An orthodontic study of temporomandibular joint disorders Part 1: Epidemiological research in Japanese 6-18 year olds

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In recent years, an increasing number of patients have complained of temporomandibular joint disorders (TMD).[1,2] In an attempt to identify the causes of TMD, the type of occlusion in children with TMD symptoms was recorded.

There have been a number of epidemiologic investigations of children with TMD symptoms[3-20] (Table 1). Since approaches and methodologies differ, the prevalence varies in these studies from 10% to 80%. Interpreting these findings requires careful consideration of the peculiarities of each investigation.[6,21]

Materials and methods

This study included 7337 children (Table 2): 3219 boys and 4118 girls from four elementary schools, four junior high schools and three high schools in Chiba and Tokyo, Japan. The data was collected from April 1986 through June 1986 by oral examination during regularly held physical examinations.

First we taught the subjects to locate their TM joint, then we asked them about past or recent TMJ sound, pain or abnormal jaw movements. Then, while palpating the TMJ, we had the subjects open and close their mouth several times to confirm the

Abstract

Malocclusion is considered one of the etiological factors of temporomandibular joint disorder (TMD). The purpose of this study was to investigate the prevalence of TMD and the relationship between TMD and the type of occlusion. The sample consisted of 7337 Japanese children, 6-18 years old, 3219 boys and 4118 girls. TMD symptoms were recorded as well as the type of occlusion in children with TMD.

The prevalence of TMD overall was 12.2%. The prevalence increased with age and was slightly higher in girls (13%) than in boys 11.1%. This difference was not statistically significant. Joint sound as the only symptom was more common in younger subjects. TMD symptoms seemed more complicated with age when pain and abnormal jaw movement combined with sound. Joint sound was the most common symptom (89.3%), followed by the combination of sound and pain (2.2%). The incidence of other symptoms was under 1%. In subjects with TMD, 24.9% exhibited crowding, 20.1% had excessive overjet, 6.8% deep bite, 6.3% edge-to-edge bite, 5.6% anterior crossbite, 5.4% open bite, and 3.8% posterior crossbite. Morphologically normal occlusion was observed in 27.1%. In this study, many subjects with TMD had malocclusions. Early treatment may be important in the prevention of severe TMD. Although those with morphologicallly normal occlusions were included, a more detailed study concerning other causes of TMD is needed also.

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Key Words

Malocclusion • Temporomandibular joint disorder • Epidemiological research

Table 1
Epidemiological and clnical studies on children with TMD

Researcher	Number of Subjects	Male:Female	Age	Prevalence symptom /sign	
Geering-Gaerney & Rakosi (71)	241	–	8-14	–	41%
Agerberg& Carlsson (72)	1106	531:575	15-74	57%	–
Ingerval & Hedegard (74)	287	287:	18-20	12%	–
Helkimo (74)	321	156:165	15-65	57%	88%
Siebert(75)	98	–	12-16	–	80%
Molin et al (76)	253	253:	18-25	12%	28%
Dibbets (77)	112	49:63	8-17	–	46%
Grosfeld &	250	114-136	6-8	–	56%
Czarnecka (77)	250	117:133	13-15	–	68%
W-Markowerowa	2100		10-15	–	40%+Brux
et al (77)					27%+Brux
Williamson (77)	304	129:175	6-16	–	35%
Helkimo et al (79)	58	0:58	18-28	45%	60%
E-Eriksson	136	62:74	7	16%	33%
et al (81)	131	70:61	11	17%	46%
	135	76:59	15	25%	61%
Magnusson,	119	59:61	11	62%	(11%mod.)
E-Eriksson, et al. (85)			15	66%	(17%mod.)
Ogura, et al (85)	2198	1095:1103	10-18	9.8%	
Ishibashi,et al. (85)	1113	561:466	12-17	30.7%	
Grosfeld,	400	197:203	15-18	–	68.25%
et al (85)	400	208:192	19-22	–	67%
Brandt (85)	1342	673:669	6-17	10.74%	
Nilner (86)	440	222:218	7-14	36%	39%
	309	147:162	15-18	41%	34%
Bernal (86)	149	79:70	3-5		21.1%
Wanman, et al (86)	285	146:139	17	62%	
Szentpetery (87)	85	56:29	11-20	16.5%	67.1%
Motegi, et al (88)	7337	3219:4118	6-18	12.2%	

Table 2
Number of Subjects

Grade		Age	Male	Female	Total
E	1	6	198	197	395
	2	7	207	209	416
	3	8	222	201	423
	4	9	224	226	450
	5	10	239	258	497
	6	11	289	265	554
J	1	12	397	395	792
	2	13	374	370	744
	3	14	375	330	705
H	1	15	217	544	761
	2	16	215	542	757
	3	17	262	582	846
E Total			1379	1356	2735
J Total			1146	1092	2238
H Total			694	1670	2346
Total			3219	4118	7337

Table 3
Prevalence of TMD by age and sex

Grade		Age	Male		Female		Total	
			Number	%	Number	%	Number	%
E	1	6	5	2.5	11	5.6	16	4.1
	2	7	7	3.4	11	5.3	18	4.3
	3	8	15	6.8	14	7.0	29	6.9
	4	9	9	4.0	10	4.4	19	4.2
	5	10	16	6.7	21	8.1	37	7.4
	6	11	15	5.2	22	8.3	37	6.7
J	1	12	51	12.9	48	12.2	99	12.5
	2	13	59	15.8	41	11.2	100	13.5
	3	14	58	15.5	68	20.6	126	17.9
H	1	15	41	18.9	94	17.3	135	17.7
	2	16	35	16.3	93	17.2	128	16.9
	3	17	46	17.6	103	17.6	149	17.6
E Total			67	4.9	89	6.6	156	5.7
J Total			168	14.7	157	14.4	325	14.5
H Total			122	17.6	290	17.4	412	17.4
Total			357	11.1	536	13.0	893	12.2

findings derived by questioning the subjects. Finally, we observed and classified the occlusions of those with TMD and asked whether or not they had received orthodontic or any other treatment for TMD.

Classification of symptoms

Sound: clicking or crepitus

Pain: pain that occurs from opening and closing the mouth, pain from chewing food and any pain in the TMJ

Abnormal jaw movement: less than two fingers of childrens' own in the open mouth, and difficulty opening and closing the mouth.

Classification of occlusion

Excessive overjet: overjet exceeding 5 mm

Anterior crossbite: at least 4 anterior teeth in crossbite

Edge-to-edge bite: both overbite and overjet 0mm

Crowding: severe crowding with normal relationship of the maxilla to the mandible

Open bite: negative overbite

Deep bite: overbite exceeding 5mm with small overjet

Posterior crossbite: molar teeth that exhibit crossbite

Morphologically normal occlusion: no abnormality in tooth alignment.

Using these standards, the research was conducted by four dentists known to the authors.

Results

The prevalence of TMD symptoms for all ages was 12.2%. The elementary school level was 5.7%, the junior high school level was 14.5% and the high school level was 17.4% (Table 3). These findings show a gradual increase in prevalence with age. School grade differences were significant respectively at the 1% level according to Chi-square analysis.

The prevalence of TMD symptoms was 11.0% for boys and 13.0% for girls. However, the sex difference was not significant at the 1% level according to the Chi-square analysis.

We used seven categories of symptoms: sound, pain, abnormal jaw movement and four combinations of these three. The most common symptom at the elementary school level was sound. The number of children with sound as a symptom increased at the junior high and high school levels. Combined problems started appearing at the junior high and high school levels. (Table 4)

The most common symptom was sound (97.2%), followed by pain (10.2%) and abnormal jaw movement (0.9%) (Table 5). Sound alone accounted for 89.3% of the symptoms, the combination of sound and pain accounted for 7.6%, pain alone 2.2% and other symptoms less than 1.00%.

There was a high percentage of TMD in cases of crowding and excessive overjet and the prevalence of each increased with age (Table 6). Morphologically normal occlusion peaked around the transition period from elementary school to junior high school. Anterior crossbite, edge-to-edge bite, open bite, deep bite and posterior crossbite exhibited a very small prevalence of symptoms and showed little increase with age.

E: Elementary school
J: Junior high school
H: High school

E: Elementary school
J: Junior high school
H: High school

S: Sound
P: Pain
A: Abnormal jaw movement

Table 4
Age difference by symptom

Grade	Age	S	S+P	P	S+A	S+P+A	A	P+A	Total
E 1	6	3.8	0.3	0	0	0	0	0	4.1
2	7	4.1	0	0.2	0	0	0	0	4.3
3	8	6.6	0	0.3	0	0	0	0	6.9
4	9	4.2	0	0	0	0	0	0	4.2
5	10	7.0	0	0.4	0	0	0	0	7.4
6	11	6.7	0	0	0	0	0	0	6.7
J 1	12	10.2	1.8	0.4	0	0.1	0	0	12.5
2	13	12.0	0.7	0.4	0.1	0.1	0.1	0	13.5
3	14	15.5	1.6	0.6	0.1	0.1	0	0	17.9
H 1	15	16.3	0.9	0.4	0	0	0.1	0	17.7
2	16	15.2	1.5	0.1	0	0	0	0.1	16.9
3	17	15.0	2.3	0.2	0.1	0	0	0	17.6
Total		10.8	0.9	0.3	0.1	0.1	0.0	0.0	12.2

Table 5
Percentage of each symptom

Symptoms	Number	%
S	796	89.3
S+P	68	7.6
P	20	2.2
S+A	3	0.3
S+P+A	3	0.3
A	2	0.2
P+A	1	0.1
Total	893	100.0

The percentages of various types of occlusion among those with TMD were as follows: crowding, 24.9%; excessive overjet, 20.1%; deep bite, 6.8%; edge-to-edge bite, 6.3%; anterior crossbite, 5.6%; open bite, 5.4%; posterior crossbite, 3.8% and morphologically normal occlusion, 27.1%.

Twelve children had received some kind of treatment for TMD. None were elementary school students, 0.6% were junior high and 2.4% were high school students. Five children had received orthodontic treatment.

Discussion

In general, our questions to the children regarding TMD were not usually well understood if they had never recognized such problems before. For this reason, we had them locate their TMJ by lightly touching the front area of their tragus. We then asked whether or not they had a current and/or past history in regard to TMD. Through palpation we further confirmed the findings gathered from the questions. Differentiating joint pain, toothache and earache seemed very difficult.

Some dentists insist on the importance of auscultation with a stethoscope, but we believe palpation provides a more reliable method for recognizing TMJ sound. There is a difficulty in examination in such a noisy classroom using a stethoscope. The standard method should be simple and reproducible in epidemiological research of this type.[6]

As mentioned above, the occlusal condition of those with TMD was examined. Only a few of the subjects were aware of symptoms. Some children said they had created sound or purposely dislocated their jaws for fun, and were simply unaware of having a temporomandibular disorder.

The examination was based on three main symptoms in order to simplify the classification. The categories selected included the identification of a single symptom and combined symptoms[16,17] in order to make the analysis of the level of severity less complicated.

The classification of occlusion should include any abnormality of upper and lower, left and right, anterior and posterior parts.

The prevalence of TMD in Japan is rather low compared with other countries. Each researcher samples different populations: e.g. elderly subjects or orthodontic patients. There is also a difference in information gained through questionnaires which

N: Morphologically normal occlusion
C: Crowding
EJ: Excessive overjet
D: Deep bite
EE: Edge-to-edge bite
A: Anterior crossbite
O: Open bite
PC: Posterior crossbite

Table 6
Age difference in the prevalence of TMD symptoms

Grade	Age	N	C	EJ	D	EE	A O	P	Total	(%)
E 1	6	1.3	0.3	0	0	0	1.0	1.5	0	4.1
2	7	1.2	0.7	0.5	0.5	0.2	0.7	0.5	0	4.3
3	8	2.4	1.2	1.4	0.5	0.2	0.5	0.5	0.2	6.9
4	9	0.7	0.6	1.3	0.2	0.2	0.7	0.2	0.2	4.2
5	10	2.0	1.2	2.4	0.4	0.2	0.6	0.2	0.4	7.4
6.	11	1.1	2.5	2.3	0.2	0.2	0.4	0	0	6.7
J 1	12	4.9	3.0	1.5	1.8	0.4	0.8	0	0.3	12.5
2	13	6.0	2.3	1.7	0.9	0.8	0.1	0.9	0.4	13.5
3	14	6.5	3.6	2.8	1.6	1.0	0.9	0.7	0.9	17.9
H 1	15	3.7	4.8	3.8	0.9	2.0	0.7	1.1	0.9	17.7
2	16	2.6	4.6	3.8	1.2	1.8	1.3	0.8	0.7	16.9
3	17	3.0	6.4	4.5	0.5	0.7	0.6	1.2	0.8	17.6
Total		3.3	3.0	2.5	0.8	0.8	0.7	0.7	0.5	12.2

depend only on people's perceptions, and information gained by doctors, especially in children who may not be aware of their condition.

This study showed an increasing trend in TMD with age similar to the Scammon's mandibular growth curve. From this finding, we believe it is important to prevent TMD at an early age.

Although several clinical studies[22-26] have shown more women have TMD than men, our research found no differences by sex. Other epidemiological reports[16,17,27] have also shown no difference between the sexes. We believe the sex difference could be due to the increased frequency of medical visits by women.

Sound was the main symptom identified at the elementary school level. After the first year of junior high school, the increase in sound was significant. The prevalence of other symptoms was very low, but definitely showed a tendency to increase. Also, combinations of symptoms increased with age. These findings indicate the need for diagnosis and treatment at an early age.[1]

Only 12 children had seen doctors to complain of TMD as their main reason to visit (0.1% of the whole). Of those 12 children, 10 had sound and pain, one had pain alone and one had abnormal jaw movement as the main complaint for the visit; none of them went to see a doctor because of sound alone. Although the numbers are small, it appears that people do not see a doctor for sound unless it is accompanied by pain and/or abnormal jaw movement.[22]

The incidence of excessive overjet and crowding increased with age. With excessive overjet, people create a habit of protruding the mandible.[28] This tends to cause a dual bite[29,30] which could, over time, aggravate the muscles of mastication and muscle tension and load the TM joints. Crowding tends to cause occlusal interferences and seems to be a critical factor in TMD.[11-14]

Anterior crossbite, skeletal especially, is less likely to interfere with occlusion during chewing.[31,32] If it creates an occlusal interference, it seems to occur most commonly with the anterior teeth and hardly seems to affect the TMJ or nearby muscles.[31] However, Mukaizawa reported that patients with an anterior crossbite are most likely to develop the symptoms of TMD at an early age. This finding demands further research.

Table 7
Prevalence by type of occlusion

Type of occlusion	Number	%
Morphologically normal occlusion	242	27.1
Crowding	222	24.9
Excessive overjet	180	20.1
Deep bite	61	6.8
Edge-to-edge bite	56	6.3
Anterior crossbite	50	5.6
Open bite	48	5.4
Posterior crossbite	34	3.8
Total	893	100.0

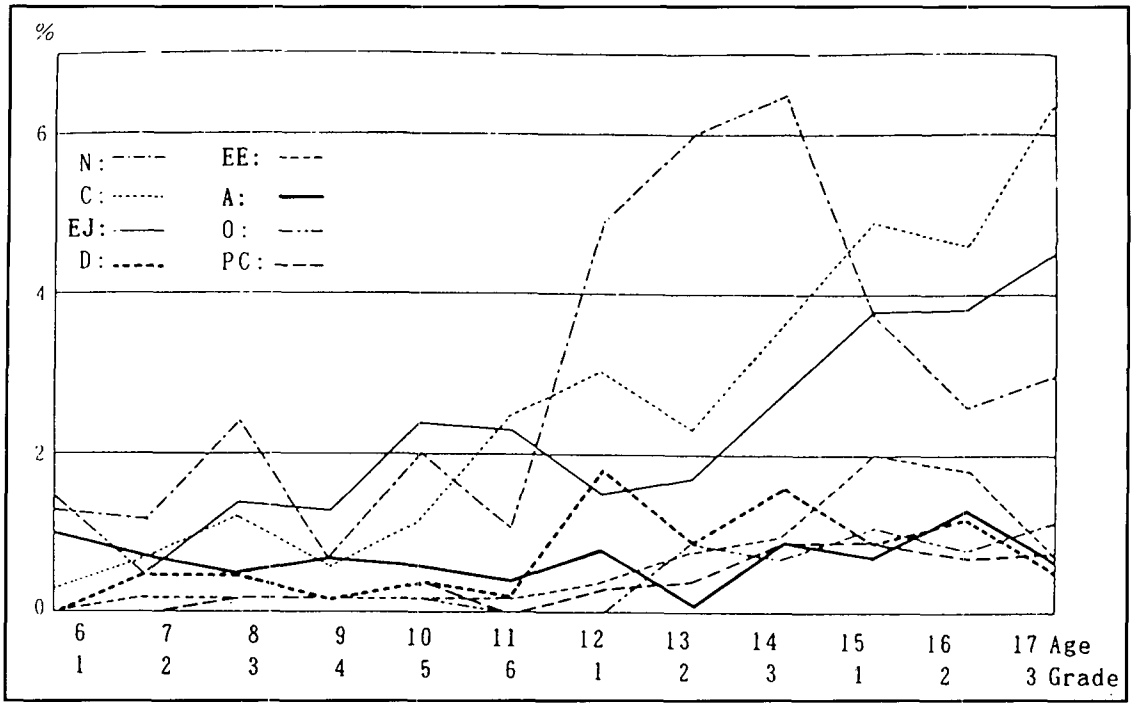

Figure 1
Age difference in the prevalence of the TMD by occlusion N: Morphologically normal occlusion C: Crowding EJ: Excesive overjet D: Deep bite EE: Edge-to-edge bite AA: Anterior crossbite O: Open bite PC: Posterior crossbite

An edge-to-edge bite has little interference and a relatively low prevalence in TMD. From this we can hypothesize that TMD may be related to the longstanding presence of occlusal interferences.

The prevalences of open bite, posterior crossbite and deep bite were small and we found no significant increase in symptoms with age. However, from clinical experience, we think TMD may accompany open bite, which is an unstable mandibular position, deep bite, which tends to push the mandible posteriorly, and posterior crossbite, which forces the mandibular position either to the left or the right. The incidence of morphologically normal occlusion with TMD reaches its peak in the upper grade levels of elementary and junior high school. This is largely related to the drastic increase in the prevalence of TMD at this age. The increase may be attributed to stress, such as from entrance examinations, or inflammation caused by the eruption of second molars.

Nilner[11-14] reported that the percentage of children with deep bite is high, while Mineno[33] noted that excessive overjet and crowding are common among TMD patients. Williamson[34] reported Angle Class I and Class II relationships were the most common occlusal types. Our findings by occlusal type show morphologically normal occlusion, crowding and excessive overjet to be most frequent with others making up a relatively small percentage.

Some reports[2,29,30] on malocclusion are from a functional point of view. Likewise, each malocclusion should be classified based on function. The fact that a large percentage of children have a morphologically normal occlusion indicates that an abnormal a-p relationship or malalignment is not always a major cause of TMD; other problems such as occlusal interference, abnormality in function and formation of the TMJ, trauma, parafunction, and habitual unilateral chewing, which are not all classified under the type of occlusion, could be causes of TMD.

Of the 12 children who had received treatment for

their TMD, six had first visited orthopedic surgeons, five had visited dentists, and one had seen a chiropractor. This suggests that dentists could become more widely recognized as providers of TMD treatment. We believe people need to be educated about this.[21,35]

Of those who had TMD, only five had received orthodontic treatment; therefore, the study of Part 2 will follow this.

Conclusions

The incidence of TMD increases with age in children and adolescents and its symptoms tend to become more complex with age. Most children with TMD have an abnormal occlusion, indicating a need for further and more detailed investigation into the pathogenesis of TMD.

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