

THE ROLE OF ORTHODONTIC TREATMENT
AND MALOCCLUSION IN THE ETIOLOGY OF
MANDIBULAR DYSFUNCTION

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by

Peter Lorne Gold

Department of Preventive Dental Science

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ABSTRACT

In recent years more patients than ever before are seeking treatment for symptoms of mandibular dysfunction. An observation that many of these individuals have had previous orthodontic treatment has led some dental clinicians to believe that orthodontic treatment may cause mandibular dysfunction.

The present study was undertaken to examine the incidence of mandibular dysfunction in young adults who had orthodontic treatment in comparison to those who had not. The same study explored the incidence and nature of dysfunction in the teenage and young adult population to determine the influence of occlusal factors on the dysfunction state.

A total of 371 subjects in two major groups were examined. The treated group consisted of 170 subjects treated with full-banded edge-wise appliances. The mean age was 18.5 years, and the male:female ratio was 1:2.5. Of these, 137 had received treatment at the University of Manitoba Graduate Orthodontic Clinic and 33 were treated in private practice. The latter group was examined at a city high school and another university. The control group consisted of 201 untreated subjects of mean age 17.3 years and male:female ratio of 1:1.7. Of these, 62 had sought treatment for malocclusion at the University of Manitoba Graduate Orthodontic Clinic, and 139 were examined in two high schools and the other university.

An anamnestic examination (oral history) and a clinical

examination were carried out on each subject. The data gathered was grouped and classified using various indices and then statistically analysed. The findings warrant the following conclusions:

1. Mandibular dysfunction was a common occurrence in the population sampled. In the anamnestic examination, 58% of all subjects reported at least one symptom of dysfunction, while in the clinical examination, one or more dysfunction signs were found in 68% of the subjects. Forty-four percent of the subjects had both dysfunction symptoms and signs. Most dysfunction found was of a minor nature. Of the 304 subjects who were found to have at least one symptom or sign of dysfunction, only 13% required treatment according to the subjective assessment of the examiner.
2. Females suffered somewhat more from dysfunction than did the males. Clinical evidence of clicking was 68% higher in females ($p < .01$), while signs and symptoms of pain were about 14% higher ($p < .001$). Most other dysfunction factors were higher for females, though not at the level of statistical significance.
3. Dysfunction signs and symptoms increased with age. In comparing the 12-15 years group with the 20-30 years group, pain signs increased by 39%. Crepitus increased fourfold ($p < .01$). Limitation of jaw movement increased by 62% ($p < .001$).
4. Subjects with dysfunction had significantly higher incidences ($p < .001$) of headache, neck, and back pain. General joint symptoms were also related to dysfunction.
5. There was a weak association between static malocclusion and

dysfunction. A similar association existed when comparing static malocclusion to functional occlusal discrepancies, such as balancing contacts, lateral centric slides, and unusual lateral guidance (e.g. guidance by only one posterior tooth).

6. There was a weak association between balancing contacts, and mandibular dysfunction. There was no association between the length or direction of centric slides and dysfunction.
7. For functional factors, it was found that the mean length of lateral and anterior centric slides were slightly higher for the treated group, while the incidence of balancing contacts was higher for the control group, as was the incidence of unusual types of lateral guidance.
8. Orthodontic treatment was not found to be an etiological factor in mandibular dysfunction. Dysfunction symptoms reported in the anamnestic examination were more prevalent in the control than the treated group. There was no difference between the control and treated group for dysfunction signs found in the clinical examination.

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INTRODUCTION

It was less than fifty years ago that Costen (1934) wrote the article which first stimulated interest in mandibular dysfunction (for some time referred to as "Costen's syndrome"). The apparent increase in the incidence of dysfunction in recent years has stimulated clinicians and researchers to investigate the extent and nature of dysfunction in the general population and to attempt to determine possible etiological factors.

Most of the early studies on the epidemiology of mandibular dysfunction were carried out on clinical patients who had sought treatment for dysfunction symptoms. A high proportion of these patients were females in the 20 to 50 year age group. More recently, a number of studies have been carried out on various groups of non-clinical subjects. These latter studies have shown that the signs and symptoms of mandibular dysfunction are common in the general population and there is no great difference in prevalence between the sexes and among the various age groups. In surveys of both clinical and non-clinical subjects, there was found a relationship between dysfunction and general joint and muscle symptoms.

An observation that a high proportion of patients seeking treatment for dysfunction symptoms had previous orthodontic treatment has led Shore (1976) and other clinicians to believe that orthodontic treatment is a common cause of mandibular dysfunction. They see the increase of orthodontic treatment in recent years as an important factor in the

apparent increasing incidence of mandibular dysfunction. The dysfunction is thought to be caused by functional occlusal discrepancies resulting from poor orthodontic finishing.

Few studies have actually been carried out to adequately examine the relationship of orthodontic treatment to dysfunction. The apparent association may be coincidental rather than causal. The relationship of dysfunction and functional occlusal factors, although examined, remains controversial as well. The relationship of dysfunction and static malocclusion (the traditional orthodontic view of malocclusion) has not been adequately examined. The incidence of mandibular dysfunction in the teenage population, the age group of most orthodontic patients, requires further documentation.

This research was conceived with the intent of furthering knowledge in these uncertain areas. In point summary the purposes of this study are as follows:

1. To examine the effect of orthodontic treatment on mandibular dysfunction by comparing the incidence of dysfunction in a group treated orthodontically and an untreated control group.
2. To compare the treated and control groups for the functional aspects of malocclusion.
3. To examine the relationship between functional occlusal factors and dysfunction.
4. To examine the relationship between static malocclusion and dysfunction.
5. To determine the incidence of dysfunction in the teenage and young adult population.

6. To examine the relationship of age and sex to mandibular dysfunction.
7. To examine the relationship of dysfunction to general joint and muscle symptoms.

REVIEW OF THE LITERATURE

Etiology of Mandibular Dysfunction

Dysfunction of the masticatory system is a well-described phenomenon in the dental literature. Because certain signs and symptoms of masticatory dysfunction often occur together, they are said by some to constitute a syndrome. This "syndrome" goes by many names, the more common of which are: Temporomandibular Joint Pain-Dysfunction Syndrome (Schwartz and Chayes, 1968); Mandibular Pain-Dysfunction Syndrome (MDS) (Molin, 1973); Temporomandibular Joint-Dysfunction Syndrome (Shore, 1959); and Myofascial Pain-Dysfunction Syndrome (MPD) (Laskin, 1969).

In this paper the term "mandibular dysfunction" will be used to describe dysfunction of the masticatory system. Temporomandibular joint will be abbreviated to "TMJ".

Some authorities, however, believe that to use the term "syndrome" in describing mandibular dysfunction implies one particular disorder with a single etiology. Zarb and Speck (1979) and Rugh and Solberg (1979) see masticatory dysfunction not as a single specific disease entity, but rather as a group of unrelated disorders with multifactorial etiology. "Mandibular dysfunction is not a syndrome but a spectrum of syndromes" (Storey, 1979).

There is agreement among many investigators in the field that the presence of the following signs and symptoms is pathognomonic for the existence of mandibular dysfunction:

1. pain in the region of the muscles of mastication and/or the temporomandibular joint

2. limitation of mandibular movement
3. temporomandibular joint sounds during mandibular movement (Bell, 1969; Greene et al., 1969; Laskin, 1969; Griffin and Munro, 1971; Hanson and Oberg, 1971; Posselt, 1971; Solberg et al., 1972; Agerberg and Carlsson, 1973; Zarb and Thompson, 1975; De Boever, 1979). According to Rugh and Solberg (1979), joint sounds alone are not generally considered sufficient evidence for specifying the dysfunctional state.

a) Theories of Etiology of Dysfunction

The signs and symptoms of mandibular dysfunction may be the result of pathologic changes within the joints, muscles and connective tissues of the masticatory system. Stretching or tearing of the joint capsule due to trauma may give rise to pain and limitation of mandibular movement. Muscle splinting to ease the painful joint may contribute to a further restriction of mandibular movement. Trauma to muscles and tendons may also cause pain and limit mandibular mobility, as may muscle spasm due to hyperactivity. Hyperactivity and spasm may cause uncoordinated function of the two heads of the lateral pterygoid muscle which in turn may lead to clicking of the TMJ (Toller, 1974). Arthritic changes to the joint may lead to crepitus and ultimately to pain and restriction of jaw movement.

Varying theories of the etiology of pathological changes to the masticatory system have been developed. For the sake of discussion these theories of etiology can be grouped in four categories:

- i. Inflammatory Arthritis Theory
- ii. Traumatic Theory

iii. Psychologic Theory

iv. Functional Theory

i. Inflammatory Arthritis Theory

Rheumatic and infectious arthritis fall under this category.

Rheumatoid arthritis (RA) is a systemic condition of unknown etiology. The incidence of RA is low in children but increases substantially with age, so that 2.5% of the population over 20 years has RA (Allander, 1970). TMJ involvement varies from 2 - 86% in different studies (Carlsson et al., 1979). Because the incidence of RA is very much less than the incidence of TMJ pain and dysfunction, RA is not likely a significant factor in the majority of cases of mandibular dysfunction.

Infectious arthritis of the TMJ occurs with even less frequency and is also not considered significant in most cases of mandibular dysfunction.

Unlike rheumatoid and infectious arthritis, osteoarthritis (arthrosis deformans) appears to have a functional etiology. Osteoarthritis is a non-inflammatory disease characterized by degeneration of the articular joint surfaces and remodelling of the underlying bone. It will be discussed further under the topic "Bruxism".

ii. Traumatic Theory

Speck and Zarb (1976) divide trauma into microtrauma and macrotrauma. Microtrauma is caused by persistent multiple minor traumas due to occlusal discrepancies, parafunction, and irregular opening and closing patterns. These etiological factors will be discussed in conjunction with the psychologic theory, functional theory, and bruxism.

Macrotrauma is a result of a sudden abnormal pressure which may

stretch and tear joint capsules and injure muscles and tendons. Based on case histories, Speck and Zarb (1976) noted that this type of injury may be due to factors such as a blow to the jaw, heavy pressures in extraction of lower molars, or mandibular deflection caused by a new dental restoration. Even a sudden wide opening of a hypermobile joint may also produce a spontaneous strain. Other investigators (Greene et al., 1969; Carlsson and Svardstrom, 1971; Solberg et al., 1972) have found that some symptomatic patients were able to trace the onset of dysfunction to a particular episode of macrotrauma.

iii. Psychologic Theory

This theory emphasizes the importance of centrally-initiated hyperactivity of the masticatory muscles. Newton (1969), Laskin (1969) and Yemm (1979) are proponents of this theory.

Psychologic stress and emotional states such as anxiety elicit muscular tension often manifest as clenching and bruxism. The persistent muscle tension leads to spasm and pain of the muscles of mastication. Altered muscle function may also lead to functional malocclusion (Laskin, 1969).

Travell (1960) cites clinical evidence to show that emotional stress, as well as noxious stimuli, can underlie the development of spasm of muscles particularly in the head and neck. The resulting pain may be referred to the area of the muscles of mastication or TMJ.

Studies by Molin and Levi (1966), Lupton (1969), Rothwell (1972), and Clark et al. (1977) have shown a positive relationship between emotional stress and mandibular dysfunction. It is of interest to note that some investigations have found that patients with mandibular

dysfunction commonly suffer from symptoms such as headache (Posselt, 1971; Helkimo, 1976; Dawson, 1974; Agerberg and Carlsson, 1975; Molin et al., 1976; Speck and Zarb, 1976) and general muscle symptoms (Berry, 1969; Helkimo, 1976; Molin et al., 1976). These symptoms may likewise be related to muscle tension of psychologic origin.

iv. Functional Theory

The functional theory emphasizes the importance of functional disharmony between the dental occlusion and TMJ. Occlusal interferences such as balancing-side contacts and discrepancies between centric relation and centric occlusion, do not allow the TMJs to assume their ideal positions. The musculature will be forced to move the mandible according to the dictates of the occlusion instead of the joints. Reflexes may be established to avoid these interferences, but the chronic muscle activity induced may lead to pain, fatigue and spasm of the masticatory muscles (Ramfjord and Ash, 1971). Interferences sufficiently severe may also cause microtrauma or macrotrauma to the TMJ and related structures. These interferences may also trigger bruxism in some individuals (Ramfjord, 1961).

Abundant clinical evidence exists to show that occlusal equilibration to harmonize the occlusion with the TMJs often leads to alleviation of dysfunction symptoms. This observation has made the Functional Theory the prime etiologic theory in the opinion of clinical dental practitioners such as Guichet (1970) and Dawson (1974).

b) Bruxism and Mandibular Dysfunction

Although the Psychologic and Functional theories differ as to whether the trigger for dysfunction is based centrally in the nervous

system, or locally in the masticatory system, both theories emphasize that parafunctional behavior and particularly bruxism may be an important factor leading to dysfunction.

The epidemiologic studies of Agerberg and Carlsson (1975) and Solberg et al. (1979) have shown that a significant number of subjects with dysfunction reported a history of bruxism. Ramfjord (1961) and Lindqvist (1974) reported clinical evidence of bruxism (bruxofacets) in many symptomatic individuals.

Vestergaard Christiansen (1975) found that one-half hour of voluntary bruxism in otherwise healthy, asymptomatic individuals can produce painful symptoms similar to those reported by dysfunction patients. These symptoms lasted as long as several days.

In a recent review of arthritis and the TMJ, the importance of bruxism was noted. "Functional overloading during mastication and/or parafunction, such as bruxism, plays a fundamental role in the cause and progression of osteoarthritis of the TMJ" (Carlsson et al., 1979). They also concluded that while crepitus is the most reproducible sign of osteoarthritis of the TMJ, pain and restriction of jaw movement may also result from arthritic changes.

c) Summary

In summary, there are various theories of the etiology of mandibular dysfunction. It seems unlikely that any single etiological factor is responsible for the signs and symptoms of mandibular dysfunction. Rugh and Solberg (1979) summarize a viewpoint presently held by many investigators in the field of dysfunction.

Conclusive evidence that there is one major cause for TMJ disorders is absent, even though there are abundant claims

to the contrary. The probability that any one patient will present dysfunctional symptoms is clearly dependent upon a staggering number of factors, many of which are not well understood. The unitary concept (one cause - one disease) must therefore be discarded in favor of the more applicable multifactorial concept (several harmful factors act upon an organ system at the same time).

Orthodontic Treatment and Mandibular Dysfunction

a) Orthodontic Treatment as a Cause of Dysfunction

Whether orthodontic treatment can lead to dysfunction remains controversial. Some clinicians have assumed there exists an association between orthodontic treatment and dysfunction, as many patients who exhibit signs and symptoms of dysfunction at ages 20 to 40 have had orthodontic treatment during adolescence (Williamson, 1977). Orthodontic clinicians and others have observed that after treatment patients may develop symptoms of mandibular dysfunction (Thompson, 1956; Roth, 1973; Perry, 1976; Williamson, 1976; Aubrey, 1978).

Shore (1976) cites orthodontic treatment as a factor in the increasing incidence of patients with mandibular dysfunction. He states that in the past 95% of patients were females usually of age 35 to 45. More recently, males now make up 25% of this group, and some patients are as young as 10 years. He believes this change is due to two factors: increasing stress at a younger age leads to bruxism; secondly, the incidence of orthodontic treatment has increased dramatically in the last ten years. Many of these cases lack proper finish, or they relapse and do not receive occlusal equilibration. The resulting occlusal interferences may ultimately lead to dysfunction.

Shore apparently bases these remarks on clinical observation. No specific study to test his hypotheses was reported.

In a study done in Britain, Franks (1967) implicated orthodontic treatment as a possible cause of mandibular dysfunction. He found in a study of 751 patients with dysfunction that 11% of these patients had undergone orthodontic treatment in comparison with 2% in a control group of patients receiving routine dental care.

Some orthodontists agree that orthodontic treatment may have the potential for causing mandibular dysfunction. During orthodontic treatment, and particularly in extraction cases where more tooth movement is needed, the changing occlusal relationships require a series of neuromuscular adaptations. If the capacity of the masticatory system to adapt is exceeded, dysfunction and pain may result (Perry, 1973). Ricketts (1966) observed that clinical symptoms of dysfunction are, in fact, sometimes seen as occlusions are changed.

Perry (1969) studied 1146 patients with malocclusions undergoing orthodontic treatment. He found that 3% had one or more symptoms of mandibular dysfunction prior to treatment, an additional 5.1% developed symptoms during active therapy and 7.4% more first noticed symptoms during retention. Thus a total of 15.5% had symptoms during therapy. However, after retainers were removed, only 5.1% continued to have symptoms.

Orthodontists have been blamed by some dental clinicians for creating occlusions which leave patients susceptible to mandibular dysfunction (Roth, 1972). Speck and Zarb (1976) note that after inadequate orthodontic treatment, some patients may lack a definite centric occlusion. The result is erratic mandibular movements as the jaw seeks a position of comfort in which to close. These chronic erratic movements may cause masticatory muscle spasm and incoordination, and lead to