Study on the Improvement of the Craniomandibular Index in the Assessment of Craniomandibular Disorders

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Ⅰ. Introduction

Craniomandibular disorders(CMD) is a collective term embracing a number of clinical problems that involve the masticatory musculature, the temporomandibular joint, or both.[1] Although our understanding of the pathophysiology of CMD is growing[2], there is confusion over the prevalence of each condition as well as over the efficacy and appropriateness of the wide range of treatments suggested for CMD. Many studies have been performed in this field of CMD. But the results vary considerably from study to study because of lack of good methodological techniques, particularly in the area of measurement of the severity of the disorders[3,4].

The ability to dependably measure clinical signs and symptoms is a minimum requirement for arriving at rational diagnosis and tracking treatment progress for any health problem. To accomplish these goals, the measurement process must be valid, reliable, and sensitive enough to differentiate between relatively small levels of disease severity. Increased sensitivity and precision facilitates rating the efficacies of various treatments. Despite significant effort directed at designing an accurate and sensitive measuring instrument, precise quantification of pain and dysfunction remains, at best, an unattained goal.

To obtain and compare valid results from different studies, it is necessary to use consistent and reliable instruments to measure severity of disease. For this purpose many indexes have been developed and Helkimo index[5,6] and Fricton's Craniomandibular Index (CMI)[3,4] are generally accepted among the clinicians. Helkimo[5,6] has been a pioneer in the development of indexes to measure severity of TMJ pain and dysfunction. In an epidemiological study of Lapps in Sweden, he developed the Anamnestic Index(AI), Clinical Dysfunction index(CDI) and Occlusal State Index(OSI)

to evaluate this population for increasing the severity of symptoms, jaw pain and dysfunction, and occlusal instability, respectively. Since these instruments were designed for epidemiological surveys, they are of limited use in clinical outcome studies, because they do not separate joint problems from muscle problems, are not sensitive enough to measure small changes in severity, place unequal weight on different signs, pose some problems in palpation reliability, and are difficult to score.

To overcome the limits of Helkimo index, Fricton developed the CMI which provides a standardized method of assessing disease severity. The CMI was designed to have clearly defined objective criteria, simple clinical methods, and ease in scoring. It is divided into the Dysfunction Index(DI) and the Palpation Index(PI). Inter-examiner and intra-examiner reliability were tested to determine whether the instrument has operational definitions sufficiently precise to allow consistency in use between different examiners and with one examiner over time. It was supported the reliability of the CMI for use in epidemiological and clinical studies.[3]

However, some questions regarding the CMI's ability to detect small to moderate changes in severity of sign and symptom remains. The CMI uses a 2-point categoric scale (report of the presence or absence of established category at each item) that may limit its sensitivity to severity changes.[7,8] Dixon et al.[9] reported that 4-point scale is more useful to detect clinical changes in muscle and joint tenderness than that of the 2-point scale. But he used 4-point scale and restriced of examine the item in muscle and joint tenderness. Therefore author suggests the Modified CMI(mCMI) and Combined CMI (cCMI) were developed based on the Fricton's CMI which were applied the all of items and use of 11-points categoric scale for compensating these problems.

The objective of this study was to compare the CMI (currently used in the CMI) with a mCMI and cCMI (expansion of CMI categories) relatived to their abilities to change in sign and symptom of CMD.

II. Materials and Methods

1. Patients

Twenty patients (4 men, 16 women; age range 12 to 47 years; mean age 22.6 years) were selected from a consecutive series of outpatients at the Department of Oral Medicine and Orofacial Pain clinic, Dental Hospital, Dankook University. All subjects were diagnosed with CMD. The patients were categorized on the basis of their histories and clinical exams as having primary masticatory muscle etiology (4 patients), a primary joint etiology (11 patients) or combination of masticatory muscle and joint etiology (5 patients).

2. Methods

All subjects received definitive treatment include muscle relaxation appliance, behavioral therapy, physical therapy, pharmacotherapy and emotional stress therapy for their state of disorder.

The masticatory system of each patient was examined using three indexes(CMI, mCMI, cCMI) before treatment, at 2nd week after treatment and 4th week after treatment. Each CMD patient had recorded on TMJ chart and questionnaire, which have been used in the Department of Oral Medicine and Orofacial

Pain clinic, Dental Hospital, Dankook University. The chart form includes the items of Fricton's CMI. The masticatory system of each patient was examined using three indexes before treatment, at 2nd week after treatment and 4th week after treatment.

3. Clinical Outcome Measures

A specific definition of each item and description of technique used to examine and score each item was established (Table 1, 2, 3 & 4; Figure 1). The score of each item was used

Table 1. Clinical examination form : Mandibular Movement and TMJ Noise

Mandibular Movement(MM)

1. Maximum opening (incisor to incisor) ( )mm
   0 : above 40 mm 1 : 37~39 mm 2 : 34~36 mm 3 : 31~33 mm
   4 : 28~30 mm 5 : 25~27 mm 6 : 22~24 mm 7 : 19~21 mm
   8 : 16~18 mm 9 : 13~15 mm 10 : below 12 mm
2. Passive stretch opening ( )mm
   0 : if not positive in restriction 1 : above 10 mm 2 : 9 mm 3 : 8 mm
   4 : 7 mm 5 : 6 mm 6 : 5 mm 7 : 4 mm 8 : 3 mm
   9 : 2 mm 10 : below 1 mm
3. Restriction [ ] NRS( ) Point : 10-NRS
4. Pain on opening Rt[ ] NRS( )
5. Pain on opening Lt[ ] NRS( )
6. Asymmetry mandibular movement
   0 : Straight opening [ ]
   2 : S. deviation on opening (<2mm) [ ]
   4 : S. deviation on opening (>2mm) [ ]
   6 : L. deviation on opening (<2mm) [ ]
   8 : L. deviation on opening (>2mm) [ ]
   10 : Jerky opening [ ]
7. Protrusion pain Rt[ ] NRS( )
8. Protrusion pain Lt[ ] NRS( )
9. Protrusion limitation [ ] ( )mm
10. Right laterotrusion pain Rt[ ] NRS( )
11. Right laterotrusion pain Lt[ ] NRS( )
12. Right laterotrusion limitation [ ] ( )mm
13. Left laterotrusion pain Rt[ ] NRS( )
14. Left laterotrusion pain Lt[ ] NRS( )
15. Left laterotrusion limitation [ ] ( )mm

limitation 0 : abvoe 7 mm 3 : 4~7 mm 6 : 2~4 mm 10 : below 2 mm

MM Total ( )

TMJ noise (TN) (Check no more than two on each side)

1. Reciprocal click	Rt[ ]	Lt[ ]
2. Reproducible opening click	Rt[ ]	Lt[ ]
3. Reproducible laterotrusive click only	Rt[ ]	Lt[ ]
4. Reproducible closing click	Rt[ ]	Lt[ ]
5. Nonreproducible click	Rt[ ]	Lt[ ]
6. Crepitus (fine)	Rt[ ]	Lt[ ]
7. Crepitus (coarse)	Rt[ ]	Lt[ ]
8. Popping	Rt[ ]	Lt[ ]

if positive than 10 point

TN Total ( )

numerical rating scale(NRS) in palpation and some area was demanded specific technique. Due to poor accessibility of lateral pterygoid site, the fifth finger or tip of dental mirror should be used to palpate with the patient's jaw in laterotrution to the ipsilateral side. Palpation of the lateral and superior aspects of the TMJ is accomplished with full mouth opening. The deep masseter is palpated immediately below the notch in the zygomatic arch with the mouth closed.

The scoring of the mCMI was designed to

Table 2. Clinical examination form : Muscle and TMJ Palpation

TMJ Palpation(TP)						
1. Lateral capsule	Rt[	] NRS( )		Lt[	] NRS( )	
2. Posterior capsule	Rt[	] NRS( )		Lt[	] NRS( )	
3. Superior capsule	Rt[	] NRS( )		Lt[	] NRS( )	
					TP Total ( )	
Extraoral jaw muscle palpation (EP)						
1. Anterior temporalis	Rt[	] NRS( )		Lt[	] NRS( )	
2. Middle temporalis	Rt[	] NRS( )		Lt[	] NRS( )	
3. Posterior temporalis	Rt[	] NRS( )		Lt[	] NRS( )	
4. Deep masseter	Rt[	] NRS( )		Lt[	] NRS( )	
5. Anterior masseter	Rt[	] NRS( )		Lt[	] NRS( )	
6. Inferior masseter	Rt[	] NRS( )		Lt[	] NRS( )	
7. Posterior digastric	Rt[	] NRS( )		Lt[	] NRS( )	
8. Medial pterygoid	Rt[	] NRS( )		Lt[	] NRS( )	
9. Vertex	Rt[	] NRS( )		Lt[	] NRS( )	
					EP Total ( )	
Intraoral jaw muscle palpation (IP)						
1. Lateral pterygoid	Rt[	] NRS( )		Lt[	] NRS( )	
2. Medial pterygoid	Rt[	] NRS( )		Lt[	] NRS( )	
3. Temporalis insertion	Rt[	] NRS( )		Lt[	] NRS( )	
					IP Total ( )	
Neck muscle palpation (NP)						
1. Superior sternocleidomastoid	Rt[	] NRS( )		Lt[	] NRS( )	
2. Middle sternocleidomastoid	Rt[	] NRS( )		Lt[	] NRS( )	
3. Inferior sternocleidomastoid	Rt[	] NRS( )		Lt[	] NRS( )	
4. Insertion of trapezius	Rt[	] NRS( )		Lt[	] NRS( )	
5. Upper trapezius	Rt[	] NRS( )		Lt[	] NRS( )	
6. Splenius capitus	Rt[	] NRS( )		Lt[	] NRS( )	
					NP Total ( )	

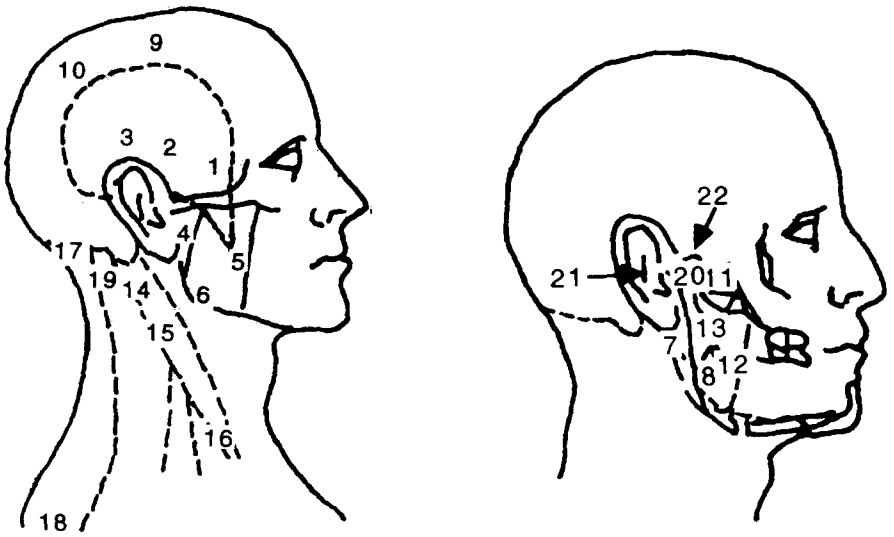
Table 3. Description of each item for Mandibular Movement

Item	Description
Maximum opening	Patients is asked to open as wide as possible and examiner measures the distance from incisal surface to incisal surface of maxillary and mandibular central incisors in the midline. The amount of overbite(the vertical overlap of maxillary over mandibular teeth) should be added to the interincisal measurement. Positive is ≤39mm and record score.
Passive stretch opening	Gentle stretching by examiner beyond voluntary maximum opening and measure identical to maximum opening. Positive is if positive in restriction or ≤41mm. And record score.
Restriction	To minimize the influence of false-negatives in maximum opening, a subjective assessment item, "restriction on opening" was added. Patient feels restriction when opening, describe the restriction rate.
Pain on opening	Any pain, but not pressure or tightness, with stretch or with maximum opening is positive and record NRS score.
Asymmetry mandibular movement	An S-curve on opening or closing or a lateral deviation at full opening is positive as distance from midline. Jerky opening is positive if there is not a smooth and/or continuous opening. And record score.
Protrusion pain	Any pain, but not pressure or tightness, during or at maximum protrusion is positive, Teeth are in light contact at end or range of motion. And record NRS score
Protrusion limitation	Examiner measures the distance between labial surface of the maxillary incisors at maxillary midline when in centric occlusion and again at maximum voluntary protrusion. It is positive if the difference between the two values is less than 7mm and record score.
Laterotrusion pain limitation	Examiner marks the point on the mandibular incisors that matches the maxillary midline and measures the difference between this midline and the mandibular point after maximum laterotrusion. It is positive if this is less than 7mm and record score.

Table 4. Description of each item for TMJ Noise

The TMJ noise must be audible by patient, and the corresponding dysfunction must be palpable by examiner. For purposes of scoring, a maximum of two distinct sound types per side is allowable for scoring.

Item	Description
Reciprocal click	Noise made upon opening and closing from centric occlusion position that is reproducible on every opening and closing. Can be eliminated with anterior repositioning jaw.
Reproducible opening click	Noise with every opening, no noise when closing.
Reproducible laterotrusive noise click	Noise with every full laterotrusive movement, no noise on opening.
Reproducible closing click	Noise with every closing, no noise when opening.
Nonreproducible click	Present on opening or closing, or in laterotrusion, but not repeatable.
Crepitus (fine)	Fine grating noise suggestive of mild bone-to-bone contact.
Crepitus (coarse)	Coarse grating noise suggestive of gross bone-to-bone contact.
Popping	Loud sound on opening that is audible to examiner at a distance without stethoscope.



Structure

Muscle: Extraoral

1. Anterior temporalis
2. Middle temporalis
3. Posterior temporalis
4. Deep masseter
5. Anterior masseter
6. Inferior masseter
7. Posterior digastric
8. Medial pterygoid
9. Vertex
10. Reference point

Muscle: Intraoral

11. Lateral pterygoid
12. Medial pterygoid
13. Temporalis insertion

Muscle: Neck

14. Superior sternocleidomastoid
15. Middle sternocleidomastoid
16. Inferior sternocleidomastoid
17. Insertion of trapezius
18. Upper trapezius
19. Splenius capitus

TMJ

20. Lateral capsule
21. Posterior capsule
22. Superior capsule

Description

Palpation is performed by first locating the distanct muscle band or part of joint and then palpating using the sensitive spade-like pad at the end of the distal phalanx of the index finger using firm pressure (approximately 1lb. per squre inch). The patients is asked "Dose it hurt or is it just pressure?" The response is positive if palpation produces a clear reaction from the patient or if patient stated that the palpation "hurt" indicating that the site was clearly more tender than surrounding structures or contralateral structure. And record the NRS. Any equivocal response by the patient would be score as negative. Site #10 can be used as a reference site to demonstrate to the patient what "pressure" feels like.

Figure 1. Palpation site and description of palpation technique for head and neck muscles and TMJ

give equal weight and 0 to 10 scores to the mDI and mPI. To do this, the mDI was calculated by using the sum of the each item score divided by the total number of positive items. The mPI was calculated by using the sum of the each item score divided by the total number of positive items. The mCMI was the sum of the mDI and mPI divided by two.

The scoring of the cCMI was designed to place equal weight on CMI and NRS. To do this, the cDI was determined by sum of Fricton's DI and average of NRS. Average of NRS was performed by using the sum of the each item score divided by ten times of total number of positive items. The cPI was determined by sum of Fricton's PI and average of NRS. Average of NRS was performed by using the sum of the each item score divided by ten times of total number of positive items. The cCMI was the sum of the cDI and cPI divided by two.

4. Statistical analysis

Measured values of all indexes for the patients were averaged. Statistical analysis was performed to compare the rate of disease severity. To determine the significance of differences among the measurements before treatment (1st visit), at 2nd week after treatment (2nd visit) and 4th week after treatment (3rd visit), and between the measurements in group of CMI, mCMI and cCMI respectively, correlations coefficient and paired t-test were used.

III. Results

The means and standard deviations of measured values of all indexes for the patients were shown by Table 5. The differences of between visits of all indexes for comparison of the change were shown by Table 6.

The degree of relationship between component of index was assessed by correlations (Table 7). The degree of relationship between the three indexes was assessed by correlations at 1st visit, 2nd visit and 3rd visit (Table 8, 9 & 10). There were found to be correlation coeffcients of each index is statistically significant ($p< 0.05$). These results suggest that three indexes are measuring the same content.

The results of paired t-test between each CMI were showed significant differences between CMI and mCMI, mCMI and cCMI of between 1st visit and 2nd visit, 1st visit and

Table 5. Measured values of all indexes for the patients

	1st Visit	2nd Visit	3rd Visit
CMI	0.173±0.056	0.133±0.048	0.081±0.049
DI	0.273±0.101	0.217±0.089	0.125±0.104
PI	0.072±0.051	0.049±0.041	0.038±0.046
mCMI	0.758±0.315	0.492±0.245	0.259±0.187
mDI	0.308±0.684	0.872±0.503	0.450±0.399
mPI	0.208±0.160	0.113±0.141	0.068±0.126
cCMI	0.535±0.079	0.407±0.103	0.287±0.127
cDI	0.720±0.180	0.577±0.191	0.435±0.274
cPI	0.372±0.174	0.236±0.177	0.138±0.137

Table 6. The differences of between visits of all indexes

	1st Visit	2nd Visit	3rd Visit
CMI	0	22.04±16.85	52.32±24.81
DI	0	18.67±19.15	57.07±29.43
PI	0	35.30±38.05	50.49±41.45
mCMI	0	35.15±2290	65.80±23.02
mDI	0	33.63±25.01	68.13±24.80
mPI	0	54.00±34.12	72.20±34.96
cCMI	0	24.52±11.87	46.53±22.30
cDI	0	20.67±17.49	40.72±34.11
cPI	0	40.92±36.18	65.60±32.87

Table 7. The results of correlation coefficient between component of index

	Correlation	P-value	Significant
CMI, mCMI	0.877	<0.0001	*
CMI, cCMI	0.687	<0.0001	*
mCMI, cCMI	0.788	<0.0001	*
DI, mDI	0.899	<0.0001	*
DI, cDI	0.751	<0.0001	*
mDI, cDI	0.78	<0.0001	*
PI, mPI	0.861	<0.0001	*
PI, cPI	0.576	<0.0001	*
mPI, cPI	0.734	<0.0001	*

* : 95% Significant Difference

Table 8. The results of correlation coefficient between each CMI

	Correlation	P-value	Significant
CMI1, mCMI1	0.789	<0.0001	*
CMI1, cCMI1	0.455	0.043	*
mCMI1, cCMI1	0.674	0.0007	*
CMI2, mCMI2	0.814	<0.0001	*
CMI2, cCMI2	0.514	0.0193	*
mCMI2, cCMI2	0.69	0.0005	*
CMI3, mCMI3	0.872	<0.0001	*
CMI3, cCMI3	0.476	0.0329	*
mCMI3, cCMI3	0.654	0.0013	*

* : 95% Significant Difference

Table 9. The results of correlation coefficient between each DI

	Correlation	P-value	Significant
DI1, mDI1	0.866	<0.0001	*
DI1, cDI1	0.764	<0.0001	*
mDI1, cDI1	0.97	<0.0001	*
DI2, mDI2	0.898	<0.0001	*
DI2, cDI2	0.82	<0.0001	*
mDI2, cDI2	0.967	<0.0001	*
DI3, mDI3	0.905	<0.0001	*
DI3, cDI3	0.543	0.0121	*
mDI3, cDI3	0.754	<0.0001	*

* : 95% Significant Difference

Table 10. The results of correlation coefficient between each PI

	Correlation	P-value	Significant
PI1, mPI1	0.842	<0.0001	*
PI1, cPI1	0.277	<0.0001	
mPI1, cPI1	0.527	<0.0001	*
PI2, mPI2	0.78	<0.0001	*
PI2, cPI2	0.54	0.2417	*
mPI2, cPI2	0.747	0.0156	*
PI3, mPI3	0.929	<0.0001	*
PI3, cPI3	0.837	<0.0001	*
mPI3, cPI3	0.829	<0.0001	*

* : 95% Significant Difference

Table 11. The results of paired t-test between each CMI

	Mean Diff	P-value	Significant
CMI1-2, mCMI1-2	-13.111	0.001	*
CMI1-2, cCMI1-2	-2.476	0.4666	
mCMI1-2, cCMI1-2	10.635	0.0091	*
CMI2-3, mCMI2-3	-0.374	0.933	
CMI2-3, cCMI2-3	8.255	0.1987	
mCMI2-3, cCMI2-3	8.628	0.0829	
CMI1-3, mCMI1-3	-13.48	<0.0001	*
CMI1-3, cCMI1-3	5.78	0.2341	
mCMI1-3, cCMI1-3	19.261	<0.0001	*

* : 95% Significant Difference

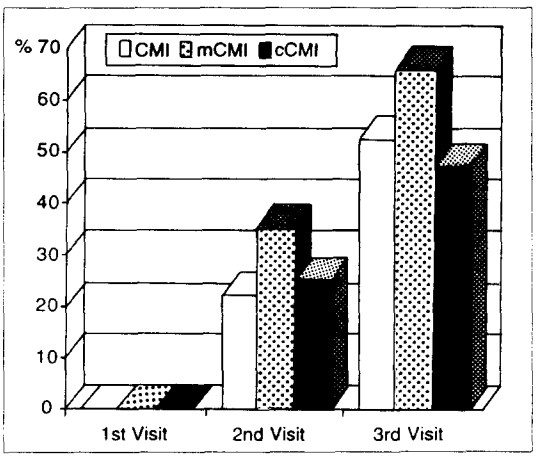


Figure 2. Improvement in each CMI(%)

Table 12. The results of paired t-test between each DI

	Mean Diff	P-value	Significant
DI1-2, mDI1-2	-14.96	<0.0001	*
DI1-2, cDI1-2	-1.998	<0.0001	
mDI1-2, cDI1-2	12.962	<0.0001	*
DI2-3, mDI2-3	3.9	<0.0001	
DI2-3, cDI2-3	18.344	<0.0001	*
mDI2-3, cDI2-3	14.444	<0.0001	*
DI1-3, mDI1-3	-11.064	0.0032	*
DI1-3, cDI1-3	16.343	0.042	*
mDI1-3, cDI1-3	27.407	<0.0001	*

* : 95% Significant Difference

Table 13. The results of paired t-test between each PI

	Mean Diff	P-value	Significant
PI1-2, mPI1-2	-18.698	0.0086	*
PI1-2, cPI1-2	-5.626	0.5019	
mPI1-2, cPI1-2	13.072	0.0101	*
PI2-3, mPI2-3	-3.016	0.6549	
PI2-3, cPI2-3	-9.487	0.2175	
mPI2-3, cPI2-3	-6.471	0.1523	
PI1-3, mPI1-3	-21.712	0.0018	*
PI1-3, cPI1-3	-15.113	0.0199	*
mPI1-3, cPI1-3	6.599	0.0719	

* : 95% Significant Difference

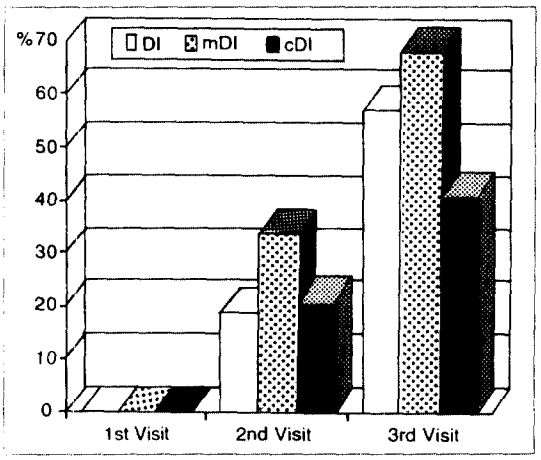


Figure 3. Improvement in each DI(%)

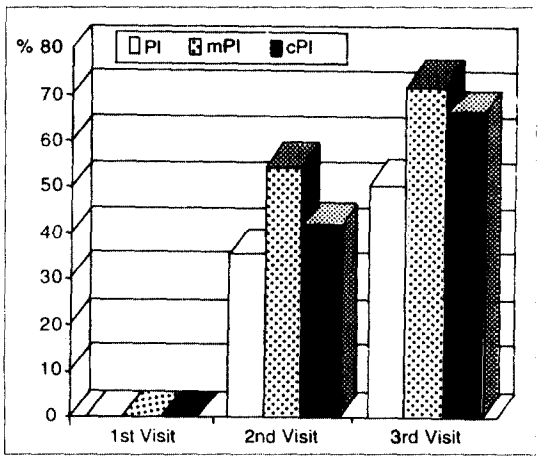


Figure 4. Improvement in each PI(%)

3rd visit ($p< 0.05$)(Table 11). In the mean improvement rate of between each CMI, mCMI were reflected larger improvement of change in diseas severity (Figure 2).

The results of paired t-test between each DI were showed significant differences between DI and mDI, mDI and cDI of between 1st visit and 2nd visit, between DI and cDI, mDI and cDI of between 2nd visit and 3rd visit, between DI, mDI and cDI of between 1st visit and 3rd visit ($p< 0.05$)(Table 12). In the mean improvement rate of between each DI, mDI were reflected larger improvement of change in diseas severity (Figure 3).

The results of paired t-test between each PI were showed significant differences between PI and mPI, mPI and cPI of between 1st visit and 2nd visit, between PI and mPI, PI and cPI of between 1st visit and 3rd visit (<0.05)(Table 13). In the mean improvement rate of between each PI, mPI were reflected larger improvement of change in disease severity (Figure 4).

Ⅳ. Discussion

Several indexes have been proposed to quantify degrees of CMD, the most widely used are the Helkimo index and Craniomandibular index. While they are generally good means for assessing disorder for epidemiological and clinical studies, they are known to lack of sensitivity sufficiently.

Helkimo[5,6] developed the Anamnestic Index (AI), Clinical Dysfunction Index(CDI) and Occlusal State Index(OSI). The Clinical Dysfunction Index was based on five symptoms: impaired range of jaw movement, impaired TMJ function, pain on jaw movement, muscle pain, and TMJ pain. Each symptom was graded by using three-grades severity scale as 0, 1, or 5 for none, mild, and severe, respectively. The score for the five symptoms were added and the dysfunction score varied from 0 to 25 points. The higher the score was, the more severe was the disorders. The Anamnestic Index was based on the patient's report of dysfunction symptoms and was similarly assessed on a three-grades scale. The Occlusal State Index was based on number of teeth, number of occluding teeth, presence of occlusal interferences, and articulation interferences. It also was assessed on a three-grades scale.

The Craniomandibular Index(CMI)[3,4] was developed to provide a standardized method of assessing disease severity. Fricton et al. used content, construct, and criterion validity methods to document the reliability and validity of the CMI. The list of the CMI was divided into those items that reflect temporomandibular joint tenderness and functioning problems, termed the Dysfunction Index (DI), and those items that reflect muscle tenderness problems, termed the Palpation Index (PI). The DI includes items related to limits in range of motion, deviation in movements, pain during movement, TMJ noise during movement, and TMJ tenderness. The PI includes items related to tenderness at distinct anatomic site during intraoral palpation of jaw muscle and extraoral palpation of jaw and neck muscle. The scoring of the CMI was designed to give equal weight and 0 to 1 scores to the DI and PI. To do this, the DI was calculated by using the sum of the positive response related to mandibular movement, TMJ noise and TMJ capsule were divided by the total number of items (twenty-six). The PI was calculated by using the sum of the positive response related to palpation of jaw and neck muscles and it was divided by the total number of items (thirty-six). Then, the CMI is the sum of the DI and PI divided by two.

Two major methodologies have been followed in applying numerical indexes to biological variables: one method consists in giving to many different signs a score between two (0=absent; 1=present) or three (0=absent; 1=present; 2=marked) consecutive numbers: the index is obtained by adding up all the scores obtained.[3,4,10] A second method is to increase the distance between the score (such as: 0=absent; 1=present; 5=severe) in order to enhance the discriminating power of the index.[5,6] While the first method is more suitable to intragroup statistical evaluations, the second one allows an easier distribution of the subjects among a given number of different groups. Conceptually, the 2-points scale is evaluated as simple and minimizes the opportunity for interpretation errors to be occured. The VAS-point scale requires the examiner to interpret the patient's response to examination, which could increase variability in outcome scores.

Numerous scales are available for measuring

pain levels and these have been critically reviewed.[11,12] The most fundamental form is a simple descriptive scale(SDS) which uses 4 or 5 points based on verbal description (none, mild, moderate, severe, very severe). The use of this scale for comparative purposes is limited by its lack of sensitivity for detecting relatively small changes. Improvement in discrimination can be achieved by using a numerical rating scale(NRS), e.g., marked 0-10 or 0-20, or by the introduction of the visual analogue scale(VAS). The VAS technique utilizes a straight line, conventionally 10cm long, whose extreme limits are marked by perpendicular lines. The ends of the scale carry a verbal description of each extreme of the symptom to be evaluated, and the patient is asked to mark the line at a position between the two extremes which represents the level of pain. Author has used a 11-point(0-10) numerical rating scale that because it performs better than both four-point simple descriptive scale or a continuous VAS scale.[7]

The measuring device that was used in this study was a "measuring triangle"[13] It has advantages in ease of manipulation, and produce less strain on the temporomandibular joint and associated musculature. And this instrument is very accurate and provide reproducible measurement. The maximum opening can easily be assessed with the triangle by sliding it between the patient's maxillary and mandibular incisors until maximum opening obtained. The triangle's wedge effect is less strain on the temporomandibular joint and associated muscle, since the triangle will help to hold the mouth open. If the subject has a long upper lip, it will be lifted by the triangle to make the teeth easily visible, eliminating the problem encountered with the straight ruler.

A specific definition of each item and description of the technique used to examine and score each item was established. For items related to range of motion, a specific level at which to determine whether the item was positive or negative was set for each movement. This level was based on normal ranges for the general population, and deviation from this range was scored.[3-6,14-18]

The distance of maximum opening was measured that after patient has opened his or her mouth as wide as possible, measured maximum interincisal opening between the incisal edges of the first maxillary and mandibular incisors. The amount of overbite (the vertical overlap of maxillary over mandibular teeth) should be added to the interincisal measurement. Next measure the patient's overjet (the horizontal overlap of maxillary over mandibular teeth) and then instruct the subject to protrude his or her lower jaw as far as possible. Measured the distance from the facial surface of the maxillary first incisor to the incisal tip of the mandibular first incisor and add this to the overjet measurement. The sum of these would be the maximum protrusion. Left and right laterotrusion should be assessed by finding an anatomical landmarks such as the midlines of the maxillary and mandibular incisors. Instruct the subject to slide his or her jaw laterally as far as possible while keeping the teeth in contact. The measurement from the landmark to this point would be done under the maximum laterotrusion.

Passive range of motion is the maximal movement of a joint when it is manipulated by a clinician on time of relaxation patient's muscle. Although it is difficult to obtain a reliable reading from a patient with significant muscle splinting, this test will help differentiate between a muscle-induced limitation of motion and a limitation due to other causes. The

patients was asked to open the mouth as wide as possible. If the movement is limited, the practitioner places an index finger on the edge of a mandibular central incisor and the thumb on the edge of the opposing maxillary tooth. In a scissor-like motion, the mandible is opened by sustained pressure, and the practitioner notes the end feel of the movements. A soft, bouncy feeling may indicate muscular or other soft tissue restriction, whereas a hard feeling may indicate osseous abnormalities, meniscal displacement, or fibrotic contracture. To minimize the influence of false-negatives in maximum opening, a subjective assessment item, "restriction on opening" was added.[4)]

Conceptually, the 2-point scale of CMI is simple and minimizes the opportunity for interpretation of errors to be occured. The NRS of mCMI requires the examiner to interpret the patient's response to examine, which could increase variability in outcome scores. In this study all patients were examined by the three examiners who were previously trained in the examination technique. Therefore inter-examiner variability was not performed, that further study is warrented. Inconsistencies in the amount of pressure, the palpation technique, the size of the distal phalanx, and the specific anatomic area palpated will introduce variability, particularly between different raters. Dworkin et al.[19)] showed that untrained examiners had much lower levels of reliability, while Fricton and Schiffman[3)] reported that for trained examiners the intrarater and interrater reliability shown as high and comparable. This reinforces the importance of standardization and calibration of examination technique.

Subjects in this study may be considered to be their own controls in that the three indexes were applied to each subject at the same point in time. Therefore, the differences found between the indexes are intrapatient differences and are free from error that could occur from comparing changes between different subjects or between patients and nonpatient controls.

According to thses results, it was assumed that the Modified Craniomandibular Index is significantly more sensitive to change the signs and symptoms than is the Craniomandibular Index in CMD patients. It is concluded that the use of the Modified Craniomandibular Index may allow identification of smaller differences in treatment efficacies than the Craniomandibular Index in future treatment comparison studies.

V. Summary and Conclusions

The objective of this study was to compare the Fricton's Craniomandibular Index (currently used in the CMI) with a Modified Craniomandibular Index and Combined Craniomandibular Index (expansion of CMI categories) related to their abilities to change in sign and symptom of craniomandibular disorders (CMD). Following the guidelines of the Craniomandibular Index, clinical evaluation were performed with 20 outpatients to be treated on CMD at the Department of Oral Medicine, Dental Hospital, DKU. Craniomandibular Index (CMI), Modified Craniomandibular Index (mCMI) and Combined Craniomandibular Index (cCMI) were generated in response to the patient's reaction. The results of the initial exam and the 2 weeks and 4 weeks examinations after treatment were compared with each indexes.

In CMD patients, the Modified Craniomandibular Index is significantly more sensitive to changes in the signs and symptoms than is the Craniomandibular Index. It is concluded that the use of the Modified Craniomandibular In-

dex may allow identification of smaller differences in treatment efficacies than the Craniomandibular Index in future treatment comparison studies.

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국문초록

두개하악장애의 평가에 이용되는 두개하악장애지수의 개선에 관한 연구

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악관절장애환자의 임상 평가를 위해서 고안된 여러지수중 현재 가장 널리 사용되고 있는 두개하악장애지수와 평가방법을 새로 고안한 변형두개하악장애지수, 혼합두개하악장애지수를 비교하여 환자의 증상변화를 민감하게 감지하는 능력을 알아보고자 본 연구를 시행하였다. 두개하악장애지수의 기준에 따라 단국대학교 치과병원 구강내과에 내원한 악관절장애환자 20명을 대상으로 임상검사를 시행하여 두개하악장애지수, 변형두개하악장애지수, 혼합두개하악장애지수를 산출하였다. 치료전, 치료후 2주, 치료후 4주에 수집된 결과를 각 지수간에 비교분석하여 다음과 같은 결과를 얻었다. 악관절장애환자의 증상평가에서 변형두개하악장애지수가 환자의 증상변화를 가장 민감하게 감지하는 것으로 나타났다 ($p<0.05$). 따라서 사용된 세가지 지수중 변형두개하악장애지수가 악관절장애환자의 경과를 관찰할때 증상변화를 관찰하기 위한 가장 효과적인 방법이라고 사료된다.