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ORIGINAL ARTICLE

The incidence of osteoarthritic change on computed tomography of Korean temporomandibular disorder patients diagnosed by RDC/TMD; a retrospective study

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ABSTRACT

Objective Osteoarthritis (OA) of the temporomandibular joint (TMJ) is generally thought to be an age-related disease like those of other joints. This study aims to investigate the incidence of computed tomographic (CT) OA changes in Korean temporomandibular disorder (TMD) patients diagnosed by the Research Diagnostic Criteria for TMD (RDC/TMD). **Materials and methods** The clinical records and radiographs of 1038 TMD patients (297 men and 741 women with mean age 31.1 ± 17.4 and 34.0 ± 16.2, respectively) diagnosed based on RDC/TMD Axis I in 2010 were reviewed. **Results** The incidence rate of OA changes in TMD patients is estimated to 27.3%, and higher in women than in men (15.5% in men and 32.0% in women) by 2.3 odds ($p < 0.001$). It has no correlation with age, showing an almost flat incidence rate throughout the age from the 2nd decade and has no correlation as well with pain or disc displacement diagnosed according to RDC/TMD, while arthrosis/arthritis diagnosis based on RDC/TMD supplemented by plain radiographs shows high risk of OA changes on CT by 38.8 odds ($p < 0.05$). **Conclusions** These results imply that the OA changes in young Korean TMD patients are as common as in the old and have no correlation with clinical pain and noise. Considered with high prevalence of TMDs known in the young population, the overall/absolute OA changes in the TMJ can be even higher in the young than in the old population, not like in other joints.

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Introduction

Osteoarthritis (OA) or degenerative joint disease (DJD) is defined as a degenerative condition of the joint characterized by deterioration and abrasion of articular cartilage and concomitant remodelling of the underlying subchondral bone.[1,2] OA of the temporomandibular joint (TMJ) is known as an age-related disease like those of other joints and also known to present higher prevalence in women than in men.[3–5] Among the patients treated in temporomandibular disorder (TMD) clinics, 8–12% get a diagnosis of DJD.[6] Autopsy results confirm TMJ degenerative disease prevalence that varies from 22% to greater than 40% of the population.[6] More recently, bone changes in the TMJ were observed in 71% of TMD patients referred to take cone beam computed tomogram (CBCT) examination of the TMJ.[3] It has been pointed out that discrepancies in estimates of TMJ OA prevalence are because diagnoses are frequently guided by the presence or absence of rather non-specific signs and symptoms of TMDs.[7] Besides, variation of samples of studies in age, gender and disease or life status must be one of the main reasons for such diversity of the results. If the study based on the general population sample in a large size covering all ages is available, it must be able to provide the result with less bias. It is naturally almost impractical to conduct such a study though.

This study aimed to investigate the incidence of OA changes confirmed by computed tomograghy (CT) in 1038 Korean patients with TMDs diagnosed by the Research Diagnostic Criteria for TMD (RDC/TMD) for the first time in 2010. We expected that the results of this study can provide information on the clinical incidence of OA changes in TMD patients in Korea and insight into the epidemiology of OA in the TMJs.

Materials and methods

Materials

A retrospective cross-sectional study was performed based on the review of the clinical records and radiographs of 1153 patients who visited the TMJ & Orofacial Pain Clinic of Seoul National University Dental Hospital and examined by a single TMD specialist, one of the authors, Lee, for their TMD-related symptoms for the first time in 2010. Finally, the records of 1038 patients (297 male and 741 female with mean age 31.1 ± 17.4 and 34.0 ± 16.2, respectively) who were diagnosed with TMD

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based on the RDC/TMD were selected for the study. The records of the patients who had TMJ fracture, major deformity such as Pierre-Robin syndrome, and systemic diseases known to affect the TMJ such as rheumatoid arthritis were excluded. The research protocol was approved by the Institutional Review Board of the University Hospital (#CRI12038).

Diagnosis of TMD and TMJ OA

Diagnosis of TMD in the TMJ & Orofacial Pain Clinic of Seoul National University Dental Hospital is made primarily by clinical examination satisfying RDC/TMD Axis I [8–10] and plain radiographs including orthopantomogram, TMJ orthopantomogram, and transcranial radiograph. Additional supplementary examination such as MRI, CT, and laboratory tests are done only in cases that require any additional information for more definite diagnosis such as OA, neoplasm, fracture, deformity, abscess, and possible rheumatologic disease, etc. Once the patient was classified into arthrosis/arthritis (RDC IIIb or IIIc) based on clinical examination or showed any OA sign in plain radiographs, additional CT examination was recommended to confirm the OA changes of the joint. However, CT was taken only when the patient agreed to take CT voluntarily. Only the cases with obvious OA changes confirmed on CT such as erosion, subcortical cyst, osteophyte, sclerosis, and loose joint body were finally diagnosed as TMJ OA, even if they had only radiographic signs without any clinical signs/symptoms such as pain or crepitus, while simple smooth flattening of the condylar shape with intact cortical line was excluded from the OA changes as well as TMJ OA diagnosis.

For the study, leaving the diagnostic criteria or necessity of treatment of TMJ OA out of the discussion, we investigated the incidence of the OA changes on CT images and its relationship with age and RDC/TMD diagnoses. RDC/TMD diagnoses were recoded dichotomously to simplify the analysis, determining if the joint could be classified into pertinent RDC group I, II, and III. In the case of RDC group III, classification was done in two different ways, pain and arthritis/arthrosis. For pain, RDC IIIa and RDC IIIb were classified as positive for RDCIIIPAIN group, and for TMJ OA, RDC IIIb and RDC IIIc were classified as positive for RDCIIIOA group.

Radiographic methods

The pain radiographs were taken into the image plates by Orthopantomograph® OP 100 (Instrumentarium Dental, Finland) for orthopantomograms and TMJ orthopantomograms and DXG-100N (Listem, Korea) for transcranial radiographs. Images were digitalized by scanning of image plates with FCR XG5000 (Fujifilm, Japan). TMJ orthopantomograms were taken according to the optimum standards provided by the manufacturer, with modified focal trough locating to the TMJ in mouth-opening position.

CT images were acquired with a SOMATOM Sensation 10 (Siemens, Munich, Germany) and 0.75 mm slice collimation. The tube voltage was 120 kV; the tube current-time was 100 mA and the rot time was 19.0 s. The corrected sagittal, corrected coronal and axial images of the TMJs were reconstructed along the true axes of the mandibular condyle with a slice thickness of 1 mm.

Statistical analysis

Binary logistic analysis was performed using SPSS 21 to analyse the relationship between the incidence of OA changes and age, gender, bilateralism and each RDC group. The data of 117 patients out of 354 patients who were requested to take CT but did not take it were treated as missing values for binary logistic analysis, while the expected number of patients with OA changes in 117 patients was approximated in each age group in proportion to the incidence rate observed in 237 patients with CT and topped it up on the data of 237 patients (named as 'observed-data') to approximate the estimated incidence rate of OA change in a total of 1038 patients (named as 'estimated-data') in the assumption that the 117 patients without CT would have had taken CT as shown in Table 1 and Figure 1.

Results

Among 1038 patients diagnosed with TMDs according to RDC/TMD supplemented by plain radiographs, 354 patients (34.1%) were requested to take CT for confirmative diagnosis of OA changes, out of which 237 patients (66.9%, 22.8% of total TMD patients) took CT and 117 patients (33.1%, 11.3% of total TMD patients) did not, because of various reasons such as radiation, cost, schedules or need of the second opinion.

More than twice as many women as men visited the clinic for TMD examination and the patient numbers were highest in the third decade followed by the second decade. In the observed-data, the incidence rate of OA changes was 18.0% (187 out of 1038 patients showing unilateral involvement in 77 (41.2%) and bilateral in 110 (58.8%) patients). The incidence rate of OA changes in female patients was 21.1% (156 out of 741 patients) and 10.4% (31 out of 297 patients) in male patients. In the estimated-data, total incidence rate was increased to 27.3% (283 out of 1038 patients). The incidence rate in female patients was estimated as 32.0% (237 out of 741 patients) and 15.5% (46 out of 297 patients) in male patients.

In the results of logistic analysis, the risk of OA changes in TMD patients was 2.3-times ($p < 0.001$, Table 1) higher in female patients than in male patients and 1.7-times ($p < 0.05$, Table 2) higher in female joints than in male joints. Interestingly, bilateral occurrence of OA changes is 1.9-times riskier in female joints than in male joints ($p < 0.05$), which was not observed in unilateral cases (Table 2). According to RDC/TMD supplemented by plain radiographs, the positive RDCIIIOA joint has 38.8-times higher risk of OA changes, 17.6-times higher risk of unilateral, and 28.6-times higher risk of bilateral OA changes than the negative joint ($p < 0.001$, Table 2), while the incidence rate and bilateralism of OA changes have no statistically significant correlation with the presence of joint (RDCIIIPAIN) or muscle pain (RDCI) and the disc displacement (RDCII) diagnosed by clinical examination based on the RDC/TMD. Likewise, it also has no statistically significant correlation with age in both genders, as shown in Table 2 and Figure 2.

Table 1. Age and gender distribution in the sample of 1038 TMD patients.

	Patients with CT			Patients missing CT			Expected no. of OA in patients missing CT		
Decade of age	Male	Female	Total	Male	Female	Total	Male	Female	Total
1st	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0	0	0
2nd	19 (19.0)	47 (31.3)	66 (26.4)	4 (4.0)	19 (12.7)	23 (9.2)	2	15	16
3rd	13 (12.4)	59 (23.3)	72 (20.1)	7 (6.7)	31 (12.3)	38 (10.6)	6	25	31
4th	3 (12.0)	33 (27)	36 (24.5)	1 (4.0)	12 (9.8)	13 (8.8)	1	10	11
5th	4 (21.1)	15 (20.3)	19 (20.4)	2 (10.5)	9 (12.2)	11 (11.8)	2	8	10
6th	0 (0.0)	23 (30.7)	23 (27.1)	2 (20.0)	8 (10.7)	10 (11.8)	0	6	7
7th and older	5 (13.5)	16 (25.0)	21 (20.8)	5 (13.5)	17 (26.6)	22 (21.8)	4	17	21
Total	44 (14.8)	193 (26.0)	237 (22.8)	21 (7.1)	96 (13.0)	117 (11.3)	15	81	96
	Estimated no of OA			Observed no of OA			TMD patients		
1st	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	3 (75.0)	4 (100.0)
2nd	11 (11.0)	51 (34.0)	61 (24.4)	9 (9.0)	36 (24.0)	45 (18.0)	100 (40.0)	150 (60.0)	250 (100.0)
3rd	18 (17.1)	72 (28.5)	90 (25.1)	12 (11.4)	47 (18.6)	59 (16.5)	105 (29.3)	253 (70.7)	358 (100.0)
4th	4 (16.0)	37 (30.3)	41 (27.9)	3 (12.0)	27 (22.1)	30 (20.4)	25 (17.0)	122 (83.0)	147 (100.0)
5th	5 (26.3)	22 (29.7)	27 (29.0)	3 (15.8)	14 (18.9)	17 (18.3)	19 (20.4)	74 (79.6)	93 (100.0)
6th	0 (0.0)	22 (29.3)	23 (27.1)	0 (0.0)	16 (21.3)	16 (18.8)	10 (11.8)	75 (88.2)	85 (100.0)
7th and older	8 (21.6)	33 (51.6)	41 (40.6)	4 (10.8)	16 (25.0)	20 (19.8)	37 (36.6)	64 (63.4)	101 (100.0)
Total	46 (15.5)	237 (32.0)	283 (27.3)	31 (10.4)	156 (21.1)	187 (18.0)	297 (28.6)	741 (71.4)	1038 (100.0)
Exp (B)					2.3***	1.0§			
95% CI					1.5–3.4	0.9–1.1			

Parentheses indicate percentage within a decade of age.
***$p < 0.001$; Analyzed by binary logistic analysis with the occurrence of OA changes as a dependent variable and decade of age (§, for one decade's change) and gender (referring to male) as independent variables.

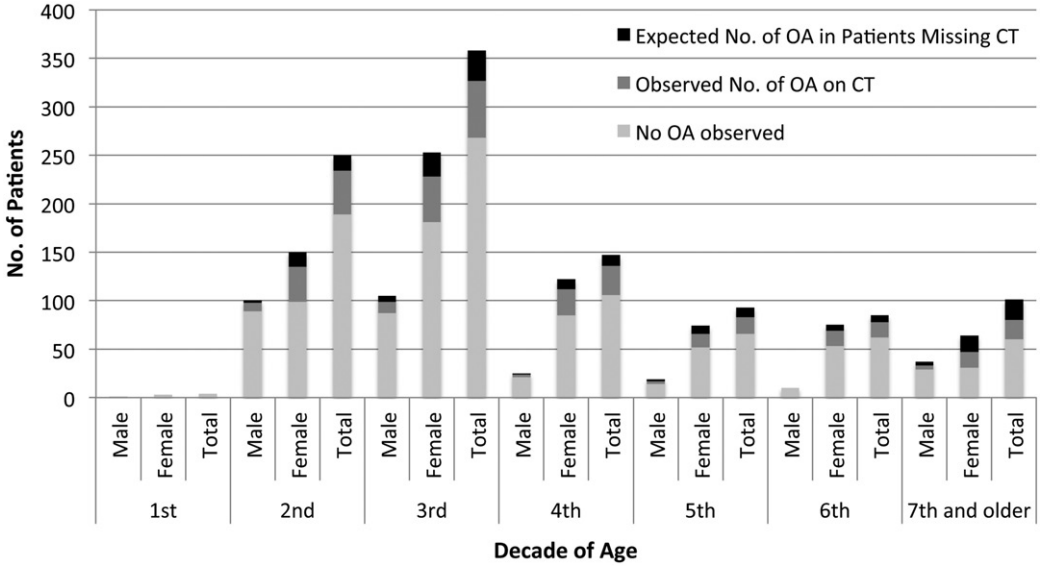

Figure 1. Age and gender distribution of TMD and OA patients.

Discussion

Although the results of epidemiological studies of TMJ OA vary according to diagnostic criteria,[3,11,12] TMJ OA is generally considered as an age-related joint disease as those of other joints of the body [13] and a gender-related joint disease with female predominance.[7,14] However, it is also the fact that there is no established epidemiological evidence based on a large-scale sample of the general population to support such a relationship or a difference between age or gender and TMJ OA compared to other joints. The best way to elucidate the actual prevalence of TMJ OA must be to study with a random sample covering all ages from the general population examined and diagnosed based on criteria in consensus for TMDs and TMJ OA. However, it is also the fact that such a study is practically almost impossible in most clinical situations. As a possible alternative to provide some information on that issue, we investigated the incidence of the OA changes in TMD patients diagnosed based on RDC/TMD. Since the clinical situation in Korea allows the patients to visit the special clinics for TMDs of university hospitals freely without any referring letter and TMDs are mostly diagnosed and managed in such special clinics rather than private clinics, we believe that the results of this study can estimate the clinical incidence of OA changes in TMD patients in Korea.

In this study, we tried to control the effects of any possible seasonal factors on the TMD occurrence by the enrolment of initially diagnosed TMD patients in a whole year. For better consistency and reliability of diagnosis, the records of 1038 patients were selected, who had been diagnosed based on the

Table 2. Number of the joints with OA or RDC diagnoses among total 1677 joints with TMDs.

		Observed no of OA									
Decade of age		Male	Female	Unilateral	Bilateral	Total	RDCI	RDCII	RDCIIIOA	RDCIIIPAIN	Total
1st		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (60.0)	0 (0.0)	3 (60.0)	5 (100.0)
2nd		13 (8.4)	56 (23.1)	21 (30.4)	48 (69.6)	69 (17.4)	204 (51.5)	187 (47.2)	99 (25.0)	161 (40.7)	396 (100.0)
3rd		17 (10.8)	74 (17.1)	27 (29.7)	64 (70.3)	91 (15.4)	352 (59.6)	261 (44.2)	149 (25.2)	220 (37.2)	591 (100.0)
4th		6 (15.8)	42 (20.8)	12 (25.0)	36 (75.0)	48 (20.0)	156 (65.0)	98 (40.8)	62 (25.8)	90 (37.5)	240 (100.0)
5th		4 (13.3)	26 (21.3)	4 (13.3)	26 (86.7)	30 (19.7)	98 (64.5)	57 (37.5)	32 (21.1)	55 (36.2)	152 (100.0)
6th		0 (0.0)	26 (21.3)	6 (23.1)	20 (76.9)	26 (19.4)	76 (56.7)	41 (30.6)	46 (34.3)	54 (40.3)	134 (100.0)
7th and older		6 (10.5)	27 (26.5)	7 (21.2)	26 (78.8)	33 (20.8)	88 (55.3)	45 (28.3)	61 (38.4)	75 (47.2)	159 (100.0)
Total		46 (10.2)	251 (20.5)	77 (25.9)	220 (74.1)	297 (17.7)	974 (58.1)	692 (41.3)	449 (26.8)	658 (39.2)	1677 (100.0)
OA†	Exp (B)		1.7*			1.0§	1.0	1.2	38.8***	1.2	
	95% CI		1.1–2.6			0.9–1.1	0.7–1.4	0.9–1.7	26.1–57.8	0.8–1.7	
Unilateral¶	Exp (B)		1.1			0.9	1.0	1.2	17.6***	1.2	
	95% CI		0.7–1.9			0.8–1.0	0.7–1.6	0.8–1.9	11.2–27.6	0.8–1.9	
Bilateral¶	Exp (B)		1.9*			1.0§	1.1	1.2	28.6***	1.0	
	95% CI		1.2–3.1			0.9–1.1	0.8–1.6	0.8–1.7	18.9–43.4	0.7–1.5	

Parentheses indicate the percentage within a decade of age.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
†Analyzed by binary logistic analysis with the occurrence of OA as a dependent variable and decade of age (§, for one decade's change), gender (referring to male), and RDC diagnoses (referring to negative) as independent variables.
¶Analyzed by multiple logistic analysis with the bilateralism of OA as a dependent variable and decade of age (§, for one decade's change), gender (referring to male), and RDC diagnoses (referring to negative) as independent variables.

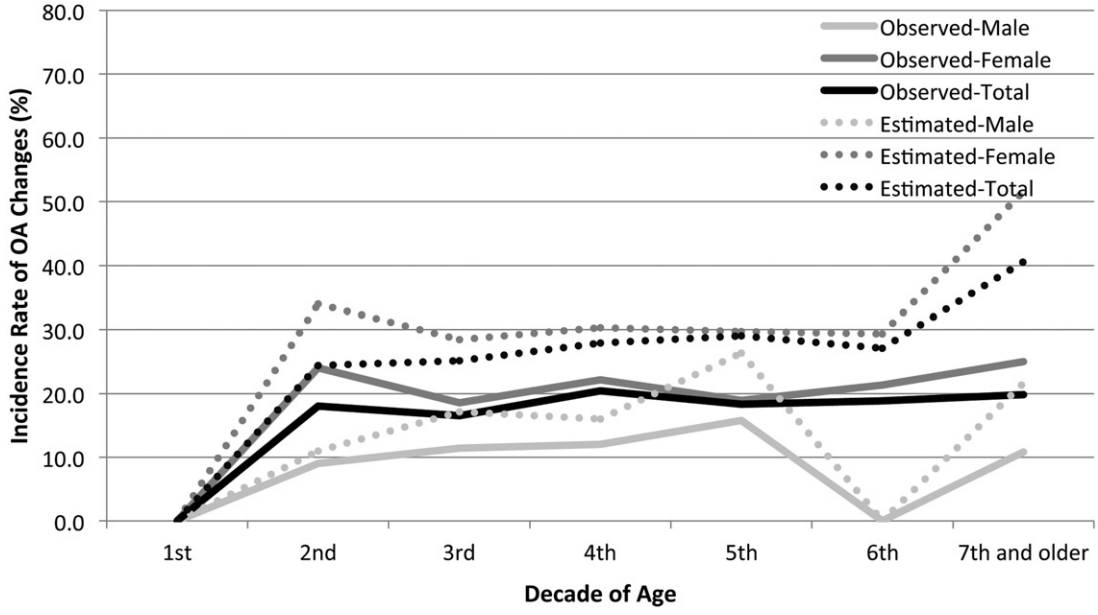

Figure 2. Incidence rate of OA changes in TMD patients.

clinical and radiological examinations satisfying RDC/TMD by a single TMD specialist at the TMJ & Orofacial Pain Clinic of Seoul National University Dental Hospital. The major limitation of this study lies in the fact that it is a retrospective study, so that the CT taking, age and gender were not controlled. The numbers of patients in each decade were not equal and some patients did not take CT in spite of classification into the RDCIIIOA group or actual recommendation of CT. For instance, as a result, in patients in their 7th decade and over, because the number of patients who did not take CT despite the request was almost the same as that of the patients who did, the expected number of the OA patients turned out almost the same as the observed number. To minimize the error of the incidence rate from this limitation in the total 1038 patients, we approximated the expected number of patients with OA changes based on the observed OA incidence rate in the patients with CT in each age group.

In the results, the risk of OA changes in the TMJ was 2.2-times ($p < 0.001$, Table 1) higher in female than in male TMD patients. This result is consistent with the results of previous studies.[3–6] The reason for this phenomenon is unclear, but it might be due to the differences of sex hormones, pain perception, responses to stress and psychological factors.[5,15,16] Several studies have not found any gender differences in degenerative change of the TMJ,[17,18] while others have reported a higher prevalence in men [19,20].

The diagnosis of TMJ OA is usually done by clinical and radiographic examinations. The clinical signs of OA are crepitus associated with movement, restriction of jaw movements and pain within the joint cavity,[21,22] which tends to be

intermittent. However, diagnosis using clinical examination solely has little reliability due to a lack of any correlation between the signs/symptoms and TMJ OA.[23] On the other hand, radiographic examination is very valuable to detect degenerative changes in osseous components.[24] Therefore, in the TMJ & Orofacial Pain Clinic of Seoul National University Dental Hospital, any possible bony abnormality of the mandibular condyle was evaluated preliminarily using all three types of radiographs consisting of orthopantomogram, TMJ orthopantomogram and transcranial radiographs taken routinely for the diagnosis of TMDs. Although computed tomography (CT) and magnetic resonance imaging (MRI) are the most powerful radiographic tools in diagnosing OA,[14,25,26] technically, they cannot be taken of every single patient because MRI usually costs a fortune and CT is always issued by its high dose of radiation. Comprehensive clinical examination supplemented by plain radiographs can provide, with low cost and risk, sufficient preliminary screening information for the determination of further confirmative examinations, as shown in the results with very high odds, 38.8 ($p < 0.001$, Table 2), of OA changes in the RDCIIIOA group. It has been reported in some previous studies that the validity of RDC/TMD Axis I diagnoses is low,[10,27,28] especially for Group III.[27] The result of this study showed no statistically significant correlation between the incidence of OA changes and pain or the disc displacement diagnosed by clinical examination according to the RDC/TMD. This must be because of the lack of correlation between clinical signs/symptoms and OA changes [23] as well as the low validity of RDC/TMD Axis I diagnosis. On the other hand, the positive RDCIIIOA group according to RDC/TMD including results of plain radiographs has 34.6-times higher odds of OA changes than the negative group. This result must reflect the diagnostic capability of plain radiographs for bony abnormality, not that of clinical signs, namely crepitus.

In lots of previous studies, the TMJ OA has been described as an age-related disease, increasing in incidence with age.[3,6,18,29,30] However, the incidences of TMJ OA were not statistically different between age groups in this study. Although some studies reported that OA was observed before adolescence, the symptoms of OA were found to occur mainly in the third decade of life, and degenerative change of the mandibular condyle seems to start at a young age,[30–32] not much has been reported about the actual incidence of OA changes in young TMJs. Sometimes, juvenile idiopathic osteoarthritis (JIA) is mentioned frequently when arthritic changes are observed in young patients, because TMJ arthritis is very common in JIA patients.[33,34] However, because any suspicious signs/symptoms of inflammatory joint diseases such as rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis and JIA were also examined and ruled out by serologic test and referral to rheumatologists in anytime during the whole follow-up period since the initial examination, it is hardly possible that such inflammatory arthritic patients were included in the 1038 patients of this study. Moreover, arthritic TMJ in a patient seronegative and aged over 16 years without any sign/symptom of arthritis in any other joints of the body cannot be diagnosed as involvement of JIA.[35] Then it can be carefully postulated that, no matter how old they are, one out of every four patients with TMDs could be accompanied by OA change in the TMJ at the moment of initial examination in Korea. Considering the high prevalence of TMDs in young ages, the incidence rate of TMJ OA in young age could be even higher than in old age in the general population. Because of the lack of reports about age-related incidence of TMJ OA comparable with the results of this study, it cannot be answered at this moment if this high incidence rate of TMJ OA in young TMD patients and low correlation between incidence rate of TMJ OA and age are a unique clinical situation in Korea affected by various socio-environmental factors or they are general clinical features of TMJ OA. To address this issue, further studies using CT or MRI with the sample in a large scale covering all ages from various ethnic groups are necessary. This will be able to provide valuable information on the relationship between OA occurrence and various anamnestic factors such as psychology, social or economical condition, ethnicity and culture to explain this high incidence of OA in young patients. It would be very interesting to correlate the pain intensity and other parameters as age and gender to the grade of OA changes as well. If any study reports the result based on the general population as such, it must be even more valuable to understand the epidemiologic feature of TMJ OA.

In conclusion, the incidence rate of TMJ OA in Korean TMD patients is higher in women than in men and has no correlation with age, showing an almost flat incidence rate throughout ages from the 2nd decade in Korean TMD patients. It has no correlation as well with pain or disc displacement diagnosed based on RDC/TMD, while arthrosis/arthritis diagnosis based on RDC/TMD supplemented by plain radiographs shows high risk of OA changes on CT, which implies that it is reasonable to use clinical examination supplemented by plain radiographs for screening TMJ OA.

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Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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