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Temporomandibular dysfunction in 1,516 patients before and after orthognathic surgery

Functional disturbances, together with esthetic considerations, are important reasons for patients to seek orthognathic surgical treatment. Functional disorders may include signs and symptoms of temporomandibular disorders (TMD), such as joint pain, chewing problems, joint noises, headaches, etc. This paper reports on TMD before and after orthognathic surgery in 1,516 patients. It is based upon the patients' own evaluations as recorded 2 years after surgery. Preoperatively 43% and postoperatively 28% of the patients reported subjective symptoms of TMD. This difference indicates an overall beneficial effect of orthognathic surgery on TMD signs and symptoms. Patients with mandibular retrognathia did not improve as much as patients with mandibular prognathia. Sagittal ramus osteotomy was less effective than vertical ramus osteotomy in relieving TMD symptoms when performed on similar diagnoses. (Int J Adult Orthod Orthognath Surg 2001;16:145–151)

Temporomandibular disorders (TMD) include a variety of symptoms in the face, jaws, and temporomandibular joints (TMJs). Symptoms of TMD include chronic pain, intermittent pain, joint sounds, and grinding of teeth. Attempts have been made to screen TMD in general populations. Often, researchers have tried to evaluate both the prevalence and severity of such disturbances.[1–6]

Helkimo[1] described TMD in a group of 321 individuals aged 15 to 65 years. He reported that 57% of the individuals described some sort of TMD, and 26% of the individuals were rated as having relatively severe symptoms, such as jaw-related pain. Clinically, Helkimo found signs of TMD among 88% of the examined individuals, 25% of which were moderate and 22% of which were severe. Restricted jaw opening was found in 8% of subjects. Helkimo reported no gender differences but found that younger individuals had fewer symptoms of TMD than older individuals. Findings similar to those of Helkimo were made by Hansson and Nilner,[2] who examined 1,069 persons employed at a Swedish shipyard. The authors reported that 71% of their subjects had some symptoms, and 30% had rather severe symptoms of TMD. Restricted jaw opening was found in 6% of the individuals. Agerberg and Carlsson[3] reported on research based on a questionnaire answered by 1,215 persons aged 15 to 74. In their study, 57% of the individuals mentioned some symptom of TMD, and 30% were aware of 2 or more symptoms. No major gender differences were reported. Österberg and Carlsson[4] examined signs and symptoms of TMD in a geriatric population of 384. All individuals in the study were age 70, and 59% of them reported subjective symptoms of TMD. Objectively, 86% demonstrated some sign of TMD, and 32% of those were rated as rather severe.

Most studies of TMD have examined adults, but Egermark-Eriksson et al[5] studied 402 young individuals, aged 7, 11, and 15, respectively. Subjectively, 16% to 25% of the children reported TMD, a percentage that increased with age. Objectively, TMD

was observed in 30% to 60% of the subjects, also increasing with age. Wännman and Agerberg[6] published a longitudinal study following 258 adolescents from age 17 through age 19. The prevalence of TMD was 20% each year. Most symptoms were of mild character, and only 6% of subjects had constant symptoms. Female individuals had TMD more often than their male counterparts.

Occlusal instability/discrepancy is mentioned as one of several etiologic factors behind TMD.[7] Such suboptimal occlusion, based on skeletal divergence, is also an apparent reason to seek or carry out orthognathic surgery.[8] Thus, one would assume that TMD would be rather pronounced among orthognathic surgery patients, and that TMD in such patient groups would decrease after orthognathic surgery.

White and Dolwick[9] reported results from 75 orthognathic surgery patients. Preoperatively, 49% of the patients had suffered from TMD. Of those, 89% improved after orthognathic surgery, 3% were unchanged, and 8% experienced worsened symptoms. Of the patients who were free of TMD prior to surgery, 8% developed such symptoms after orthognathic surgery. Temporomandibular disorders were more common among patients with mandibular retrognathism than among those with mandibular prognathism, but in both groups TMD symptoms were reduced after surgery. Similarily, Kerstens et al[10] reported TMD in 22% of patients with mandibular retrognathism versus 12% of patients with mandibular prognathism. After orthognathic surgery, 66% of the preoperatively symptomatic patients had fewer or no symptoms, including 80% of the patients with TMD related to mandibular retrognathism. In Kerstens et al's material, 12% of the preoperatively asymptomatic patients developed TMD postoperatively. De Clerc et al[11] studied 196 orthognathic surgery patients, of whom 27% reported preoperative TMD. Of these, 65% improved after surgery. In that study, 33% of preoperatively symptom-free patients developed TMD after orthognathic surgery. Recently, Panula et al[12] published a prospective study in which 73% of the patients had signs of TMD before orthognathic surgery. After treatment, 60% had some signs of TMD. The most obvious treatment effect was seen on headache, which was reduced from 63% of the patients preoperatively to only 25% of patients at the final checkup.

The aim of the present study was to evaluate preoperative and postoperative TMD among patients treated with orthognathic surgery.

Material and methods

The study is based on findings from 1,516 patients who underwent orthognathic surgery at the department of Maxillofacial Surgery at Karolinska Hospital, Stockholm, from the mid-1980s through 1996. They represent 97% of those treated during the time period mentioned.

At their final checkup, 2 years after surgery, the patients filled out a questionnaire including, but not limited to, questions about TMD. With respect to TMD, the patients were asked, in separate questions for pre- and postoperative situations, if they had been or were currently aware of any TMD symptoms. If so, the patients were asked to mark one or several of the alternatives, which were joint pain, chewing pain, joint noises, grinding and gnashing of teeth, headaches, and morning headaches.

Data from the questionnaires were coded for statistical analysis, and statistical calculations using chi-square analyses were performed with the SOLO statistical system (Biomedical Data Package Statistical Software). Statistical significance was determined as P values below .05.

Three experienced maxillofacial surgeons performed the vast majority of the surgical procedures. Over the years, vertical ramus osteotomy (VRO) was utilized for most mandibular setbacks, although sagittal ramus osteotomy (SRO) for mandibular setback became relatively common during the second half of the time period covered by the study. In connection with VRO, no osteosynthesis was performed. The time with maxillomandibular fixation (MMF) after VRO was shortened, from up to 8 weeks in the early phase down to about 5 weeks toward the end of the study period. Likewise, as SRO went from wire to screw

Table 1 Distribution of various symptoms of TMD in the whole patient material, in male and female patients, and in younger and older halves of the population*

	Whole population (n = 1516)				Male (n = 558)				Female (n = 958)				Young (≤ 21 years) (n = 773)				Old (> 21 years) (n = 743)			
	Preop		Postop		Preop		Postop		Preop		Postop		Preop		Postop		Preop		Postop	
Symptom	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
No TMD	865	57	1084	72	379	68	430	77	486	51	653	68	493	64	536	69	421	57	548	74
Joint pain	173	11	95	6	41	7	20	4	132	14	75	8	58	8	46	6	122	16	49	7
Chewing pain	129	9	57	4	32	6	12	2	97	10	45	5	54	7	37	5	84	11	20	3
Joint noise	366	24	301	20	108	19	93	17	259	27	208	22	162	21	175	23	216	23	126	17
Grinding	80	5	28	2	18	3	9	2	62	7	19	2	20	3	12	2	63	8	16	2
Headache	151	10	40	3	30	5	10	2	124	13	30	3	61	8	18	2	103	14	22	3
Morning headache	72	5	24	2	13	2	5	1	58	6	19	2	27	3	12	2	48	6	12	2

*Note that patients may have marked several alternatives, so the sum of the columns may not match the number of patients in each column.

fixation, MMF was no longer used or was replaced by a shorter period on maxillomandibular training elastics.

Some patients may have had several diagnoses, but in this study they were grouped according to their mandibular diagnosis.

The clinical examination at the 2-year checkup included evaluation of occlusion and jaw-opening capacity. Jaw opening was considered normal if the patient could open a distance of more than 3 fingers between the incisors, almost normal for an opening between 2 and 3 fingers, reduced if the opening capacity was between 1 and 2 fingers, and severely reduced for anything less than that. The occlusion was considered normal if it fulfilled established criteria for normal occlusion. Occlusal interferences and horizontal, vertical, or transverse relapses resulted in lower scores set by the examiner, usually the surgeon.

Results

The 1,516 patients in this study consisted of 958 female (63%) and 558 male (37%) individuals. The mean age at the time of surgery was 26 years, and the median age was 21 years.

Detailed information on the results can be seen in Tables 1 to 3. Prior to surgery, 651 of the 1,516 patients (43%) reported subjective symptoms of TMD, ie, 1 or more of the following: joint clicking (n = 366; 24%), TMJ pain (n = 173; 11%), and recurrent headaches (n = 151 10%) (Table 1). Postoperatively, the whole patient population improved with respect to TMD symptoms. Thus, at the final checkup only 432 of the patients (28%) reported subjective symptoms of TMD. This change was statistically significant ($P < .0001$). While preoperatively, 15% of the patients had more than 1 symptom of TMD prior to surgery, only 6% reported such a situation 2 years after surgery.

With respect to age, 36% of the patients who were 21 years or younger reported preoperative TMD, compared with 43% of those in the older half. This difference between the age groups was statistically significant ($P < .01$). Postoperatively, 31% of the younger half reported subjective symptoms of TMD, compared with 26% of the older patients, a difference that was no longer significant ($P = .06$).

Prior to surgery, 32% of the male patients and 49% of the female patients reported symptoms of TMD. This difference was significant ($P < .001$) and persisted postoperatively, when 23% of the male population and 32% of the female population had subjective symptoms of TMD (Table 1).

Of the major mandibular malocclusion diagnoses in this population, 580 were mandibular prognathism, 526 were

Table 2 Distribution of various symptoms of TMD pre- and postoperatively related to various diagnoses

	Mandibular prognathism (n = 580)				Mandibular retrognathism (n = 526)				Anterior open bite (n = 396)				Mandibular laterognathism (n = 170)			
	Preop		Postop		Preop		Postop		Preop		Postop		Preop		Postop	
Symptom	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
No TMD	342	59	441	76	289	55	349	66	231	58	288	73	64	38	116	68
Joint pain	59	10	33	6	59	11	16	3	39	10	43	11	26	15	12	7
Chewing pain	49	8	20	3	46	9	11	2	28	7	27	7	17	10	9	5
Joint noise	130	22	97	17	133	25	77	15	106	27	125	32	68	40	35	21
Grinding	12	2	7	1	44	8	4	1	20	5	13	3	14	8	3	2
Headache	50	9	16	3	66	13	9	2	37	9	14	4	32	19	5	3
Morning headache	23	4	8	1	28	5	7	1	15	4	6	2	14	8	4	2

Table 3 Distribution of patients with and without TMD as related to type of fixation after sagittal ramus osteotomy

	Bicortical screw fixation (n = 380)				Miniplate osteosynthesis (n = 6)				Upper border wire fixation (n = 120)				Lower border wire fixation (n = 37)			
	Preop		Postop		Preop		Postop		Preop		Postop		Preop		Postop	
Condition of patient	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
No TMD	200	53	247	65	2	33	4	67	79	67	82	68	22	60	24	65
Various symptoms	176	47	133	35	4	67	2	33	40	33	38	32	15	40	13	35

mandibular retrognathism, 396 were anterior open bite, and 170 were mandibular laterognathism (Table 2). Of the patients with mandibular prognathism, 41% displayed preoperative TMD and 24% had postoperative TMD; those with mandibular retrognathism went from 45% preoperatively to 34% postoperatively; subjects with anterior open bite went from 42% preoperatively to 27% postoperatively; and patients with laterognathism went from 62% preoperatively to 32% postoperatively (Table 2). While joint noise and headache, for example, were relatively evenly distributed between patients with prognathism, retrognathism, and open bite, these symptoms were much more prevalent among patients with laterognathism (Table 2).

In both the VRO group and the SRO group, 44% of patients reported preoperative TMD. Postoperatively, however, only 22% of the VRO-treated patients experienced subjective symptoms of TMD, compared with 35% of those treated with SRO. While VRO was used only for mandibular setbacks and occasionally for mandibular rotations, SRO was used for both mandibular setbacks and advancements. The use of SRO for mandibular advancement resulted in a decrease in TMD from 45% to 34% of patients. The use of SRO for mandibular setback resulted in no improvement: 31% of patients reported TMD both before and after surgery. When VRO was used for mandibular setback, the TMD decreased from 42% to 22%.

Four types of osteosynthesis in SRO were used: upper border steel wire, lower border steel wire, miniplates, and bicortical screws. In these groups, TMD pre- and postoperatively were distributed as follows: upper border wire: from 33% to 32%; lower border wire: 40% to 35%; miniplate: 67% to 33%; and bicortical screws: 47% to 35% (Table 3). It should be observed that there were only 6 patients in the miniplate group.

Of the patients who were preoperatively free of TMD, 21% developed TMD after treatment. Of the preoperatively symptom-free prognathic patients, 17% developed some type of TMD, while 25% of those with symptom-free retrognathism developed symptoms. This difference was significant ($P = .04$).

Postoperatively, slightly fewer than 10% of the patients had a reduced or severely reduced jaw-opening capacity. Good postoperative jaw-opening capacity was correlated with low reports of TMD. Of those with the best opening capacity (3 fingers), 26% reported symptoms of TMD, compared with 45% of those who could only open over 1 to 2 fingers. This difference was significant ($P = .006$). Among patients with normal or fair occlusion postoperatively, 27% reported TMD, compared with 47% of those with poor occlusion ($P = .008$).

Discussion

This study supports the earlier findings of several authors.[9–15] The impact of that support rests to a large extent on the size of the patient material in this study and on the nearly intact cohort. In previous studies of general populations, TMD were reported in between 20% and 59% of the individuals studied.[1–6] About half of those were considered, on various grounds, to be more pronounced or severe TMD. This fits well with the results in this paper, where 43% of the patients reported preoperative TMD and 15% reported a more advanced symptomatology, expressed as more than one symptom of TMD. In general, the patients reported fewer TMD after orthognathic surgery than before. Also, the severity of TMD was reduced, expressed as fewer patients with 2 or more symptoms of TMD after orthognathic surgery. To some extent, this is probably a result of the improved occlusion following treatment.[7] When postoperative TMD was related to postoperative occlusion, there was a positive correlation between good occlusal condition and few signs of TMD.

With respect to age, we found more TMD with increasing age, which supports previous findings.[1,3,5,6] As in the report of Panula et al,[12] the older half of our patient population improved more than the younger half with respect to TMD. While the age-dependent difference in TMD prior to surgery was no longer significant after surgery, the gender difference in our material persisted after surgery. With respect to gender, the literature has been somewhat contradictory. Our finding that female patients reported more TMD than male patients did support Wännman and Agerberg.[6] On the other hand, Panula et al[12] found that their female patients improved more than their male patients, while in our patients we saw no significant difference in improvement related to gender.

In our study, mandibular retrognathia was followed by less favorable treatment results than was mandibular prognathia. While preoperatively, 41% of the prognathic and 42% of the retrognathic patients reported TMD, there was a large difference after treatment, when only 24% of those with previous prognathism reported TMD, compared with 34% of those with preoperative retrognathism. Several previous authors[9,10,15] have made similar observations, although they often also recorded less favorable conditions preoperatively among retrognathic patients than among prognathic patients.

In our material the majority of the patients with mandibular prognathism were treated with VRO, and all cases of mandibular retrognathism were treated with SRO. Thus, the differences in results between prognathic and retrognathic patients may depend not only on the diagnoses, but also on the treatment modalities. The VRO or similar procedures have been suggested to be useful in the treatment of TMD,[16] while some have seen SRO as a potential risk to produce TMD.[17] An SRO may dislocate the mandibular condyles as a result of the osteosynthesis used.[17] Such statements, though, have been based on the use of a lag screw technique, which compresses the bone fragments to each other. Among our patients with mandibular prognathism, a certain number were treated with SRO, but the majority were treated with VRO. When these prognathic patients were divided according to the surgical procedure performed, it was found that among those treated with VRO, TMD

was reduced from 42% to 22%, while among those treated with SRO, TMD was reported by 31% of patients both before and after treatment. We have no explanation as to why preoperatively TMD was relatively low among those who received SRO for mandibular setback.

In the whole group of patients operated on with SRO, no differences were observed with respect to the type of osteosynthesis used. All the screws used were position screws, which may be the reason why no increase in TMD was seen after screw osteosynthesis compared with, eg, wire osteosynthesis. As previously mentioned, the risk of forcing the condyle out of the fossa has been attributed to the use of lag screws. Such a technique compresses the lateral fragment to the medial, which is not the case when position screws are used.

Our finding that preoperatively symptom-free retrognathic patients developed TMD more often than did their prognathic counterparts supports several previous reports.[9,10] Again, this may be a result of both the diagnoses as much as the surgical procedure carried out. However, given the relative similarity between the preoperative conditions in the 2 diagnostic groups and the difference between VRO and SRO when performed on similar diagnoses, it seems likely that SRO might have a potential to create TMD under certain conditions.[13]

It should also be noted that SRO in this material was performed without the use of a condyle positioner. Such a device has been advocated to allow correct positioning of the condyle in the glenoid fossa during the osteosynthesis.[18] To our knowledge, though, no study has demonstrated a true effect of such positioning systems, expressed as reduced frequency of TMD. In fact, the remodeling capacity of the condyle and other joint structures has been suggested to overcome even relatively large joint dislocation.[19]

With respect to various diagnoses, we would like to emphasize the conditions reported by patients with laterognathia. As a group, these patients obviously had severe preoperative TMD and had very favorable outcomes. Similar observations also have been reported previously.[14]

In general, orthodontic/orthognathic surgical treatment seems to have a beneficial outcome for patients with respect to TMD. It should be stressed, though, that in all cases, such treatment does not result in freedom from TMD in patients with such disorders, and, in fact, in some patients TMD symptoms may actually develop after orthodontic/orthognathic surgical treatment, just as they can in any general population.

References

1. Helkimo M. Studies on function and dysfunction of the masticatory system. IV. Age and sex distribution of symptoms of dysfunction of the masticatory system in Lapps in the north of Finland. Acta Odontol Scand 1974;32:255–267.
2. Hansson T, Nilner M. A study of the occurrence of symptoms of diseases of the temporomandibular joint, masticatory musculature and related structures. J Oral Rehabil 1975;2:313–324.
3. Agerberg G, Carlsson GE. Functional disorders of the masticatory system. I. Distribution of symptoms according to age and sex as judged from investigation by questionnaire. Acta Odontol Scand 1972;30:597–613.
4. Österberg T, Carlsson GE. Symptoms and signs of mandibular dysfunction in 70-year-old men and women in Gothenburg, Sweden. Community Dent Oral Epidemiol 1979;7:315–321.
5. Egermark-Eriksson I, Carlsson GE, Ingervall B. Prevalence of mandibular dysfunction and orofacial parafunction in 7-, 11- and 15-year old Swedish children. Eur J Orthod 1981;3:163–172.
6. Wännman A, Agerberg G. Two year longitudinal study of signs of mandibular dysfunction in adolescents. Acta Odontol Scand 1986;44:333–342.
7. Magnusson T, Ahlborg G, Finne K, Nethander G, Svartz K. Changes in temporomandibular joint pain-dysfunction after surgical correction of dentofacial anomalies. Int J Oral Maxillofac Surg 1986;15:707–714.
8. Athanasiou AE, Melsen B, Eriksen J. Concerns, motivation, and experience of orthognathic surgery patients: A retrospective study of 152 patients. Int J Adult Orthod Orthognath Surg 1989;4:47–55.
9. White CS, Dolwick MF. Prevalence and variance of temporomandibular dysfunction in orthognathic surgery patients. Int J Adult Orthod Orthognath Surg 1992;7:7–14.
10. Kerstens HCJ, Tuinzing DB, van der Kwast WAM. Temporomandibular joint symptoms in orthognathic surgery. J Craniomaxillofac Surg 1989;17:215–218.
11. De Clerc CAS, Abeloos JSV, Mommaerts MY, Neyt LF. Temporomandibular joint symptoms in an orthognathic surgery population. J Craniomaxillofac Surg 1995;23:195–199.
12. Panula K, Somppi M, Finne K, Oikarinen K. Effects of orthognathic surgey on temporomandibular joint dysfunction. A controlled prospective 4-year follow-up study. Int J Oral Maxillofac Surg 2000;29:183–187.

13. Hu J, Wang D, Zou S. Effects of mandibular setback on the temporomandibular joint: A comparison of oblique and sagittal split ramus osteotomy. J Oral Maxillofac Surg 2000;58:375–380.
14. Kobayashi T, Honma K, Izumi K, Hayashi T, Shingaki S, Nakajima T. Temporomandibular joint symptoms and disc displacement in patients with mandibular prognathism. Br J Oral Maxillofac Surg 1999;37:455–458.
15. Thomas PM, Tucker MR. Complex orthodontic problems: The orthognathic patient with temporomandibular disorders. Semin Orthod 1999;5:244–256.
16. Tasanen A, Jokinen J. Closed condylotomy in the treatment of osteoarthritis of the temporomandibular joint. Clinical and radiographic study. Int J Oral Surg 1981;10:230–235.
17. Foley WL, Frost DE, Paulin WB Jr, Tucker MR. Internal screw fixation: Comparison of placement pattern and rigidity. J Oral Maxillofac Surg 1989; 47:720–723.
18. Raveh J, Vuillemin T, Lädrach K, Sutter F. New techniques for reproduction of the condyle relation and reduction of complications after sagittal ramus split osteotomy of the mandible. J Oral Maxillofac Surg 1988;46:751–757.
19. Hackney FL, Van Sickels JE, Nummikoski PV. Condylar displacement and temporomandibular joint dysfunction following bilateral sagittal split osteotomy and rigid fixation. J Oral Maxillofac Surg 1989;47:223–227.