
A Retrospective Study on the Prevalence of Temporomandibular Disorders in 9,909 Chinese Subjects with Malocclusions Prior to Orthodontic Treatment

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Objective: To investigate the prevalence and clinical characteristics of temporomandibular disorders (TMD) in a population prior to orthodontic treatment and to evaluate the possible risk factors for TMD.

Methods: Clinical documentations and radiographs of 9,909 patients with malocclusions were retrospectively reviewed. All the patients were from the Orthodontic Department of Peking University School and Hospital of Stomatology during January 1998 to December 2003. The prevalence of TMD was calculated and the clinical characteristics were investigated. The association between the prevalence and the potential risk factors including aging, gender and malocclusion classifications was analysed using the method of chi-square and multivariate logistic regression analysis.

Results: The prevalence of TMD was 8.6% in this population and statistically higher in females (9.5%) than in males (7.0%) ($\chi^2 = 18.125$, $P < 0.01$). The prevalence had a positive association with age and increased in adolescence and young adulthood ($\chi^2 = 157.503$, $P < 0.01$). Patients with Angle II malocclusion were more likely to suffer TMD than patients with Angle I malocclusion (odds ratio [OR] = 1.445, $P < 0.01$).

Conclusion: Aging, female gender and Angle II malocclusion were risk factors for the occurrence of TMD in the population.

Key words: temporomandibular disorders, orthodontics, risk factor

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Temporomandibular disorders (TMD) collectively embrace a group of clinical problems involving temporomandibular joint (TMJ) and masticatory muscles. TMD usually includes a wide variety of signs and symptoms, such as pain from TMJ or masticatory muscles, clicking or pain on mandibular movement and abnormal mandibular movement. Although TMD have been known by clinicians for a long time, the aetiology is still poorly understood and several related clinical problems are still pending.

The relationship between orthodontic treatment and the occurrence of TMD has long been of interest to the practicing orthodontists during the last two decades and still remains controversial¹. Although most studies supported the opinion that orthodontic treatment neither increases nor decreases the risk of the development of

TMD²⁻⁵, no consensus has been reached and potential detrimental effects still capture the attention of this community⁶. Further studies are still needed to elucidate the relationship between orthodontic treatment and TMD occurrence.

Better understanding of the epidemiology of TMD in the population before orthodontic treatment is of critical importance in resolving this complex problem. TMD occurring in children and adolescents were not rare, and several studies have reported positive association between the occurrence of TMD and age increase^{4,7-9}. Symptoms and signs of TMD that occur during or after orthodontic treatments may have a great possibility of being the manifestation of the natural course of TMD development.

The purpose of the present study was to investigate the prevalence and clinical characteristics of TMD in a Chinese population before orthodontic treatment and to determine whether there was a relationship between TMD occurrence and aging, gender or malocclusion type. This information will improve our understanding in the occurrence of TMD related to orthodontic treatment.

Materials and Methods

Subjects

Inclusion criteria: patients with malocclusions referring to the Orthodontic Department of Peking University School and Hospital of Stomatology from January 1998 to December 2003 were included.

Exclusion criteria: patients with a history of previous orthodontic treatment, facial trauma, jaw surgery or systemic diseases which could potentially involve TMJ were excluded.

A total of 9,909 subjects, 6,326 females and 3,583 males, were finally included in this study. The constituent ratios of females and males were 63.8% and 36.2% respectively. The subjects aged from 4 to 48 years old with a median age of 13. The 25, 75 and 90 percentiles of age in this population were 12 years, 18 years and 24 years respectively. The constituent ratios of patients with Angle I, II and III malocclusion were 55.1%, 28.6% and 16.3% respectively.

Clinical and radiological examinations

All subjects were examined by experienced and qualified orthodontists following a standardised procedure:

1. Documenting of the subjective symptoms of joint pain, sound, locking and positive history of TMD.

2. Joint sounds were investigated by digital palpation during opening, protrusion and lateral excursion of the mandible. Pain during the active movements was recorded. The maximum active mouth opening of at least 35 mm was considered as normal. Limitation, deviation and deflection during opening were documented. In addition, manual functional analyses of TMJ function were also performed during lateral and protrusive movements.
3. Imaging procedure included panoramic radiography, transcranial radiography and transpharyngeal radiography. Two experienced radiologists interpreted all the images. Subjects with one or more of the following radiological findings were considered as TMJ osteoarthritis: erosion, flattening, sclerosis, osteophyte and pseudocyst of the condyle, as well as sclerosis of articular eminence.

The diagnostic criteria proposed by Ma and Zhang in 1997, which have prevailed in China for more than 10 years, were adopted in this study^{10,11}. The criteria include muscle disorders, disc displacements, synovitis and/or capsulitis, and osteoarthritis.

Statistical analysis

In order to investigate the relationship between the prevalence of TMD and age, the subjects were classified into six groups according to age, which was in accordance with dentition development. The prevalence of TMD in various age groups was calculated and the potential relationship with aging was investigated by employing the method of linear-by-linear association chi-square analysis.

The sex difference and differences between various malocclusion groups were analysed by chi-square analysis. Multivariate logistic regression analysis was also performed to estimate the odds ratios and 95% confidence intervals of age, female gender and malocclusion types.

Statistical Package for the Social Sciences (version 11.5 for Windows) was used in data analysis.

Results

TMD prevalence and its relationship with gender, age and malocclusion classifications

Of the 9,909 patients with malocclusions prior to orthodontic treatment, 849 were diagnosed as TMD, according to the diagnostic criteria proposed by Ma and Zhang: 599 of the TMD patients were female and 250 were male. The prevalence of TMD was 8.6% in the whole population and was statistically higher in

Table 1 Association between the prevalence of TMD and gender in 9,909 subjects

	Total	TMD patients	TMD prevalence (%)
Males	3583	250	7.0
Females	6326	599	9.5
Total	9909	849	8.6

$\chi^2 = 18.125, P < 0.01.$

Table 2 Association between the prevalence of TMD and age in 9,909 subjects

Age group (years)	Males			Females			Total		
	Total	TMD patients	Prevalence (%)	Total	TMD patients	Prevalence (%)	Total	TMD patients	Prevalence (%)
<10	388	5	1.3	546	24	4.4	934	29	3.1
11–13	1,707	101	5.9	2,964	199	6.7	4,671	300	6.4
14–17	715	59	8.3	1,088	111	10.2	1,803	170	9.4
18–20	296	33	11.1	585	84	14.4	881	117	13.3
21–25	269	25	9.3	603	89	14.8	872	114	13.1
>25	208	27	13.0	540	92	17.0	748	119	15.9
Total	3,583	250	7.0	6,326	599	9.5	9,909	849	8.6

Table 3 Association between the prevalence of TMD and malocclusion types in 9,909 subjects

Malocclusion	Males			Females			Total		
	Total	TMD patients	Prevalence (%)	Total	TMD patients	Prevalence (%)	Total	TMD patients	Prevalence (%)
Angle I	1,925	121	6.3	3,533	290	8.2	5,458	411	7.5
Angle II	1,041	77	7.4	1,791	221	12.3	2,832	298	10.5
Angle III	617	52	8.4	1,002	88	8.8	1,619	140	8.6

females (9.5%) than in males (7.0%) ($\chi^2 = 18.125, P < 0.01$; Table 1).

The prevalence figures of TMD in various age groups are listed in Table 2. The chi-square test for linear trend showed the prevalence of TMD increased positively with age in females, males and total population (χ^2 values were 38.458, 111.737 and 157.503 respectively; $P < 0.01$; Table 2).

Female subjects with Angle II malocclusion showed higher prevalence than those with Angle I or III malocclusion (χ^2 values were 23.707 and 8.387 respectively;

$P < 0.01$; Table 3), while no significant difference was found among three malocclusion groups in males ($\chi^2 = 3.701, P > 0.05$; Table 3). The differences between patients with Angle I and III malocclusions were not significant either in females or in the whole population (χ^2 values were 0.337 and 3.343 respectively; $P > 0.05$; Table 3).

Multivariate logistic regression analysis showed that female gender, age increase and Angle II malocclusion could be considered as risk factors for TMD occurrence (Table 4). Females were 1.327 times more likely

Table 4 Multivariate logistic regression analysis of risk factors for TMD occurrence

	OR	95% confidence interval	P value
Female (versus male)	1.327	1.136–1.550	0.000
Age	1.325	1.265–1.387	0.000
Angle I malocclusion	Reference		
Angle II malocclusion	1.445	1.234–1.693	0.000
Angle III malocclusion	1.311	1.070–1.606	0.01

Table 5 The prevalence of related clinical signs in 9,909 subjects

Age group (years)	Total	Click		Pain		Abnormal mandibular movement	
		No.	Prevalence (%)	No.	Prevalence (%)	No.	Prevalence (%)
<10	934	16	1.7	5	0.5	15	1.6
11–13	4,671	183	3.9	64	1.4	152	3.3
14–17	1,803	113	6.3	29	1.6	76	4.2
18–20	881	86	9.8	19	2.2	45	5.1
21–25	872	83	9.5	16	1.8	38	4.4
>25	748	84	11.2	20	2.7	46	5.7
Total	9,909	565	5.7	153	1.5	369	3.7

to suffer TMD than males (odds ratio [OR] = 1.327, $P < 0.01$). The prevalence increased positively with age (OR = 1.325, $P < 0.01$). Patients with Angle II malocclusion were 1.445 times more likely to suffer TMD than those with Angle I malocclusion (OR = 1.445, $P < 0.01$), while no statistical difference was found between patients with Angle I and III malocclusion (OR = 1.311, $P = 0.01$).

The prevalence of clinical signs related to TMD

The prevalence of click, pain and abnormal jaw movement (including deviation, lock and limited mouth opening) were 5.7%, 1.5% and 3.7% respectively and increased positively with age (χ^2 values were 142.790, 13.486 and 24.586 respectively; P values were all below 0.01; Table 5).

TMJ osteoarthritis was detected in 159 subjects; the prevalence was 1.6%.

Discussion

The prevalence of TMD in children and the adolescent population has been reported previously and varied considerably depending on the sample selected, the criteria used to define TMD and the type of study conducted. The prevalence of TMD reportedly ranges from 12.2 to 74% in the literature^{9,12–17}, mostly around 20%^{9,12,14,15}. Irrespective of this variation, it can still be concluded that TMD are common in children and adolescents. Furthermore, some studies reported evidence supporting the positive association between TMD occurrence and aging¹⁸. Some children and adolescents may encounter TMD-associated problems that may last for several years during or after orthodontic treatment. From this perspective, symptoms and signs of TMD occurring during or after orthodontic treatment must be scrutinised individually and the presumed cause-and-effect relationship must be questioned.

In the present study, TMD occurrence rate was 8.6% and lower than the prevalence from other studies^{9,12-17}. Several contributing factors might account for this variation of the prevalence. Owing to the retrospective methodology adopted in the present study, information bias could not be avoided in the data collection. At the same time, the subjects recruited in the present study were ready to accept orthodontic treatment and were characterized by a relatively young age. The characteristics of TMD prevalence might exhibit some variations in this population. Although not a strictly collected epidemiologic sample, the subjects were considered to constitute a reasonably good body for the study because of the relatively large sample size.

The results of the present study indicate that the prevalence of TMD is low in children but increases positively with aging from adolescence into young adulthood, which coincides with the results of previous studies^{4,7,9,18-21}. In the investigation of TMD in 3,105 Chinese children and adolescents, Deng concluded that the prevalence of TMD was higher in the mixed and early permanent dentition groups than in the primary and permanent dentition. Higher frequencies of occlusal interference and occlusal instability in the mixed dentition have been found to be associated with functional disturbances¹². Longitudinal studies have also found that TMD signs and symptoms often fluctuate with time in adulthood and may be self-limited in the long term^{4,20,22}. It is generally considered that symptoms and signs of TMD increase during adolescence but remain at a stable prevalence level in adulthood. So TMD occurring during orthodontic treatment in adolescents cannot simply be ascribed to the treatment itself. The natural course of this disease should be fully emphasized in the investigation of potential effect that orthodontic treatments may exert on TMJ function.

Recent epidemiologic studies have generally found significant female gender predilection in TMD prevalence^{7,15,17,19,20,23-28}. The results of the present study also found that females were more likely to suffer TMD than males. Because the subjects in this study were selected from an orthodontic department rather than from a TMD clinic, this sex predilection cannot be explained in the way that females are more likely to seek treatment for TMD. The sex difference was reportedly to be more significant in permanent dentition or in adulthood and cannot be observed in all age groups^{9,29}; in particular, it is not prominent in children. The prominent sex predilection in adulthood might be due to factors such as physiological and anatomical differences, behavioural differences, hormonal and psy-

chological differences, whereas these sex differences are not significant in children.

The most frequent clinical sign of TMD was joint click, which could occur in children. Previous epidemiological studies showed that the prevalence of click significantly increased from primary to permanent dentition stage in children and adolescents, but remained fairly constant in adulthood^{4,9,20,21}. This investigative result was also supported by the present study, in which the prevalence of pain and abnormal jaw movement was relatively low compared with clicking. Severe functional disturbances, such as locking and mouth opening limitation, were extremely rare. These findings indicated that TMD was relatively mild in children and adolescents; severe symptoms and clinical signs of TMD were rare. These findings were also in line with the results of previous epidemiological studies which showed that TMD was self-limiting in its natural course of development, and progression into severe pain and dysfunction was rare²⁰.

The aetiological importance of occlusal factor in the development of TMD has been a topic of great controversy for a long time. It has been indicated by many previous studies that, in general, occlusal factors are of limited aetiological importance for pain and dysfunction of the masticatory system³⁰. Although certain morphological malocclusion types were reported to be closely associated with TMD, definite epidemiological evidence is still needed. Angle II malocclusion, open bite, deep overbite, long centric more than 4 mm, unilateral crossbite and the missing of more than five molars have been reported to have potential harm on TMJ function^{4,13,20,31-34}. It has been demonstrated that there is a higher risk for patients with Angle II malocclusion developing into TMD in the present study. Multivariate logistic regression analysis was used to control the confounding factor of gender, and Angle II malocclusion was finally proved to be a risk factor for TMD development. Although it is impossible, on an individual basis, to predict the risk of TMD based on the presence of the malocclusion, the group of patients with Angle II malocclusion had more TMD-related signs and symptoms than normal controls³. This association might be partly explained in the way that patients with distal molar relationship are more prone to be accompanied by mandibular developmental deficiency and deep overbite or overjet, so a relatively larger dimensional range is needed during mandibular functional movements.

In conclusion, aging, female gender and Angle II malocclusion could be regarded as risk factors for the occurrence of TMD. The frequency of TMD-related

clinical signs increased positively with age from adolescence to young adulthood. Females and patients with Angle II malocclusion were more likely to suffer TMD.

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