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Comparison of mouth rinsing performance between adults and children using a contactless vital sensing camera

Running title: Mouth rinsing in adults and children

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Abstract

Background
Evaluating mouth rinsing skills is useful for assessing oral function, but current evaluation methods are subjective.

Objectives
This study compared mouth rinsing between adults and children using a contactless camera to capture lip motion.

Methods
The subjects comprised 16 adults and 13 children with no oral dysfunction. A compact vital sensing camera adapted from a Microsoft Xbox One Kinect Sensor® (Kinect) was placed 100 cm from the floor and 120 cm from the subject; 5, 10, and 15 mL of water were used as samples. Participants were instructed to hold the sample in the oral cavity, close the lips, and move the sample alternatively left and right for 15 s. Maximum/minimum displacement from the reference plane and rinsing cycle for each sample were analyzed by one-way analysis of variance.

Results
In adults, there was no significant difference in the maximum/minimum displacement between the left and right sides of the angulus oris due to differences in sample amount. In children, the right maximum significantly differed between the 5- and 15-mL and 10- and 15-mL samples, while the left maximum significantly differed between the 5- and 10-mL and 5- and 15-mL samples. The right minimum significantly differed between the 5- and 10-mL samples, as did the duration of mouth rinsing between the 5- and 15-mL samples.

Conclusions
In children, lip movement and mouth rinsing duration tended to decrease with increasing sample volume. Evaluating lip movement using a contactless vital sensing camera is useful for assessing children's development of oral function.

Keywords mouse rinsing, lip motion, vital sensing camera, adult, child, oral function development

1. Background

During development, while the maxillofacial size and form dramatically change, oral functions, including chewing, swallowing, and speech, are gradually acquired[1-7]. These functions are based on the development or progression of maxillofacial muscle coordination and cooperation. Mouth rinsing skills also require the coordination of facial muscles and are developed via sensorimotor reactions. In dental practice, professionals evaluate the mouth rinsing skills of children to assess the development of oral functions. A previous study found that mouth rinsing skills are related to oral functions such that mouth rinsing evaluation can be a subjective method of evaluation of left-right symmetry and rhythm during rinsing and reported that these skills matured at the age of 5 years[8]. Despite being a useful method for assessing oral functions, the current protocols and methods of evaluation are subjective. The purpose of this study was to compare the quality and quantity of acquired mouth rinsing skills between adults and children. We hypothesized that mouth rinsing motion can be quantified by lip motion. We previously used a contactless vital sensing 3D camera to quantify the expansion and contraction in transverse lip motion during swallowing[9]; however, there has been a recent increase in the progression and development of contactless telemedicine technology due to the coronavirus disease pandemic[10]. Therefore, this study utilized a contactless vital sensing camera to evaluate differences in mouth rinsing skills between adults and children.

2. Materials and Methods

2.1 Participants and ethical considerations

This study was conducted in our laboratory from March 2020 to April 2021. This study comprised 16 voluntary adults (mean age 26.4 ± 2.8 years, male: female, 10:6) and 13 children (mean age 7.3 ± 1.4 years, male: female, 5:8). All subjects were generally healthy and had no issues regarding oral function. The inclusion criteria were as follows: 1. no history of motor dysfunction, mental disorders, allergies, nasal diseases, or other illnesses; 2. competent lips and normal nasal breathing; and 3. well-supported occlusion with normal overlap of the teeth. The exclusion criteria were as follows: 1. inability to follow rinsing instructions; 2. excessive movement while rinsing, resulting in inaccurate detection of lip movements; and 3. failure to extract the waveform of lip motions and measure maximum/minimum displacement even if lip motion could be detected. This study complied with the ethical principles of the Declaration of Helsinki and was approved by the Ethics Committee on Epidemiological Studies, Kagoshima University Graduate of Medical and Dental Sciences (authorization number: 170082 Epidemic-Revised 3). Adult participants provided written informed consent, and children provided informed assent.

2.2 Evaluation of mouth rinsing

In this study, a contactless vital sensing camera was adapted from a Microsoft Xbox One Kinect Sensor® (Kinect). The Kinect is a device that three-dimensionally (3D) acquires the shape and motion information of an object without using a marker. The software development platform was Microsoft Visual Studio 2015, and the programming language was C#. Kinect for Windows SDK v2.0 is an openly available development software[11, 12], which uses a program that recognizes facial shapes (Face Tracking). Face Tracking can estimate 3D positional information of facial feature points and used to recognize the 3D position of the corners on both sides of the object. A proprietary program is used to record the change according to time in the distance between the corners of the mouth. This program was used in the current study. A personal computer was also used for measurement and analysis (DAIV7N-B, Mouse computer Ltd.) along with a high-definition multimedia interface recorder (AREA SD-2WAYCUP) and digital timer (Apple iPad).

Based on a study by Yamamoto et al., the Kinect was placed 100 cm above the floor, and the lateral distance to the subject was 120 cm. The subject sat on a chair with both feet on the floor. The position of the headrest was adjusted such that the inferior margin of the ala nasi and that of the tragus were parallel to the floor. The measurer instructed the subject to maintain the head position as much as possible. As fluoride mouth rinses are typically 5 or 10 mL in volume, samples of plain water of volumes 5, 10, and 15 mL were used. Mouth rinsing was defined as holding the sample in the oral cavity and closing the lips upon hearing an electronic tone, then moving the sample to the left and right sides of the mouth alternately upon hearing a second electronic tone. All samples were assessed three times in each subject.

2.3 Quantitative analysis

Figure 1 shows the determination of the median reference plane to calculate the distance from the lip corner. The midpoint between the bilateral outer canthus and the bilateral inner canthus was named the center of the eye (EC). In addition, the mean of the vector consisting of the outer canthus and the vector consisting of the inner canthus was calculated and named vector N. The plane vertical to N and including the EC was defined as the median reference plane. A vertical line was drawn from the left and right sides of the angulus oris with respect to the median reference plane to calculate the distance. Numerical data obtained during mouth rinsing for 15 s were extracted as a motion waveform. To analyze lip motion, 10 cycles were extracted from 15 s and analyzed (Fig. 2). The average value of the 10 cycles was used as the representative value of each variable.

2.4 Statistical analysis

The reproducibility of the waveforms for 10 cycles was evaluated by a one-way repeated measures analysis of variance (ANOVA). Further, each dependent variable was tested by a one-way repeated measures ANOVA to determine the differences among the three sample volumes. The differences among samples were compared using the Tukey test. Prior to these corrections, an $\alpha=0.05$ was applied to all analyses.

3. Results

Tables 1 and 2 present the reproducibility during mouth rinsing in adults, which was verified by a one-way repeated measures ANOVA with the maximum and minimum distance and rinsing cycle duration as dependent variables. No significant difference was observed in the distance between both sides of the mouth and cycle duration in adults.

Table 3 presents the results of the multiple comparison of sample differences verified by a one-way repeated measures ANOVA with maximum and minimum distance and rinsing cycle duration as dependent variables. There was no significant difference between the maximum and minimum distance or cycle duration in adults. However, significant differences were noted between the maximum distance on the left and right sides ($p<0.001$, $p<0.001$), minimum distance on the right side ($p=0.016$), and duration of the rinsing cycles on both sides ($p=0.011$, 0.022) in children using different sample volumes. Figure 3 shows the multiple comparison tests of the maximum and minimum distance and the rinsing cycle duration. There were no significant differences in the maximum and minimum distance and rinsing cycle duration among the different sample volumes in adults. In contrast, significant differences were noted in the maximum distance on the left side between 5 and 15 mL, 10 and 15 mL ($p=0.001$, 0.025), right side between 5 and 10 mL, 5 and 15 mL ($p<0.001$, $p=0.018$) and the minimum distance on the right side between 5 and 10 mL ($p=0.013$) in children. Further, the rinsing cycle duration on the left side between 5 and 15 mL, and on the right side between 5 and 15 mL ($p=0.015$, 0.021) significantly differed among the samples in children.

4. Discussion

This study aimed to assess the quality and quantity of acquired mouth rinsing skills and how sample quantity affects lip motion during rinsing in adults and children. Our findings indicated no significant difference in the maximum and minimum distance or the duration of mouth rinsing among the three sample volumes in adults, suggesting that the difference in the volume does not inhibit lip movement. This suggests that the coordinated movements of the facial muscles and tongue required for mouth rinsing are fully developed. In contrast, significant differences were observed in the maximum and minimum distances and the duration of mouth rinsing among the different sample volumes in children, suggesting that the volume may inhibit lip movement. As the sample volume increased, the amount of lip movement and the rinsing duration tended to decrease. Therefore, it seems that mouth rinsing was hindered in children when the sample volume was too large. Although a previous study[8)] reported that mouth rinsing skills matured at the age of 5 years, our results indicated that mouth rinsing skills were still developing at the age of 7 years.

Recently, various methods have been used to evaluate oral function in children, including the use of gummy jellies or occlusal force[13-15)]; however, these methods are costly and sourcing the food and equipment is not easy. Furthermore, using food in the evaluation carries a risk of triggering allergies, and the child's parents may not provide consent. In contrast, evaluation based on mouth rinsing is simple, safe, and low cost; despite this, few studies have used this method for the assessment of oral function in children.

Body surface information (e.g. lip, oral cavity, neck) is predominantly measured using video analysis and high precision motion capture[16,17]. The high performance and miniaturization of equipment and program sophistication have allowed us to obtain measurements using inexpensive and high-performance contactless 3D cameras. The Kinect adopted in the present study is a relatively new marker-less motion capture camera and has already been applied as a rehabilitation tool in the fields of nursing and medicine[18,19]. The Kinect offers high reproducibility and accuracy, and is thus useful as a measuring instrument[9,20,21]. Further, as it is a contactless vital sensing camera, it aids in the execution of non-invasive oral function tests and is particularly effective in children.

5. Limitations

In this study, we evaluated cued mouth rinsing rather than free mouth rinsing, meaning that we could only analyze lip motion, but not other coordinated motions. Additional studies are necessary to assess other oral functions, such as tongue motion, mastication, and swallowing. Further, the relationship between mouth rinsing skills and other oral functions was not investigated in this study. Additionally, our sample size was relatively small. By increasing the number of subjects, more credible data can be obtained. In addition, it is considered that the developmental stage can be evaluated by subdividing the cohort into smaller age groups. In the future, longitudinal studies including children from different settings are warranted to confirm our findings.

6. Conclusions

In children, the amount of lip movement and the duration of mouth rinsing tended to decrease with increasing sample volume. The evaluation of mouth rinsing skills using contactless vital sensing cameras will aid the comparison of mouth rinsing skills between adults and children and can be used to assess oral function maturation.

Contributorship
The first and second authors equally contributed to this study.

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Table 1 Reproducibility during rinsing in adults as verified by repeated-measures one-way ANOVA of the maximum and minimum distance and rinsing cycle duration

Table 1 presents the results of reproducibility during mouth rinsing in adults, which was verified by a one-way repeated measures ANOVA, with the maximum and minimum distance and rinsing cycle duration as dependent variables. No significant difference was observed in the maximum and minimum distance and the duration of the rinsing cycles in adults.

Table 2 Reproducibility during rinsing in children as verified by repeated-measures one-way ANOVA of the maximum and minimum distance and rinsing cycle duration

Table 2 presents the results of reproducibility during mouth rinsing in children, which was verified by a one-way repeated measures ANOVA, with the maximum and minimum distance and rinsing cycle duration as dependent variables. No significant difference was observed in the maximum and minimum distance and the duration of the rinsing cycles in children.

Table 3 Multiple comparison by sample quantity difference were verified by repeated measurements and multiple comparisons of one-way ANOVA with maximum and minimum distance and rinse cycle duration as dependent variables

Table 3 presents the results of the multiple comparison of sample differences verified by a one-way repeated measures ANOVA, with maximum and minimum distance and rinsing cycle duration as dependent variables. There was no significant difference between the maximum and minimum distance or the cycle duration in adults. However, significant differences were noted between the maximum distance on the left and right sides, minimum distance on the right side, and duration of the rinsing cycles on both sides in children using different sample volumes.

Figure Legends

Fig. 1 Determination of the median reference plane

The midpoint between the bilateral outer and inner canthus was named EC. In addition, the average distance of the vector consisting of the outer canthus and that consisting of the inner canthus was calculated and named vector N. The plane vertical to N and including EC was defined as the median reference plane. A vertical line was drawn from the left and right angulus oris with respect to the median reference plane to calculate the distance. Numerical data obtained during mouth rinsing for 15 s were extracted as a motion waveform.

Fig. 2 Analysis of lip motion

Ten cycles were extracted and analyzed from 15 s. (A) The maximum and minimum distance on the left and right sides of the angulus oris with respect to the median reference plane were calculated in each waveform. (B) The time required for one cycle, set from the maximum to the maximum value was calculated.

Fig. 3 Multiple comparison tests of maximum and minimum distance and rinsing cycle duration

There were no significant differences in the maximum and minimum distance and rinsing cycle duration among the different sample volumes in adults. In contrast, significant differences were noted in the maximum distance on both sides and in the minimum distance on the right side among the different sample volumes in children. Further, the rinsing cycle duration on both sides significantly differed among the sample quantities in children.

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA											
				Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7	Cycle 8	Cycle 9	Cycle 10	P-value
Maximum (Left)	16	5 mL	Mean (mm)	26.84	27.08	26.68	26.53	26.95	26.64	26.68	26.88	26.59	26.71	0.726
			SD (mm)	2.13	2.09	2.54	2.58	2.18	2.43	2.21	2.32	2.12	2.23	
		10 mL	Mean (mm)	25.28	25.16	25.32	25.37	25.47	25.31	25.08	25.17	25.16	25.10	0.803
			SD (mm)	3.33	3.23	3.39	3.39	3.28	3.33	2.95	3.16	2.70	3.30	
		15 mL	Mean (mm)	26.22	25.07	26.01	26.13	26.3	26.4	26.14	25.92	25.86	26.14	0.623
			SD (mm)	2.09	2.44	2.52	2.19	2.46	2.37	2.48	2.07	2.37	2.40	
Maximum (Right)	16	5 mL	Mean (mm)	27.67	27.36	27.28	27.54	27.38	27.35	27.39	27.20	26.84	26.91	0.136
			SD (mm)	2.12	2.70	2.98	2.82	3.13	2.68	2.65	2.81	2.83	2.87	
		10 mL	Mean (mm)	27.17	27.39	27.47	27.43	27.27	27.14	26.75	27.38	27.27	26.81	0.328
			SD (mm)	2.19	2.36	2.43	2.22	2.70	2.54	2.62	2.59	2.41	2.61	
		15 mL	Mean (mm)	27.41	27.28	27.65	27.53	27.52	27.35	27.16	27.28	27.40	26.90	0.468
			SD (mm)	2.33	2.31	2.40	2.59	2.26	2.51	2.61	2.58	2.66	3.00	
Minimum (Left)	16	5 mL	Mean (mm)	17.07	17.01	17.13	17.34	17.08	17.26	17.17	17.05	17.09	17.14	0.831
			SD (mm)	2.24	2.45	2.59	2.36	2.59	2.60	2.28	2.34	2.45	2.28	
		10 mL	Mean (mm)	17.51	16.96	17.16	16.80	17.25	17.13	17.04	17.01	17.28	17.58	0.216
			SD (mm)	2.01	2.08	2.41	2.32	2.46	2.08	2.40	2.11	2.31	2.47	
		15 mL	Mean (mm)	17.02	17.01	16.63	16.51	16.70	16.62	16.70	16.77	17.06	17.10	0.307
			SD (mm)	2.24	2.17	2.41	2.34	2.25	2.42	2.19	2.33	2.06	2.34	
Minimum (Right)	16	5 mL	Mean (mm)	18.95	18.82	18.95	18.86	18.98	18.68	18.53	18.57	18.82	18.47	0.429
			SD (mm)	1.93	2.06	1.88	2.13	1.86	1.93	1.97	2.00	1.73	2.03	
		10 mL	Mean (mm)	19.86	19.79	19.67	19.60	19.54	19.54	19.66	19.74	19.24	19.46	0.249
			SD (mm)	3.14	3.13	3.27	3.27	3.39	3.42	3.47	3.37	3.29	3.38	
		15 mL	Mean (mm)	19.16	19.16	18.81	18.65	18.49	18.63	18.80	18.94	18.75	18.78	0.415
			SD (mm)	1.83	1.96	2.10	1.85	1.72	1.76	1.98	2.24	1.66	1.93	

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA										
				Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7	Cycle 8	Cycle 9	P-value
Rinsing cycle (Left)	16	5 mL	Mean (Sec)	1.07	0.96	0.93	0.93	0.95	0.97	0.98	1.04	0.98	0.171
			SD (Sec)	0.40	0.39	0.34	0.37	0.29	0.43	0.31	0.37	0.40	
		10 mL	Mean (Sec)	0.94	0.96	0.94	0.96	0.95	0.95	0.93	0.94	0.95	0.965
			SD (Sec)	0.42	0.47	0.42	0.44	0.39	0.34	0.44	0.42	0.43	
		15 mL	Mean (Sec)	0.89	0.94	0.96	0.92	0.98	0.90	0.94	0.96	0.92	0.566
			SD (Sec)	0.41	0.48	0.46	0.38	0.39	0.37	0.43	0.48	0.40	
Rinsing cycle (Right)	16	5 mL	Mean (Sec)	1.02	0.99	0.94	0.97	0.91	1.00	0.92	1.01	0.95	0.215
			SD (Sec)	0.38	0.41	0.35	0.42	0.30	0.32	0.39	0.37	0.35	
		10 mL	Mean (Sec)	0.99	0.95	0.99	0.97	0.91	0.92	0.99	0.87	0.99	0.078
			SD (Sec)	0.47	0.44	0.43	0.40	0.37	0.38	0.41	0.43	0.44	
		15 mL	Mean (Sec)	0.96	0.91	0.95	0.99	0.95	0.93	0.92	1.03	0.92	0.696
			SD (Sec)	0.46	0.45	0.46	0.43	0.37	0.41	0.37	0.56	0.42	

Table.1

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA											
				Cycle 1	Cycle 2	Cycle 3	Cycle 4	cycle 5	Cycle 6	Cycle 7	Cycle 8	Cycle 9	Cycle 10	P-value
Maximum (Left)	13	5 mL	Mean (mm)	21.31	21.19	21.66	21.18	21.15	21.68	21.47	20.48	20.93	20.84	0.475
			SD (mm)	3.48	3.11	2.66	2.86	3.52	2.29	2.39	2.23	2.07	2.37	
		10 mL	Mean (mm)	21.38	20.46	20.82	20.75	20.68	20.63	21.15	20.34	20.68	20.99	0.365
			SD (mm)	3.18	3.35	2.95	3.19	2.89	2.87	2.34	2.19	2.30	2.40	
		15 mL	Mean (mm)	20.64	20.30	19.83	20.16	19.72	20.35	20.05	19.80	19.72	20.12	0.580
			SD (mm)	2.99	3.05	2.70	2.89	2.45	3.12	2.43	2.56	2.72	2.61	
Maximum (Right)	13	5 mL	Mean (mm)	23.27	23.28	22.72	23.31	23.20	23.05	22.91	22.52	22.84	22.13	0.342
			SD (mm)	2.87	2.34	2.86	3.13	2.48	2.53	2.32	2.69	2.72	2.79	
		10 mL	Mean (mm)	22.13	22.15	22.32	22.73	22.44	22.04	21.99	21.34	21.39	21.68	0.168
			SD (mm)	3.08	2.80	2.59	2.24	2.92	2.37	2.60	1.84	1.96	2.22	
		15 mL	Mean (mm)	22.16	22.04	22.00	21.80	21.63	21.16	21.08	22.03	21.83	21.38	0.448
			SD (mm)	3.06	2.54	2.68	2.40	2.80	2.68	2.97	2.33	2.94	2.25	
Minimum (Left)	13	5 mL	Mean (mm)	14.38	14.54	14.28	14.31	14.26	14.31	14.61	14.40	14.51	14.63	0.861
			SD (mm)	1.75	1.82	2.00	1.57	2.05	1.94	1.66	1.95	1.63	1.86	
		10 mL	Mean (mm)	14.30	14.75	14.73	14.62	14.57	14.72	14.44	15.19	14.72	14.94	0.516
			SD (mm)	1.80	1.79	2.19	1.73	1.88	1.53	1.36	1.78	1.32	1.72	
		15 mL	Mean (mm)	14.38	14.45	13.97	14.23	13.99	14.20	14.69	13.90	14.14	14.40	0.367
			SD (mm)	1.52	1.85	1.87	1.75	2.14	1.43	2.31	1.56	1.64	1.97	
Minimum (Right)	13	5 mL	Mean (mm)	17.03	16.85	16.19	16.25	16.42	16.44	16.44	16.66	16.44	16.08	0.356
			SD (mm)	1.65	1.26	1.43	1.86	1.71	2.27	2.11	1.76	2.04	1.52	
		10 mL	Mean (mm)	15.64	16.03	16.21	15.89	16.03	15.63	15.35	15.55	15.68	16.00	0.567
			SD (mm)	1.72	1.82	1.97	2.43	1.94	1.59	2.06	2.40	2.10	2.31	
		15 mL	Mean (mm)	15.80	16.10	16.07	15.83	15.81	15.90	16.10	16.26	16.47	16.35	0.379
			SD (mm)	1.74	1.44	1.57	1.47	1.61	1.38	1.73	1.79	1.56	1.82	

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA										
				Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7	Cycle 8	Cycle 9	P-value
Rinsing cycle (Left)	13	5 mL	Mean (Sec)	1.15	1.06	1.09	1.22	1.14	0.96	1.14	1.32	1.16	0.403
			SD (Sec)	0.62	0.64	0.64	0.62	0.57	0.42	0.40	0.53	0.40	
		10 mL	Mean (Sec)	1.30	1.07	1.04	1.06	0.98	1.14	1.00	1.16	1.03	0.707
			SD (Sec)	0.99	0.70	0.75	0.58	0.36	0.49	0.46	0.50	0.49	
		15 mL	Mean (Sec)	1.05	1.03	0.98	1.02	0.98	1.01	0.93	0.96	0.93	0.810
			SD (Sec)	0.61	0.54	0.65	0.52	0.43	0.49	0.32	0.34	0.38	
Rinsing cycle (Right)	13	5 mL	Mean (Sec)	1.04	1.09	1.10	1.13	1.23	1.04	1.21	1.23	1.20	0.706
			SD (Sec)	0.50	0.71	0.56	0.46	0.73	0.49	0.48	0.39	0.48	
		10 mL	Mean (Sec)	1.04	1.24	1.01	1.00	1.00	1.13	1.03	1.10	1.04	0.656
			SD (Sec)	0.65	0.98	0.70	0.46	0.53	0.47	0.42	0.48	0.56	
		15 mL	Mean (Sec)	0.99	1.00	1.02	1.05	1.17	1.01	0.97	0.89	0.98	0.879
			SD (Sec)	0.55	0.60	0.63	0.48	0.82	0.55	0.35	0.29	0.32	

Table.2

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA		
			Mean (mm)	SD (mm)	P-value
Maximum (Left)	16	5 mL	26.76	2.15	-
		10 mL	26.10	2.02	-
		15 mL	26.11	2.23	-
		Total	-	-	0.069
Maximum (Right)	16	5 mL	27.29	2.66	-
		10 mL	27.21	2.31	-
		15 mL	27.35	2.40	-
		Total	-	-	0.794
Minimum (Left)	16	5 mL	17.13	2.34	-
		10 mL	17.17	2.13	-
		15 mL	16.81	2.15	-
		Total	-	-	0.246
Minimum (Right)	16	5 mL	18.76	1.82	-
		10 mL	18.67	1.85	-
		15 mL	18.82	1.73	-
		Total	-	-	0.623

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA		
			Mean (Sec)	SD (Sec)	P-value
Rinsing cycle (Left)	16	5 mL	0.98	0.09	-
		10 mL	0.95	0.10	-
		15 mL	0.93	0.10	-
		Total	-	-	0.389
Rinsing cycle (Right)	16	5 mL	0.97	0.09	-
		10 mL	0.95	0.10	-
		15 mL	0.95	0.10	-
		Total	-	-	0.863

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA		
			Mean (mm)	SD (mm)	P-value
Maximum (Left)	13	5 mL	21.19	2.41	-
		10 mL	20.79	2.60	-
		15 mL	20.07	2.51	-
		Total	-	-	**<0.001**
Maximum (Right)	13	5 mL	22.92	2.39	-
		10 mL	22.02	2.16	-
		15 mL	21.71	2.33	-
		Total	-	-	**<0.001**
Minimum (Left)	13	5 mL	14.42	1.63	-
		10 mL	14.70	1.48	-
		15 mL	14.24	1.63	-
		Total	-	-	0.104
Minimum (Right)	13	5 mL	16.48	1.52	-
		10 mL	15.80	1.79	-
		15 mL	16.07	1.42	-
		Total	-	-	**0.016**

Dependent variable	Statistic	SQ	Repeated-measures one-way ANOVA		
			Mean (Sec)	SD (Sec)	P-value
Rinsing cycle (Left)	13	5 mL	1.14	0.44	-
		10 mL	1.09	0.46	-
		15 mL	0.99	0.40	-
		Total	-	-	**0.011**
Rinsing cycle (Right)	13	5 mL	1.14	0.44	-
		10 mL	1.07	0.45	-
		15 mL	1.01	0.38	-
		Total	-	-	**0.022**

Table.3

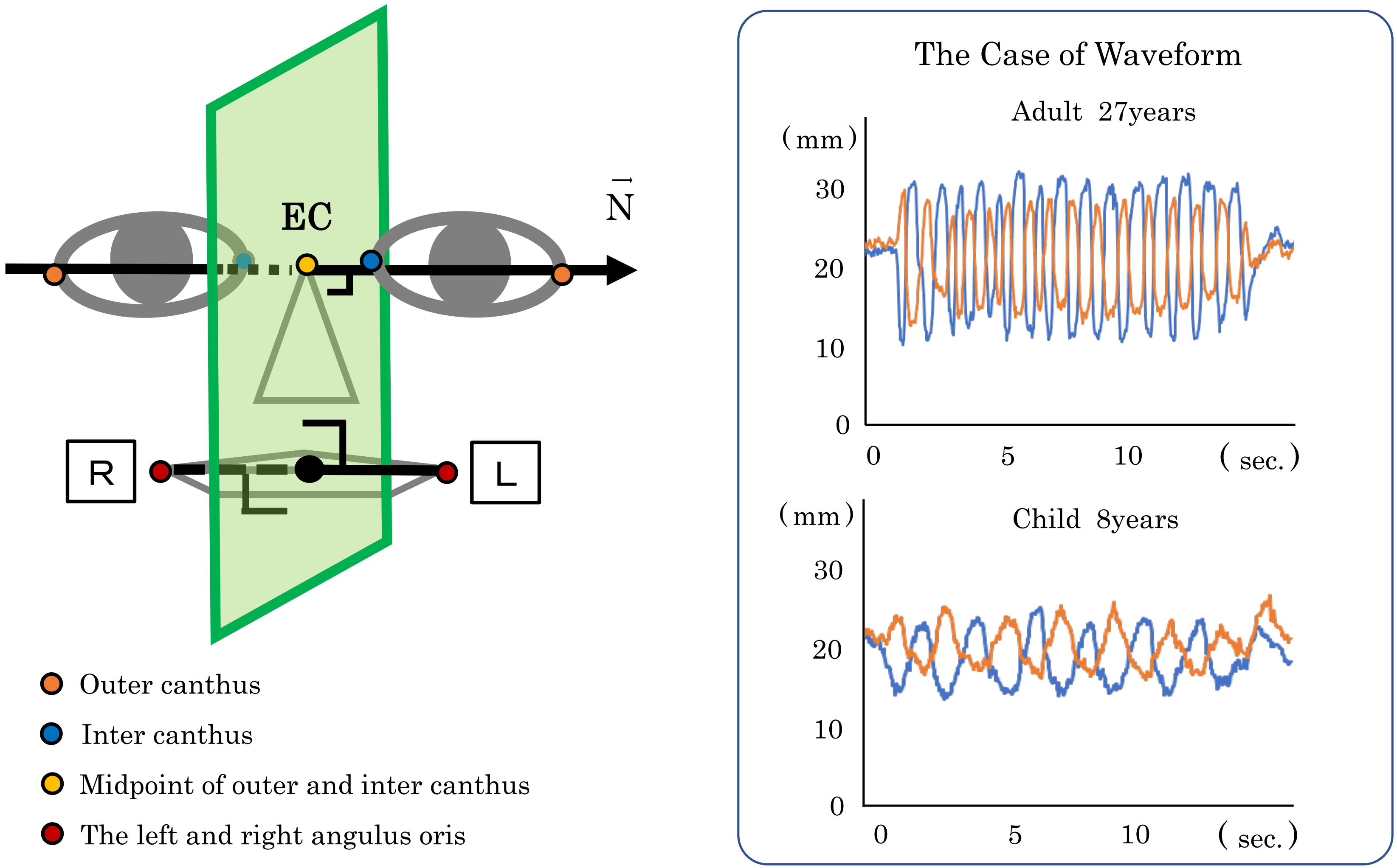
EC
N
R
L
Outer canthus
Inter canthus
Midpoint of outer and inter canthus
The left and right angulus oris
The Case of Waveform
Adult 27years
(mm)
30
20
10
0
0
5
10
(sec.)
Child 8years
(mm)
30
20
10
0
0
5
10
(sec.)

Fig.1

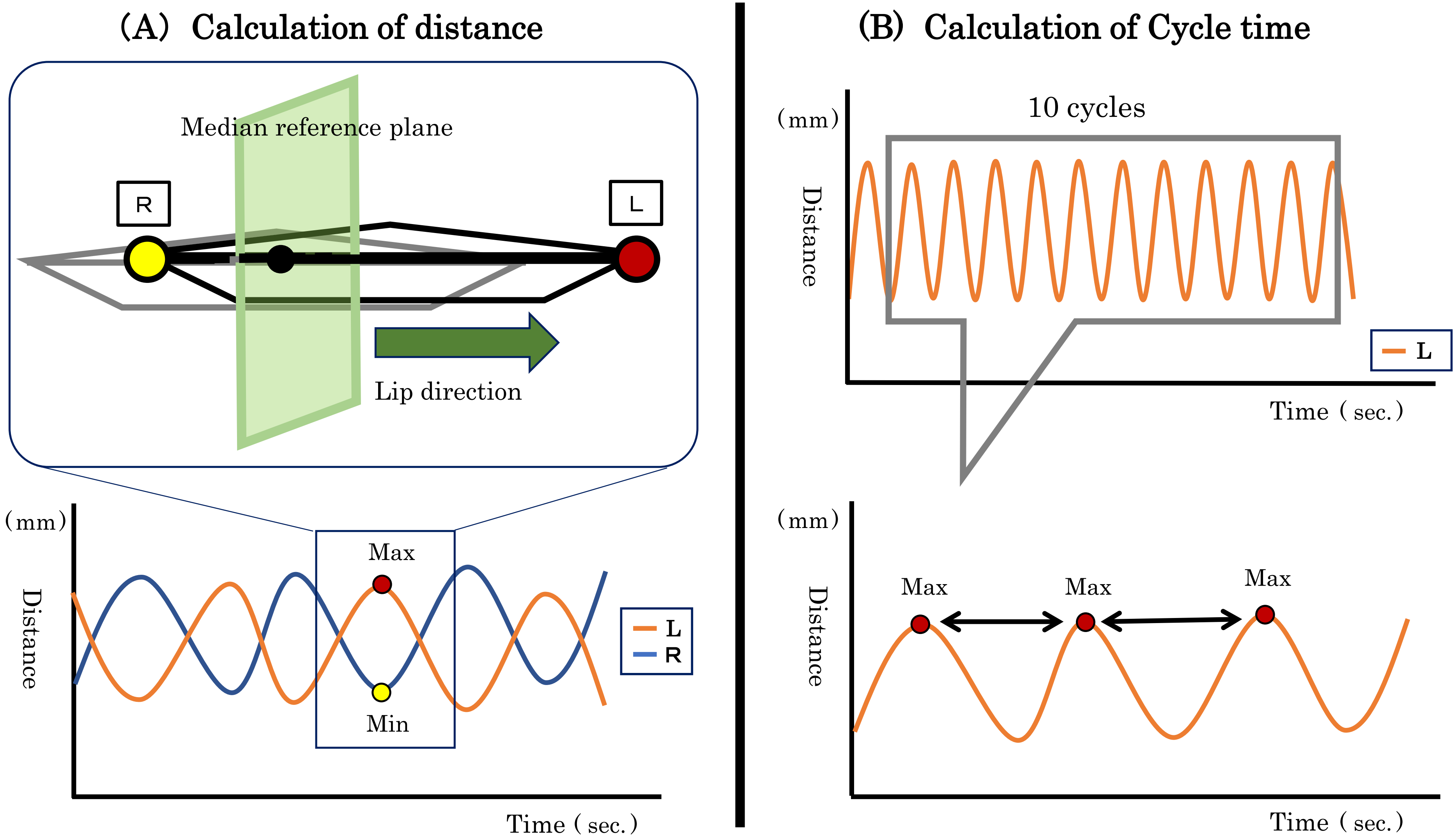
(A) Calculation of distance
Median reference plane
R
L
Lip direction
(mm)
Distance
Max
Min
L
R
Time (sec.)
(B) Calculation of Cycle time
(mm)
10 cycles
Distance
L
Time (sec.)
(mm)
Distance
Max
Max
Max
Time (sec.)

Fig.2

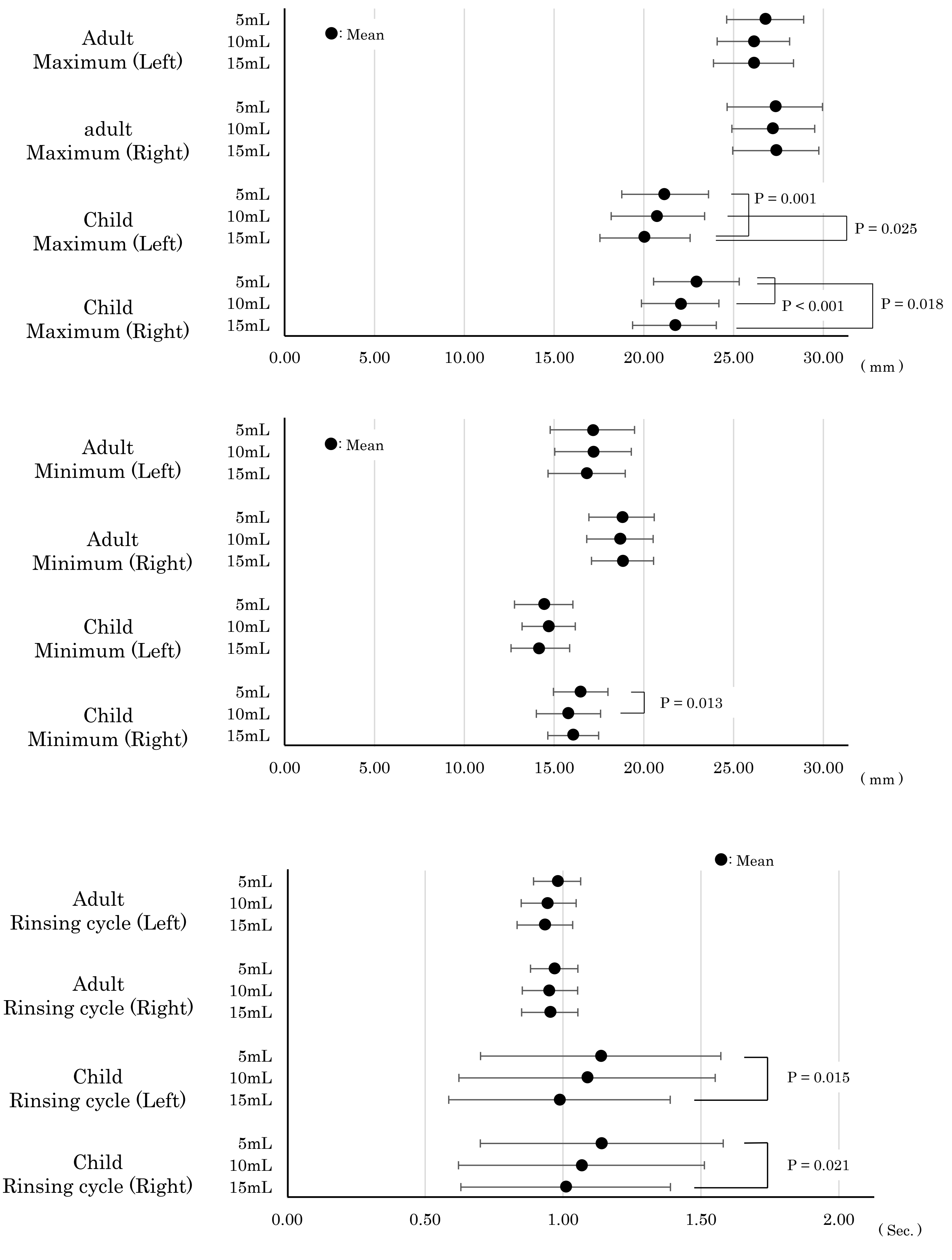
Adult Maximum (Left)
adult Maximum (Right)
Child Maximum (Left)
Child Maximum (Right)
5mL
10mL
15mL
●: Mean
P = 0.001
P = 0.025
P < 0.001
P = 0.018
0.00 5.00 10.00 15.00 20.00 25.00 30.00 (mm)
Adult Minimum (Left)
Adult Minimum (Right)
Child Minimum (Left)
Child Minimum (Right)
P = 0.013
Adult Rinsing cycle (Left)
Adult Rinsing cycle (Right)
Child Rinsing cycle (Left)
Child Rinsing cycle (Right)
P = 0.015
P = 0.021
0.00 0.50 1.00 1.50 2.00 (Sec.)

Fig.3