Jaw movement analysis in subjects with implant-supported prosthesis

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I. Introduction

Prosthetic treatment is required when teeth are lost due to caries, periodontal disease, trauma. This may be crown and bridge, removable partial denture, complete denture or implant prosthesis. Recently, implant prosthesis has come to play an important role in prosthodontic treatment. It is now possible to almost completely restore patient chewing ability, esthetics, speech and psychologic comfort.

Mandibular movement have been investigated to evaluate and analyze chewing pattern, malocclusion, Temporomandibular disorder, mandibular surgery, speech. Methods for measuring mandibular movement have been developed continuously throughout the years. In 1889, Luce measured mandibular movement with still photography. Cinephotography by Hildebrand, gnathic replicator by Cannon, stereophotography by Erdman, photoelectric device by Gillings, radionuclide tracking device by Salomon and various other method had been used[9,12,13,37,41].

Kinesiograph designed by Jankelson et al is used for jaw tracking[16], however this device is limited to incisor point checking. It is impossible to check condylar and molar point with this device, but it is easy to place and also possible to check jaw tracking with EMG data by Hannam[2,10,11,17,33,42].

Although complete denture rehabilitation can restore a patient's appearance and perceived social role, other aspects of impaired oral function associated with being edentulous can be compensated for only to a limited extent[3]. Implant prosthesis is reported to improve oral function to a degree approaching that of dentate persons with respect to chewing efficiency and muscle activity[19]. The purpose of this study was to explore the mandibular movement of complete implant supported fixed prosthesis wearing patients and compare that movement with that of natural dentition and complete denture wearing patients.

II. Materials and Method

1. Control and experimental group

The experimental group is comprized of 8 patients(Table 1). Implant subjects were chosen according to the following criteria:

(1) full arch fixed implant prosthesis in mandible
(2) 6-10 fixtures
(3) occlusal surface : resin or porcelain occlusion

Table 1. Information of fully implant supported fixed prosthesis

Patient number	Fixture number	Occlusion	Opposite Arch	Age
1	8	Resin	Natural dentition	70
2	6	Resin	CD	56
3	6	Resin	CD	63
4	6	Porcelain	RPD	59
5	6	Resin	RPD	62
6	6	Porcelain	CD	37
7	10	Resin	Implant Prosthesis	68
8	10	Resin	CD	70

(CD : complete denture, RPD : removable partial denture)

(4) opposite arch: natural dentition, complete denture, removable partial denture
(5) Angle Class I molar relationship
(6) No evidence of temporomandibular joint problem or masticatory dysfunction

Implant prosthesis wearers consisted of 8 women (Average age : 60.6 years).

Two different control group were selected. The first group had normal dentition and the second one was patients wearing complete dentures.

Normal dentition group was chosen according to the following criteria

(1) complete number of natural teeth retained except the third molar
(2) Angle class I occlusal relationship
(3) no masticatory function problem
(4) no history of orthodontic treatment and prosthetic treatment.

Five female students of The Seoul National University were selected to be subjects for the natural dentition control (Average age : 25.5 years).

Complete denture wearers

(1) Angle class I occlusal relationship
(2) no masticatory functional problem
(3) minimum 3 months denture use
(4) full arch complete dentures

The complete denture wearers consisted of 8 women (Average age : 64.3 years).

2. Recording method

Mandibular movement was recorded with a Sirognathograph (Siemens, Benshiem, Germany) and analyzed with the BioPAK program (Bioresearch, Milwaukee, U.S.A.).

Patients were seated with the Frankfort plane parallel to the floor. A magnet was placed horizontally with the center of the magnet at the mandibular labial frenum and on the gingival third of central incisor. The magnet was positioned parallel to the interpupillary line. Stomahesive (BioResearch, Milwaukee, U.S.A.) was used for attachment of the magnet[45] (Fig. 2).

Sirognathograph sensor array comes with one elastic band used for its placement on the patient's head, but it is not possible to stably place it. The system was adjusted with a head band system of Saphon Visitrainer.

Upper crossbar was placed parallel to interpupillary line and the side bar was parallel to the Frankfort plane. The sensor array was aligned with the magnet using a magnet position bar (Fig. 1).

3. Border and functional movement

Unilateral chewing and border movement were analyzed. Yurkstas and Manly recommended the use of peanuts, ham, and carrots as test food of choice[23]. Raw carrots were used for fuctional unilateral chewing.

Fig. 1. Sirognathograph in place on a subject.

Fig. 2. Position of magnet on the prosthesis.

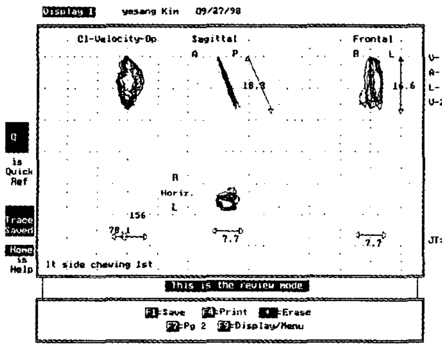


Fig. 3. Unilateral chewing pattern.

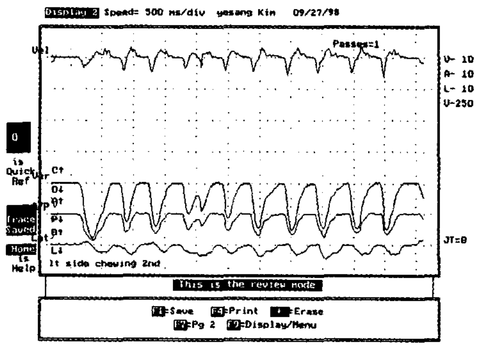


Fig. 4. Sweep display of chewing pattern.

Carrots were chopped to the standardized size of 1.0cm×1.0cm×0.5cm. The sample weighed 0.5g. 6 pieces were used, so the total weight was 3g. Yukstas, Manly recommended 3 - 5g for stability testing of complete dentures. The patient was advised to chew the sample food ten times unilaterally on the patient's preferred side. This test was repeated two times.

The executed movements were recorded with a Sirognathograph and a BioPAK system. To record border movement in frontal and sagittal plane, the subject was induced to carry out the exercise three times. And border movement in frontal and sagittal plane was recorded three times repeatedly. To measure the border movement in sagittal plane, the patient was told to close in centric occlusion first and then protrude to the maximum with sliding contact of teeth and open the mouth to the maximum and close the mouth in maximal retrusion (Fig. 5).

For measuring border movements in frontal plane, the patient was induced to close in centric occlusion and slide the mandible to the left and right to the maximum (Fig. 6).

After the measurement, the movement of chewing cycle was analyzed. Movements were divided into 10 segments. Horizontal and vertical range of movement in frontal plane, anterior and posterior range of movement in sagittal plane, maximum moving distance of incisor point, maximum opening and closing velocity of movement were measured (Fig. 3, Fig. 4).

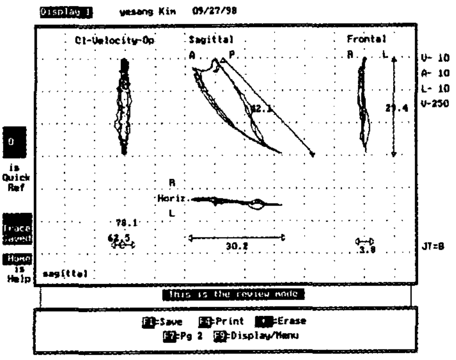


Fig. 5. Border movement in sagittal plane.

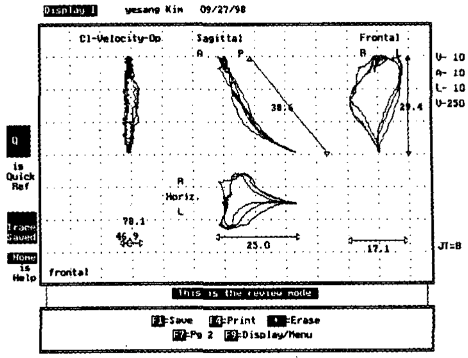
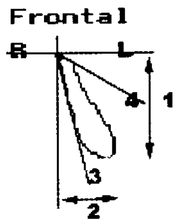
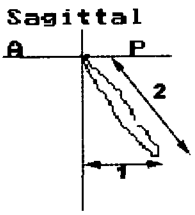


Fig. 6. Border movement in frontal plane.



1. Height of chewing cycle
2. Width of chewing cycle
3. Opening angle
4. Closing angle
5. Chewing angle = | Closing angle - Opening angle |



1. Anterior and posterior range of chewing cycle
2. Maximum moving distance of chewing cycle

Fig. 7. The analysis criteria of chewing cycle.

4. Statistical Analysis

For statistical analysis, Microsoft Excel (version : Office 98, Microsoft) and SPSS program (Ver 7.5). Oneway ANOVA test and Scheffe's multiple range analysis were run.

Ⅲ. Results

1) Height of the chewing cycle in frontal plane

a) raw data analysis

There were no significant differences among groups. The increasing order in mean was CD group, implant prosthesis group and natural dentition group(Fig. 8, Table 2).

b) ratio analysis

To know the range of motion within border movement, we measured the ratio of functional movement data and border movement data.

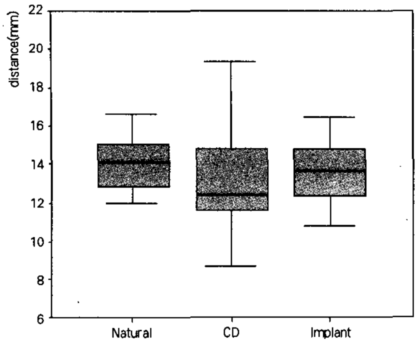


Fig. 8. Raw datas of the height of the chewing cycle in frontal plane

Table 2. Result of Scheffe's analysis in the height of the chewing cycle in frontal plane.

Group		N	1*
Scheffe	CD	22	13.1605
	Implant	24	13.5171
	Natural	14	14.0821
	p		.359

* : Subset for alpha = .05

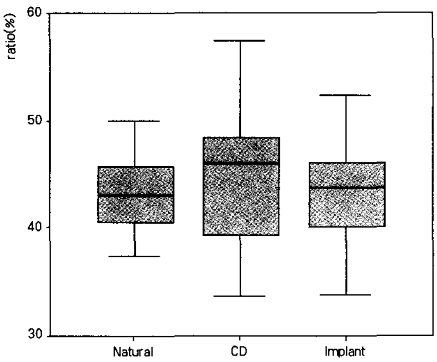


Fig. 9. Ratio data of the height of the chewing cycle in fontal plane.

Table 3. Results of Scheffe's analysis in the height of the chewing cycle in frontal plane

Group		N	1*
Scheffe	CD	14	43.1657
	Implant	24	43.2650
	Natural	22	44.1741
	p		.831

* : Subset for alpha = .05

Analyzed data = (functional movements/ border movements) * 100

There were no significant differences among groups. Age, patient's attitude to the test, and unfavorable prosthesis may affect border and functional movement. In complete denture wearing group and implant prosthesis group, border movement was restricted. Relatively the ratio of complete denture wearing patients and implant prosthesis was increased(Fig. 9, Table 3).

2) Width of the chewing cycle in frontal plane

a) raw data analysis

The value in the implant group was significantly lower than that of the natural dentition group and the CD group. Intragroup difference was higher in natural dentition and complete denture wearing group than implant group(Fig. 10, Table 4).

b) ratio analysis

Two different chewing pattern could be observed in frontal plane. One was a grinding pattern, the other is a chopping pattern. Consistency and toughness of food, type of prosthesis, shape of the occlusal surface, chewing habit, occlusion type and other factors may influence shape of chewing pattern(Fig. 11, Table 5).

It was impossible to discriminate the differences

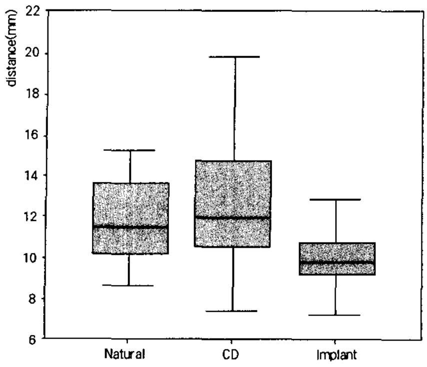


Fig. 10. Raw data of the width of the chewing cycle in frontal plane.

Table 4. Result of Scheffe's analysis in the width of the chewing cycle in frontal plane

Group		N	1	2
Scheffe	CD	24	3.9492	
	Implant	14		4.9613
	Natural	22		5.3043
	p		1.000	.689

1 ＜ 2 at P＜0.05

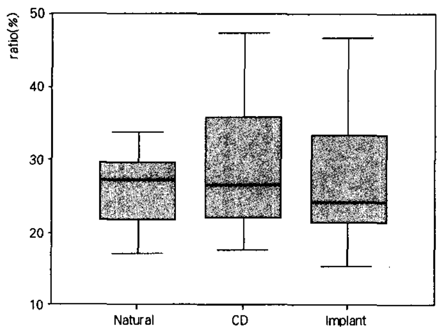


Fig. 11. Ratio data of the width of the chewing cycle in frontal plane.

Table 5. Result of Scheffe's analysis in the width of the chewing cycle in frontal plane

Group		N	1*
Scheffe	CD	14	25.9029
	Implant	24	27.5688
	Natural	22	29.0559
	p		.488

* : Subset for alpha = .05

among the ratio data of the test group in the width of the chewing cycle.

3) Chewing angle in frontal plane

The value in the complete denture group was significantly lower than that of the natural dentition group(Fig. 16, Table 10).

4) Maximum moving distance incisor point in sagittal plane

a) raw data analysis

There were no significant differences between the natural dentate person and implant group. The maximum moving distance in the complete denture group were significantly lower than that of the natural dentition group(Fig. 12, Table 6).

b) ratio analysis

The values seen in the implant group were significantly different from the CD group and the natural dentition group. The ratio seen in implant group was lower than that of other groups. Border movement of the CD group was limited extensively, so the ratio of the CD group was higher than raw data results(Fig. 13, Table 7).

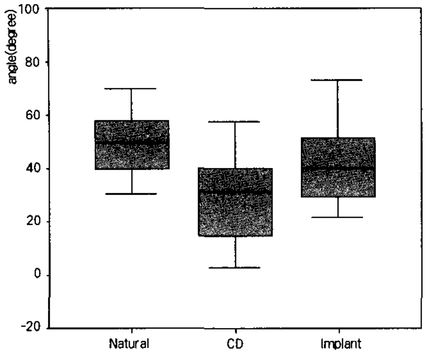


Fig. 16. Raw data of chewing angle.

Table 10. Results of Scheffe's analysis

Group		N	1	2
Scheffe	CD	22	30.0859	
	Implant	24	40.8379	40.8379
	Natural	14		50.1986
	p		.124	.202

1 〈 2 at P〈0.05

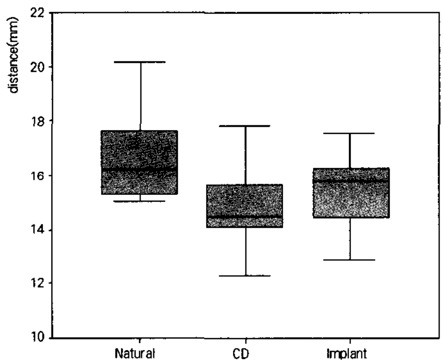


Fig. 12. Raw data of the maximum moving distance in sagittal plane.

Table 6. Results of Scheffe's analysis

Group		N	1	2
Scheffe	CD	22	14.9082	
	Implant	24	15.5221	15.5221
	Natural	14		16.7721
	p		.548	.090

1 〈 2 at P〈0.05

5) Maximum anterior and posterior range of movement in sagittal plane

a) raw data analysis

The values in the complete denture group and the implant group were significantly lower than that of the natural dentition group(Fig. 14, Table 8).

b) ratio data analysis

The value seen in the implant group was significantly lower than the natural dentition group(Fig. 15, Table 9). Chewing pattern in sagittal plane was analyzed on two criteria. One is the maximum moving distance of incisor point and the other is the anterior and posterior range of movement. Both values were lower in the implant group than the natural dentition group.

It can be assumed that chewing pattern in the implant group was more confined to the frontal plane than other group because the two values measured were lower.

6) Maximum opening velocity

The value of the test groups increased in following order, the natural dentition group, the CD group, and the implant prosthesis group. The value in the natural dentition group was significantly

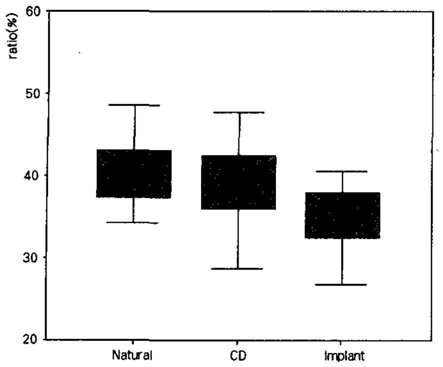


Fig. 13. Ratio data of the maximum moving distance in sagittal plane.

Table 7. Results of Scheffe' s analysis

	Group	N	1	2
Scheffe	CD	24	35.0408	
	Implant	22		39.2769
	Natural	14		40.0257
	p		1.000	.874

1 < 2 at P<0.05

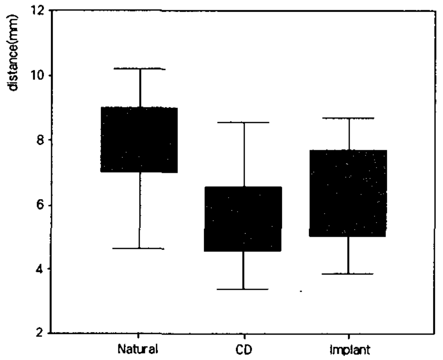


Fig. 14. Raw data of the maximum anterior and-posterior range of movement in sagittal plane.

Table 8. Results of Scheffe' s analysis

	Group	N	1	2
Scheffe	CD	22	5.7386	
	Implant	24	6.3592	
	Natural	14		8.0443
	p		.468	1.000

1 < 2 at P<0.05

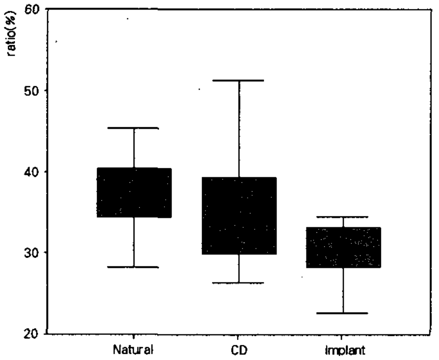


Fig. 15. Ratio data of the maximum anterior and-posterior range of movement in sagittal plane.

Table 9. Results of Scheffe' s analysis

	Group	N	1	2
Scheffe	CD	24	20.2013	
	Implant	22	24.2614	24.2614
	Natural	14		27.8714
	p		.073	.123

1 < 2 at P<0.05

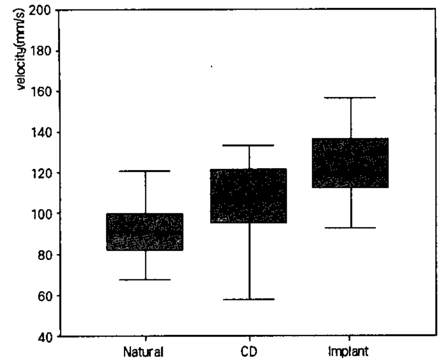


Fig. 17. Raw data of maximum opening velocity.

Table 11. Results of Scheffe's analysis

Group		N	1	2
Scheffe	CD	14	93.5643	
	Implant	22		115.2934
	Natural	24		123.5417
	p		1.000	.554

1 < 2 at P<0.05

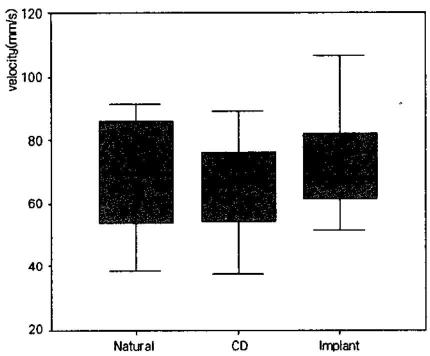


Fig. 18. Raw data of maximum closing velocity.

Table 12. Results of Scheffe's analysis

Group		N	1*
Scheffe	CD	22	64.9341
	Implant	14	69.0221
	Natural	24	71.7267
	p		.402

* : Subset for alpha = .05

lower than that of the CD and the implant prosthesis group(Fig. 17, Table 11).

7) Maximum closing velocity

The value in the test group increased in following order, the CD group, the natural dentition group, and the implant prosthesis group. But there were no significant differences among the test groups(Fig. 18, Table 12).

IV. Summary of the results

1. Natural dentition

Border movement guiding by subject oneself was rather smooth and natural in comparison to complete denture wearer and implant supported prosthesis wearer. Maximum moving range of incisor point and anterior and posterior range of movement was higher than the other group. Chewing angle was also higher than the other group. But maximum opening velocity was the lowest among the test group(Fig. 19).

2. Complete denture

Some patient showed restricted border and functional movement. They were hard to chew carrot. The other patient showed fluent border and functional movement. It might be due to ridge con-

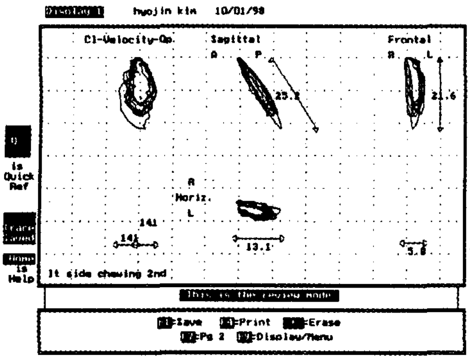


Fig. 19. Left side unilateral chewing of one test dentate control.

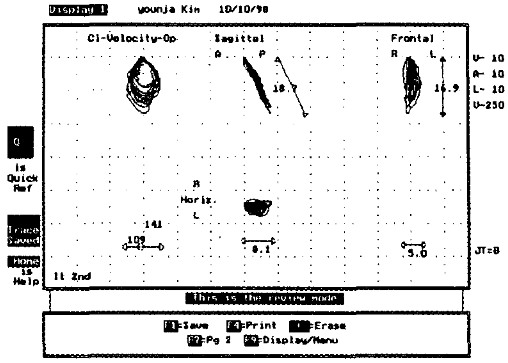


Fig. 20. Left side unilateral chewing of complete denture wearer who had poor residual alveolar ridge.

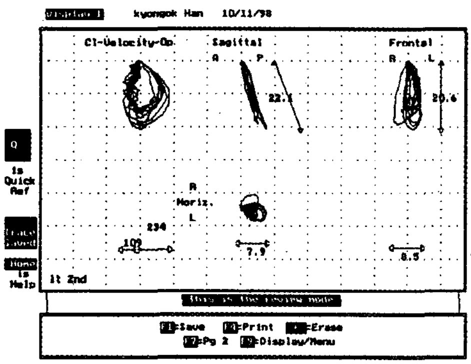


Fig. 21. Left side unilateral chewing of complete denture wearer who had good residual alveolar ridge.

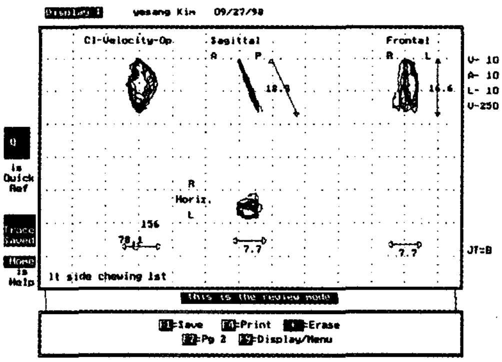


Fig. 22. Left side unilateral chewing of patient who had complete implant supported prosthesis in maxilla and mandible.

dition, retention and stability of denture. Intragroup difference was higher than the other group.

Width of the chewing cycle was higher than the other groups, but standard deviation was too high to be reliable. Maximum moving distance of incisor point and anterior and posterior range of movement was lower than the others. Chewing angle was also lower that the others(Fig. 20, 21).

3. Implant prosthesis

Chewing pattern was slightly different as opposing arch types. Patients wearing maxillary complete denture had unnatural and rather limited border movement than patients with maxillary complete implant supported prosthesis and patients with upper natural dentition. Chewing pattern at frontal plane was rhythmic but the movement was hard to find core of movement. Patients did easily crush the carrot. Height of the chewing cycle was not significantly different from the others. Width of the chewing cycle was significantly lower than the others. Maximum moving range of incisor point were not significantly different from the others. Maximum anterior and posterior range of movement in sagittal plane was significantly lower than natural dentition group. Chewing angle was not significantly different from the others. Maximum opening and closing velocity was the highest(Fig. 22).

V. Discussion

Mastication is considered a rhythmic event with timing that is generated in the reticular substance of the brain stem and can be modified by inputs from the central and peripheral nervous system[26]. Habitual mastication is a rhythmic event[26-29]. Natural chewing pattern is characteristic for each individual[1]. But determining a mean chewing movement can be difficult[28]. All recordings showed a large variety of individual movement patterns. Because of the variety of individual movements the measurement revealed relatively high standard deviation[4].

In order for jaw tracking to be acceptable, it must be carried out in a standardized manner, and specific movements should be measured which have been shown in controlled clinical recordings to be reproducible. As with all human movement there is a broad range of intra and interindividual values[15]. Type of food, emotional and psychological status, sex difference may take part in chewing movement.

At first, the test food was standardized into same size and weight. Many studies prove that chewing pattern is changed in relation to the resistance of food. Width of the chewing stroke increased when chewing hard foods[8]. When soft food is chewed the angulated patterns appear much less frequently and the slim and drop shaped forms are favored[35]. Chewing hard food is characterized by shorter times for the chewing cycles and greater vertical and sagittal amplitudes of the movements. Longer vertical dimensions of the pattern and smaller frontal widths obviously lead to smaller that is steeper angles of approach to the intercuspal position. Ahlgren found that a wide grinding chewing cycle was used with gum, whereas carrots and peanuts called for a more vertical chopping stroke[1]. To compare the data, the standardized sample food must be used. Yurkstas and Manly recommended the use of peanuts, ham or carrots for test food. Kapur recommended the use of raw carrot[23]. Raw carrot recommended for the stability test of complete denture. Because raw carrot have different resistance nature according to the area, we used the outerside portion of carrot away from the center.

The patient usually chewed unilaterally at a preferred side. Preferred side is not associated with handedness[43]. No association was found between chewing side preference and handedness, footedness, eyedeness or earedness[14]. If several chewing cycles are computed to assess a mean chewing movement, cycles toward opposite sides tend to abate reciprocally. Therefore statistical studies usually have been performed on unilateral voluntary masticatory movements[26].

Although chewing on only one side of the jaw may be necessary to analyze the pattern of jaw movements during enforced unilateral chewing to classify chewing strokes, any method of investigating masticatory function that uses an apparatus that interferes with subconscious chewing or imposes voluntary control over the chewing cycle, introduces a degree of bias and may therefore invalidate the observation[30]. In research on mastication, there is a need to distinguish between habitual and deliberate unilateral chewing. Deliberate unilateral chewing is the accepted model for study of the influence of a specific factor upon mastication[38].

Patient's cooperation to the test have an effect on the results. Sirognathograph can measure mandibular movement easily and quickly. But this device presses the nasion area forcefully. Patients feel pain, when the test have lasted more than ten minutes. Patient who were cooperative to the test were selected. Chewing movement may vary according to the emotional and physical status of the patient[31,32]. A slight alteration in the masticatory pattern in repeated registrations, might mean an adaptation to the test situation. If this is the case, initial training of the test situation as was done in the present study would reduce the risk of registered changes to be affected by adaptation[18].

Sex difference also might have an effect on the result. Because patients were almost female, only female patients were selected. Differences were found between men and women with respect to cycle time, velocity of movement, dimensions of the chewing envelope, and duration of the pause in the intercuspal position. The sex of the subject have been shown to effect mandibular displacement[30].

Accuracy of device can have an effect on the results. Mandibular kinesiograph provides an accuracy of 0.1mm for resolution of madibular positions in the vicinity of occlusion. The accuracy and linearity of the electrognathographic method have been tested, with an accuracy of 1% achieved in the spatial domain to which chewing movements are confined[35] Sirognathograph tended to underestimate the true jaw opening by about 13% and that this relationship was linear for openings of less that 45mm. Beyond 45mm the relationship was no longer linear[40]. Functional movement may be less than 45mm, so we can have the linear data and compare the data among group.

Sirognathograph yields an error in presentation on the borders of the prism-shaped area of up to 10%. Correct positioning of the magnet obtains a spatial region of nearly 15×15mm horizontally and 25 mm vertically. Inside this region nonlinearities are less than 1%. Error of the readout of the graphic tracing was 0.5mm[31]. Michler[25] and Maruyama[24] tested the Sirognathograph and found that a 10 degree rotation of magnet caused a 1mm displacement. Additional errors due to head movement during the recording are always possible. To avoid error due to head movement, we alter the device with head cap system of Saphon Visitrainer.

There were no significant differences among the test groups in the height of the chewing cycle in the frontal plane. The mean in increasing order is CD group, implant prosthesis group and natural dentition group. But border movement of CD group and implant prosthesis group was restricted, so the ratio of functional movement and border movement in increasing order was natural dentition group, implant prosthesis group and CD group.

Intragroup differences was too high to standardize the mean data in the width of the chewing cycle in frontal plane. But the data of implant prosthesis group was significantly lower than those of other groups. Majority of implant prosthesis group have upper complete denture and worn resin teeth occlusion, so the chewing pattern was different from natural dentition group. Opening and closing path of chewing cycle was more vertical than other groups. The width of the habitual chewing movements at the first segment on the frontal projection was greater in denture wearerrs. Unilateral chewing cycles had greater dimensions with wide and curved opening strokes in denture wearers. Incisor point movements during lateral contact movements in patients whose dentures had nonanatomically formed teeth differed essentially from the same movements in dentate subjects[4].

The mean increasing order of chewing angle was CD, implant and natural dentition group. The chewing angle of CD group was significantly lower than that of natural dentition group. CD group had the lowest maximum moving distance values of the incisor point. The values of CD group were significantly lower than those of natural dentition group. There were no significant differences between natural dentition group and implant prosthesis group in the maximum moving distance values of the incisor point. In anterior and posterior range of chewing cycles in sagittal plane, the natural dentition group have the highest value. The values of natural dentition group were significantly higher than that of CD and implant group. There is no significant differences among the test groups in the maximum closing velocity. But the closing velocity of complete denture group was lower than that of implant and natural dentition group.

Mandibular movement of complete denture wearer have remarkable contrast according to the condition of residual alveolar ridge, retention and stability of denture, age, occlusion, and shape of denture teeth. Patient with good residual alveolar ridge and well fabricated denture had not remarkable difference against natural dentition. They have rhythmic chewing pattern and natural border movement. Chewing movement of denture wearers with good alveolar ridge occurred within the scope of approximately the same area as that of dentate subjects[31]. There was no difference of chewing angle size and velocity of movement[22].

But patient with poor residual alveolar ridge have unnatural chewing pattern and restricted border movement. Chewing patterns of the complete denture wearers with poor alveolar ridge were characterized by less vertical opening and less lateral excursions than those of the subjects with natural teeth[39]. These differences suggested that complete denture wearers avoid extreme chewing movements to avoid dislocating the dentures. The poor fit which leads to reduced chewing efficiency and relapsing denture sore spots was the main reason for edentulous patient seeking implantation in the mandible[4]. Denture wearers had a shallow angle of disocclusion in the frontal view compared with the natural dentition subjects[5]. The test subjects showed a wide intraindividual variation in chewing patterns in the complete denture situation[19]. Smaller chewing cycles was associated with slower mandibular velocity in the group of complete denture wearers compared with dentate persons[19].

Denture wearers do not prefer anatomic over nonanatomic posterior teeth to any significant degree. Denture teeth of both 0 degree and 30 degree designs produced a rounded, poorly defined intercuspal position in contrast to a sharp well defined intercuspal position in the natural dentition subjects[5].

The characteristic findings of the more anterior chewing movements of the edentulous subjects, particularly the females may possibly be explained by several factors. 1) there is an anterior migration of the edentulous mandible. 2) the vertical dimensions of occlusion is reduced during the establishment of interarch relationships 3) the reduced cusp height of the artificial teeth could cause difficulties in localizing the bolus and require a stronger force to crush the carrots. 4) considering the direction of muscle fibers that are primarily engaged in the closing movement and the fact in denture wearers maximum intercuspation is achieved in centric relation position, it appears that the mandible is placed more anteriorly in the attempt to find optimum muscle length for generating the strongest contractions. However, the posterior borders of the chewing movement envelopes for denture wearers generally are placed more posteriorly in comparison to those of dentate subjects, particularly in male subjects[4].

Implant prosthesis have been reported to improve oral function to a degree approaching that of dentate persons with respect to chewing efficiency and muscle activity[19].

Patients with implant supported fixed prosthesis chew carrot easily and naturally irrespective of opposite arch status. Patients with resin occlusal surface had chopping type chewing pattern according to wear of resin teeth and altered occlusal pattern. Patient with porcelain superstructure had natural grinding type chewing pattern.

General chewing pattern underwent only minor changes. However some chewing cycle parameters showed obvious alterations. Increased velocity and displacement especially in the opening phase. The cycle duration showed a tendency to decrease due to significant shortening of the occlusion phase. This can be attributed to the stabilization of the occlusion provided by the fixed denture in the mandible[19].

5 patients of implant prosthesis group wore complete maxillary dentures, it was not expected that the effect of the implant prosthesis treatment would result in an improvement that would approach dentate individuals[19]. Consequently, analyzed parameters in implant prosthesis patient improved but did not fully coincide with dentate persons. 2 patients have opposite upper RPD, and 1 patient have opposing full arch implant supported prosthesis. Patient with opposite RPD or full arch implant supported prosthesis have unrestricted border movement and grinding type chewing pattern. Implant prosthesis treatment actually influences mandibular border movements as well as chewing patterns.

Female dentate subjects recorded a greater chewing width on the frontal projection[30]. Female dentate subjects have the lowest opening velocity. Female subjects perform the chewing movements in a different manner as a result of culture. Perhaps female subjects are taught to perform chewing movements more slowly and well measured, while the male subjects do so more strongly and with less conscious control[31].

Ⅵ. Conclusions

On the basis of the analysis of chewing movement of complete implant supported fixed prosthesis wearers, complete denture wearers and natural dentate subjects recorded using a Sirognathograph, the following conclusions are drawn :

1. No difference was found in the height of chewing cycle in frontal plane among the test groups($p>0.05$).
2. Differences were found in the width of chewing cycles in frontal plane between implant and natural dentition group and between implant and complete denture group($p<0.05$).
3. Differences were found in the anterior and posterior range of chewing cycles in sagittal plane between implant and natural dentition group and between implant and complete denture group($p<0.05$).
4. No difference was found in the chewing angle in frontal plane between implant and natural dentition group and between implant and complete denture group($p>0.05$).
5. No difference was found in the maximum moving distance of incisor point in frontal plane between implant and natural dentition group and between implant and complete denture group($p>0.05$).
6. The maximum opening velocity of natural dentition group was significantly lower than that of complete denture wearer and implant prosthesis wearer($p<0.05$).
7. No difference was found in the maximum closing velocity among the test groups($p>0.05$).
8. There is great individuality in the mastication.

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ABSTRACT

임플랜트 보철 환자의 하악 운동에 관한 연구

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임플랜트 보철 환자의 하악 운동에 관한 연구를 위해 완전 고정성 보철 치료를 한 8명의 환자와 상하악 총의치를 장착한 8명의 환자, 그리고 5명의 자연치아 피검자를 대상으로 Sirognathograph(Siemens, Benshiem, Germany)와 BioPAK program(BioResearch, Milwaukee, U.S.A.)으로 한계운동과 당근 시편에 대한 편측 저작운동에 대한 검사를 시행하였다.

편측 저작 운동은 전두면에서의 저작운동의 높이와 폭, 전두면에서의 저작각도, 시상면에서의 절치기준점의 최대 이동거리, 시상면에서의 저작운동의 전후방 이동거리, 최대개구속도, 최대폐구속도의 기준점으로 각 저작주기의 성적을 평균처리 하여 다음과 같은 결론을 얻었다.

1. 전두면에서의 저작운동의 높이는 자연치, 총의치, 임플랜트 군간에 유의성있는 차이가 없었다 (p>0.05).
2. 전두면에서의 저작운동의 폭은 임플랜트 군이 자연치, 총의치 군에 비해 유의성있게 작은 수치를 보였다(p<0.05).
3. 전두면에서의 저작각도 분석시 임플랜트 군과 자연치 군, 임플랜트 군과 총의치 군간에 유의성있는 차이가 없었다(p>0.05).
4. 시상면에서의 절치기준점의 최대 이동거리 분석시 임플랜트 군과 자연치 군, 임플랜트 군과 총의치 군간에 유의성 있는 차이가 없었다(p>0.05).
5. 시상면에서의 전후방이동거리는 자연치 군이 임플랜트 군, 총의치 군에 비해 유의성있게 크게 나타났다(p<0.05).
6. 최대개구속도는 자연치 군이 총의치 군과 임플랜트 군에 비해 유의성있게 작은 수치를 보였다 (p<0.05).
7. 최대폐구속도는 각 군간에 유의성 있는 차이가 없었다(p>0.05).
8. 저작운동은 개인간의 차이가 커서 명확한 결론을 유추하기가 어려웠다.

주요어 : 완전 고정성 임플랜트 보철물, 하악 운동, Sirognathograph