A Study on Developing an Objective Evaluation Method of the Signs and Symptoms of Temporomandibular Joint Internal Derangement

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Ⅰ. INTRODUCTION

Orofacial pain can be classified as pain caused by extracranial structures such as teeth, periodontal tissues, salivary glands and maxillary sinus, pain caused by intracranial structure , neurovascular pain, muscular pain, arthrogenous pain, neuropathic pain and psychogenic pain[1]. Pain and dysfunction of stomatognathic system is usually caused by muscular hyperactivity or temporomandibular joint(TMJ) diseases. But the mechanism of pain and dysfunction in the TMJ and masticatory muscles at the tissue levels is not well known except for systemic inflammatory joint diseases such as rheumatoid arthritis. Even though muscular fatigue and spasm have been suggested to be the cause of pain and tenderness in the masticatory muscles and the TMJ[2,3], there is a report that aseptic inflammatory reaction within muscular tissue might be responsible for pain after muscular hyperactivity[4].

Even though inflammation usually causes pain, swelling, redness and fever, that of the TMJ rarely shows swelling, redness and fever at such a level as to be perceived in clinical tests and shows only pain at a clinically perceptible level. Even though the fact that there is localized tenderness on palpation of TMJ is accepted as the clinical sign of inflammation, there is no clear evidence that inflammation does exist. Most TMJ capsulitis

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are accompanied with TMJ ID(internal derangement) and degenerative pathologic change. It is hard to make a definite conclusion on the natural process of TMJ ID, but the evidence suggests that ID is transferred to a degenerative process after condylar locking[5]. Also, according to a recent research report, continuity within TMJ ID-Degenerative Joint Diseases-Dysfunction is not so well predicted as Rasmussen suggested, but in about 7% of patients whose TMJ noises make no trouble there is progression to that with problem in about 1 to 7.5 years[6], some of which progressed to a more severe state of anterior disc displacement without reduction[7].

If this state continues, there usually follows reduction of pain comparing with acute condylar locking, but often pain continues and occlusal adjusting appliances, physical therapy and medications are ineffective. The patients irresponsive to general therapeutic procedures are classified as those who show pain and dysfunction due to severe intracondylar structural changes and as those with chronic pain syndrome complicated by multiple contributing factors. In the former, the chief complaint is constant pain in the joint and an objective evaluation of it is necessary.

Additional information about localized and constant TMJ pain and tenderness can be obtained by the measurement of pressure pain threshold(PPT) on TMJ area, bone scintigraphy and synovial fluid analysis. Chung et al[8] reported high reliability and validity by applying measuring device for PPT, which is used to overcome low reliability when measuring PPT of masticatory muscles. Bone scintigraphy is known to be helpful in treatment by offering information necessary to judge whether degenerative pathologic changes of joints exist or not[9,10]. This is due to fact that while normal radiology shows pathologic change only after 30-50 percent decrease of the weight of mineral in bony structure[11], bone scintigraphy shows the difference as little as 5-10 percent decrease[12]. Bone scintigraphy is a sensitive method in the early diagnosis of bony pathologic changes.

Synovial fluid analysis has been done in many other joints and is also recommended for the TMJ. Synovial fluid analysis has most commonly been used to differentiate between noninflammatory(e.g. osteoarthrosis), inflammatory(e.g. rheumatoid arthritis), infectious and hemorrhagic lesions of the joints and can also be used to decide whether crystals have formed in gout[13].

Synovial fluid analysis is most commonly used in the knee joint. Degenerative changes within the joint decrease the concentration of glycosaminoglycan(GAG)s and therefore decrease lubricating action in the joint and cause more severe dysfunction. The concentration of proteins in normal synovial fluid is low due to the comparative impermeability of synovial membrane to globulins with large molecular weight, but as the inflammation progresses, the concentration of proteins in the synovial fluid increases as plasma proteins enter the joint cavity through the synovial membrane. It is also known that hyaluronic acid(HA), which functions in the maintenance of high consistency of synovial fluid, is high in concentration in normal synovial fluid and low in joints with diseases and therefore plays an important role in lubricating action in the joint. But little is known about the role of synovial fluid and change in the structure secreting synovial fluid in TMJ dysfunction because of the following reasons. 1) the TMJ area is small, 2) there is high risk of contamination of blood in aspiration and it is difficult to confirm

the location of the synovial fluid in the object tested, 3) It is hard to compare with a control group.

The aim of this study is to investigate the characteristics of TMJ ID according to the degree of progression of TMJ ID by measuring the VAS of painful joint by palpation , by measuring the PPT and using bone scintigraphy and synovial fluid analysis in order to develop an objective standard of signs and symptoms of TMJ ID.

II. MATERIALS AND METHODS

(1) Subjects

Forty-two subjects (8 males and 34 females, mean age : 30.3 ± 11.9) who were diagnosed as TMJ ID patients by clinical examination participated in this study. They were drawn from the patients who visited the Orofacial Pain Clinic of Dept. of Oral Medicine and Oral Diagnosis, Seoul National University Dental Hospital and who had taken temporomandibular joint arthrography for accurate diagnosis.

Table 1. Demography of patients

	Number	Age (Mean ± S.D.)
Male	8	19.9 ± 2.9
Female	34	32.8 ± 11.8
Total	42	30.3 ± 11.9

(2) Methods

1) TMJ pain measurement in VAS method

After manual palpation of TMJ area, presence of tenderness and degree of pain were measured in VAS(visual analogue scale) for each surface(superior, lateral and posterior surfaces).

2) Estimation of pressure pain threshold in TMJ area

Authors measured pressure pain threshold(PPT) of subjects with electronic Algometer Type I (Somedic AB). Ending point of Algometer were placed on each side of TMJ capsule(lateral, superior and posterior sides), increasing pressure by 40kPa/sec and patients were told to push the button in their hands when they first felt pain sensation. Digitalized PPT values were stopped when the button was pushed , and were recorded. While recording PPT, the opposite side of examine site was supported by operator's hand but, the patient could not see his own PPT value on the screen.

3) Bone Scintigraphy

After injection of ^{99m}Tc-MDP 740-927 NBq (20-25mCi) intravascularly, bone scintigraphy was taken in Dept. of Nuclear Medicine, Seoul National University Hospital without any clinical, radiographic informations. The results were classified as active or inactive.

4) TMJ arthrography and synovial fluid collection

Authors injected normal saline into the lower compartment of the TMJ after infiltration anesthesia and collected synovial fluid by aspiration. TMJ arthrography was taken with individual lateral sectography (QS101627-W, Denar Co.) after injection of radiopaque contrast media(Rayvist, Schering Co.) under fluoroscopy (BV25, Philips Electronic Ltd.).

5) Synovial fluid analysis

① Analysis of hyaluronic acid

Hyaluronic acid concentration was measured with uronic acid carbazole reaction[17]. 0.5ml of

collected synovial fluid sample was added into 3.0ml sulfuric acid reagent(0.025M sodium tetraborate · $10H_2O$) under cooling. The tubes were shaken with constant cooling and then heated for 10min in a vigorously boiling distilled water bath and cooled to room temperature. Then 0.1ml of carbazole reagent(0.125% carbazole in absolute ethanol) was added. The tubes were heated in boiling bath for further 15min, and cooled to room temperature. The optical density was read at A_{530}(Ultrospec 2000, Pharmacia Biotech Ltd.) and glucuronolactone (Sigma Chemical Co.) was used as standard.

② Analysis of total protein

Concentration of total protein were calculated according to the following formula with measurement of optical density at A_{280} and A_{260}.

Protein concentration(mg/ml)=1.5xA_{280}-0.75x A_{260}

③ Analysis of albumin

Concentration of albumin was calculated according to the following formula with measurement of optical density at A_{628} with albumin assay kit(Sigma Chemical Co.).

$$\text{Albumin conc.(g/dL) of sample} = \frac{A_{standard} - A_{blank}}{A_{standard} - A_{blank}} \times \text{conc. of standard}$$

④ Analysis of immunoglobulin

Analysis of IgG and IgM in synovial fluid was done with by ELISA(enzyme-linked immunosorbent assay) method(EL312e, BIOTEK Instruments Inc.). Human IgG and IgM(Sigma Chemical Co.) were used as standards. Peroxidase conjugated goat anti-human IgG and IgM(Sigma Chemical Co.) were used as antibody, OPD(ophenylenediamine dihydrochloride) tablet set (Sigma Chemical Co.) as substrate, 0.1% Tween, 50mM Tris, 0.15M NaCl were used as buferred solution.

6) Statistical analysis

Student T-test and analysis of variance(ANOVA), correlation analysis were used with SAS program in IBM PC.

Ⅲ. RESULTS

Temporomandibular joints of forty-two patients were classified by clinical and arthrographic results as the followings. The number of joints with neither click nor pain (0) were 7, joints with click but no pain (I a) were 18, joints with both click and pain (I b) were 18, joints with periodic closed lock (Ⅱ) were 11, joints with acute closed lock (Ⅲ) were 11, joints with chronic closed lock (Ⅳ) were 3 and joints with degenerative bony change (Ⅴ) were 16(Table 2).

Table 2. Classification of temporomandibular joints according to the stage of TMJ internal derangement

Stage	Number
no pain, no click (0)	7
no pain, click (I a)	18
pain, click (I b)	18
periodic closed lock (Ⅱ)	11
acute closed lock (Ⅲ)	11
chronic closed lock (Ⅳ)	3
degenerative joint disease (Ⅴ)	16

Bone scintigraphy were taken in 18 patients(36 joints) of all subjects, and then classified as active or inactive state , and also classified according to presence of pain. The

Table 3. Classification of temporomandibular joints according to bone scan and pain

	Bone scan (positive)	Bone scan (negative)	Total
Painful joint	23	1	24
Nonpainful joint	10	2	12
Total	33	3	36

number of active joints were 33 out of the 36 joints in bone scintigraphy and 23 out of the 33 active joints showed pain. 1 out of the 3 inactive joints in bone scintigraphy showed pain(Table 3).

In progression of TMJ ID, there was significant difference in stages at palpation of posterior side of condyle in VAS. Stage II showed highest VAS value and lowest PPT value. In addition, only stage II showed significant correlations with stage 0 at superior VAS and with the stage V at posterior VAS(Table 4).

Concentration of synovial fluid component showed no significant correlation in the progression of TMJ ID, but IgG concentrations had the tendency to increase in stage Ⅳ and showed significant correlation with other stages. And concentrations of total proteins, IgG, IgM and albumin showed tendency to increase in stage V(Table 5).

Significant relationships were detected within VAS and within PPT($p<0.001$). The significant relationships were detected between VAS and PPT in superior($p<0.01$) and posterior ($p<0.05$) sides. Total protein concentration showed significant correlation with hyaluronic acid concentration($p<0.001$), IgG ($p<0.01$) and IgM($p<0.001$). Hyaluronic acid concentration showed significant correlation with concentrations of IgG($p<0.01$), IgM ($p<0.001$) and albumin ($p<0.01$). IgG concentration showed

Table 4. Means and standard deviations of VAS and PPT according to the stage of TMJ ID

	Stage 0 (n=5)	Stage I a (n=18)	Stage I b (n=13)	Stage Ⅱ (n=11)	Stage Ⅲ (n=10)	Stage Ⅳ (n=3)	Stage V (n=14)	ANOVA	Significance between stages
VAS lat.	1.40 ± 2.07	2.11 ± 2.37	1.92 ± 2.10	3.36 ± 1.36	2.00 ± 1.41	3.00 ± 3.46	3.21 ± 1.63	0.265	.
VAS sup.	0.80 ± 0.84	1.28 ± 1.56	1.92 ± 1.19	2.82 ± 2.09	2.13 ± 1.46	2.33 ± 3.21	2.64 ± 1.78	0.112	*(0,Ⅱ)
VAS post.	0.80 ± 1.10	2.89 ± 2.47	2.31 ± 2.21	4.55 ± 1.75	2.75 ± 1.83	2.33 ± 3.21	3.36 ± 1.34	0.033*	*(0,Ⅱ) *(0,V)
PPT lat.	82.20 ± 29.23	92.17 ± 26.09	81.53 ± 27.54	75.91 ± 15.84	78.20 ± 28.08	97.33 ± 22.90	76.93 ± 26.23	0.512	.
PPT sup.	73.00 ± 27.78	84.06 ± 23.93	68.00 ± 18.29	63.00 ± 24.97	75.00 ± 30.88	76.00 ± 37.47	77.21 ± 19.74	0.392	.
PPT post.	77.40 ± 10.53	82.17 ± 26.62	67.08 ± 19.35	59.64 ± 16.64	69.60 ± 25.47	59.67 ± 32.33	75.07 ± 17.98	0.153	.

* : $p<0.05$
VAS : visual analogue scale
PPT : pressure pain threshold
Stage 0 : no pain, no click
Stage I a : no pain, click
Stage I b : pain, click
Stage Ⅱ : periodic closed lock
Stage Ⅲ : acute closed lock
Stage Ⅳ : chronic closed lock
Stage V : degenerative joint disease

Table 5. Means and standard deviations of synovial fluid contents according to the stage of TMJ ID

	Stage 0	Stage I a	Stage I b	Stage II	Stage III	Stage IV	Stage V	ANOVA	Significance between stages
Total protein (mg/mℓ)	0.129 ± 0.19 (n=7)	0.164 ± 0.14 (n=16)	0.160 ± 0.171 (n=13)	0.078 ± 0.080 (n=9)	0.111 ± 0.136 (n=10)	0.080 ± 0.085 (n=2)	0.320 ± 0.453 (n=15)	0.199	.
Hyaluronic acid (μg/mℓ)	4.48 ± 3.02 (n=6)	5.57± 3.83 (n=16)	6.89 ± 6.88 (n=15)	4.70± 4.28 (n=10)	5.92± 3.92 (n=9)	3.03 ± 2.74 (n=3)	6.17 ± 6.83 (n=12)	0.871	.
Ig G (μg/mℓ)	28.73 ± 21.38 (n=6)	51.81 ± 31.53 (n=11)	51.98 ± 32.65 (n=7)	36.72 ± 17.21 (n=6)	49.29 ± 42.56 (n=7)	147.38 (n=1)	49.97 ± 43.29 (n=19)	0.074	*(0,IV)(I a,IV) (I b,IV) (II,IV)(III,IV) (IV,V)
Ig M (μg/mℓ)	1.32± 2.91 (n=5)	5.99± 6.50 (n=7)	7.48 ± 14.91 (n=5)	0.55 ± 0.74 (n=5)	5.18 ± 9.89 (n=5)	13.24 (n=1)	9.57 ± 13.04 (n=6)	0.555	.
Albumin (mg/mℓ)	0.088 ± 0.15 (n=5)	0.028 ± 0.038 (n=7)	0.044 ± 0.032 (n=10)	0.072 ± 0.128 (n=8)	0.033 ± 0.028 (n=8)	0.055 ± 0.064 (n=2)	0.107 ± 0.089 (n=7)	0.375	.

* : $p<0.05$
Stage 0 : no pain, no click
Stage I a : no pain, click
Stage I b : pain, click
Stage II : periodic closed lock
Stage III : acute closed lock
Stage IV : chronic closed lock
Stage V : degenerative joint disease

Table 6. Pearson's correlation analysis among VAS, PPT and synovial fluid contents

	VAS lat.	VAS sup.	VAS post.	PPT lat.	PPT sup.	PPT post.	Total protein	Hyal-uronic acid	Ig G	Ig M	Albu-min
VAS lat.											
VAS sup.	0.60***										
VAS post.	0.66***	0.48***									
PPT lat.	-0.05	-0.17	-0.1								
PPT sup.	-0.01	-0.34**	-0.16	0.56***							
PPT post.	-0.14	-0.22	-0.28*	0.61***	0.65***						
Total protein	0.16	0.05	-0.02	0.10	-0.03	0.04					
Hyaluronic acid	0.05	0.11	-0.004	0.02	0.09	-0.03	0.48***				
Ig G	0.05	0.14	0.02	-0.02	-0.01	-0.04	0.43**	0.42**			
Ig M	0.30	0.14	-0.16	0.27	0.001	-0.01	0.82***	0.80***	0.73***		
Albumin	0.15	0.28	0.33*	-0.14	-0.21	-0.30	0.34	0.51**	-0.10	0.39	

* : $p<0.05$, ** : $p<0.01$, *** : $p<0.001$
VAS : visual analogue scale PPT : pressure pain threshold

significant correlation with concentration of IgM ($p<0.001$), There were significant correlation between albumin concentration and posterior VAS($p<0.05$)(Table 6).

Authors analyzed correlations with VAS and PPT according to activity showed in bone scintigraphy and presence of clinical pain. Gr oup showing active joints in bone scintigraphy showed higher VAS value than that of inactive joints, but no significant difference was shown. No significant difference in PPT was shown either. Group showing inactive joints in bone scintigraphy showed significant difference in lateral and posterior VAS, in posterior PPT according to the presence of pain($p<0.05$) (Table 7).

The results of synovial fluid analysis did not show significant differences from results of

Table 7. Means and standard deviations of VAS and PPT according to the result of bone scan and pain

	Bone scan (positive)		Bone scan (negative)			
	Group I (n=20)	Group II (n=9)	Group III (n=1)	Group IV (n=2)	ANOVA	Significance between groups
VAS lat.	2.40 ± 1.79	2.22 ± 2.64	5.00	0 ± 0	0.249	*(III,IV)
Total	2.34±2.04		1.66±2.89			0.60
VAS sup.	2.15 ± 1.79	1.22 ± 1.92	2.00	0.50 ± 0.71	0.447	.
Total	1.86±1.85		1.00±1.00			0.44
VAS post.	3.75 ± 2.07	2.66 ± 2.18	6.00	0.50 ± 0.71	0.091	*(III,IV)
Total	3.41±2.13		2.33±3.21			0.43
PPT lat.	70.35 ± 17.83	92.22 ± 25.60	48.00	73.50 ± 7.78	0.041*	.
Total	77.14±22.56		65.00±15.72			0.37
PPT sup.	60.50 ± 23.44	85.22 ± 25.76	47.00	70.50 ± 21.92	0.085	.
Total	68.17±26.42		62.67±20.60			0.73
PPT post.	59.00 ± 19.44	72.22 ± 18.33	47.00	90.00 ± 16.97	0.078	*(III,IV)
Total	63.10±19.78		75.67±27.57			0.32

* : $p<0.05$

VAS : visual analogue scale PPT : pressure pain threshold

Group I : bone scan positive, painful

Group II : bone scan positive, nonpainful

Group III : bone scan negative, painful

Group IV : bone scan negative, nonpainful

Table 8. Means and standard deviations of synovial fluid contents according to the results of bone scan and pain

	Bone scan (positive)		Bone scan (negative)			
	Group I	Group II	Group III	Group IV	ANOVA	Significance between groups
Total protein (mg/mℓ)	0.155 ± 0.191 (n=20)	0.150 ± 0.158 (n=8)		0.090 ± 0.127 (n=2)	0.890	.
Total	0.154±0.179		0.090±0.127			0.629
Hyaluronic acid (μg/mℓ)	4.28 ± 2.71 (n=20)	3.46 ± 3.70 (n=8)	4.33 (n=1)	2.52 (n=1)	0.877	.
Total	4.04±2.98		3.43±1.28			0.775
Ig G (μg/mℓ)	40.14 ± 30.62 (n=14)	46.76 ± 31.11 (n=6)		41.19 ± 49.37 (n=2)	0.914	.
Total	42.13±30.10		41.19±49.37			0.968
Ig M (μg/mℓ)	2.48 ± 4.47 (n=13)	3.38 ± 6.65 (n=4)		0.09 ± 0.10 (n=2)	0.736	.
Total	2.69±4.84		0.09±0.10			0.470
Albumin (mg/mℓ)	0.101 ± 0.124 (n=14)	0.032 ± 0.026 (n=5)		0.015 ± 0.021 (n=2)	0.336	.
Total	0.083±0.111		0.015±0.021			0.406

VAS : visual analogue scale
PPT : pressure pain threshold
Group I : bone scan positive, painful
Group II : bone scan positive, nonpainful
Group III : bone scan negative, painful
Group IV : bone scan negative, nonpainful

bone scintigraphy and presence of pain(Table 8).

IV. DISCUSSION

Histological and functional study of the articular disc and surrounding tissues which are the subject to TMJ ID and degenerative joint diseases, has been reported for a long time thanks to the development of arthrography and magnetic resonance imaging(MRI)[18,19]. But there are difficulties in making an exact diagnosis of some pathologic states of TMJ, judging whether it is acute or chronic and selecting the method of treatment.

Because unlike other inflammatory reactions, that of TMJ rarely shows swelling, redness and fever at such a level as to be perceived in clinical tests and shows only pain, the presence of localized tenderness on palpation of TMJ area is considered as the clinical sign of inflammation of TMJ area. Most TMJ capsu-

litis are accompanied with TMJ ID or degenerative pathologic change and it is reported that ID is transferred to a degenerative process after a period of clicking[5]. Localized TMJ pain can be changed according to the progression of TMJ ID or arthrosis, so an objective evaluation of TMJ pain is important in understanding the essence of the disease. The evaluation of pain should not be a burden to both patients and operators, and it should express the degree of pain clearly and should be reliable and valid. Among several methods for evaluating pain, VAS method and pressure pain threshold(PPT) using algometer can be applied to patients easily. It is reported that an objective evaluation of TMJ pain using VAS and PPT is reliable and valid and offers important information for the understanding of essence of the disease.

The comparison of VAS and PPT according to TMJ ID stage shows us that VAS value on posterior palpation shows significant differences according to progression of TMJ ID and the stage of joints with periodic closed lock (stage Ⅱ) showed highest VAS value and lowest PPT value. The comparison of the differences between stages tells us that the VAS value of superior palpation shows significant difference between the joints with neither click nor pain(stage 0) and joints with intermittent closed lock(stage Ⅱ) and the VAS value of posterior palpation shows significant difference between the joints with neither click nor pain(stage 0) and joints with intermittent closed lock(stage Ⅱ) and between the joints with neither click nor pain(stage 0) and joints with degenerative joint disease (Ⅴ). According to the progression of TMJ ID the VAS value showed tendency to increase followed by decrease in value and PPT value showed tendency to decrease followed by increase in value. But PPT value showed no difference according to the progression of TMJ ID. In all the things considered above, we can say that VAS was more useful than PPT in measuring pain on TMJ area according to the progression of TMJ ID, and that significant information was derived especially from posterior palpation. We also know that patients with intermittent closed lock complain of greatest degree of pain.

Synovial fluid analysis to show the biochemical change in joints has been most commonly used in the knee joint[20,21], and also in TMJ since 1960. Schmid and Ogata[14] reported that we can take 0.1-0.2 ml synovial fluid from the TMJ, which is enough to be used for the analysis. Yehia et al[15] and Samuelson et al[22] reported that synovial fluid analysis plays an important role in the diagnosis and treatment of various types of joint diseases including inflammatory joint diseases. Patrick and Ward[23] reported that synovial analysis makes it possible to differentiate between septic lesions of joints and those caused by gout and also has a subsidiary role in the diagnosis of TA(traumatic arthritis), DJD(degenerative joint disease), RA(rheumatoid arthritis) and SLE(systemic lupus erythematosus). Toller[24] reported that the change in the consistency of synovial fluid and the decrease in lubricating action necessary to translating movements cause TMJ noise and TMJ ID.

Synovial fluid is composed of material from plasma due to osmosis(proteins such as albumin and haptoglobin and uric acid), materials from the synthesis and secretion of articular composing tissue(HA) and material from secretion of articular tissue(chondroitin sulfate). Synovial membrane in normal state is comparatively impermeable that blood cell and plasma protein with large molecular

weight cannot pass easily, so there exists small amount of plasma protein[14,15,24] and few blood cells[25] in the synovial fluid compared to proteins in the plasma. Actually materials over 100 angstroms in diameter cannot pass through it[26].

Nettelbladt et al[27] reported that the concentration of haptoglobin in the synovial fluid has direct relationship with the degree of inflammatory change in the connective tissues around the synovial fluid. Kushner and Somerville[28] studied into the permeability of human synovial membrane, reporting that the amount of proteins increases in direct proportion to the degree of inflammation and the total amount of proteins, which differs according to the degree of inflammation, reaches 2-10 times that of normal value. After Israel[13] examined the inflammatory state of synovial membranes using arthroscopy and took synovial fluids from 20 patients who were diagnosed as TMJ ID patients and then analyzed the relationship, he reported that the average protein concentration increases according to inflammatory state of the synovial membrane. Chung et al[29] analyzed the synovial fluid from 60 joints with pathologic changes and 10 normal joints and reported that total amount of protein averaged 0.205 ㎎/㎖ in the latter and 1.259 ㎎/㎖ in the former. In this study we compared the composition of synovial fluid according to the TMJ ID stage in order to form an objective standard of signs and symptoms of TMJ ID and found that average amount of total protein(0.320 ㎎/㎖) is increase in the joints with degenerative pathologic change compared with that of normal joints(0.129 ㎎/㎖) but that there is no overall tendency of increase or decrease in the average amount of total protein according to the TMJ ID.

Normal synovial fluid has high concentration of HA and this material enables the fluid to have high consistency and it plays an important role in lubricating the TMJ[14-16]. Dahl et al[30] reported that the concentration of HA is often lower in joints with disease than in normal joints. Suzuki[31] studied the relationship between biochemical findings and clinical symptoms from 29 human TMJ and reported that the molecular weight of HA is higher in normal joints and that there is no significant relationship between HA and the chronicity of the disease. They also reported that in the case of joints with closed lock, the molecular weight of HA is lower in more severe cases. In this study we could not find significant differences in HA concentration of the normal joints and of those with TMJ ID stage. HA concentration is highest in joints with pain and click(6.89 ㎍/㎖) and smallest in chronic closed lock(3.03 ㎍/㎖).

Bone scintigraphy shows no significant difference between joints in active state and in inactive state in VAS and PPT values and also, total protein amount in the synovial fluid of joint, albumin concentration, HA concentration, IgG and IgM concentration did not show significant differences either. Considering that joints in inactive states are only 3 out of 36 joints, more subjects are needed in order to obtain a more meaningful information. But considering that joints in active state are 33 out of 36 joints and that 10 out of 33 joints are painless, bone scintigraphy is inappropriate as an objective evaluating method.

In this study, we tried to verify the correlation between TMJ ID and VAS, PPT, arthrography, bone scintigraphy and TMJ synovial fluid analysis in order to develop an objective method in evaluating signs and symptoms of TMJ ID. Though bone scinti-

graphy and synovial fluid analysis were not so useful as expected, measurement of pain by VAS is estimated as helpful in making an objective evaluation on signs and symptoms of TMJ ID.

As far as the problem in synovial fluid analysis is concerned, Kopp[25] argued that the difficulties in obtaining the synovial fluid with saline aspiration technique of TMJ, which results in an underestimation of the biochemical changes in TMJ disease, are due to dilution and the anatomy of the TMJ. Alstergren et al[32] reported that it is possible to develop the least harmful and most dependable method by measuring the concentration of synovial fluid composition after calculating the degree of dilution in superior joint cavity with vitamin B.

In this study, we obtained the synovial fluid in inferior joint cavity to decrease the burden of patient in obtaining synovial fluid and analyzed it as if the dilution rate of saline and synovial fluid were same. If a method which makes it possible to obtain sufficient amount of synovial fluid while maintaining the original status of individual synovial fluid is developed in the near future, it is sure to aid in understanding the progressive stages of TMJ ID and the progression of degenerative pathologic change and offer helpful information for diagnosis and treatment TMJ ID.

V. CONCLUSIONS

This study was performed to provide more knowledge on objective evaluation of the signs and symptoms of temporomandibular joint internal derangement through visual analogue scale(VAS), pressure pain threshold (PPT), arthrography, bone scintigraphy and synovial fluid analysis. Forty-two subjects (eighty-four joints) who were diagnosed as TMJ internal derangement patients by clinical examination and TMJ arthrography were included. The intensity of TMJ pain was evaluated by visual analogue scale (VAS). The PPT on TMJ area was evaluated by electronic algometer. Bone scintigraphy and TMJ arthrography were taken and synovial fluid was aspirated before taking a TMJ arthrogram. Hyaluronic acids, total proteins, IgG, IgM and albumin concentrations of synovial fluid were analyzed.

The obtained results were as follows :

1. The number of joints with neither click nor pain (0) were 7, joints with click but no pain (Ⅰa) were 18, joints with both click and pain (Ⅰb) were 18, joints with periodic closed lock (Ⅱ) were 11, joints with acute closed lock (Ⅲ) were 11, joints with chronic closed lock (Ⅳ) were 3 and joints with degenerative bony change (Ⅴ) were 16.
2. The number of active joints were 33 out of 36 in bone scintigraphy and 23 out of the 33 active joints had pain. But, the VAS, PPT and other values of active joints did not show any significant difference with those of nonactive joints.
3. VAS was more useful than PPT on measuring pain according to progression of temporomandibular joints internal derangement, especially on the posterior side.
4. Stage Ⅱ showed highest VAS value and lowest PPT value. In addition, only stage Ⅱ showed significant correlations with stage 0 at superior VAS and with stage Ⅴ at posterior VAS.
5. Total protein, IgG, IgM and albumin concentration showed no significant correlation in progression of temporomandibular joint internal derangement, but they showed a

tendency to increase in stage V.

6. Hyaluronic acid concentration showed no significant correlation in progression of temporomandibular joint internal derangement, but it showed a tendency to decrease in stage Ⅳ.

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국문초록

악관절내장증의 증상과 징후의 객관적 평가법의 개발에 관한 연구

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저자들은 악관절내장증의 증상과 징후의 객관적 평가법을 개발하기 위하여 서울대학교치과병원 구강진단과 악안면동통진료실을 내원한 환자중 좌우 양 관절중 한 관절 이상의 관절에 악관절내장이 있는 남자 8명(평균연령: 19.9±2.9세), 여자 34명(평균연령: 32.8±11.8세) 총 42명(84개 관절)에 대하여 VAS 및 압통역치 측정, 악관절조영술, 골신티그래피 검사 및 악관절 활액의 분석을 시행하였다. 악관절 동통의 심도는 VAS로 측정을 하였으며 PPT는 electronic algometer로 평가를 하였다. 악관절조영사진을 얻기 직전 활액을 채취하였으며 그 성분중 Hyaluronic acid, 총단백질, IgG, IgM 과 albumin을 분석하여 그 상관관계를 분석한 결과 다음과 같은 결론을 얻었다.

1. 악관절 내장증으로 내원한 환자 42명, 총 84개 관절중, 무통성이고 관절잡음이 없는 경우가 7개 관절, 무통성이고 단순관절음만 존재하는 경우가 18개 관절, 동통 및 단순관절음이 존재하는 경우가 18개 관절, 간헐적인 폐구성 과두걸림이 있는 경우가 11개 관절, 급성 폐구성 과두걸림의 경우가 11개 관절, 만성 폐구성 과두걸림의 경우가 3개 관절, 퇴행성 관절질환이 존재하는 경우가 16개 관절이었다.
2. 연구대상중 18명의 환자, 총 36개 관절에 대한 골 신티그래피 검사 결과, 활동성으로 나타난 경우가 33개 관절이었고 이중 23개 관절이 동통성이었으며, 활동 상태 관절의 VAS 항목과 압통역치 항목 및 여러 검사 항목들은 비활동 상태 관절의 항목과 유의한 차이를 나타내지 않았다.
3. 악관절내장의 진행정도에 따른 악관절부위의 동통의 측정에 있어서는 압통역치의 측정보다는 VAS에 의한 방법이 더 유용하며 특히, 후방부의 촉진시에 유의한 정보를 얻을 수 있었다.
4. 악관절 내장증의 진행 단계에 따라, VAS 항목과 압통역치 항목을 비교해 본 결과, 주기적인 과두걸림(Ⅱ) 단계에서 가장 높은 VAS 수치와 가장 낮은 압통역치를 나타내었으며 상방 촉진시 VAS 항목에서 주기적인 과두걸림(Ⅱ) 단계와 증상 및 징후가 없는(0) 단계 사이와 후방 촉진시 VAS 항목에서 주기적인 과두걸림(Ⅱ) 단계 및 퇴행성 관절 질환(Ⅴ) 단계와 증상 및 징후가 없는(0) 단계 사이에서만 유의성을 나타내었다.
5. 활액내 총단백질량, albumin 량, IgG 및 IgM 농도는 악관절 내장증의 진행에 따라 유의성을 나타내지는 않았으나 퇴행성 관절 질환(Ⅴ) 단계에서 증가되는 양상을 나타내었다.
6. 활액내 hyaluronic acid 의 농도는 악관절 내장증의 진행에 따라 유의성을 나타내지는 않았으나 만성 폐구성 과두걸림(Ⅳ) 단계에서 감소되는 양상을 나타내었다.