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Incidence of temporomandibular joint clicking in adolescents with and without unilateral posterior cross-bite: a 10-year follow-up study

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SUMMARY **Among different malocclusions, posterior cross-bite is thought to have a strong impact on the correct functioning of the masticatory system. The association between unilateral posterior cross-bite (UPCB) and temporomandibular joint (TMJ) clicking, however, remains still controversial. The aim of this study was to investigate whether the presence of UCPB during early adolescence increases the risk of reporting TMJ clicking after a long-term follow-up. A longitudinal survey design was carried out in a group of 12-year-old young adolescents, who were examined at baseline for TMJ clicking sounds and unilateral posterior cross-bite. After 10 years, 519 subjects could be reached by a telephone survey. Standardised questions were used to collect self-reported TMJ sounds and to determine whether participants had received an orthodontic treatment. Logistic regression analysis revealed a significant association between unilateral posterior cross-bite and subjectively reported TMJ clicking (odds ratio = 6·0; 95% confidence limits = 3·4–10·8; $P < 0.0001$). The incidence of TMJ clicking was 12%. At a ten-year follow-up, self-reports of TMJ clicking were significantly associated with the presence of UPCB at baseline, but not with the report of having received an orthodontic treatment. Within the limitation of this study, the presence of unilateral posterior cross-bite in young adolescents may increase the risk of reporting TMJ sounds at a 10-year follow-up. The provision of an orthodontic treatment, however, does not appear to reduce the risk of reporting TMJ sounds.**

KEYWORDS: **cross-bite, temporomandibular disorder, disc displacement, click, long term**

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Background

Among different malocclusions, unilateral posterior cross-bite (UPCB) is thought to have a strong impact on the correct functioning of the masticatory system (1–3). The association between posterior cross-bite and temporomandibular disorders (TMDs) is controversial in the literature across time. According to a systematic review specifically focusing on the association between posterior cross-bite, muscular pain and disc displacement, the distribution of the studies supporting or not supporting the association is similar (4). A possible explanation to the lack of consistency may be represented by the selection of the samples. Indeed, most of the studies are based on orthodontic patients or selected controls among dental students or staff members that are not representative of the general population (5–11). Furthermore, most of the previous studies have been cross-sectional and fewer reported long-term data (5, 6, 12–17). Hence, the association between posterior cross-bite and TMDs deserves further investigation by longitudinal long-term studies, to determine the possible risk factors.

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In 2002 we started a population-based epidemiologic study by recruiting adolescents from among secondary schools (18). The possible association between UPCB and TMJ clicking was investigated and resulted not significant.

The aim of this study was to analyse the association between TMJ clicking and UPCB in the same sample after 10 years. The null hypothesis to be tested was that the presence of UPCB during adolescence is not associated with the development of TMJ clicking in the long term.

Materials and methods

Detailed description of the subjects included and the methods used has been previously published (18) and are only briefly reported here. In the previous study, participants were recruited from among secondary schools by means of a two-stage cluster sampling. From 1680 subjects originally screened, 1291 adolescents (708 males and 583 females) were included in the study, with a mean age (±s.d.) of 12·3 ± 1·1 years.

Posterior cross-bite was diagnosed when the participant had one or more teeth of the posterior group (from canine to second molar) in an irregular (at least one cusp wide) bucco-lingual or bucco-palatal relationship, with one or more opposing teeth (19). Temporomandibular joint disc displacement with reduction was diagnosed according to the Axis I Group IIa of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (20). Temporomandibular joint clicking was recorded both as clinical sign and as self-report symptom. Positive diagnoses of right, left and bilateral TMJ disc displacement with reduction were all grouped into one dichotomous variable (Yes/No).

After ten years, the subjects were interviewed by telephone and received standardised questions about TMJ clicking sounds, facial trauma (questions modified from 15a, 17a of RDC/TMD Patient History Questionnaire) (21) and the possible provision of orthodontic treatment since last examination (Q1. Does your jaw click or pop when you open or close your mouth or when chewing? Q2. Have you had an injury to your face or jaw during the last 10 years? Q3. Have you received an orthodontic treatment during the last 10 years?). Self-reported TMJ clicking was compared to self-reported TMJ clicking registered at baseline in 2002.

Statistics

Data collected were first analysed by means of conventional descriptive statistics. Accuracy of self-reported TMJ clicking was assessed at baseline in 2002, using objective TMJ clicking as gold standard. A statistic analysis was performed to compare the original sample and the follow-up sample and to assess the presence of selection bias. Continuous variables were reported as mean and standard deviation (s.d.), while categorical variables were reported as absolute number and percentage. Continuous variables were compared by means of t-test, while categorical variables were compared by means of chi-squared tests. Two separated analyses were performed: the first one including the whole sample and the second one excluding subjects presenting subjective TMJ clicking at baseline, to estimate the incidence and the ten-year risk of developing subjective TMJ clicking. Multivariable logistic regression was used with subjective TMJ clicking at follow-up as dependent variable and age, gender and self-report of orthodontic treatment further than facial trauma *a priori* as independent variables. Results of logistic regression model were reported as odds ratio (OR) and 95% confidence interval (C.I.). Statistical analyses were carried out by means of the statistical package SPSS software (Release 15.0*), with a P value $< 0{\cdot}05$ considered statistically significant.

Results

The flow chart of the study is reported Fig. 1. In 33·5% ($n = 433$) of the subjects included in the original sample (18), the telephone number was not available; no statistically significant differences for the baseline characteristics were found between subjects with and without available telephone number. Of the 858 subjects identified, 519 could be reached by phone and interviewed, 219 women and 300 men with a mean age ±standard deviation of 22·2 ± 1·1 at follow-up, representing our follow-up sample (participation rate 60%) (Fig. 1). No statistically significant differences were found between lost to follow-up ($n = 339$) and subjects interviewed ($n = 519$), with exception of unilateral posterior cross-bite. Specifically, participation rate was 58%

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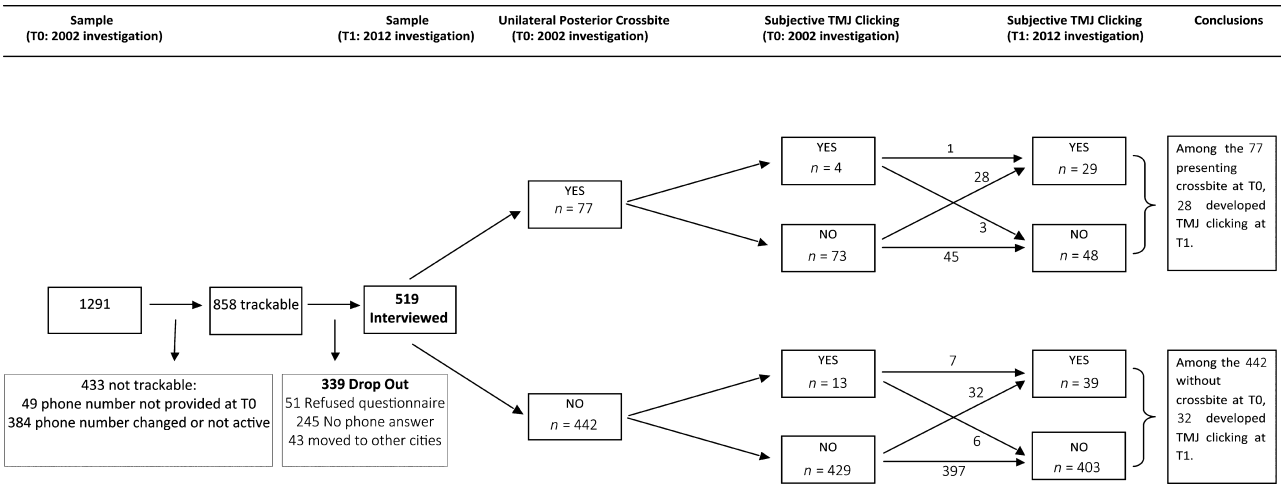

Fig. 1. Longitudinal variation in reported temporomandibular joint clicking sounds. Numbers indicate the number of subjects.

and 78%, respectively, in subjects without and with unilateral posterior cross-bite ($P < 0{\cdot}001$).

Accuracy of self-reported TMJ clicking at baseline showed a sensitivity of 0·47 and specificity of 0·99.

When considering data retrieved in 2002, the association between subjective TMJ clicking and posterior cross-bite was not significant in the whole original sample (1291 subjects) ($P = 0{\cdot}96$). Moreover, in 2002, this association was not significant either in the 519 subjects included in the follow-up sample ($P = 0{\cdot}31$), or in the lost to follow-up group ($P = 0{\cdot}65$).

In 2012, 68 participants of 519 (13·1%, 37 females and 31 males) reported TMJ self-reported clicking. Twenty-nine participants (5·6%) had TMJ clicking and UPCB concurrently. Subjective TMJ clicking was significantly associated with posterior cross-bite ($P < 0{\cdot}0001$). The incidence of TMJ clicking in the sample without click at baseline ($n = 502$) was 12% (Table 1). A significant association was found between UPCB and the risk of developing subjective TMJ clicking at ten years follow-up (Table 1).

We performed a multiple logistic regression, considering the TMJ clicking as the response variable (two modalities: present, absent), and UPCB (two modalities: yes, no), age, gender (two modalities: boys, girls), orthodontic treatment and trauma (two modalities: yes, no) as independent variables. Logistic model was fitted to the whole follow-up sample ($n = 519$) and to the sample without the subjects presenting subjective TMJ clicking at baseline ($n = 502$). The results of logistic regression analysis on the whole sample suggested that UPCB and trauma were the only variables included into the model significantly associated with the TMJ clicking (Table 2). Similar results were obtained excluding 17 subjects presenting subjective TMJ clicking at baseline, with a significant association between the development of self-reported TMJ clicking and UPCB (OR: 7·55; 95% C.I. 4·12-13·86; $P < 0{\cdot}001$) and trauma (OR: 3·19; 95% C.I. 1·13-9·06; $P = 0{\cdot}029$).

Table 1. Ten-year incidence of self-reported temporomandibular joint (TMJ) clicking overall and by gender, unilateral posterior cross-bite, trauma, orthodontic treatment and age in 502 subjects without subjective TMJ clicking at baseline

Subjective TMJ clicking (2012)			
	No (%)	Yes (%)	*P* value
Overall	442 (88·1)	60 (12)	
Gender			
Female	179 (84·8)	32 (15·2)	0·06
Male	263 (90·4)	28 (9·6)	
Cross			
No	397 (92·5)	32 (7·5)	<0·001
Yes	45 (61·6)	28 (38·4)	
Trauma			
No	421 (88·6)	54 (11·4)	0·09
Yes	21 (77·8)	6 (22·2)	
Orthodontic treatment			
No	330 (89·4)	39 (10·6)	0·11
Yes	112 (84·2)	21 (15·8)	
Age			
<12ys	226 (87·3)	33 (12·7)	0·57
>12ys	216 (88·9)	27 (11·1)	

Number of observation 502 without subjective TMJ clicking at baseline.

Table 2. Results of multiple regression analysis with self-reported temporomandibular joint (TMJ) clicking as the dependent variable and posterior cross-bite, gender, age, orthodontic treatment and trauma as independent variables

Dependent variable: subjective TMJ clicking				
	95% confidence intervals			
Independent variable	Odds ratio	Lower	Upper	*P* value
Posterior Crossbite				
No†	–	–	–	–
Yes	6·01	3·37	10·69	<0·001
Gender				
Female†				
Male	0·59	0·34	1·02	0·061
Age (years)	1·06	0·82	1·37	0·660
Previous or current orthodontic treatment				
No†				
Yes	1·32	0·74	2·36	0·350
Trauma				
No†				
Yes	2·92	1·11	7·71	0·030

†Reference group; number of observation 519 with and without subjective TMJ clicking at baseline.

The prevalence of TMJ subjective clicking in the follow-up sample did not differ between subjects who received or did not receive orthodontic treatment during the last ten years, both in the whole sample (Table 3) and after excluding subjects presenting subjective TMJ clicking at baseline. Also, the report of having received an orthodontic treatment was not significantly associated with subjective TMJ clicking when considering the 77 subjects presenting UPCB (Table 4). In particular, in the sample that had not received orthodontic treatment ($n = 51$), self-reported TMJ clicking was observed in 41·2%. Conversely, in the sample that had received orthodontic treatment ($n = 26$), self-reported TMJ clicking was observed in 30·8%. Similar results were obtained among the 73 subjects presenting UPCB without self-reported TMJ clicking at baseline ($P = 0·54$).

Discussion

The present study showed a significant association between unilateral posterior cross-bite and TMJ self-reported clicking at 10-year follow-up (odds ratio = 6·0; $P < 0·0001$). The incidence of TMJ clicking was 38% among subjects presenting UPCB at baseline and 7·5% in those not presenting UPCB at baseline.

Table 3. Distribution of subjective temporomandibular joint (TMJ) clicking, unilateral posterior cross-bite, gender and age by orthodontic treatment in 519 participants

	Previous or current orthodontic treatment†		
	No ($n = 379$)	Yes ($n = 140$)	*P* value
Number of cases reporting TMJ clicking (%)	45 (11·9%)	23 (16·4%)	0·17
Number of cases diagnosed as unilateral posteriori crossbite (%)	51 (13·5%)	26 (18·6%)	0·15
Number of females (%)	153 (40·4%)	66 (47·1%)	0·17
Mean age in years (s.d.)	22·30 (1·03)	22·05 (1·09)	0·20

†Reference group; number of observation 519 with and without subjective TMJ clicking at baseline.

Table 4. Distribution of subjective temporomandibular joint (TMJ) clicking and orthodontic treatment in the 77 subjects presenting unilateral posterior cross-bite

Dependent variable: subjective TMJ clicking				
	95% confidence intervals			
Independent variable	Odds ratio	Lower	Upper	*P* value
Orthodontic treatment†				
No ($n = 51$)	–	–	–	–
Yes ($n = 26$)	0·64	0·23	1·73	0·37

†Reference group; number of observation 77 with and without subjective TMJ clicking at baseline

The study has some strengths and limitations. The main strengths include the relative high number of subjects investigated the long-term follow-up and the use of multivariate statistics. Indeed, most of the earlier studies have been cross-sectional (4), and the fewer studies on the topic reporting long-term data (5, 6, 12–17) were based on smaller samples, or samples selected from orthodontic patients or dentistry students (5, 6), with possible impact of the external validity of the results.

An important limitation can be ascribed to the fact that our assessment of TMJ clicking was obtained by a telephone interview with no objective assessment of TMJ sounds, thus being at risk of recall bias. The interview was chosen because a great percentage of subjects recalled after 10 years moved from Naples for

working reasons or university studies as a consequence of the transition from adolescence to adulthood. Nonetheless, a survey method is more practical than history taking and clinical examination, which are considered the gold standard for TMD diagnosis (22, 23) and has been used in previous epidemiologic research (16, 17, 24–29).

However, it must be stressed that a correct diagnosis of posterior cross-bite was performed in the first investigation (18), because the sample was recruited directly in the secondary schools and underwent clinical examinations. Furthermore, the accuracy of self-reported TMJ clicking assessed at baseline considering objective TMJ clicking as gold standard showed high specificity. Therefore, we believe that the risk of overestimating TMJ disc displacement using self-reported TMJ clicking as investigation tool may be low.

Another limitation is the high number of lost to follow-up that can be deemed as 'suspect' (30). The high number of lost to follow-up can be ascribed to several reasons. Firstly, we have to stress that we were able to recall 60·5% of the original sample, as 433 subjects could not be traced because of telephone number not available, home and/or phone number changed. Among the 858 subjects contacted, 339 did not answer the phone, moved to other cities and not contactable or refused to answer the questionnaire because of diffidence to phone surveys, stress by continuous call centre contacts and fear of possible commercial aims. The subjects lost to follow-up did not differ from participants surveyed with respect to gender or to the objectively based TMJ disc displacement diagnosis made at baseline ($P = 0{\cdot}80$). Conversely, the availability of the subjects to complete the questionnaire was greater among those presenting posterior cross-bite in 2002 ($P < 0{\cdot}001$). The sensitisation of individuals reporting posterior cross-bite by the dentists could ascribe their greater availability to enter in the study. This could represent a limit of the study. However, the observed participation rate greater than 60% could reduce the risk of bias.

Self-reported TMJ clicking, collected through the phone survey, was compared to the self-reported TMJ clicking retrieved in 2002. Consistently with other findings (5, 13, 15, 31–34), the prevalence of TMJ clicking increased considerably with the age (3·3% in 2002, and 13·1% in 2012). After 10 years, there was a significant association between UPCB and self-reported TMJ clicking ($P < 0{\cdot}001$; OR=6·00). Furthermore, accordingly to previous studies (5, 6), the development in subjects asymptomatic at baseline of self-reported TMJ clicking after 10 years was significantly associated with UPCB. Probably, the association between cross-bite and disc displacement in young adults could be the consequence of a lack of adaptation in the long term (35, 36). However, this hypothesis needs to be confirmed by further long-term controlled studies. Another possible explanation could be ascribed to anatomical factors as a consequence of the skeletal asymmetry associated with UPCB (37–39). Indeed, among subjects with UPCB, the height of the articular eminence on the shifted side of the mandible has been reported to be significantly different from that on the contralateral side (38). Moreover, in Angle Class I adult subjects with UPCB, the condyle ipsilateral to the UPCB is located more posteriorly than that contralateral to the UPCB (39) as compared to normal subjects. Finally, it has been reported that facially asymmetric adult subjects with UPCB exhibit not only mandibular asymmetry but also remodelling of the condylar head and glenoid fossa (37). Considering that anatomical characteristics seem to influence joint function (40), anatomical asymmetries in the glenoid fossa and condyle head could explain the higher prevalence of disc displacements in subjects with UPCB. Nevertheless, more studies are needed, specifically comparing anatomical asymmetries and disc displacement in healthy and UPCB subjects.

Interestingly, the report of previous orthodontic treatment was not associated with subjectively reported TMJ sounds both in the whole sample (Table 3), and in the sample presenting posterior cross-bite only (Table 4). This means that, the provision of an orthodontics treatment does not appear to reduce the risk to report TMJ sounds clicking sounds thereafter. However, as for clicking sounds, the evaluation of orthodontics treatment was only based on self-report report with no objective evaluation of occlusion and of the quality of orthodontic correction.

In conclusion, within the limitation of the present study, our findings indicate that UPCB is associated with subjectively reported TMJ sounds at long-term follow-up and that the 10 years incidence of self-reported TMJ clicking is higher in subjects who presented UPCB at baseline. Having an orthodontic treatment, however, does not reduce the risk of reporting TMJ sounds. Further longitudinal studies are needed to

elucidate the relationship between objectively assessed disc displacement, unilateral posterior cross-bite and its orthodontic correction.

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Conflicts of interest

No conflict of interest declared. This research was carried out without funding.

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