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RESEARCH ARTICLE

Comparison of Clinical and Radiological Characteristics of Temporomandibular Joint Osteoarthritis in Older and Young people

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Abstract:

Background and Objectives:

The relatively high prevalence of temporomandibular joint (TMJ) osteoarthritis (OA) in older people increases the necessity to investigate the specific characteristics of TMJ-OA in this particular population. This study aimed to analyze the longitudinal changes in clinical and radiological characteristics of TMJ-OA in older people.

Methods:

We retrospectively analyzed the clinical features and cone-beam computed tomography (CBCT) images of 76 participants with TMJ-OA. Participants were classified into two groups according to age. The older people group included 33 participants over 50 years of age, and the control group included 43 participants in their 15-29 years. We analyzed the differences in clinical features and the distribution of destructive bony changes on CBCT images between groups.

Results:

The duration of pain was significantly shorter in the older people group ($P = .046$); however, the treatment duration was significantly longer in the older people group ($P = .001$). There was a significant difference in the distribution of destructive bony features between groups ($P = .005$). In the older people group, "three or more features" (36.3%) were the most common, whereas in the control group, "erosion" (44.2%) was the most common. After treatment, there was little improvement in the frequency of "erosion" in the older people group. There was a significant difference in the proportion of erosion after treatment between the groups ($P = .033$).

Conclusion:

In older people with TMJ-OA, active treatment to effectively induce condylar remodeling should be considered.

Keywords: Cone-beam computed tomography, Degenerative changes, Degenerative joint diseases, Older people, Prognosis, Temporomandibular joint, Osteoarthritis.

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1. INTRODUCTION

Osteoarthritis (OA) is the most common joint disease worldwide, characterized by deterioration of the articular tissues and gradual remodeling of the underlying bone progresses [1 - 3]. OA is caused by mechanical overloading-induced fibrillation, erosion, and cracking in the cartilage layer [4]. In this respect, OA is known as an age-related disease and can affect any joint in the body, including the hand, knee, and hips, which are positioned to bear the physical load [5, 6].

Approximately 10% of men and 18% of women over 60 years of age suffer from pain and disability associated with OA [2]. However, OA of the temporomandibular joint (TMJ) may differ from that of other joints [6, 7]. The TMJ is known to be relatively less affected by age than other joints. Indeed, the epidemiology of TMJ-OA in the literature shows that degenerative changes in the TMJ can occur in adolescents, with the prevalence in women peaking in those aged 20-40 years [8 - 10].

In recent studies, however, the prevalence of TMJ-OA in older people has gradually increased, unlike in previous studies [11, 12]. Despite the relatively high prevalence of TMJ-OA in

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older people, little is known about the prognosis of the disease in this population. Unlike osteoarthritis of other joints, a longitudinal study on the prognosis of TMJ-OA, which is known to be relatively less affected by age [3, 7], is needed.

Accordingly, this study aimed to retrospectively investigate longitudinal changes in radiological characteristics in older people with TMJ-OA along with clinical characteristics. Medical records and radiographic images of participants were evaluated and longitudinal changes of radiographic images with treatment were analyzed.

2. MATERIALS AND METHODS

2.1. Subjects

We reviewed patients diagnosed with TMJ-OA who visited the Department of Oral Medicine, Jeonbuk National University Dental Hospital, with TMJ pain from 2014 to 2018. TMJ-OA was diagnosed according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) [13]. All patients had familiar pain with the TMJ palpation on clinical examination. The diagnosis of TMJ-OA (RDC/TMD criteria, Axis I, Group III) [13] was confirmed by degenerative osseous changes on cone-beam computed tomography (CBCT). According to the TMJ CT criteria [14], degenerative osseous changes on CBCT include erosion, subchondral cysts, and osteophytes. Flattening and/or sclerosis that is not accompanied by erosion, osteophytes, and subchondral cysts is considered indeterminate evidence for TMJ-OA [14, 15].

Participants who had been treated using conventional modalities and had taken follow-up CBCT at the end of treatment were finally selected. Conventional modalities included physical therapy, occlusal stabilization appliance (2-mm-thick hard acrylic resin in the molar area; OSA) therapy, and medication. The end of treatment was determined when participants had normal joint movement and no pain with the TMJ palpation on clinical examination.

According to a report by the National Health Insurance Service of Korea, the number of patients with degenerative arthritis in their 50s has increased rapidly [16]. In addition, Jo *et al.* [6] reported that the odds ratio of degenerative change in the TMJ increases from the 50s. Accordingly, participants aged 50 years and above among the reviewed patients were selected. As a control group, participants in their 10-29 years were selected to exclude the effect of age-related degenerative bony changes as much as possible. As mentioned before, the TMJ is relatively less affected by age and TMJ-OA was relatively common in young patients in their 10s and 20s [6, 17]. Therefore, individuals in their 10s to 20s were selected as the control group to compare age-related differences in the characteristics of TMJ-OA. We excluded individuals with a history of TMJ surgery, condylar fracture, trauma, or systemic joint disease such as rheumatoid arthritis. A total of seventy-six participants were finally included.

This study adhered to the Declaration of Helsinki II and was approved by the Institutional Review Board of Jeonbuk National University Hospital (IRB No: CUH 2018-04-032; date of approval: June 12, 2018).

2.2. Radiographic Evaluation

The distribution of condylar degenerative features on CBCT images before and after treatment was assessed by 2 oral medicine specialists independently (W.J. and K.E.L.). Disagreement was resolved by discussion and decision with a third oral medicine specialist (B.J.S.). An experienced oromaxillofacial radiologist cross-checked its accuracy (K.A.K.). Five types of degenerative features were analyzed: erosion, osteophyte, flattening, subcortical sclerosis of the condyle, and erosion of the articular eminence. The criteria for degenerative features were as follows [14, 15]:

- (1) Erosion: loss of continuity of the articular cortical bone or surface irregularity of the condyle;
- (2) Osteophyte: marginal bony outgrowth of the condyle;
- (3) Flattening: loss of the rounded contour of the condylar surface;
- (4) Subcortical sclerosis: increased cortical plate thickness;
- (5) Erosion of articular eminence: loss of continuity of the articular eminence surface.

2.3. Clinical Evaluation

Clinical signs and symptoms were evaluated based on the patient's history and clinical examination by an experienced oral medicine specialist at the first visit and at the end of treatment. Clinical variables, including the maximum mouth opening (MMO) range (mm), comfortable mouth opening (CMO) range (mm), pain score (numeric rating scale; NRS) before and after treatment, TMJ pain duration (months), treatment duration (months), presence of joint noise (clicking), presence of mouth opening limitation (MOL), and presence of myalgia were evaluated. A range of MMO less than 40 mm was regarded as the presence of MOL.

2.4. Statistical Analysis

All statistical analyses were performed using a dedicated statistical software (SPSS V 25.0; IBM, Armonk, NY, USA). The t-test or Mann-Whitney U test was used to analyze the differences in duration of TMJ pain, duration of treatment, pre-treatment MMO (pre-MMO), post-treatment MMO (post-MMO), pre-treatment CMO (pre-CMO), post-treatment CMO (post-CMO), and pre-treatment NRS (pre-NRS) between groups. The frequency of other clinical data and radiological features was analyzed using chi-squared or Fisher's exact test. Statistical significance was set at $P < 0.05$.

3. RESULTS

3.1. Demographic and Clinical Characteristics

The participants included 62 women and 14 men, with a mean age of 36.1 years. The mean CBCT assessment interval was 18.5 months. The demographic characteristics of the study groups are summarized in Table 1. In both groups, the number of women was higher than that of men, but the proportion of female participants in the control group was significantly lower than that in the older people group ($P = .015$).

Table 1. The demographic distribution of study participants (brackets contain standard deviation unless otherwise indicated).

	Older People Group (n=33)	Control Group (n=43)	Total (n=76)
Age (years)	60.2 (8.1)	17.5 (3.4)	36.1 (22.1)
Sex (n, %)	Men	12 (27.9)	14 (38.8)
	Women	31 (93.9)	31 (72.1)

Table 2 shows the clinical characteristics of each group. The duration of pain and duration of treatment were significantly different between the groups ($P = .046$, $P = .001$). The older people group had a shorter duration of pain although a longer treatment duration than the control group.

Table 2. Clinical features of study participants by group (brackets contain standard deviation unless otherwise indicated).

Clinical Features	Older People Group (n=33)	Control Group (n=43)	P Value
Duration of pain (months)	3.8 (3.4)	7.5 (7.1)	0.046
Treatment duration (months)	24.1 (18.0)	14.2 (5.8)	0.001
Pre-NRS	3.9 (2.0)	4.3 (1.8)	0.319
Pre-MMO (mm)	38.9 (5.8)	37.8 (6.8)	0.445
Post-MMO (mm)	43.8 (3.1)	45.7 (5.5)	0.082
Pre-CMO (mm)	35.1 (7.0)	33.2 (7.6)	0.277
Post-CMO (mm)	42.8 (3.9)	44.7 (5.8)	0.105
Clicking sounds (N, %)	Yes	18 (41.9)	0.058
	No	25 (58.1)	
Myalgia (N, %)	Yes	31 (72.1)	0.610
	No	12 (27.9)	
MOL (N, %)	Yes	25 (58.1)	0.754
	No	18 (41.9)	

NRS, numeric rating scale; Pre-NRS, NRS before treatment; MMO, maximum mouth opening; Pre-MMO, MMO before treatment; Post-MMO, MMO after treatment; CMO, comfortable maximum opening; Pre-CMO, CMO before treatment; Post-CMO, CMO after treatment; N, number; MOL, mouth opening limitation.

Table 3 presents the correlations between age, pre-NRS score, and treatment duration for all participants. Age significantly positively correlated with treatment duration and negatively correlated with pain duration.

Table 3. Correlation matrix of clinical factors.

	Treatment Durations	Age	Pain Duration	Pre-NRS	Post-NRS
Treatment duration	1.000				
Age	0.326**	1.000			
Pain duration	-0.024	-0.242*	1.000		
Pre-NRS	-0.202	-0.097	0.068	1.000	
Post-NRS	-0.013	-0.092	0.142	0.032	1.000

NRS, numeric rating scale; Pre-NRS, NRS before treatment; Post-NRS, NRS after treatment. Correlation was analyzed using Spearman's correlation. * $p < 0.05$, ** $p < 0.01$.

3.2. Evaluation of Destructive Bony Changes

Table 4 shows the distribution of the types of degenerative features on first-time CBCT images by the group. The older participants had more complicated degenerative features than the control group ($P = .005$). In the older people group, "three or more" was the most common finding; however, in the control group, "erosion" alone was the most common finding.

Table 4. The distribution of types of degenerative features on first-time CBCT images by group.

Distribution	Older People Group (n=33)	Control Group (n=43)
Ero (n, %)	4 (12.1)	19 (44.2)
Ero & Ost (n, %)	3 (9.1)	5 (11.7)
Ero & Flat (n, %)	3 (9.1)	4 (9.3)
Ero & Scl (n, %)	6 (18.2)	5 (11.7)
Ero & AE_ero (n, %)	5 (15.2)	4 (9.3)
3 or more (n, %)	12 (36.3)	6 (14.0)
P value	0.005	

CBCT, cone-beam computed tomography; Ero, erosion; Ost, osteophyte; Flat, flattening; Scl, sclerosis; AE_ero, erosion of articular eminence.

The changes in the cumulative number of degenerative features according to treatment are shown in Table 5. When two or more degenerative features were observed in the condyle, each feature was counted separately. Both before and after treatment, the distribution of articular eminence erosion in the older people group, was higher than that of the control group ($P = .004$, $P < .001$). In both groups, flattening and sclerosis increased after treatment. Erosion disappeared in almost 40% of participants in the control group after treatment. In contrast, there was little change in the number of patients with erosion in the older people group ($P = .033$).

Table 5. Changes in the cumulative number of degenerative features according to treatment.

Degenerative Features		Older People Group (n=33)	Control Group (n=43)	P Value
Erosion (n, %)	Before treatment	33 (100)	43 (100)	-
	After treatment	28 (84.8)	27 (62.8)	0.033
Osteophyte (n, %)	Before treatment	21 (27.6)	9 (20.9)	0.136
	After treatment	7 (21.2)	8 (18.6)	0.777
Flattening (n, %)	Before treatment	14 (42.4)	7 (16.3)	0.120
	After treatment	18 (54.5)	18 (41.9)	0.272
Sclerosis (n, %)	Before treatment	9 (27.3)	10 (23.3)	0.689
	After treatment	14 (42.4)	12 (27.9)	0.186
AE_ero (n, %)	Before treatment	12 (36.4)	4 (9.3)	0.004
	After treatment	9 (27.3)	0 (0)	0.000

AE_ero, erosion of articular eminence.

4. DISCUSSION

This study was conducted to evaluate longitudinal changes in radiological and clinical characteristics in older people with TMJ-OA. Our results were consistent with several studies showing the disagreement between the severity of clinical and radiographic results of TMJ-OA [18 - 21]. Pain and mouth-opening limitations were reduced after treatment in both

groups, but there was little improvement in condylar erosion in the older people group. A follow-up CBCT imaging is considered necessary for the treatment of TMJ-OA as symptoms and signs did not consistently correlate with destructive bone changes in the condyle. There was a considerable difference in sex distribution between the two groups. The older people group had a much higher proportion of female patients than that of the control group. It is considered because hormonal changes, especially after menopause, affect degenerative bone changes in the older people group [9, 14].

In the older people group, multiple osseous changes were predominantly observed than the control group even though the duration of pain was no longer than that of the control group, and “erosion” alone was most common in the control group. This result is explained by the presence of undestructive osseous changes, which is a sign of physiological adaptive response to increased loading and aging [22 - 24]. Flattening, sclerosis, and osteophyte not accompanied by erosion are considered undestructive changes [14, 15]. Previous studies reported that these undestructive features had been observed with 10 ~ 40% frequency in asymptomatic elderly patients [22, 23, 25].

The distribution of eminence erosion also differed between groups. In the older people group, approximately 40% of the patients had eminence erosion, more than 10% in the control group. In the older people group, this result showed a higher distribution (<10%) than in previous studies [5, 26]. In general, each type of osseous change occurs at different stages of TMJ-OA [24]. As TMJ-OA progresses, radiographic evidence of active TMJ-OA, such as erosions, increases. Once the inflammatory condition resolves, the joint structures experience an adaptation process, resulting in sclerosis and flattening [14, 24]. Erosion of eminence is considered to occur in the longer disease duration of TMJ-OA [27]. However, in this study, the duration of pain in older participants was shorter, even though they more frequently had multiple erosions of the eminence. This discrepancy can be explained by the subjectivity of pain interpretation [9]. Lövgren *et al.* reported that self-reported TMJ pain decreases with advancing age [28]. The majority of patients with TMJ pain are expressed as mild pain [29, 30]. With increasing age, the number of other body diseases that are more painful may also increase. This results in elderly patients being less aware of mild TMJ pain [9].

A guideline for choosing an intervention and consensus treatment for complete remission of TMJ-OA are lacking [21, 31]. TMJ-OA treatment aims to relieve arthralgia, improve TMJ functions, and lead to bone remodeling [31]. OSA treatment is known to be effective in relieving pain and restoring TMJ functions through the reduction of excessive overloading [7, 21, 32]. In addition, OSA treatment reduces destructive bone changes and induces bone remodeling in the condyle [33, 34]. Although all participants in this study were treated with OSA, most of the older people group had condylar erosion even after treatment; erosions disappeared in only 15.2% of patients. It is a higher frequency than the distribution of erosion shown in asymptomatic elderly participants in

previous studies [22, 23, 25]. In addition, while the erosion of articular eminence was disappeared in the control group, it hardly decreased in the older people group. The integrity of the cortical lining is considered to more accurately reflect the pathological condition of TMJ than the morphological changes of the condyle [27]. These results imply that older people with TMJ-OA may have disadvantages for treatment, especially for condyle recovery and remodeling. Age affects bone homeostasis. As we age, bone resorption dominates over bone formation, slowing the rate of bone remodeling [35, 36]. Although TMJ-OA is known to be relatively less susceptible to aging [3, 7], it can be thought that aging-induced changes in joint homeostasis influenced the prognosis of TMJ-OA. It is necessary to study other treatment strategies to induce remodeling in which condylar erosion has disappeared effectively in older people with TMJ-OA.

Some clinicians have questioned the necessity of TMJ-OA treatment because several studies have shown that TMJ-OA is self-limiting [9, 37, 38]. This question may be more pronounced in older people. As mentioned earlier, in older people, diseases with more severe symptoms in other body areas may take precedence over TMJ-OA [9]. This perception could be one of the reasons why clinicians and patients hesitate to treat TMJ-OA. However, based on the results of this study, TMJ-OA in older people might have a longer duration of treatment and a poor prognosis than in other age groups. We believe that further research is needed in the future.

This study had several limitations. First, it was performed retrospectively and was based on patients' medical records. The data could be biased because the study was performed on treated patients in a single hospital. In addition, there was no comparison of progress according to treatment strategies in older people with TMJ-OA. Second, there was no quantitative evaluation of bony changes in this study. Quantitative comparison of the degree of bone destruction in older people and the control groups is important. However, to the best of our knowledge, quantitative evaluation methods for TMJ-OA are still lacking. In the future, a quantitative evaluation should be conducted to analyze the degree of bone destruction in older people. Thus, further studies that quantitatively evaluate the radiologic changes in patients with TMJ-OA are required.

CONCLUSION

The number of older people with TMJ-OA is increasing. In older people with TMJ-OA, the treatment period maybe longer, and bone changes may not improve after treatment. Signs of active TMJ-OA, such as condylar erosion or osteophytes, should be detected through periodic TMJ examinations, and active treatment should be considered to maintain normal TMJ function in older people.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The present study was approved by the Institutional Review Board of Jeonbuk National University Hospital, Republic of Korea (IRB No: CUH 2018-04-032; date of approval: June 12, 2018).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from all the participants.

STANDARDS OF REPORTING

STROBE guidelines and methodologies were followed in this study.

AVAILABILITY OF DATA AND MATERIALS

All data supporting the results of this study are available from the corresponding author [B.J.S] upon request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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