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**Original Article**

## **Curvature of Cervical Vertebra in 8020 Achievers Observed by Lateral Cephalogram**

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### **Abstract**

The hypothesis of this research was that elderly people with many remaining teeth and good occlusion (8020 achievers) would be able to maintain proper head and body posture, despite aging. The purpose of this study, as a first stage, was to clarify the aging phenomenon of cervical curvature in 8020 achievers in comparison with that in young adults.

Subjects consisted of twenty-eight 8020 achievers, with a mean age of  $82.96 \pm 3.3$  years and  $26.5 \pm 4.0$  teeth. For comparison, forty adults in their 20's with a mean age of  $22.9 \pm 0.7$  years and  $28.2 \pm 0.6$  teeth were also enrolled. The cervical vertebra was assessed based on the distance from the CV line (tangential line of the 2nd and 6th cervical vertebra) to each cervical vertebra and the angles formed by the cervical and reference lines in the cranial bone.

Every distance from the CV line to each cervical vertebra in the 8020 group was bigger than that in the 20's group ( $p < 0.01-0.001$ ). The distance from the CV line to CV-3 and CV-5 in 8020 women was larger than that in 8020 men ( $p < 0.05$ ). Every distance from the CV line to each cervical vertebra in 8020 women was larger than that in 20's women ( $p < 0.01-0.001$ ). There was no significant difference between 8020 men and 20's men. The difference between the women's group was more marked than that between age groups for men.

The cervical curvature in 8020 achievers showed a greater tendency toward cervical lordosis than that in young adults. In the 8020 achievers, the curvature in women was greater than that in men. The curvature in 8020 women seemed was marked, showing strong cervical lordosis, despite the presence of many remaining teeth and good occlusion. It remains to be determined by comparing 8020 achievers with ordinary elderly whether the condition of the teeth influences spinal curvature with aging.

**Key words:** Cervical vertebra—Lordotic curvature—8020 achievers—Aging—Cephalogram

## Introduction

The human body undergoes various changes with age. During the fetal period, only dorsal kyphosis is seen. By the time infants are capable of sitting and the neck can support the head, however, cervical lordosis is seen. As children begin to walk, lumbar lordosis appears. At between 12 and 14 years of age, when the abdominal and back muscles have developed sufficiently, thoracic kyphosis is seen. Body posture is maintained as the spine forms a gentle S-shaped curvature with cervical lordosis, thoracic kyphosis and lumbar lordosis<sup>11)</sup>. Proper body posture is particularly important in maintaining health, and the spine is not only the core of posture maintenance, but also protects spinal nerves and supports the body<sup>7)</sup>. The cervical spine supports the skull, and allows the diverse movements of flexion, extension, rotation and side flexion. The cervical spine thus receives large amounts of physical stimulation, and a relationship to occlusion has been suggested<sup>13,19)</sup>. Hiraga *et al.*<sup>5)</sup> and Nagakubo<sup>12)</sup> have all reported many adults with abnormal symptoms affecting the neck to the back and lumbar region, and occlusal abnormalities and malocclusion affecting the function and morphology of the cervical spine via the temporomandibular joint.

The size of the elderly population is growing in Japan, and the Ministry of Health, Labor and Welfare and the Japanese Dental Association launched the 8020 campaign in 1989, with the aim of increasing the number of people with at least 20 teeth at 80 years of age<sup>2,3,10,16)</sup>. Since then, many studies on people  $\geq 80$  years old who have at least 20 teeth (8020 achievers), have reported a high quality of life for this population. Studying the teeth and

other anatomical parts of 8020 achievers is relevant not only for health maintenance, but also for various social reasons, and the results of such studies may allow people to live longer and in better health.

The hypothesis of this research was that elderly people with many remaining teeth and good occlusion (8020 achievers) would be able to maintain proper head and body posture, despite aging. The purpose of this study, as a first stage, was to clarify the aging phenomenon of cervical curvature in 8020 achievers in comparison with that in young adults.

## Methods

### 1. Subjects

Subjects consisted of twenty-eight 8020 achievers with normal occlusion, a mean age of  $82.96 \pm 3.3$  years and a mean of  $26.5 \pm 4.0$  teeth. For comparison, 40 adults in their 20's with normal occlusion, a mean age of  $22.9 \pm 0.7$  years and  $28.2 \pm 0.6$  teeth were enrolled (Table 1). Informed consent was obtained from all subjects.

### 2. Measurement and analysis

Lateral cephalogram was used. Measurement points and items were established as described below. The CV line was defined as the line connecting the superior contact point of the dorsal tangential line of the odontoid process of the 2nd cervical vertebra and the lowest dorsal point of the 6th cervical vertebra.

The SN plane is the line connected from point S (center of Sella Turcica) to point N (anterior limit of meso-frontal suture) as defined by Northwestern analysis. FH plane is

Table 1 Participant characteristics

	Participant	Men/Women	Mean age (M/W)	Remaining teeth (M/W)
8020	28	14/14	83.5/82.4	27/25.5
20's	40	20/20	24/22.7	28/28

the line connected from point Or (lowest point on external border of orbital cavity) to point Po (most superior point of external auditory meatus) as defined by Downs' analysis.

1) Angle measurements

- (1) CV-SN angle: angle formed by the CV line and SN plane
- (2) CV-FH angle: angle formed by the CV line and FH plane
- (3) CV-Occ angle: angle formed by the CV line and occusal plane

2) Distance measurements

- (1) CV-2: distance from the CV line to the dorsal midpoint of the 2nd cervical vertebra
- (2) CV-3: distance from the CV line to the dorsal midpoint of the 3rd cervical vertebra
- (3) CV-4: distance from the CV line to the dorsal midpoint of the 4th cervical vertebra
- (4) CV-5: distance from the CV line to the dor-

sal midpoint of the 5th cervical vertebra  
(5) CV-6: distance from the CV line to the dorsal midpoint of the 6th cervical vertebra (Fig. 1).

A statistical analysis was performed with the Student's *t*-test to compare the difference between 8020 achiever and 20's group where a probability of less than 0.05 was considered statistically significant. To compare the difference between the four groups (8020 men, 8020 women, 20's men and 20's women), the statistical analysis was performed with the Kruskal-Wallis and Student-Newman-Keuls multi comparison test where a probability of less than 0.05 was considered statistically significant.

## Results

### 1. Comparison between 8020 achievers and adults in their 20's (Table 2)

Mean distance from the CV line to each cervical vertebra in the 8020 group was as follows: CV-2,  $2.41 \pm 2.11$  mm; CV-3,  $3.46 \pm 3.7$  mm; CV-4,  $3.23 \pm 3.81$  mm; CV-5,  $2.13 \pm 2.95$  mm; and CV-6,  $1.13 \pm 1.41$  mm. Mean distance from the CV line to each cervical vertebra in the 20's group was as follows: CV-2,  $0.50 \pm 1.58$  mm; CV-3,  $0.63 \pm 2.77$  mm; CV-4,  $-0.19 \pm 2.25$  mm; and CV-5,  $0.16 \pm 1.06$  mm. Every distance from the CV line to each cervical vertebra in

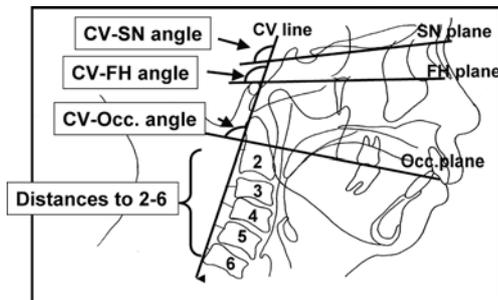


Fig. 1 Measured distances and angles

Table 2 Comparison between 8020 achievers and adults in their 20's

Variables	8020 (n=28)		20's (n=40)		8020 vs. Y
	Mean	SD	Mean	SD	<i>t</i> -test
CV to 2 (mm)	2.41	2.11	0.5	1.58	***
CV to 3 (mm)	3.46	3.7	0.63	2.77	***
CV to 4 (mm)	3.23	3.81	0.25	2.83	***
CV to 5 (mm)	2.13	2.95	-0.19	2.25	**
CV to 6 (mm)	1.13	1.41	0.16	1.06	**
CV to SN (°)	111.89	9.77	106.08	5.35	**
CV to Occ (°)	91.07	9.45	87.95	5.39	n.s.
CV to FH (°)	103.18	9.31	101.1	4.38	n.s.

\*\*\*:  $p < 0.001$ ; \*\*:  $p < 0.01$ ; \*:  $p < 0.05$ ; n.s.: not significant

the 8020 achievers was bigger than that of 20's group ( $p < 0.01-0.001$ ).

Mean CV-SN angle was  $111.89 \pm 9.77^\circ$  for in the 8020 achievers and  $106.08 \pm 5.35^\circ$  in 20's group. Forward inclination of the cervical spine was significantly greater in the 8020 achievers ( $p < 0.05$ ). No significant intergroup differences were identified for CV-FH or CV-Occ angles.

## 2. Comparison among 8020 men, 8020 women, 20's men and 20's women (Table 3, 4)

The distance from the CV line to CV-3 and CV-5 in 8020 women (CV-3,  $5.14 \pm 3.46$  mm; CV-5,  $3.21 \pm 3.48$  mm) was greater than that in 8020 men (CV-3,  $1.79 \pm 3.23$  mm; CV-5,  $1.04 \pm 1.83$  mm) ( $p < 0.05$ ).

Mean distance from the CV line to each cervical vertebra in 8020 women was as follows: CV-2,  $3 \pm 2.45$  mm; CV-3,  $5.14 \pm 3.46$  mm;

CV-4,  $4.61 \pm 3.94$  mm; CV-5,  $3.21 \pm 3.48$ ; and CV-6,  $1.5 \pm 1.82$ . Mean distance from the CV line to each cervical vertebra in women in their 20's was as follows: CV-2,  $0 \pm 1.48$  mm; CV-3,  $0.05 \pm 2.52$  mm; CV-3,  $-0.5 \pm 2.68$  mm; CV-4,  $-1 \pm 1.93$  mm; and CV-5,  $-0.18 \pm 1.05$  mm. Every distance from the CV line to each cervical vertebra in 8020 women was greater than that in 20's women ( $p < 0.01-0.001$ ).

There was no significant difference between 8020 men and 20's men.

No significant intergroup differences were identified for CV-SN, CV-FH or CV-Occ angles.

## Discussion

Matsumoto *et al.*<sup>9)</sup> reported that thoracic kyphosis advances and lumbar lordosis diminishes with age, thus increasing cervical lordosis in a compensatory manner. Mori<sup>11)</sup>

Table 3 Result of measurements

Variables	8020 Men		8020 Women		20's Men		20's Women	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CV to 2 (mm)	1.82	1.58	3.00	2.45	1.00	1.55	0.00	1.48
CV to 3 (mm)	1.79	3.23	5.14	3.46	1.20	2.96	0.05	2.52
CV to 4 (mm)	1.86	3.25	4.61	3.94	1.00	2.85	-0.50	2.68
CV to 5 (mm)	1.04	1.83	3.21	3.48	0.63	2.29	-1.00	1.93
CV to 6 (mm)	0.75	0.73	1.50	1.82	0.50	0.97	-0.18	1.05
CV to SN ( $^\circ$ )	112.14	8.47	111.64	11.24	105.30	5.77	106.85	4.91
CV to Occ ( $^\circ$ )	90.93	7.34	91.21	11.47	90.45	4.74	85.45	4.89
CV to FH ( $^\circ$ )	103.29	6.68	103.1	11.63	102.65	3.70	99.55	4.54

Table 4 Comparison of four groups

Variables	8020M vs. 8020W	8020M vs. 20's M	8020W vs. 20's W	20's M vs. 20's W
CV to 2	n.s	n.s.	**	n.s
CV to 3	*	n.s.	**	n.s
CV to 4	n.s	n.s.	**	n.s
CV to 5	*	n.s.	***	*
CV to 6	n.s	n.s.	**	n.s
CV to SN	n.s	n.s.	n.s	n.s
CV to Occ	n.s	n.s.	n.s	n.s
CV to FH	n.s	n.s.	n.s	n.s

SNK-test \*\*\*:  $p < 0.001$ , \*\*:  $p < 0.01$ , \*:  $p < 0.05$ , n.s.: not significant

reported that this is caused by a decrease in the moisture content of fibrous cartilage in intervertebral spaces and regressive degeneration such as fibrosis. The hypothesis of this research was that the elderly people with many remaining teeth and good occlusion (8020 achievers) would be able to maintain proper head and body posture, despite aging. We believe that well-balanced occlusal force on the cervical vertebra might delay age-mediated change.

Distance from the CV line to each cervical vertebra and the angle formed between the CV line and SN plane indicate the degree of curvature, not just forward inclination as reflected by CV-SN angle. For example, high CV-4 and CV-5 values indicate marked curvature. Between 8020 achievers and adults in their 20's, significant differences were revealed in CV-2, CV-3, CV-4, CV-5, CV-6 and CV-SN angle. Degree of lordotic curvature in 8020 achievers was greater than that in adults in their 20's. Between 8020 men and men in their 20's, no significant differences were seen in any distances or angles. Between 8020 women and women in their 20's, significant

differences were noted in CV-2, CV-3, CV-4, CV-5 and CV-6. Compared to women in their 20's, 8020 women displayed marked lordosis. The difference between the women's groups was more marked than that between age groups for men.

The curvature in 8020 women seemed to indicate cervical lordosis, despite many remaining teeth and better occlusion than 8020 men. No significant intergroup differences were identified for CV-SN, CV-FH or CV-Occ angles. The relationship between cervical inclination and the reference lines in the cranial bone showed no change. This indicates that change in the angle of cervical curvature in elderly people generally may not be affected by number of teeth.

According to Suzuki<sup>18)</sup>, cervical curvature is morphologically classified into: normal lordosis, reduced lordosis, kyphosis, S-shape, and hyper-lordosis (excessive spinal lordosis, very rare). Under this classification system, lordosis can be classified into 3 grades depending on severity, but since no straight type is used, the present study employed the convenient and clinical classification system developed by Imai<sup>8)</sup>: lordotic, straight, kyphotic, and S-shaped (Fig. 2).

In the present study on 8020 achievers and adults in their 20's, the lordotic and straight types were common in 8020 men, while the lordotic type was common in 8020 women, indicating that most women had a cervical curvature, as reported by Imai<sup>8)</sup> (Table 5).

Aida *et al.*<sup>1)</sup> reported that muscle strength starts to decline at around 25 years of age, and continues at an annual rate of 0.5% after 40 years of age, with 30–40% of muscle strength being lost by the age of 80 years. This also

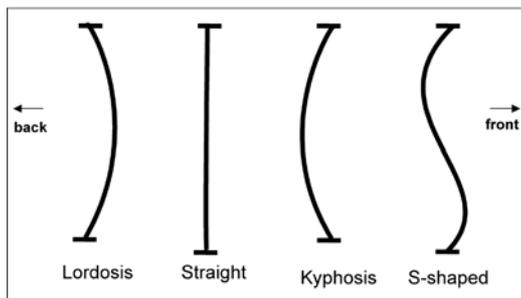


Fig. 2 Cervical spine curvature

Table 5 According to Imai's classification system

	Lordosis	Straight	Kyphosis	S-shaped
8020 men	5	6	2	1
8020 women	12	0	1	1
Men in their 20's	9	6	5	0
Women in their 20's	2	6	11	1

applies to the strength of back and leg muscles, which play important roles in posture maintenance, and these muscles are closely involved with osteoporosis. Strong trunk muscles, such as back muscles, suppress decreases in vertebral bone density<sup>6)</sup>. The above age-related changes are believed to be the cause of the marked lordosis seen in women in this study. Although a significant difference was found in curvature between the women's groups, no such difference was found between the men's groups. This indicates sex-dependent differences in curvature.

Kyphotic curvature was seen in several of the women in the 20's group in this study. Yamaguchi<sup>19)</sup> reported that the neck consists of various muscle groups, and in order to support the skull, mild lordosis is common in healthy individuals and persons with normal occlusion, and that the straight, kyphotic and S-shaped types are undesirable. Imai<sup>8)</sup> reported that lordotic curvature is desirable for the cervical spine to properly support the skull, and that the straight type places the weight of the skull directly on the shoulders, causing shoulder stiffness. Furthermore, kyphotic and S-shaped curvatures can negatively affect autonomic nerves, causing not only shoulder and neck stiffness, but also autonomic system symptoms. Imai<sup>8)</sup> also noted that, in recent years, many young men and women are displaying kyphotic cervical curvatures. Saito *et al.*<sup>14)</sup>, Shingai<sup>15)</sup>, Suzuki *et al.*<sup>17)</sup> and Yamaguchi<sup>19)</sup> have also reported that many people with a kyphotic cervical spine display anterior overbite. The reason for this is that in order to mask a protruded chin and make the profile appear normal, people tend to look down and pull the mandible backward<sup>4)</sup>. Such psychological factors contribute to kyphosis.

In conclusion, cervical curvature in 8020 achievers showed a greater tendency toward cervical lordosis than that in young adults. In 8020 achievers, the curvature in women was greater than that in men. The curvature in 8020 women showed marked lordosis, despite the presence of many remaining teeth and good occlusion. It remains to be determined

by comparing 8020 achievers with ordinary elderly whether the condition of the teeth influences spinal curvature with aging.

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