Recognition, prevalence, and risk factors of internal derangements of the temporomandibular joint

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Chapter 7

Prevalence and risk factors of internal derangements

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Abstract

The aim was to assess the prevalence and risk factors of types of internal derangements (IDs) of the temporomandibular joint. 1835 children and 320 adults were examined for the presence of anterior disc displacement with reduction (ADD) and hypermobility, and possible risk factors were documented. Both IDs had about an equal prevalence. For the development of ADDs, the most important risk factor was increasing age during childhood and adolescence. For girls, age was a larger risk factor than for boys. Since the prevalence of ADDs in the adults was comparable with that in the oldest children, it was concluded that ADDs develop during growth, probably as result of an intra-articular space insufficiency. For hypermobility, most risk factors were associated with a higher joint flexibility, *viz.*, amount of mouth opening, female gender, and non-Caucasian race.

Introduction

An internal derangement (ID) of the temporomandibular joint (TMJ) is described as a deviation in position or form of the articular tissues (Glossary of prosthodontic terms, 1999). Functionally, such a deviation interferes with smooth TMJ movements. Examples are anterior disc displacement with reduction (ADD) and hypermobility. An ADD is characterized by an anterior displacement of the disc in closed jaw position, that improves its relation with the condyle during mouth opening, usually resulting in a click (Farrar and McCarty, 1982). Hypermobility implies an excessive TMJ mobility (Dijkstra *et al.*, 1993). During wide opening and subsequent closing, jerky movements and clicking sounds are noted when the condyle snaps over the apex of the eminence.

Although most IDs cause no, or only little, discomfort, an ADD may develop into a more serious condition, *viz.*, a non-reducing disc displacement ('closed lock'). Occasionally, an open lock occurs in a hypermobile joint. Unfortunately, it is largely unknown how often and under what conditions such developments occur (Pullinger and Seligman, 2001). This obscurity is probably due to the fact that so far, epidemiological studies were mainly focused on TMJ clicking as such, and less on the underlying causes (e.g., ADD, hypermobility). As a result, and despite the above-given clear-cut descriptions of an ADD and hypermobility, the prevalence rates and risk factors of types of IDs are still unknown, let alone that more insight has been obtained into the possible long-term implications of IDs.

A possible risk factor for the development of an ID may be increasing age during childhood and adolescence (Egermark-Eriksson *et al.*, 1981; Dibbets and van der Weele, 1992; Thilander *et al.*, 2002). Unfortunately, an unequivocal interpretation of these latter studies is hampered by a lack of ID classification, the large age increments used (Egermark-Eriksson *et al.*, 1981), and the non-representative (orthodontic) samples studied (Dibbets and van der Weele, 1992). For the study of increasing age and other possible risk factors, large population samples are needed. As a consequence, one is limited to clinical examinations. Using clinical criteria to distinguish types of IDs, our aim was to assess the prevalence and risk factors of types of IDs in population samples of children and adults.

Materials and methods

Participants

1835 children (mean age (SD = 10.8 (3.9 yrs) from 7 Dutch schools, 220 students (mean age (SD = 21.9 ± 3.6 yrs), and 100 employees of our dental school (mean age (SD = 43.5 (9.8 yrs) were recruited. All gave informed consent. The inclusion criterion was an age in the predetermined range of 4-18 yrs, 19-30 yrs, and over 30 yrs. The parents of ten children declined the child's participation.

Protocol

All participants underwent a standardized oral history and clinical examination, performed by one of two trained dentists (Table 1). For the youngest children, the phrasing of the questions was adjusted to clarify them. Clicks were scored using palpation and auscultation, while the participants performed the following, maximally performed tasks that all started from and ended in intercuspal position:

- open and close;
- laterotrusion to the right and left; and
- protrusion.

If a click was reproducible (*i.e.*, present on at least two of three consecutive trials), the following, additional tasks were performed:

- opening that started from and ended in a protruded position; and
- free opening and loaded closing.

Loading was a manual, downward directed force on the chin (Huddleston Slater *et al.*, 1999).

Table 1. Variables scored during the oral history and clinical examination

Oral history

Age	years
Gender	boy, girl
Race	(non-) Caucasian
Clenching	never, sometimes, often, regularly, always
Tiredness (masticatory muscles)	idem
Pain (masticatory muscles)	idem
Pain during function	idem
Use of chewing gum	never, piece/week, piece/day, more
Smoking	idem
Sleeping position	side, back, stomach, varying
History of orthodontic treatment	no, yes

Clinical examination

Overbite	mm
Overjet	mm
Protrusion	mm
Maximal mouth opening	mm
Molar relation	Angle Classification
Deviation in growth [a]	-2, -1, 0, 1, 2
Deviation in dental development [b]	-2, -1, 0, 1, 2

[a] *recoded from body height (see Data analysis)*

[b] *recoded to deviation in dental development (see Data analysis)*

Techniques

For auscultation, the bell of an infant stethoscope (3M Littmann, St. Paul, MN, USA) was placed over the lateral pole of the TMJ. Palpation was performed with the index and middle fingers. Both joints were palpated simultaneously. Clicks were denoted when observed with either technique. The inter-rater reliability of these techniques and the validity of the below-described criteria have been tested previously (Huddleston Slater *et al.*, 2002b, 2002c).

Clinical diagnosis

The criteria for ADD were:

- reproducible clicking on opening and (loaded) closing; and
- elimination of clicking on protrusive opening.

The criteria for hypermobility were:

- reproducible clicking on opening and (loaded) closing; and
- clicking in the last part of opening and the first part of closing, in combination with jerky movements; and
- no elimination of clicking on protrusive opening.

When the click did not meet one of the above-described sets of criteria, e.g., due to a posteriorly displaced disc, it was classified as "other". Crepitation was not taken into account.

Data analysis

To correct for the dependency between "age" and the variables "body height" and "dental development stage", "body height" was recoded into a 5-point scale, based on the number of standard deviations that it deviated from Dutch means (Burgemeijer *et al.*, 1998), and was further called "deviation in growth". For example, if body height was more than 2 standard deviations less than the norm, it was scored as "-2". "Dental development stage" was similarly recoded (Prahl-Andersen *et al.*, 1979) and was called "deviation in dental development".

Logistic regression models were used to predict the presence of an ADD or hypermobility in the children group. For both adult groups, only the prevalence of types of IDs was calculated. χ^2 tests were used to compare the prevalence of ADD and hypermobility between the sub-sample of the oldest children and the adults.

Results

In the children group, IDs were, on average, present in 15% of the joints; in the group of 19-30 year-olds, in 28%; and in those over 30 years of age, in 32%. The IDs in the children group were classified as ADD in 52% of these joints, and as hypermobility in 45%. In 3%, the ID was classified as "other". The prevalence rates in the oldest children were comparable with those of the adult samples (χ^2 test; $p > 0.05$). For ADDs, this can be gathered from Fig. 1A, which shows an increase in prevalence with age during childhood and adolescence, more in girls than in boys, with a stabilization into adulthood. The prevalence of hypermobility (Fig. 1B), does not increase with age, neither within the children group nor into adulthood, but is generally higher in girls than in boys.

In the logistic regression model for ADD, a significant interaction was found between gender and age. This interaction effect can also be gathered from the difference in odds ratios between boys and girls (Table 2). For ADD, the model chose the variable "age" as first predictor; for hypermobility, "mouth opening". The model was further improved by the other variables shown in Table 2. The explained variance was 7.9% for ADD and 9.9% for hypermobility.

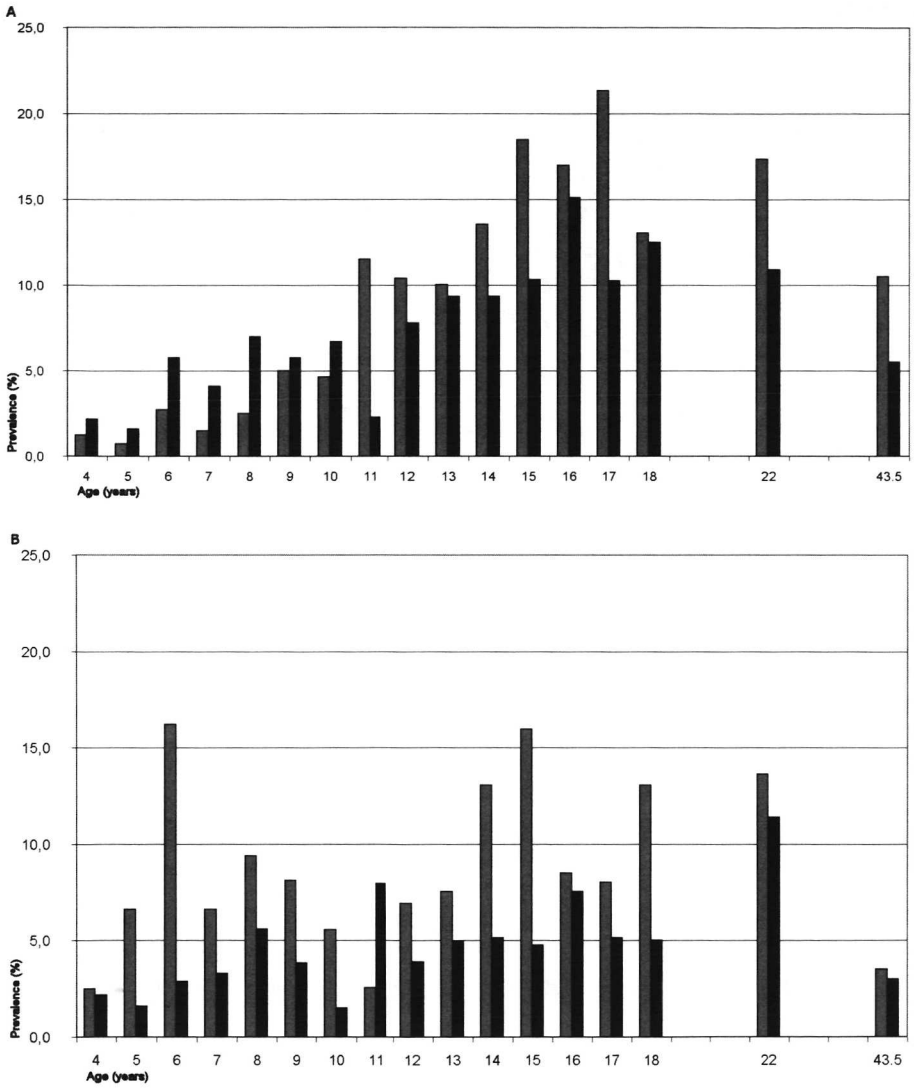

Figure 1. Prevalence rates (%) of ADD (A) and hypermobility (B). Grey bars represent females; black bars, males.

Table 2. Logistic regression models with odds ratios and confidence intervals for ADD and hypermobility

ADD

		Odds Ratio	Confidence Interval
Age [a]	boys	1.07	1.01 - 1.13 [b]
	girls	1.20	1.14 - 1.27 [b]
History of orthodontics (reference: no)		1.48	1.11 - 1.97 [b]
Overbite		1.09	1.01 - 1.18 [b]
Protrusion		1.07	1.01 - 1.14 [b]

Hypermobility

		Odds Ratio	Confidence Interval
Maximal mouth opening		1.08	1.06 - 1.10 [b]
Gender (reference: boys)	girls	2.44	1.82 - 3.27 [b]
Race (reference: Caucasian)	non-Caucasian	2.83	1.94 - 4.14 [b]
Deviation in growth (reference: no deviation)	"-2"	7.41	2.54 - 21.6 [b]
Pain (masticatory muscles) (reference: never)	sometimes	1.67	1.14 - 2.46 [b]
regularly		3.44	1.12 - 10.55 [b]

[a] = *significant interaction effect between gender and age ($p < 0.05$)*

[b] = *significant ($p < 0.05$)*

Discussion

In the present study, the prevalence and risk factors were determined for types of IDs, while in most previous studies, these were determined for TMJ clicking as such. Recently, sets of criteria for the clinical distinction between types of IDs were developed and tested for their reliability (Huddleston Slater *et al.*, 2002b). Also, their concurrent validity was assessed in comparison with opto-electronic movement recordings and magnetic resonance imaging (MRI) (Huddleston Slater *et al.*, 2002c). Based on the outcome of these previous studies, it is safe to assume that with these sets, types of IDs can be detected and therefore used in large-scale studies to the prevalence and risk factors of IDs.

Among other theories (for a review, see Pullinger and Seligman, 2001; Pullinger *et al.*, 2002), it has been suggested that ageing of the TMJ (*i.e.*, an increasing failure of its adaptive capacity) is a risk factor for the development of an ADD (Stegenga, 2001). To test whether ageing is a risk factor indeed, or whether an ADD is merely caused by growth and bodily development, the prevalence of IDs was calculated not only in a sample with schoolchildren, but also in two adult groups. The finding that the prevalence of ADD in the adult groups was comparable with that of the oldest schoolchildren suggests that growth and bodily development are risk factors for an ADD; not ageing of the TMJ.

Numerous hypotheses for the development of disk displacements have been proposed (Pullinger *et al.*, 2002) but none of the proposed risk factors was strong. Among others, Pullinger *et al.* (2002) suggested that the development of an ADD is related with various anatomical relations between components of the TMJ. In line with this suggestion and the finding that the closing click always occurs just before the condyle re-enters the fossa (Farrar and McCarty, 1982; Huddleston Slater *et al.*, 2002a), an ADD may be the result of a space insufficiency within the joint, so that the condyle and disc cannot be jointly accommodated in the fossa. As a compromise, the disc then gets anteriorly displaced. The fact that the found risk factors for ADD, are mostly related with growth and bodily development, corroborates the suggestion that a space insufficiency is involved in the etiology of ADDs indeed. The finding that in girls, who tend to mature earlier than boys, ADDs develop earlier, makes this suggestion even stronger. Since the explained variance of the regression model was only 7.9%, many other unknown factors have to be involved in the development of ADDs as well.

The finding that the prevalence of hypermobility was higher for female participants is not surprising, because women are generally more flexible in their joints than men. The

observed association between hypermobility and the amount of mouth opening further illustrates this aspect. The race-effect may be linked to the less pronounced articular eminence in non-Caucasians (Fletcher, 1985), which may render their TMJs less stable. Why retardation in growth was associated with hypermobility is difficult to understand and needs further research. Lastly, muscle pain as risk factor for hypermobility may be interpreted as a reaction to the subluxation.

In short: ADD and hypermobility have an approximately equal prevalence. ADDs develop during growth, more rapidly in girls than in boys, maybe as a result of a space insufficiency within the TMJ. Hypermobility is associated with a higher flexibility of the joint.