


ORIGINAL RESEARCH

Temporomandibular disorders in patients with early rheumatoid arthritis and at-risk individuals in the Dutch population: a cross-sectional study

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ABSTRACT

Objective To evaluate the prevalence of temporomandibular disorders (TMD) in patients with early rheumatoid arthritis (ERA) and individuals at-risk of RA.

Methods 150 participants were recruited in three groups (50 per group): (1) patients with ERA (2010 EULAR criteria) (2) at-risk individuals and (3) healthy controls. All participants were tested for seropositivity of rheumatoid factor and anticitrullinated protein antibodies. A possible TMD diagnosis was determined according to the standardised and validated diagnostic criteria for TMD (DC/TMD) in five categories: myalgia, arthralgia, articular disc displacement, degenerative joint disease and headache attributed to TMD. Results were tested for the prevalence of TMD (all categories combined) and TMD pain (myalgia and/or arthralgia). To investigate a possible role for bruxism, a probable sleep and/or awake bruxism diagnosis was determined based on self-report and several clinical features.

Results The prevalence of any TMD diagnosis did not differ between the three groups. However, at-risk individuals more often had a TMD-pain diagnosis than healthy controls ($p=0.046$). No such difference was found between the ERA group and the control group. However, within the ERA group, seronegative patients had a TMD-pain diagnosis more often than seropositive patients (4/12 (33%) vs 3/38 (8%), $p=0.048$). Participants with a TMD-pain diagnosis were more often diagnosed with probable sleep bruxism than those without a TMD-pain diagnosis.

Conclusion The prevalence of TMD pain is increased in individuals at-risk of RA and seronegative ERA patients, and is associated with bruxism signs and symptoms. These results suggest that health professionals should be alert to TMD pain in these groups.

BACKGROUND

Rheumatoid Arthritis (RA) is an autoimmune disease that causes inflammation of the synovial joints, eventually resulting in destruction of cartilage and bone.¹ Most patients with RA are affected by the so-called seropositive form of RA, defined by the presence of specific antibodies: IgM rheumatoid factor (IgM-RF)

Key messages**What is already known about this subject?**

- ▶ Systemic diseases such as rheumatoid arthritis (RA) can also affect the temporomandibular joint. Temporomandibular disorders (TMD) can negatively influence oral function and oral health-related quality of life.

What does this study add?

- ▶ This is the first study that examined TMD in individuals at-risk of RA, showing an increased prevalence of TMD pain in this population as compared with a healthy control group.
- ▶ This study examined TMD using the standardised and validated diagnostic criteria for TMD (DC/TMD) in a group of early RA (ERA) patients. Current literature only provides limited information on TMD in ERA patients, not using the DC/TMD.

How might this impact on clinical practice?

- ▶ The results of this study suggest that health professionals should be alert to TMD pain in individuals at-risk of RA and seronegative ERA patients, and thus suggests a direction for offering customised care.

and antibodies against citrullinated proteins (ACPA).² According to the 2010 EULAR criteria, diagnosis of RA depends on a scoring system including several factors, for example, IgM-RF and/or ACPA positivity and symptom duration, while a definite synovitis in at least one joint is required.³ In the Dutch population, approximately 17 000 new patients (incidence of 0.1% per year) get diagnosed with RA each year.⁴

RA can also affect the temporomandibular joint (TMJ). The prevalence of TMJ involvement in patients with RA has been reported to range between 19% and 86%.⁵⁻⁷ As previous studies describe a wide variation in diagnostic criteria (DC), assessment methods and RA



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disease duration, it is difficult to determine the overall prevalence and possible variations during the course of the disease.

Data on TMJ involvement in early RA (ERA) are limited; solely based on palpation, Chin Jen Sem *et al* found an 11% prevalence of TMJ pain in patients with newly diagnosed RA.⁸ As several characteristics of RA can be present before the clinical outbreak of arthritis, for example, arthralgia and increased serum levels of IgM-RF and/or ACPA, individuals with an elevated risk of RA can be identified.⁹ Currently, no information is available on the prevalence of TMJ involvement in people at-risk of RA. Research on both patients with ERA and individuals at-risk of RA would therefore be a valuable addition to the available literature, and could also be of value for the collaboration between rheumatologists and dentists around RA onset in the TMJ.

To fully explore possible TMJ involvement in ERA patients and at-risk individuals, it would be preferable to consider all disorders of the TMJ. These comprise pain and dysfunction of the TMJ and the masticatory muscles as well as TMJ sounds (ie, clicking and/or crepitus) during function. To systematically examine the masticatory system and to arrive at a temporomandibular disorder (TMD) diagnosis, the DC/TMD have been composed and validated by an international consortium.¹⁰ The DC/TMD use standardised tests, taking into account both arthrogenous and myogenous aspects. Bruxism—defined as a repetitive jaw-muscle activity characterised by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible^{11 12}—is reported to play a role in the development of TMD.¹³ It is, therefore, a relevant factor to consider when analysing TMD in any population.

Insight into TMD prevalence around RA onset would provide information on whether alertness to a possible TMD during this timeframe is needed. Our aim is, therefore, to evaluate the prevalence of TMD according to the DC/TMD, and a possible role for bruxism, in patients with ERA and in individuals with an increased risk of RA compared with a healthy control group. We hypothesise that the prevalence of TMD in both ERA and at-risk individuals is higher than in healthy controls.

METHODS

Study design

This study is part of a larger parent study. A full description of the study protocol has been published.¹⁴ The study protocol has been registered in the Dutch National Trial Register (NTR, NTR6362).

Participants and recruitment

Three groups of participants were recruited: (1) patients with ERA (2) persons with an increased risk of RA and (3) a control group without autoimmune conditions. Subjects were eligible for inclusion if they were aged 18 years or older, had a minimum of 12

natural teeth, and were willing and able to give written informed consent. Groups 1 and 2 were recruited at Reade, a rheumatology clinic in Amsterdam, The Netherlands. For group 1, patients were diagnosed with RA and fulfilled the 2010 EULAR RA criteria³ within the last year. From January 2018, newly diagnosed patients were approached and informed about this study by a nurse of Reade. For group 2, from November 2017, new participants in the Reade at-risk cohort,^{15–17} and inclusions up to 6 months retrospectively, were approached by a physician. Participants in this cohort have the combination of inflammatory-type arthralgia and increased serum levels of IgM-RF and/or ACPA. After oral consent to the nurse or physician of Reade, potential participants for groups 1 and 2 were contacted, thoroughly informed about this study, and eventually recruited by a dentist (JMK).

Participants for the control group (group 3) were recruited from among the regular dental patient population at the Academic Centre for Dentistry Amsterdam (ACTA), and from among a group of people who expressed interest in participating in research at ACTA. Recruitment was done by a dentist (JMK), either directly or after initial approach by a dental student of ACTA. Control subjects were matched to groups 1 and 2 for sex and age.

Potential participants were approached until the targeted amount of 50 participants in each group was reached, which occurred in March 2019 for group 2 and in July 2019 for groups 1 and 3. All research visits took place at Reade and all clinical examinations were performed by one trained dentist (JMK). Because all recruitment and scheduling of research appointments was performed by the same dentist, blinding of the examiner was not feasible.

Outcome variables

General health status

Prior to the research visit, all subjects completed a medical questionnaire to identify possible confounders, such as comorbid disorders and medication use. During the research visit, additional questions were asked about recent use of analgesics because of the potential masking effect on TMD pain during the clinical examination.

Venous blood was collected to determine serum levels of IgM-RF and ACPA; individuals with IgM-RF levels of >5.0 kU/L and/or ACPA levels of >10.0 kU/L were considered seropositive; otherwise, subjects were considered seronegative.

For ERA patients, the Disease Activity Score (DAS28) score¹⁸ was determined by a trained registered nurse of Reade. A DAS28 score of <2.6 is associated with being in remission according to the American Rheumatism Association criteria.¹⁹ The ERA patients were also asked to complete the routine assessment of patient index data 3 (RAPID-3) questionnaire, resulting in a score ranging from 0 to 10, representing the subjective disease status.²⁰

TMJ disorders

The presence of a TMD was classified according to the DC/TMD.¹⁰ Five diagnostic categories were recognised: (1) myalgia (2) arthralgia (3) disc displacement (4) degenerative joint disease and (5) headache attributed to TMD. Prior to the research visit, all participants filled out the DC/TMD symptom questionnaire with 14 questions on pain in the joint area, headache, joint sounds and joint locking^{21 22} (see reference for URL).

The clinical examination was performed according to the DC/TMD Clinical Examination Protocol.²³ To determine a possible TMD-pain diagnosis (myalgia or arthralgia), the clinical examination included the measurement of maximum mandibular movements (opening, protrusion and laterotrusion to both sides), and the registration of possible pain in the TMJs and/or surrounding muscles during these movements. Pain on palpation was recorded on both the masseter muscles and the temporal muscles (nine points on each muscle), and on the lateral pole and around the lateral pole of both TMJ condyles. To be diagnosed with myalgia or arthralgia, a participant had to report familiar pain during one of the clinical tests in the muscle or joint area, respectively, combined with reported orofacial pain that is influenced by jaw activity during the past 30 days on the questionnaire.

Non-painful symptoms, for example, unpleasantness, tension and soreness, were also recorded during the clinical examination. When a participant reported pain on the questionnaire and recognised the location of unpleasant non-painful symptoms, but not pain, during the clinical examination, these participants were categorised as having a DC/TMD diagnosis. This decision was made based on the current insight that both pain and non-painful symptoms are associated with TMD pain.²⁴

A possible disc displacement or degenerative joint disease diagnosis was based on the presence of clicking sounds or crepitation, respectively. Participants were asked to perform each of the following jaw movements three times: open and close, protrusion, and laterotrusion to both sides. To be diagnosed with a disc displacement or degenerative joint disease, respectively, the click or crepitation should be heard by, or be palpable to the examiner during the examination, combined with reported sounds by the participant on the questionnaire or during the examination.

To be diagnosed with a headache attributed to TMD, a participant had to report a familiar headache induced by jaw movement or palpation during the clinical examination, combined with reported headache in the temporal region that is influenced by jaw activity on the questionnaire, and a TMD-pain diagnosis in the category myalgia and/or arthralgia.

The dentist performing the clinical research (JMK) was trained in performing the described examinations by a specialist in TMD who was calibrated by the International Network for Orofacial Pain and Related Disorders Methodology consortium.²⁵

Bruxism

To study a possible role of bruxism, both subjective and objective bruxism activity were measured. These findings were used to determine a bruxism diagnosis according to the diagnostic grading system proposed by Lobbezoo *et al.*^{11 12} According to this grading system, 'possible' bruxism is diagnosed based on self-report, and thus, patients were asked about their assumption of performing bruxism activity while awake and/or during sleep using the questions from the DC/TMD oral behaviours questionnaire.²¹ Participants were diagnosed with possible bruxism if they reported grinding and/or clenching with a frequency of at least '1–3 nights a month' (sleep bruxism) or 'sometimes' (awake bruxism).

'Probable' bruxism is diagnosed based on the combination of self-report and clinical findings, that is, the presence of at least one of the following: a bruxoposition (ie, an obvious and reproducible contact position of the teeth of the upper and lower jaw, indicating grinding towards and/or clenching in this contact position), impressions of the teeth in the soft tissues (cheeks, tongue and/or lips) and tooth wear of mechanical nature with a minimum grade 2 according to the Tooth Wear Evaluation System.²⁶

Statistical analysis

Descriptive statistics were used to describe the characteristics of the study cohort. For continuous variables, the independent samples t-test was used when comparing the means of two groups, and the one-way analysis of variance was used when comparing the means of more than two groups. Differences between groups on binary variables were tested with a χ^2 test, or Fisher's exact test when appropriate. A two-sided alpha level of 0.05 was used for all statistical analyses.

For the primary outcome, that is, prevalence of TMD and TMD-pain diagnoses, the three study groups were compared. Additionally, within the ERA group, seropositive and seronegative patients were compared. Secondary, to test for a possible relation between the prevalence of TMD (pain) and other variables, for example, use of analgesic medication during the past 24 hours and mandibular movement capacity, participants with and without a TMD(-pain) diagnosis within the total study population were compared. For analyses including bruxism as a variable, the probable bruxism diagnoses were used.

RESULTS

Characteristics of the study sample

From November 2017 to July 2019, 150 participants were included, 50 per group. [Table 1](#) displays the characteristics of the study sample. The ERA patients were included in the study after being diagnosed with RA for an average of 3.1 ± 1.7 months. The time since RA diagnosis was longer for seronegative patients than for seropositive patients (3.8 ± 2.2 vs 2.9 ± 1.4 months, $p=0.011$). The majority (88%) of ERA patients was treated with

Table 1 Characteristics of the study sample

	ERA group (n=50)	At-risk group (n=50)	Control group (n=50)	P value
Age, years (mean (SD))	52.1 (13.2)	51.4 (10.3)	51.2 (11.0)	0.923*
Gender, female (n (%))	39 (78)	38 (76)	38 (76)	0.963†
IgM-RF positive (n (%))	37 (74)	46 (92)	0 (0)	–‡
ACPA positive (n (%))	31 (62)	24 (48)	0 (0)	–‡
DAS28 (mean (SD))	2.61 (1.17)	–	–	–
RAPID-3 (median (IQR))	3.09 (1.07–4.47)	–	–	–
Analgesic medication <24 hours (n (%))	12 (24)	16 (32)	9 (18)	0.265†
Pharmacological treatment for RA				
Methotrexate (n (%))	44 (88)	–	–	–
Other (n (%))	4 (8)	–	–	–
No pharmacological treatment (n (%))	2 (4)	–	–	–
Prednisone (n (%))	39 (78)	–	–	–

*One-way ANOVA, F=0.080.

† χ^2 test, $\chi^2=0.075$.

‡A difference in IgM-RF or ACPA positivity was not tested between the groups, because seropositivity was an inclusion criterion for the at-risk group and an exclusion criterion for the control group, and a difference is thus obvious.

ACPA, anticitrullinated protein antibodies; ANOVA, analysis of variance; DAS, Disease Activity Score; ERA, early rheumatoid arthritis; IgM-RF, IgM rheumatoid factor; ; RA, rheumatoid arthritis; RAPID-3, routine assessment of patient index data 3.

methotrexate, mostly in combination with prednisone, according to the Dutch guideline on drug treatment of RA²⁷ (table 1).

Temporomandibular disorders

No significant differences were found for the prevalence of TMD diagnoses between the three study groups (table 2). Because a temporomandibular disc displacement is a very

common condition in the general population that usually requires no treatment,²⁸ results are also reported for numbers of participants with a TMD-pain diagnosis (either myalgia, arthralgia or both), and for having a degenerative joint disease diagnosis (table 2). A significantly higher number of participants in the at-risk group had a TMD-pain diagnosis compared with the control group (p=0.046). No

Table 2 Prevalence of TMD, TMD pain, DJD and mandibular movement capacity in the study sample

	ERA group (n=50)	At-risk group (n=50)	Control group (n=50)	Test statistics	P value
Diagnosis according to DC/TMD					
TMD diagnosis* (n (%))	20 (40)	19 (38)	14 (28)	$\chi^2=1.604^*$, 1.131†	0.205‡§, 0.288¶§
TMD-pain diagnosis† (n (%))	7 (14)	8 (16)	2 (4)	$\chi^2=4.000†$	0.16‡ ** 0.046¶§
DJD diagnosis (n (%))	6 (12)	2 (4)	2 (4)		0.269‡ ** 1.0¶ **
Bruxism					
Probable sleep bruxism (n (%))	9 (18)	14 (28)	11 (22)		0.485§
Mandibular movement capacity					
Maximum mouth opening, mm (mean (SD))	49.1±7.2	51.4±5.2	50.7±6.3	F=1.815	0.167††
Maximum protrusion, mm (mean (SD))	8.5±2.1	7.8±2.5	8.2±2.8	F=0.836	0.436††
Maximum laterotrusion, mm (mean (SD))	10.6±2.3	10.7±2.4	9.9±3.0	F=1.332	0.267††

Significant p-values are presented in bold writing.

*Myalgia, arthralgia, disc displacement, DJD and/or headache attributed to TMD.

†Myalgia and/or arthralgia.

‡ERA group versus control group.

§ χ^2 test.

¶At-risk group versus control group.

**Fisher's exact test.

††One-way ANOVA (F).

ANOVA, analysis of variance; DC, diagnostic criteria; DJD, degenerative joint disease; ERA, early rheumatoid arthritis; n, number of observations; TMD, temporomandibular disorders.

such difference was found when comparing the ERA group to the control group. However, within the ERA group, seronegative patients had a TMD-pain diagnosis significantly more often than seropositive patients (4/12 (33%) vs 3/38 (8%), $p=0.048$).

Sixteen out of 17 participants with a TMD-pain diagnosis reported on the duration of their pain complaints, with a median (IQR) of 15 (4–138) months. For six out of eight (75%) participants with a myalgia, the diagnosis was bilateral. For arthralgia, 6 out of 12 participants (50%) had a bilateral diagnosis, and another three participants (25%) had unfamiliar pain or non-painful symptoms on the contralateral side. A total of 37 participants reported to have used analgesic medication, mostly paracetamol, during the past 24 hours. There was no difference in analgesic medication use between participants with or without a TMD-pain diagnosis ($p=0.765$).

No difference was found between the groups in mandibular movement capacity, that is, maximum mouth opening, protrusion and laterotrusion (table 2). For laterotrusion, an average of the laterotrusion to the left and to the right was used for analysis, because there was no significant difference in laterotrusion between the painful and non-painful side ($p=0.933$) in participants with unilateral TMD pain. When comparing participants with and without a TMD-pain diagnosis in the total study population, also no difference was found in mandibular movement capacity (opening $p=0.906$, protrusion $p=0.788$ and laterotrusion $p=0.333$).

Bruxism

The number of participants reporting on awake bruxism only—five in total—was too small for statistical analysis, and thus only results for sleep bruxism were further analysed. Thirty-five participants reported possible sleep bruxism activity, of which 34 participants were diagnosed with probable sleep bruxism—nine in the ERA group, 14

in the at-risk group, and 11 in the control group—with no significant difference between the groups ($p=0.485$).

No difference was found in probable sleep bruxism diagnosis between participants with and without any TMD diagnosis (15/53 (28%) vs 19/97 (20%), $p=0.223$). However, participants with a TMD-pain diagnosis had a probable sleep bruxism diagnosis more often than participants without a TMD-pain diagnosis (8/17 (47%) vs 26/133 (20%), $p=0.011$).

Relation to disease activity in the ERA group

Within the ERA group, no difference in the prevalence of TMD ($p=0.355$) or TMD pain ($p=0.697$) was found between patients with a DAS28 score <2.6 and patients with a DAS28 score ≥ 2.6 . However, the RAPID-3 score was significantly higher for patients with a TMD diagnosis compared with patients without a TMD diagnosis (3.76 ± 1.97 vs 2.46 ± 2.06 , $p=0.031$). This difference was not found between patients with or without a TMD-pain diagnosis (3.72 ± 2.40 vs 2.86 ± 2.06 , $p=0.324$).

The RAPID-3 score did not differ between seropositive and seronegative ERA patients (3.0 ± 1.8 vs 3.0 ± 2.2 , $p=0.982$). However, when comparing the DAS28 score of both groups, seronegative patients were more often categorised as being in remission compared with seropositive patients (10/12 (83%) vs 14/38 (37%), $p=0.005$).

Pain and non-painful symptoms without a DC/TMD diagnosis

In addition to the official DC/TMD classifications, figure 1A and B shows the prevalence of unfamiliar pain and non-painful symptoms during the clinical examination for the categories myalgia and arthralgia, respectively. In addition to the 17 participants with a TMD-pain diagnosis, a total of eight participants—five in the ERA group, two in the at-risk group, and one in the control group—reported pain influenced by jaw function on the questionnaire, but did not confirm familiar pain or non-painful symptoms during the clinical examination. The

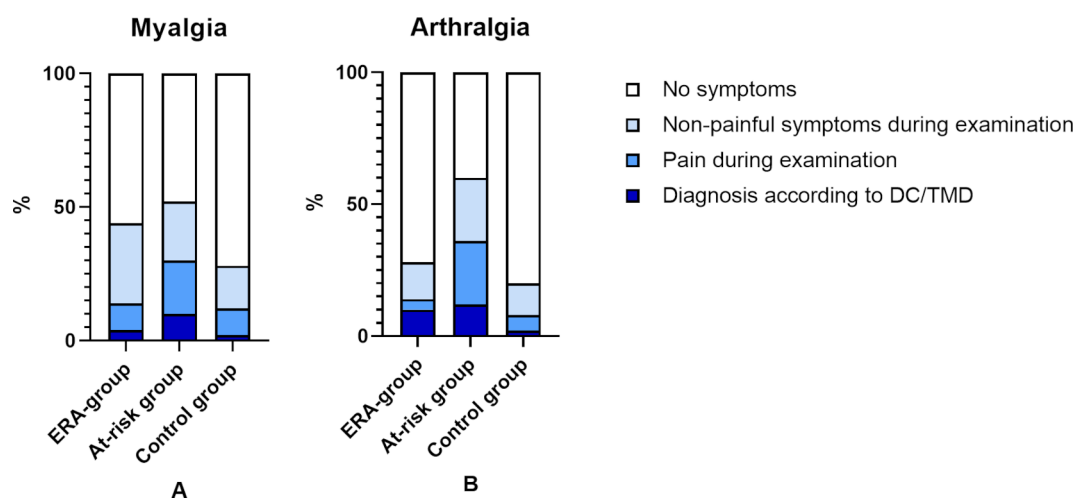


Figure 1 Percentages of participants with a diagnosis according to the diagnostic criteria for temporomandibular dysfunction (DC/TMD), unfamiliar pain during examination, non-painful symptoms during examination and no symptoms. (A) results for myalgia; (B) results for arthralgia. ERA, early rheumatoid arthritis.

positive predictive value of the DC/TMD questionnaire in the present study population is thus $(17 / (17+8)) = 68\%$.

In the ERA group, two patients reported familiar pain in the TMJ during the clinical examination and pain in the questionnaire, but not during the past 30 days, and thus did not receive a DC/TMD arthralgia diagnosis. Two other ERA patients reported previous pain in the TMJ, which resolved since the start of pharmacological treatment for RA. One ERA patient with an arthralgia diagnosis reported to have less pain after taking daily doses of prednisone. Out of these five patients, four were seropositive ERA patients.

DISCUSSION

The prevalence of TMD according to the DC/TMD was investigated cross-sectionally in patients with ERA, individuals at risk of developing RA, and an age-matched and sex-matched healthy control group. The three groups did not differ when comparing them based on the prevalence of TMD, that is, myalgia, arthralgia, disc displacement, degenerative joint disease and headache attributed to TMD combined. However, when considering TMD-pain diagnoses only—myalgia and/or arthralgia—participants in the at-risk group had a higher prevalence of TMD pain than those in the control group. These results suggest that medical professionals should be alert for TMD-pain disorders in individuals at-risk of RA, in order to identify individuals that might benefit from referral to a dentist—preferably with a specialisation in orofacial pain and dysfunction if available in the region. In addition to official TMD diagnoses, the results of this study also show a high prevalence of pain and non-painful symptoms during the clinical examination not resulting in an official diagnosis, particularly in the at-risk group. This could be an early sign of later TMD-pain complaints,²⁹ and further strengthens the suggestion to be alert to TMD-pain disorders in individuals at-risk of RA. With these results, this study is the first to report on TMJ involvement in at-risk individuals.

The ERA group did not differ from the control group in prevalence of TMD pain. However, within the ERA group, seronegative patients more often had a TMD-pain diagnosis than seropositive patients. Seronegative patients were also more often categorised as being in remission based on the DAS28 score, possibly due to the longer time between RA diagnosis and participation in the study and thus better results of the pharmacological treatment for RA. Furthermore, both the DAS28 score and RAPID-3 score were not related to the prevalence of TMD pain. In only a few patients TMJ pain had subsided after treatment for RA. These results suggest that TMD pain occurs regardless of the general disease status, and could be associated with seronegative RA.

On the other hand, some cases indicate that the start of pharmacological treatment for RA could have lowered the prevalence of TMD in the ERA group; two patients

reported familiar pain during the clinical examination and on the questionnaire, but not during the past 30 days, and three patients specifically mentioned experiencing less pain or even being pain free since the start of pharmacological treatment for RA. This is in accordance with the findings of Chin Jen Sem *et al*,⁸ where prevalence of pain on palpation of the TMJ in a group of ERA patients decreased after the start of systemic RA treatment. Because four out of these five patients were seropositive ERA patients, the mechanism of TMJ involvement and thus the effect of systemic treatment on the TMJ might be seropositivity dependent. This corresponds to the findings of Alstergren *et al*, where TMJ pain on mandibular movement was mainly correlated to systemic factors in seropositive patients, but to local factors in seronegative patients.³⁰ Furthermore, seropositive patients had higher systemic inflammatory activity, but lower TMJ movement pain intensity,³⁰ which also corresponds to our findings.

In our study, mandibular movement capacity was not related to TMD pain, nor limited in ERA patients and at-risk individuals. In general, maximum mouth opening capacity can be limited in patients with TMD and is therefore often an outcome measure when evaluating TMD-treatment efficacy,³¹ but our results do not confirm a relation between TMD pain and limited mouth opening for the present study population. For ERA patients, our results do correspond to an earlier study by Kroese *et al*,³² where patients with ERA and established RA were compared: while TMJ pain was already present in ERA, reduced mouth opening capacity was found to be related to established RA.

We noted that for the vast majority of participants who reported possible sleep bruxism, also a probable bruxism was determined based on clinical findings. The prevalence of probable sleep bruxism did not differ between the three groups. However, probable sleep bruxism was found more often in participants with a TMD-pain diagnosis compared with participants without a TMD-pain diagnosis. These results suggest an association between sleep bruxism and TMD pain in the present study population. This corresponds to literature on other populations.^{13 33 34}

Implications for practice

Based on our results, it is recommended to watch out for the possible presence of TMD pain in individuals at-risk of developing RA and in patients with seronegative ERA. In the ERA group, TMD pain occurred regardless of general disease status. The few individuals that did seem to benefit from general RA treatment on TMD pain, reported that they experienced less pain or were pain free since the start of the pharmacological treatment. This suggests that an effect on TMD pain can be expected early, and thus screening for a possible TMD that needs additional treatment should start soon after the start of the pharmacological treatment.

In our study, the positive predictive value of the DC/TMD questionnaire was 68% for TMD-pain diagnoses. Only four questions need to be answered in order to screen for possible TMD pain, of which three do not have to be answered if the

answer to the first question is negative. Therefore, the section about pain of the questionnaire²² could be a quick, simple, and valid screening tool for rheumatologists or other health professionals in order to identify ERA patients or at-risk individuals that could benefit from further TMD examination and management.

Strengths and limitations

Strengths of this study include the extensive and standardised TMD examination according to the DC/TMD, the evaluation of bruxism as a possible associated factor, and the matching of the control group to the other two groups. However, there are also certain limitations to this study. Within the ERA group, some analyses were performed to compare seropositive and seronegative patients, and to compare patients with a DAS28 score higher or lower than 2.6. Although the results indicate some interesting differences, dividing the ERA group in subgroups consequently means lowering the number of subjects per group, which limits the power of the analyses and generalisability of the results. These results should, therefore, be interpreted with caution, and research on a larger group of ERA patients would be necessary to confirm the present findings.

Possible related factors to a TMD(-pain) diagnosis were tested for the total study population, in order to have total numbers that are substantial enough for statistical analysis. These analyses, therefore, do not provide information on the individual groups. For the same reason, results for myalgia and arthralgia were combined as TMD-pain disorders. Consequently, the results do not provide specific information on the nature of the TMD pain. However, independently of its nature, TMD pain is a relevant clinical outcome because it can negatively influence the oral health-related quality of life, most often on the subdomains of psychological discomfort and disability, and causing functional limitation.^{35 36}

In this study, probable bruxism was diagnosed based on self-report and several clinical factors. This is a limitation of the study, since definite bruxism diagnoses were not established. Furthermore, the number of participants reporting awake bruxism was too small for statistical analyses. However, the diagnostic grading system for bruxism requires polysomnographic recording or electromyographic recording for a definite diagnosis of sleep or awake bruxism, respectively,^{11 12} which are labour-intensive and costly procedures that are therefore only seldom applied in larger clinical studies. Furthermore, there is still much debate about the ideal way to assess sleep and awake bruxism, as acknowledged by the authors of the diagnostic grading system.¹² For future research including the assessment of awake bruxism, the use of Ecological Momentary Assessment^{37 38} is recommended.

CONCLUSION

The results of this study provide a valuable insight into the prevalence and clinical characterisation of TMJ involvement in patients with ERA and at-risk individuals.

Based on these results, it is recommended to be alert to TMD-pain disorders in individuals at-risk of developing RA and in patients with seronegative ERA. The DC/TMD symptom questionnaire is suggested as a useful tool for rheumatologists or other health professionals to screen for possible TMD pain in these groups. Individuals who might benefit from further TMD examination and management can then be identified and referred to a suitable dental healthcare provider, preferably with a specialisation in orofacial pain and dysfunction. Sleep bruxism might be an important factor in the development of TMD pain in the study population.

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REFERENCES

- 1 Scott DL, Wolfe F, Huizinga TWJ. Rheumatoid arthritis. *Lancet* 2010;376:1094–108.

- 2 Malmström V, Catrina AI, Klareskog L. The immunopathogenesis of seropositive rheumatoid arthritis: from triggering to targeting. *Nat Rev Immunol* 2017;17:60–75.
- 3 Aletaha D, Neogi T, Silman AJ, et al. 2010 rheumatoid arthritis classification criteria: an American College of Rheumatology/ European League against rheumatism collaborative initiative. *Ann Rheum Dis* 2010;69:1580–8.
- 4 Netherlands Institute for Health Services Research. Tabellenboek Reumatische aandoeningen in Nederland, 2016. Available: https://www.nivel.nl/sites/default/files/bestanden/Tabellenboek_Reumatische_aandoeningen_Nederland.pdf
- 5 Wolfe F, Katz RS, Michaud K. Jaw pain: its prevalence and meaning in patients with rheumatoid arthritis, osteoarthritis, and fibromyalgia. *J Rheumatol* 2005;32:2421–8.
- 6 Bono AE, Learreta JA, Rodriguez G, et al. Stomatognathic system involvement in rheumatoid arthritis patients. *Cranio* 2014;32:31–7.
- 7 Lin Y-C, Hsu M-L, Yang J-S, et al. Temporomandibular joint disorders in patients with rheumatoid arthritis. *J Chin Med Assoc* 2007;70:527–34.
- 8 Chin Jen Sem JP, van der Leeden M, Visscher CM, et al. Prevalence, course, and associated factors of pain in the temporomandibular joint in early rheumatoid arthritis: results of a longitudinal cohort study. *J Oral Facial Pain Headache* 2017;31:233–9.
- 9 van Boheemen L, van Schaardenburg D. Predicting rheumatoid arthritis in at-risk individuals. *Clin Ther* 2019;41:1286–98.
- 10 Schiffman E, Ohrbach R, Truelove E, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network* and orofacial pain special interest Group†. *J Oral Facial Pain Headache* 2014;28:6–27.
- 11 Lobbezoo F, Ahlberg J, Glaros AG, et al. Bruxism defined and graded: an international consensus. *J Oral Rehabil* 2013;40:2–4.
- 12 Lobbezoo F, Ahlberg J, Raphael KG, et al. International consensus on the assessment of bruxism: report of a work in progress. *J Oral Rehabil* 2018;45:837–44.
- 13 Jiménez-Silva A, Peña-Durán C, Tobar-Reyes J, et al. Sleep and awake bruxism in adults and its relationship with temporomandibular disorders: a systematic review from 2003 to 2014. *Acta Odontol Scand* 2017;75:36–58.
- 14 Kroese JM, Volgenant CMC, van Schaardenburg D, et al. Temporomandibular joint function, periodontal health, and oral microbiome in early rheumatoid arthritis and at-risk individuals: a prospective cohort study protocol. *BDJ Open* 2020;6:7.
- 15 van Beers-Tas MH, Marotta A, Boers M, et al. A prospective cohort study of 14-3-3η in ACPA and/or RF-positive patients with arthralgia. *Arthritis Res Ther* 2016;18:76.
- 16 Holla JFM, van Beers-Tas MH, van de Stadt LA, et al. Depressive mood and low social support are not associated with arthritis development in patients with seropositive arthralgia, although they predict increased musculoskeletal symptoms. *RMD Open* 2018;4:e000653.
- 17 van Beers-Tas MH, Blanken AB, Nielen MMJ, et al. The value of joint ultrasonography in predicting arthritis in seropositive patients with arthralgia: a prospective cohort study. *Arthritis Res Ther* 2018;20:279.
- 18 van Riel PLCM, Renskers L. The disease activity score (DAS) and the disease activity score using 28 joint counts (DAS28) in the management of rheumatoid arthritis. *Clin Exp Rheumatol* 2016;34:S40–4.
- 19 Fransen J, Creemers MCW, Van Riel PLCM. Remission in rheumatoid arthritis: agreement of the disease activity score (DAS28) with the Ara preliminary remission criteria. *Rheumatology* 2004;43:1252–5.
- 20 Pincus T, Bergman MJ, Yazici Y. RAPID3—an index of physical function, pain, and global status as “vital signs” to improve care for people with chronic rheumatic diseases. *Bull NYU Hosp Jt Dis* 2009;67:211–25.
- 21 Ohrbach R. E. diagnostic criteria for temporomandibular disorders: assessment instruments, 2016. Available: www.rdc-tmdinternational.org [Accessed 2 Aug 2017].
- 22 Eke PI, Genco RJ. Cdc periodontal disease surveillance project: background, objectives, and progress report. *J Periodontol* 2007;78:1366–71.
- 23 Ohrbach RGY, List T, Michelotti A, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) clinical examination protocol: version 06January2014. Available: www.rdc-tmdinternational.org [Accessed 2 Aug 2017].
- 24 Baad-Hansen L, Thym M, Lobbezoo F, et al. To what extent is bruxism associated with musculoskeletal signs and symptoms? A systematic review. *J Oral Rehabil* 2019;46:845–61.
- 25 International network for orofacial pain and related disorders methodology (inform) DC-TMD examiner training, 2016. Available: <https://www.iadr.org/INFORM/DC-TMD/Examiner-Training>
- 26 Wetselaar P, Lobbezoo F. The tooth wear evaluation system: a modular clinical guideline for the diagnosis and management planning of worn dentitions. *J Oral Rehabil* 2016;43:69–80.
- 27 Ntr Richtlijn Medicamenteuze Behandeling van Reumatoïde artritis 2020.
- 28 Poluha RL, Canales GDlaT, Costa YM, et al. Temporomandibular joint disc displacement with reduction: a review of mechanisms and clinical presentation. *J Appl Oral Sci* 2019;27:e20180433.
- 29 Ohrbach R, Bair E, Fillingim RB, et al. Clinical orofacial characteristics associated with risk of first-onset TMD: the OPPERA prospective cohort study. *J Pain* 2013;14:T33–50.
- 30 Alstergren P, Fredriksson L, Kopp S. Temporomandibular joint pressure pain threshold is systemically modulated in rheumatoid arthritis. *J Orofac Pain* 2008;22:231–8.
- 31 Calixtre LB, Moreira RFC, Franchini GH, et al. Manual therapy for the management of pain and limited range of motion in subjects with signs and symptoms of temporomandibular disorder: a systematic review of randomised controlled trials. *J Oral Rehabil* 2015;42:847–61.
- 32 Kroese JM, Kopp S, Lobbezoo F. TMJ pain and crepitus occur early whereas dysfunction develops over time in rheumatoid arthritis. *J Oral Facial Pain Headache* . 2020;Fall;34(4):398–405.
- 33 Huhtela OS, Näpänkangas R, Joensuu T, et al. Self-Reported bruxism and symptoms of temporomandibular disorders in Finnish university students. *J Oral Facial Pain Headache* 2016;30:311–7.
- 34 Magalhães BG, Freitas JLdeM, Barbosa ACdaS, et al. Temporomandibular disorder: otologic implications and its relationship to sleep bruxism. *Braz J Otorhinolaryngol* 2018;84:614–9.
- 35 Dahlström L, Carlsson GE. Temporomandibular disorders and oral health-related quality of life. A systematic review. *Acta Odontol Scand* 2010;68:80–5.
- 36 Papagianni CE, van der Meulen MJ, Naeije M, et al. Oral health-related quality of life in patients with tooth wear. *J Oral Rehabil* 2013;40:185–90.
- 37 Osiewicz MA, Lobbezoo F, Bracci A, et al. Ecological Momentary assessment and intervention principles for the study of awake bruxism behaviors, part 2: development of a smartphone application for a multicenter investigation and chronological translation for the Polish version. *Front Neurol* 2019;10:170.
- 38 Zani A, Lobbezoo F, Bracci A, et al. Ecological Momentary assessment and intervention principles for the study of awake bruxism behaviors, part 1: general principles and preliminary data on healthy young Italian adults. *Front Neurol* 2019;10:169.