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A Study of Criteria for Arrangement of Teeth and Shape of Posterior Residual Ridges by Moiré Topography

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Summary

The aim of this work was to clarify by Moiré topography the morphological criteria for arrangement of teeth. The alveolar crest line and alveolar crest zone were defined by Moiré topography photographs from 139 upper edentulous stone casts and 20 upper and lower casts which were mounted to articulators. From the results the overlap area between upper and lower alveolar crest zones was classified into 6 types. It is suggested that the overlap areas and the angle between interalveolar lines are very useful as criteria for posterior tooth arrangement in clinical procedures.

Introduction

Since the artificial posterior teeth of complete dentures provide the primary masticating elements, their position in relation to the supporting and surrounding structures, to the shape of alveolar ridges, to the inclination of the occlusal plane, and their relationship with the upper and lower ridges after establishment of jaw relationships must be carefully analyzed and controlled by the dentist. The problem of the arrangement of posterior teeth has been studied by many researchers among whom the study of Gysi¹⁾ has been generally accepted by many practitioners. The author also has standardized the crest of ridges and/or the alveolar crest line for arrangement of posterior teeth for complete dentures.

Recently, however, Yanagawa²⁾ and Takanashi³⁾ have indicated that the posterior teeth of complete dentures should be positioned at some area which they defined as the "General Zone". Suggestions for placement of posterior teeth based on some width and/or space in relation to upper and lower ridges attempts to complete denture construction.^{4,5,6)}

The purpose of this study was to define the alveolar crest line and alveolar crest zone and to clarify the morphological criteria for arrangement of posterior teeth by Moiré topography.

Materials and Methods

The study was carried out on a series of 139 artificial stone casts of the edentulous upper jaws of 67 males (from 40 to 80 years of age) and 72 females (from 30 to 70 years of age) and 20 upper and lower edentulous casts (12 from males and 8 females) which were mounted to articulators. These casts were selected at random time intervals in our laboratory. The reasons for observing a number of upper casts by their Moiré fringes is that it is easy to get the anatomical landmarks, and the morphological features of the upper casts may be compared distinctly with those of the lower casts.

An apparatus for Moiré topography (FM 3011, Fuji Shashin Koki Inc., Ohmiya, Japan) was used for photographing and measuring the upper and lower casts (Fig. 1). This apparatus consists of a point source of light, Moiré grid (pitch: 1.0 mm), and camera. The reference points were located at the incisive papilla (A) and the deepest part of the hamular notch on both sides (H, I) in 139 casts, because these parts of the maxilla are not so influenced by resorption (Fig. 2). In 20 casts, the points were transferred to the lower casts by using a modified dental surveyor accessory which enabled overlapping of the photographs. Casts were oriented with the gratings parallel to the standard plane which included three reference points using the "technical stage" which had already been adjusted to be parallel to the plane of the gratings, and the highest portion of the ridges was brought to approximately 1.0 mm from the gratings (Fig. 3). The Moiré topography photographs were taken under these conditions and were lined and marked in accordance with the three reference points (Figs. 4 and 5).

Results and Discussion

Upper edentulous casts

Results of the classification of the posterior alveolar crest line and alveolar crest zone are shown in Figs. 6 and 7, and their frequency of appearance are shown in Tables 1 and 2. The shape of the posterior alveolar crest line was classified into 4 types. About 60% of them had a symmetrical pattern, and about 40% were asymmetrical. The area 3.0 mm from the alveolar crest region shown by Moiré fringes was classified into 6 types. About 70% of them were parallel to the alveolar crest line, but no relationship was observed between the shape of the alveolar crest line and alveolar crest zone. The reason for this was considered as due to the time of extraction of the respective teeth and/or to a certain difference in the rate of alveolar bone resorption. The widths determined for the alveolar crest zone are shown in Table 3.

The average width of buccal and lingual alveolar crest zones from the first to fifth portions was about 3.5 mm for the buccal in males and about 4.6 mm for the lingual. In females, on the other hand, it was about 3.0 mm for the buccal and about 3.8 mm for the lingual. From a comparison between the lingual and buccal alveolar crest zones, the former was slightly wider than the latter in both male and female. The area of buccal and lingual region of alveolar crest zone indicates identical width to alveolar crest line and have identical distance to alveolar crest line buccolingually. It is thus a very useful way to determine the alveolar crest zone in the clinic.

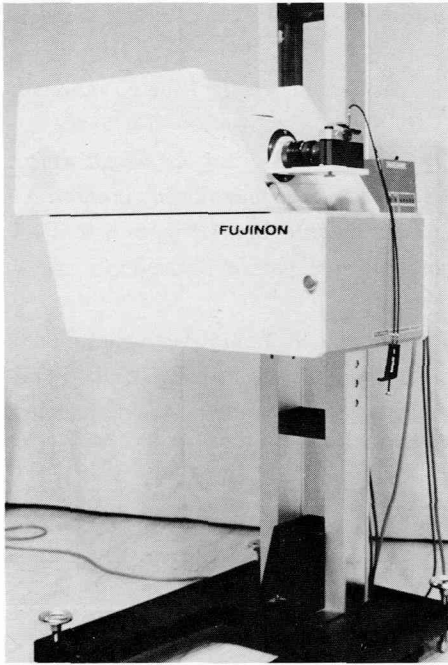


Fig. 1. Moiré topography apparatus (FM3011)

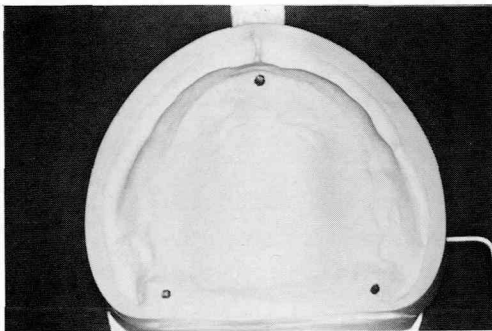


Fig. 2. The three reference points

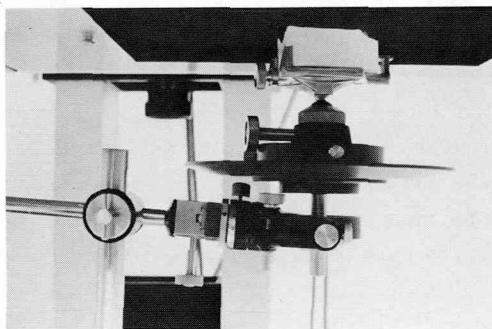


Fig. 3. Relation between alveolar ridges and gratings

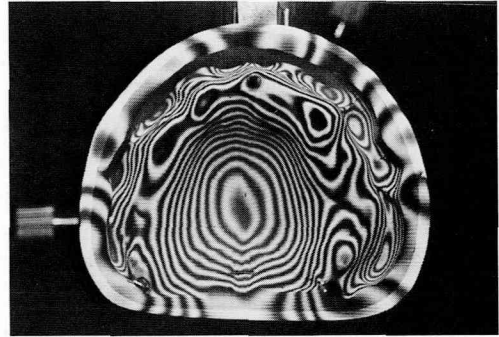


Fig. 4. Typical Moiré topography photograph (pitch : 1.0 mm)

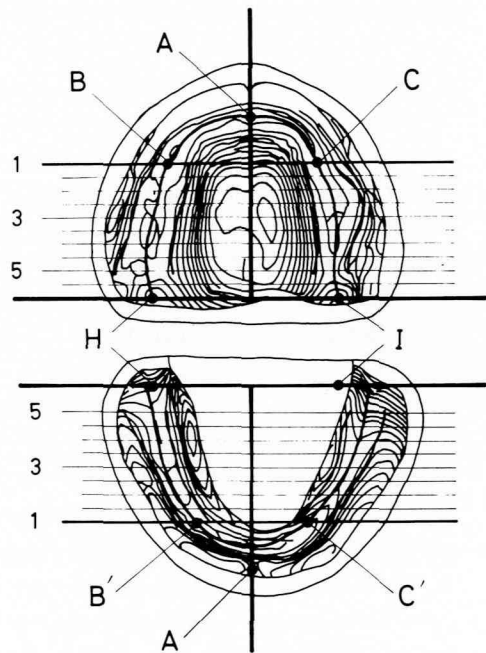


Fig. 5. Standard lines and reference points

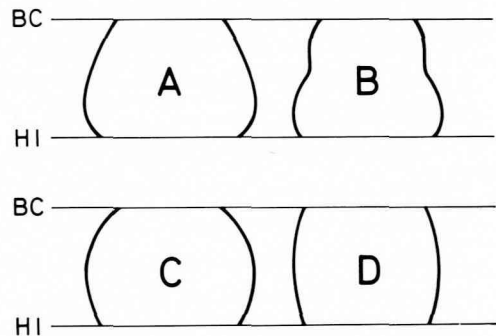


Fig. 6. Classification of posterior alveolar crest line shapes

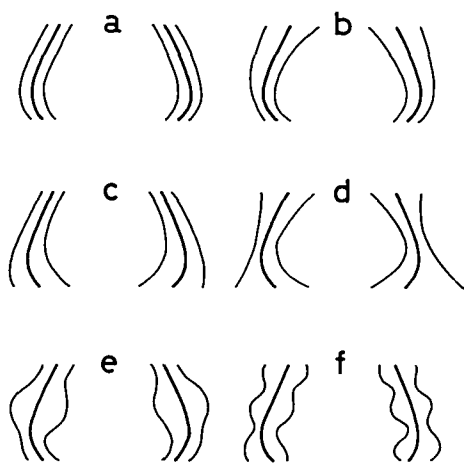


Fig. 7. Classification of posterior alveolar crest zone shapes

Table 1. Classification of posterior alveolar crest line

		Male(67)	Female(72)
Symmetric Pattern	A	19	12
	B	4	18
	C	17	5
	D	2	7
Total		42	42
Asymmetric Pattern	A - B	7	6
	A - C	1	2
	A - D	0	1
	B - C	6	12
	B - D	2	5
	C - D	9	4
Total		25	30

Table 2. Classification of posterior alveolar crest zone

	Male(67)	Female(72)	Total
a	33	39	72
b	6	12	18
c	3	4	7
d	1	0	1
e	14	11	25
f	10	6	16

Table 3. Width of alveolar crest zone (mm)

Portion		Male				Female			
		Right		Left		Right		Left	
		Buccal	Lingual	Lingual	Buccal	Buccal	Lingual	Lingual	Buccal
1	Max	8.0	8.9	8.0	8.0	8.0	7.5	6.6	6.6
	Min	1.3	2.2	1.7	1.3	1.3	1.7	1.7	1.3
	$\bar{X} \pm SD$	3.8 \pm 1.4	4.7 \pm 1.3	4.8 \pm 1.2	3.4 \pm 1.2	3.3 \pm 1.3	4.0 \pm 1.1	4.1 \pm 1.1	3.1 \pm 1.1
2	Max	10.2	7.1	8.0	7.1	8.0	6.2	8.9	4.9
	Min	1.7	2.6	2.6	0.8	1.3	1.7	2.2	1.3
	$\bar{X} \pm SD$	3.7 \pm 1.4	4.5 \pm 1.1	5.0 \pm 1.3	3.3 \pm 1.2	3.2 \pm 1.1	3.7 \pm 0.9	4.3 \pm 1.2	2.8 \pm 0.9
3	Max	9.5	8.9	9.3	7.5	9.3	7.5	8.9	7.1
	Min	2.2	2.6	2.6	0.8	1.3	1.7	2.2	1.3
	$\bar{X} \pm SD$	4.0 \pm 1.6	4.8 \pm 1.3	5.1 \pm 1.4	3.6 \pm 1.3	3.3 \pm 1.4	3.9 \pm 1.2	4.2 \pm 1.4	3.0 \pm 1.0
4	Max	8.0	9.8	10.7	6.2	8.9	6.2	7.5	7.5
	Min	1.7	2.2	2.2	1.7	1.3	1.7	2.2	0.8
	$\bar{X} \pm SD$	4.0 \pm 1.5	4.7 \pm 1.5	4.9 \pm 1.4	3.4 \pm 1.1	3.3 \pm 1.7	3.7 \pm 0.9	3.7 \pm 1.2	2.9 \pm 1.2
5	Max	8.9	9.3	6.2	6.2	5.3	6.2	5.3	6.2
	Min	1.3	2.2	1.7	1.3	1.3	1.7	1.7	1.3
	$\bar{X} \pm SD$	3.2 \pm 1.2	4.3 \pm 1.4	4.0 \pm 0.9	2.9 \pm 0.9	2.7 \pm 0.8	3.4 \pm 0.9	3.4 \pm 0.8	2.5 \pm 0.9

Upper and lower casts mounted on articulators

The shape of upper alveolar crest lines was classified into 4 types, the same as that of the lines in upper cast only, with 50% of them being symmetrical. On the other hand, the shape of mandibular alveolar crest lines was classified into 2 types, and most of them were symmetrical. The lines were partly of parabolic and/or partly between straight or V-shaped and constituted the main morphological difference between maxillary and mandibular bone or dental arch as observed by Moiré topography. This distinctive feature has been pointed out by many researchers and becomes a problem for the proper relationship between upper and lower ridges for arranging the artificial teeth and forming the artificial dental arch.

The widths of the alveolar crest zone in the first, third, and fifth portions in 20 casts are shown in Table 4. The width of the lower alveolar crest zone was slightly less than that of the upper one. A great majority of alveolar ridges indicated the same inclination buccolingually, because the area of buccal and lingual of lower alveolar crest zone has identical width to the alveolar crest line. To observe the overlap pattern, the alveolar crest line and alveolar crest zone in upper and lower casts were projected on to the occlusal plane. The correspondence of the upper and lower alveolar crest lines were classified in accordance with the classification of Okino and Tsubone⁷⁾. Results of the classification of correspondence type in 20 cases are presented in Table 5, and Figure 8 shows a typical pattern of the overlap area of upper and lower alveolar crest zones. The aim of this classification was to obtain more distinctive criteria for arrangement of posterior teeth. No relationship was observed between alveolar crest line and alveolar crest zone shapes as shown in Table 6. So it is different for determining proper tooth arrangement only by observing the relationship between upper and lower alveolar crest lines. However, one suggest the proper tooth arrangement position by determining the overlap area between upper and lower alveolar crest zones.

Concerning the frequency of appearance of these patterns, the C-type occurred in 26 out of 40 samples (about 65%); P-type, 5 (about 12.5%); ⊕-type, 4 (about 10%); N-type, 3 (about 7.5%); and A-type and ⊖-type, 1 (about 2.5%). Almost all of them had some overlap area in their middle portion.

The relationship among classified pattern, the average value of overlap width, and the angle between interalveolar crest lines and occlusal plane are presented in Table 7. Figures in parentheses mean the angle between the interalveolar lines which connect the buccal side of the upper alveolar crest zone and lingual side of the lower one.

Even in a case in which the angle between interalveolar crest lines was less than 80 degrees, it was possible to set the posterior teeth into a normal relationship by considering this angle. The upper alveolar crest zone was wider than the lower one in both A and ⊖-types. From an examination of the angle of the interalveolar line and the vertical distance between upper and lower ridges, we can set the teeth normally in A-type. On the other hand, for the ⊖-type it was very difficult to set the teeth because the angle between interalveolar lines was above 100 degrees. It is clear in Fig. 9 that the adaptable range of classifications consists of three elements which are the distance between ridges, the angle between interalveolar crest lines, and the width of the alveolar crest zone. As stated above, the classifications of alveolar crest zone and the angle between interalveolar lines are consider-

Table 4. Width of alveolar crest zone in each portion (mm)

		Portion		
		1	2	3
Upper	Min-Max	4.4-12.0	5.0-13.9	5.4-14.4
	$\bar{X} \pm SD$	8.27 \pm 1.69	8.53 \pm 2.05	8.40 \pm 2.24
Lower	Min-Max	4.3-11.7	4.5-12.1	4.3-13.5
	$\bar{X} \pm SD$	6.86 \pm 1.47	6.78 \pm 1.83	7.28 \pm 2.02

Table 5. Classification of type of correspondence in 20 cases

Portion Type	1 (1st premolar region)	3 (1st molar region)	5 (2nd molar region)
C-type	Overlap	Overlap	Overlap
P-type	Overlap	Overlap	-----
Ⓐ-type	Overlap	-----	-----
N-type	-----	-----	-----
A-type	-----	Overlap	Overlap
Ⓟ-type	-----	-----	Overlap

Table 6. Relationship between classification of alveolar crest line and type of overlap area (Figures in parentheses mean the number of cases having a given type of overlap area)

Type of Overlap area	C (26)	P (5)	Ⓐ (4)	N (3)	A (1)	Ⓟ (1)
Classification of Okino and Tsubone						
I	1	---	---	---	---	1
III	3	---	1	---	---	---
IV	6	1	---	1	---	---
V	12	3	2	---	1	---
VIII	4	1	1	2	---	---

Table 7. Relationships among type of overlap area, width of overlap area, inter-ridge distance, and angle between interalveolar crest lines (Figures in parentheses mean the angle between interalveolar lines)

Type	Portion	C	P	Ⓐ	N	A	Ⓟ
Width of overlap area (mm)	1	4.7	6.4	3.1	-----	-----	-----
	3	5.0	3.7	-----	-----	3.4	-----
	5	4.4	-----	-----	-----	6.0	1.2
Inter-ridge distance (mm)	1	18.9	17.7	23.4	23.0	20.9	25.0
	3	19.3	18.5	22.8	24.0	20.4	24.0
	5	16.8	15.9	18.4	20.3	18.7	23.0
Angle between interalveolar crest lines (degree)	1	92.8	90.0	79.6	73.4 (88.0)	109.0 (90.0)	117.8 (104.0)
	3	89.0	79.0	72.7 (87.0)	70.0 (84.7)	102.0 (80.0)	113.5 (100.0)
	5	82.6	71.7 (89.5)	67.6 (82.7)	70.0 (87.0)	87.2	110.6 (89.0)

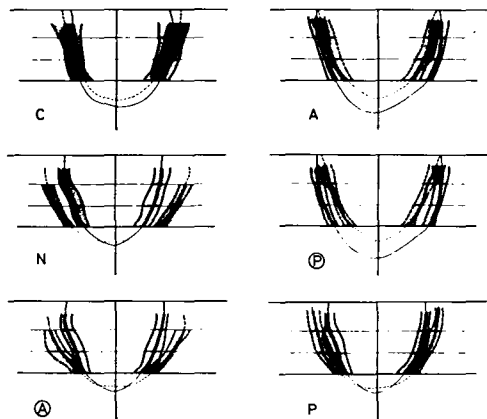


Fig. 8. Typical patterns of overlap areas between upper and lower alveolar crest zones

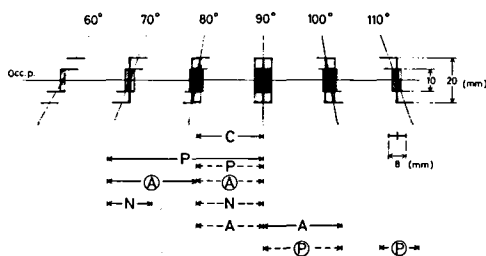


Fig. 9. Relationships among three elements and the classifications of overlap area (Solid line means the adaptable range of classifications in terms of the angle between interalveolar crest lines. Broken line means corrected adaptable range in terms of the angle between interalveolar lines)

ed to be useful for setting the posterior teeth for complete denture construction.

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