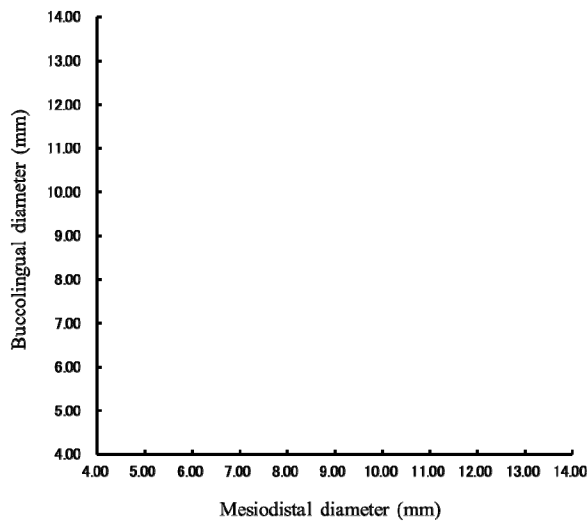


Fig.1 The first step to draw a Dental Proportion Chart

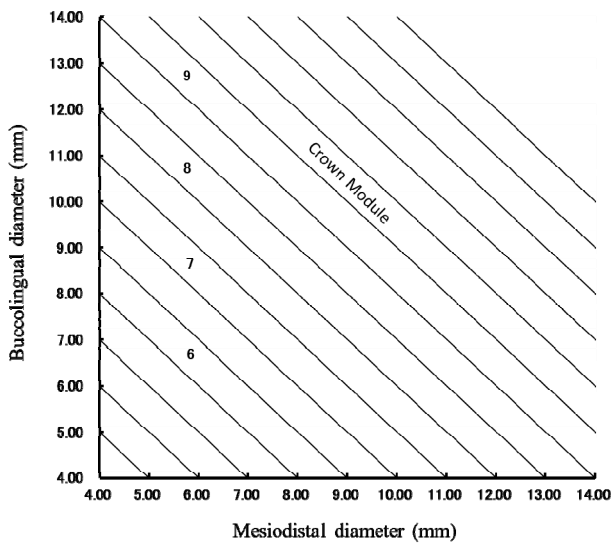


Fig.2 Inserting crown module coordinate on the Dental Proportion Chart

10 mm on the buccolingual crown diameter coordinate and 4 mm on the mesiodistal crown diameter coordinate is equivalent to 7 mm on the crown module coordinate, while 4 mm on the buccolingual crown diameter coordinate and 10 mm on the mesiodistal crown diameter coordinate is also 7 mm on the crown module coordinate. A line drawn from 10 mm on the buccolingual crown diameter coordinate to 10 mm on the mesiodistal crown diameter coordinate is the crown

module coordinate of 7 mm; it is the oblique line from the upper left to the lower right on the graph in Figure 2. Every point on the 7 mm crown module line reflects a crown module of 7 mm.

The crown index is calculated as buccolingual crown diameter divided by mesiodistal crown diameter x 100. A value of 4 mm on the mesiodistal crown diameter coordinate and 4 mm on the buccolingual crown diameter coordinate gives a value of 100 on the crown index coordinate (Figure 3). Similarly, 12 mm

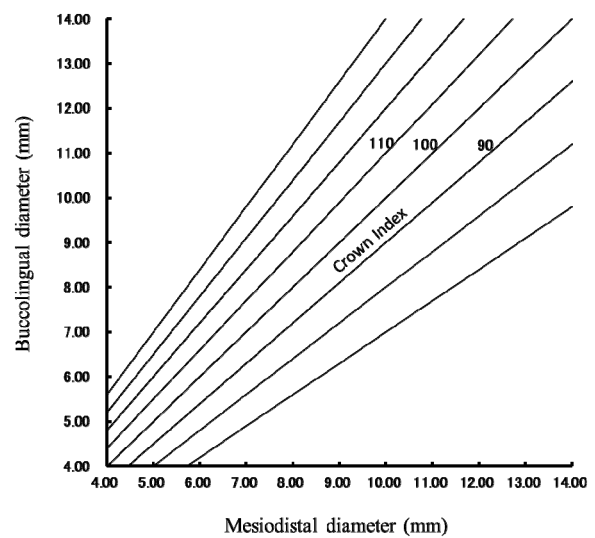


Fig.3 Inserting crown index coordinate on the Dental Proportion Chart

on buccolingual crown diameter coordinate and 12 mm on the mesiodistal crown diameter coordinate also gives a value of 100 on the crown index coordinate. A line drawn from the respective point (4 mm, 4 mm) to the other point (12 mm, 12 mm) is equivalent to 100 on the crown index line. It is expressed as an oblique line from the upper right to the lower left in Figure 3. Additional crown index lines can be drawn in the same manner. Every point on 100 crown index line is equivalent to a crown index of 100.

Figure 4 shows a completed DPC with its four coordinates, mesiodistal crown diameter, buccolingual crown diameter, crown module and crown index. Figure 5 shows ordinary plots of Japanese teeth measurements (Table 1), i.e., 2 coordinates, of mesio-

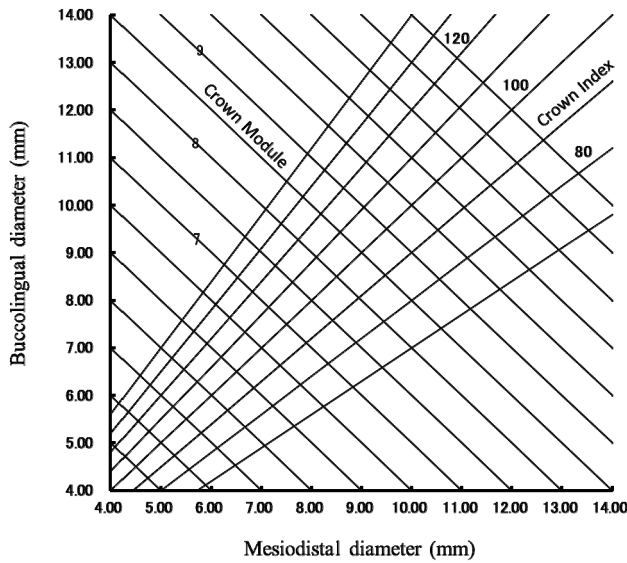


Fig.4 The Dental Proportion Chart

Table 1 Mesiodistal and buccolingual diameter (mm)^[6]

Category	Mesiodistal diameter		Buccolingual diameter	
	Upper	Lower	Upper	Lower
1	8.6	5.4	7.2	5.7
2	6.9	6.1	6.1	6.2
3	7.9	6.7	8.3	7.6
4	7.3	7.1	9.4	7.7
5	6.9	7.4	9.3	8.3
6	10.6	11.4	11.8	10.8
7	9.6	11.6	11.6	10.9
8	8.9	10.5	10.6	10.1

Crown module=(mesiodistal diameter + buccolingual diameter)/2
Crown index=(100*buccolingual diameter)/mesiodistal diameter

distal crown diameter relative to buccolingual crown diameter for upper and lower teeth followed from first incisor to third molar, while Figure 6 shows the same values plotted on the DPC.

3. Description about plotted values on the DPC

A comparison of upper and lower teeth the first incisors on the DPC (Figure 6) show that the upper is larger in both mesiodistal and buccolingual crown diameters than the lower. So, the crown module is larger in the upper incisor than in the lower incisor. However, the crown index is smaller in the upper than in the lower between 84 and 105. On the second incisors both the size and the shape are not so differ from the first incisors. The crown indices on the upper incisor are smaller than any other teeth. The upper

canine is larger with regard to the crown module than the lower canine, but the crown indices are not so different around 110.

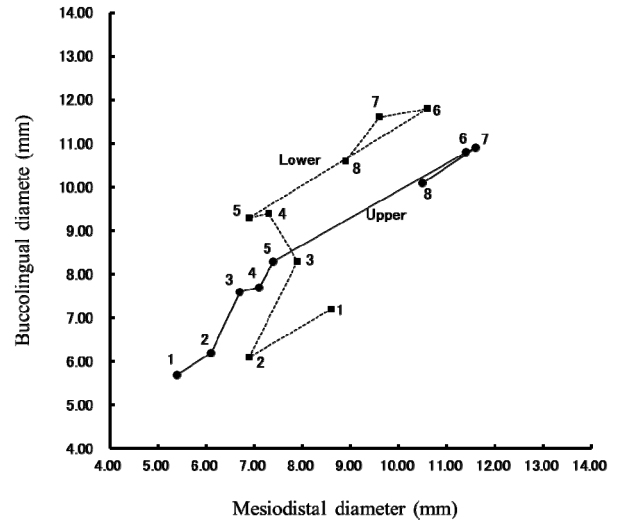


Fig.5 Tooth size changes in mesiodistal and buccolingual crown diameters

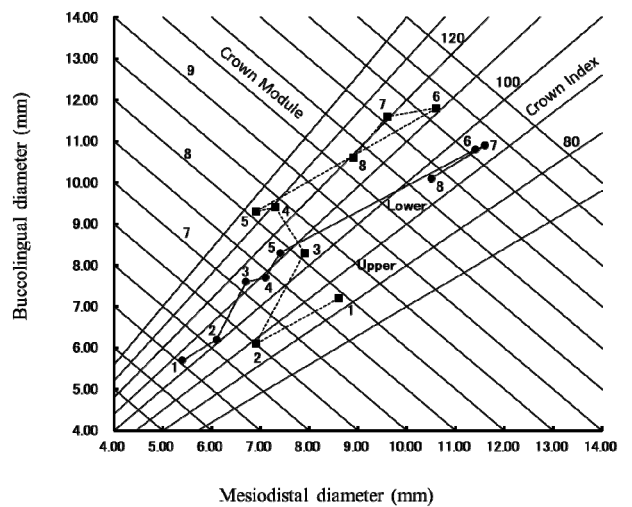


Fig.6 Tooth size changes in mesiodistal and buccolingual crown diameters on the Dental Proportion

Crown indices on the upper cheek teeth (premolars and molars) are larger than those on all the lower teeth. The upper and lower second premolars on the DPC show that crown modules are almost the same, but upper premolar has a bigger crown index than the lower. Crown modules increase from the first to the

second premolar in the lower jaw but decrease in their maxillary isomers. Among the premolars, the crown modules are not so different but the crown indices of the upper teeth are larger than those of the lower teeth. The upper premolars are larger and more rectangular in the shape of the occlusal outline than the lower premolars.

Crown modules on the upper molars are arranged in size from the third to the second and first molar in order, while those of the lowers are arranged in size from the third to the first and second molar in order. Although the crown modules of the upper and lower first molars are very close to each other, differences are more obvious in the second and third molars. The crown indices on the upper molars are larger than those on the lowers, such that second molars have the largest indices on the uppers and the smallest on the lowers. The scattered lower indices from the third molar to the second molar are almost parallel to the crown index line, showing a minimal decrease. Crown indices among the premolar are larger than in the molars on both upper and lower premolars, respectively.

The range of the crown module between the central incisor and the third molar on the lower teeth is greater than the range observed among the upper teeth. In particular, the crown modules of the lower incisors are smaller than the others. The crown module of the upper central incisor is very close to those of the upper premolars. The crown modules are larger in the molars than those of other tooth types. The crown modules vary from 6.5 and 11.5 in the upper teeth, and between 5.5 and 11.5 in the lower teeth. The crown indices vary between 85 and 135 in the upper teeth, and between 100 and 115 in the lower teeth.

Trends in the magnitude of mesiodistal and buccolingual crown diameters are clear on ordinary charts, but trends in crown module and crown index are not ordinarily available. Compared to the ordinary chart (Figure 5), crown module and crown index coordinates on the DPC (Figure 6) help the researcher visualize the relationship between the magnitude and the proportion of the selected tooth and also tooth class trends in three dental characteristics and one proportion simultaneously. And tooth class scale exists latently so that the DPC essentially contains five

coordinates in a single graph. While the absolute size of the mesiodistal and buccolingual crown diameters between sexes or specific samples may be reasonably similar, the proportions of mesiodistal and buccolingual crown diameters may differ. In contrast, several charts may be required if ordinary charts were used. The DPC thus permits a relatively simple approach to visualizing relationships of the magnitudes and the proportion between upper and lower teeth, and may also be applied for comparisons between sexes and among populations.

4. Conclusion

The Dental Proportion Chart clearly demonstrates trends in the tooth class change of mesiodistal and buccolingual crown diameters, crown module and crown index, and also upper and lower tooth differences in the respective characteristics and proportions.

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Conflict of Interest

The authors declare that they have no conflict of interest concerning this study.

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Abstract (Japanese)

人類学調査の歯の計測において、歯冠近遠心径、歯冠頬舌径は基本的な計測項目である。これらの計測値をグラフで示す場合、計測項目ごとに別のグラフにプロットして分析することが多い。本研究では座標平面の X 座標に歯冠近遠心径、Y 座標に歯冠頬舌径をとると、歯冠近遠心径、歯冠頬舌径の値から歯の指数で代表的な、歯冠モジュール(Crown Module : (歯冠近遠心径 + 歯冠頬舌径) ÷ 2) と歯冠指数(Crown Index : (100 * 歯冠頬舌径) ÷ 歯冠近遠心径) も同じグラフ上に示すことができるよう工夫した。このように歯冠近遠心径、歯冠頬舌径をもとに 4 変数を 1 つのグラフ上に示すことができる、歯冠多次元チャート(Dental Proportion Chart: DPC)を考案・作成した。歯冠の大きさとプロポーシオンは、歯種に伴う変化が大きくその変化のパターンには関心がもたれてきた。DPC 上に中切歯から第三大臼歯の歯冠近遠心径、歯冠頬舌径をプロットすると、歯冠モジュールと歯冠指数の変化も一目でわかり、DPC を用いることにより、歯冠の大きさとプロポーシオンを同時に把握することができる。歯種による歯冠の大きさやプロポーシオンの変化から、歯の左右差、上下顎の差、個体差などの分析、また集団の各歯種の歯冠の平均値の変化パターンから、人種差、男女差などの分析に有用であるだろう。

Key words : 歯冠多次元チャート, 歯冠近遠心径, 歯冠頬舌径, 歯冠モジュール, 歯冠指数

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