

Evaluation of the Research Diagnostic Criteria for Temporomandibular Disorders for the Recognition of an Anterior Disc Displacement with Reduction

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The aim of this Focus Article is to review critically the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) for the recognition of an anterior disc displacement with reduction (ADDR) in the temporomandibular joint (TMJ). This evaluation is based upon the experience gained through the careful analysis of mandibular movement recordings of hundreds of patients and controls with or without an ADDR. Clinically, it is a challenge to discriminate between the two most prevalent internal derangements of the TMJ: ADDR and symptomatic hypermobility. It is due to the very nature of these derangements that they both show clicking on opening and closing (reciprocal clicking), making reciprocal clicking not a distinguishing feature between these disorders. However, there is a difference in timing of their opening and closing clicks. Unfortunately, it is not feasible to use this difference in timing clinically to distinguish between the two internal derangements, because it is the amount of mouth opening at the time of the clicking which is clinically noted, not the condylar translation. Two other criteria proposed by the RDC/TMD for the recognition of an ADDR are the 5-mm difference in mouth opening at the time of the opening and closing clicks, and the detection of joint sounds on protrusion or laterotrusion in case of non-reciprocal clicking. These, however, run the risk of false-positive or negative results and therefore have no great diagnostic value. Instead, it is recommended that the elimination of clicking on protrusive opening and closing be examined in order to distinguish ADDRs from symptomatic hypermobility. J OROFAC PAIN 2009;23:303-311

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The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) provide a dual-axis diagnostic system for TMD.¹ The physical Axis I recognizes the clinical TMD conditions and the Axis II assesses the psychological status and the pain-related disability of the patient. The Axis I diagnoses are divided into three main groups, among which is Group II with anterior disc displacements (ADDs) in the temporomandibular joint (TMJ). In a TMJ with an ADD, the disc is displaced from its normal position between the condyle and the articular eminence to an anterior position in maximum intercuspation.² In most cases, the disc is restored (reduced) to its normal, physiological relationship with the condyle on opening, usually resulting in an opening click.

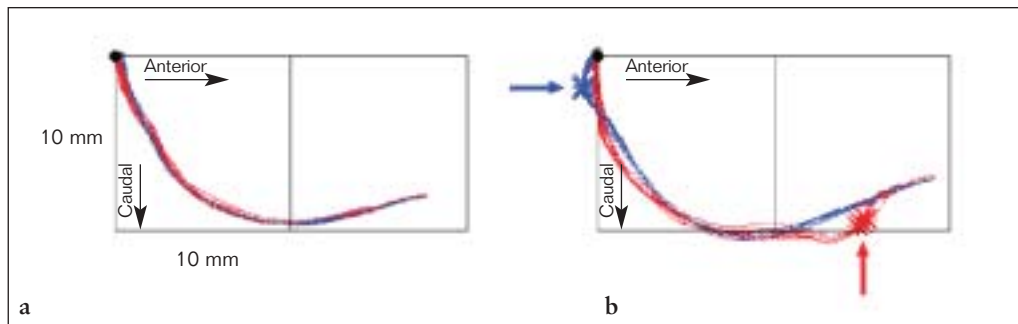


Fig 1 The superposition of six sagittal opening and closing movement traces of the kinematic center of a TMJ without (*a*) and with an ADDR (*b*). Interferences in the movement traces (see *arrows*) coincided with the reduction (opening click) and the dislocation of the disc (closing click). Opening traces are in red; closing traces are in blue. • denotes the starting point of the movement traces. Opening and closing clicking sounds are indicated with red and blue asterisks, respectively.

Late during closing, the disc gets dislocated again in an anterior direction with respect to the condyle, giving rise to a (usually much softer) closing click. This ADD is called an anterior disc displacement with reduction (ADDR) and is generally considered a harmless disorder of the TMJ, causing little or no discomfort to the patient.² However, in some cases, the anteriorly displaced disc does not reduce (anymore) on opening and stays permanently displaced with respect to the condyle (ie, an anterior disc displacement without reduction). In the acute phase, the TMJ is then often painful and it is impossible for the patient to fully open his or her mouth. In the long run, the pain usually subsides and the mouth opening restores to acceptable levels. Despite these clinical improvements, the disc is still anteriorly displaced, thereby possibly rendering the TMJ vulnerable to joint degeneration.³

Knowledge of the prevalence rate, the onset, and the natural course of ADDRs is scarce. So far, most epidemiological studies have focused on the most important clinical symptom of an ADDR, viz, TMJ clicking on movement,^{4,5} and less on the underlying causes of the clicking.^{4,5} However, TMJ clicking may be indicative of other types of internal derangements rather than an ADDR, such as symptomatic hypermobility.^{6,7} From a research point of view, and for proper counseling of patients with a clicking TMJ, it is important to look beyond the clinical phenomenon of TMJ clicking and be able to differentiate between the different underlying causes of clicking.

The validity of the RDC/TMD criteria is so far based upon consensus, reached by a team of recognized TMD specialists (“face-validity”). Studies to investigate their validity were encouraged when

the RDC/TMD were first presented in 1992. Efforts have recently been made to produce a revised version of the RDC/TMD.^{8,9} The aim of this Focus Article is to review critically the RDC/TMD for the recognition of an ADDR in the TMJ. This evaluation is based upon the experience gained by the authors through the careful analysis of the electronic mandibular movement recordings of hundreds of patients and controls with or without an ADDR. These recordings were made as part of a long-term study of the onset and natural course of internal derangements of the TMJ and of risk factors associated with these disorders.¹⁰⁻¹²

The instrumental recording of mandibular movements enables the objective documentation of the results of a clinical examination of the TMJ.⁶ In the Department of Oral Kinesiology of the Academic Centre for Dentistry Amsterdam (ACTA), an opto-electronic system has enabled the recording of mandibular movements with six degrees of freedom.¹³ With the use of rigid body mathematics, a reconstruction of the movement traces of any mandibular point relative to the skull could then be obtained. In the objective documentation of a clinical examination, the movement traces of the lower incisal point and those of the kinematic centers of the TMJ¹⁴⁻¹⁶ have been reconstructed. Specific characteristics of condylar movement traces, such as limited length, crossing of opening and closing traces, or a substantial distance between opening and closing traces, may suggest the presence of an ADDR. To avoid “false-positive” diagnoses, it is important that condylar movement traces of asymptomatic joints show none of these characteristics. Movement traces of the kinematic center of the condyle meet these criteria (Fig 1a), because they are insensitive to the

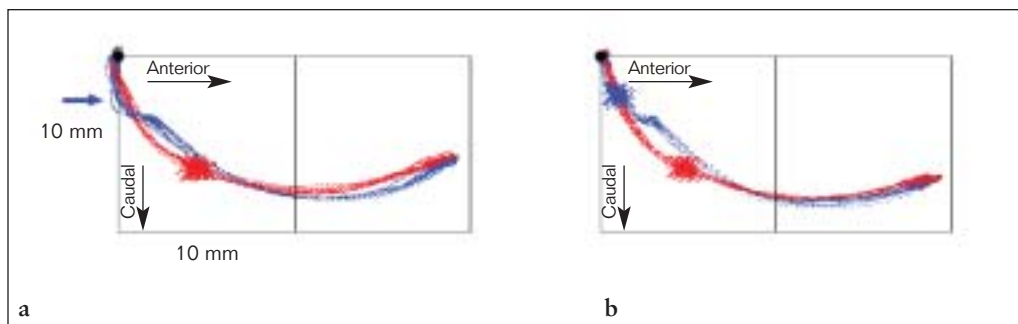


Fig 2 Superimposed sagittal movement traces of the kinematic center of a TMJ with an ADDR during free opening and closing (*a*) and during free opening and loaded closing (*b*). Despite the movement interferences at the end of free closing (*arrow*), indicative of the dislocation of the disc, no closing clicks were detected. Loading of the mandible during closing enhanced the intensity of the closing clicks as evidenced by the appearance of the closing clicks. For further explanation, see Fig 1 legend.

(often variable) rotatory component of condylar movements.¹⁷ Simultaneous with the mandibular movements, joint sounds have been recorded using small condenser type microphones placed over the palpated lateral poles of the TMJs. In the otherwise smooth opening and closing movement traces of the kinematic center of a TMJ with an ADDR, reproducible interferences can be observed (see arrows in Fig 1b) which are associated with the occurrences of the opening (reduction) and closing (dislocation) clicks.^{6,18,19} In a kinematic study with 30 participants with an ADDR, it was noted that opening clicks can occur over a broad range of the condyle's kinematic center opening trace (7.3 ± 4.5 mm), whereas closing clicks occur in a narrow range (1.5 ± 1.1 mm) just before the kinematic center reaches its end position.¹⁸ The distance travelled by the condyle's kinematic center from the starting point of the movement until the opening click was found to be not correlated to the distance travelled from the closing click until the end of the closing movement ($P = .14$). This suggests that the mechanisms responsible for the reduction and dislocation of the disc are unrelated.

The RDC/TMD Criteria to Recognize an ADDR

The RDC/TMD offer two sets of criteria to recognize an ADDR. In the first set, an ADDR is recognized:

- When the clicking in the TMJ is reciprocal (viz, clicking on opening and on closing)
- When the clicking is reproducible on at least two of three consecutive movement trials

- When the interincisal distance at the time of the opening click is at least 5 mm greater than the interincisal distance at the time of the closing click
- When the clicking is eliminated on protrusive opening and closing

In the second set, an ADDR is recognized:

- When there is clicking in the TMJ on either opening or closing
- When there is clicking during lateral excursion and/or protrusion

The clinical RDC/TMD criteria for the recognition of an ADDR are now considered in sequence.

Reciprocal Clicking During Opening and Closing

Reciprocal clicking is the acoustical manifestation of the reduction (opening click) and the dislocation of the disc (closing click) during opening and closing movements. The clinical observation of the reciprocal nature of ADDR clicking may be hampered by the fact that the closing click is usually much softer than the opening click. Figure 2a illustrates that the absence of an observable closing click does not necessarily imply that there is no ADDR present in the TMJ. The interferences in the condylar movement traces at the end of closing (see arrow) indicate the dislocation of the disc and the presence of an ADDR in the TMJ.

Although not undisputed,²⁰ biomechanical modeling of the human TMJ²¹ and careful analysis of the opening and closing traces of the kinematic

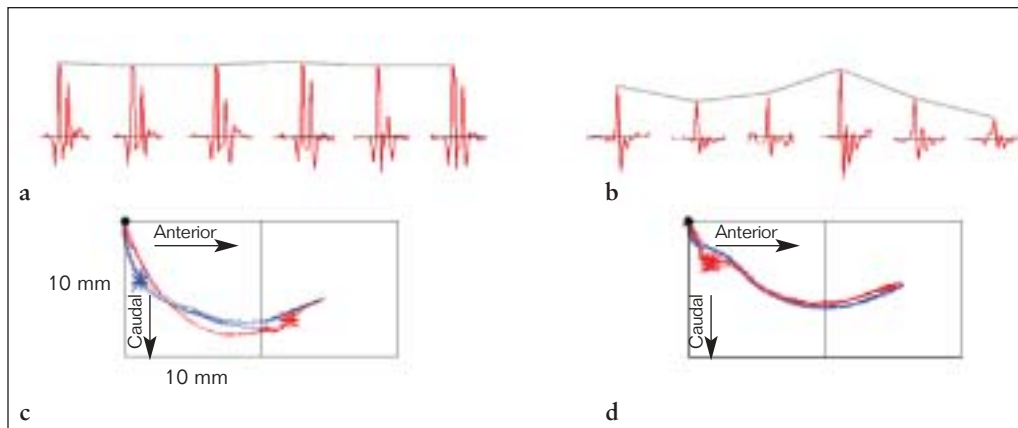


Fig 3 Sound recordings of two patients with a small (*a*) and a large (*b*) variation in acoustic intensity of their TMJ clicking sounds during opening. Despite these differences, the superimposed sagittal kinematic center movement traces and the timing of the opening clicks with respect to these traces were highly reproducible (*c*, *d*). For further explanation, see Fig 1 legend.

center²² have suggested that the TMJ's compressive load is less during closing than during opening. This may, amongst other reasons, account for the differences in acoustic intensity between the opening and closing clicks. The compressive load in the TMJ during closing can be increased by applying a small (about 30 N) downwardly directed force to the patient's chin during closing. When an ADDR is the cause of the TMJ clicking, the acoustic intensity of the closing click will then increase and, in most cases, the patient will also report a (louder) closing click^{7,18} (Fig 2b).

Thus, if there is doubt about the reciprocal nature of the TMJ clicking, the acoustic intensity of the closing click may be enhanced by lightly loading the mandible on closing through the application of a small downwardly directed force (about 30 N) to the patient's chin.

Clicking Sounds Reproducible on at Least Two of Three Consecutive Movement Trials

It is an often-made clinical observation that the loudness of the clicking sounds of an ADDR may vary considerably from one opening movement trial to another and this may seriously hamper the observation of the clicking on at least two of three consecutive movement trials. Figure 3 shows the sound recordings of patients with a small (Fig 3a) and a large (Fig 3b) variation in the acoustic intensity of their TMJ clicking sounds during opening. Irrespective of the variations in clicking sounds, both patients showed only small variations in the

opening movement traces of their condyle's kinematic center and in the timing of the disc reduction with respect to these traces (Figs 3c and 3d). In a kinematic study with 30 participants with an ADDR,¹⁸ the short-term (within a 20-second recording period) within-subject standard deviations (SD) in the distances travelled by the condyle's kinematic center between the maximum occlusion position and the time of clicking were small (0.5 mm for the opening click and 0.4 mm for the closing click). These small SDs suggest that the large variation in the acoustic intensity of clicking sounds is not an indication of an unstable ADDR condition within the TMJ, nor is it the result of a large variation in the velocities with which the mandibular movements are being performed.²³

Sometimes there is a large variation in the acoustic intensity of TMJ clicking sounds and this may also (partly) explain the observation in follow-up studies that TMJ clicking may substantially fluctuate over time.^{4,5} Preliminary results from a kinematic study to the 1-year time course of ADDRs indicate that, in the majority of cases, the ADDR is stable over the period of investigation.¹² Therefore, while clicking sounds may fluctuate over time, the ADDR is in most cases a stable TMJ condition.

Variations in the acoustic intensity of ADDR clicking may be related to variations in the compressive load of the TMJ during consecutive movements. A softer clicking sound is then related to a smaller load within the TMJ. The detection of TMJ clicking sounds can then be improved by increasing the compressive load within the TMJ through

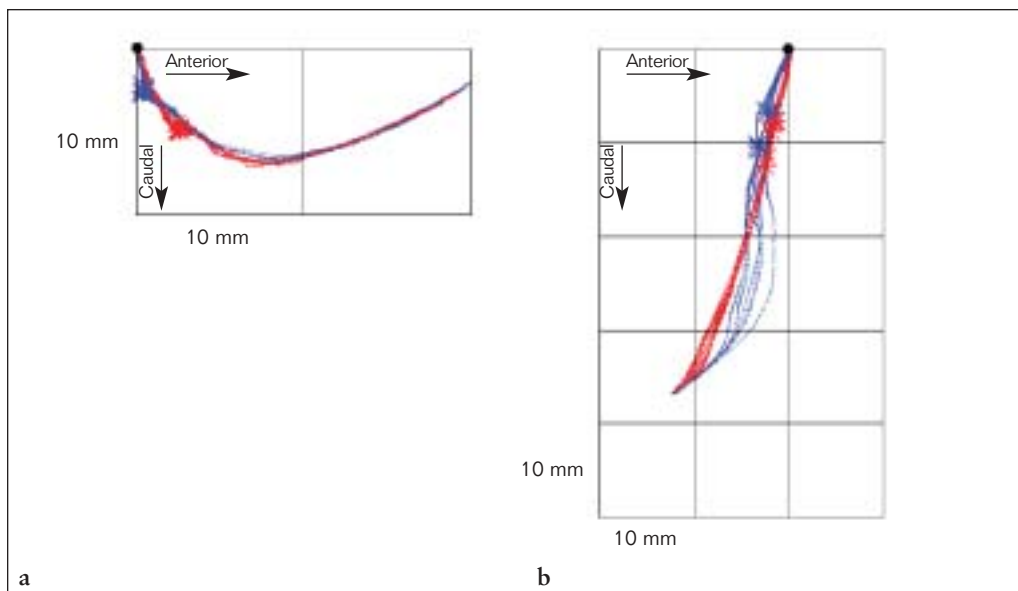


Fig 4 Example of failure of the 5-mm criterion for an ADDR with an early reduction on opening. Superimposed sagittal movement traces of the kinematic center (*a*) and of the lower incisal point (*b*) during six opening and closing movements. Despite the fact that the translation of the kinematic center at the time of the opening click was greater than at the time of the closing click, the 5-mm criterion for the interincisal distances was not fulfilled. For further explanation, see Fig 1 legend.

lightly loading the mandible not only during closure, but also during opening. Thus, light mechanical loading of the TMJ (about 30 N) not only during closing but also during opening may facilitate the detection of TMJ clicking sounds.

An Interincisal Distance at the Time of the Opening Click That Is at Least 5 mm Greater Than at the Time of the Closing Click

A study incorporating 30 participants with an ADDR¹⁸ showed that the 5-mm criterion is not very characteristic for an ADDR. It is true that the average interincisal distance at the time of the opening click (19.8 ± 10.1 mm) was significantly greater ($P = .000$) than the distance at the time of the closing click (8.0 ± 6.0 mm). However, in only 22 of the 30 participants was the difference in interincisal distance greater than 5 mm. This indicates that the 5-mm criterion has a sensitivity of about 73% and will give rise to false negative results in 27% of the patients with an ADDR. Especially for early reducing ADDRs, false negative results may be expected (Fig 4).

The high within-subject SDs in the interincisal distances at the time of the opening and closing clicks (1.9 mm and 2.5 mm, respectively)¹⁸ indicate

that the within-subject SD in the interincisal difference between opening and closing clicks is about 3.1 mm. This illustrates that it is difficult to find differences smaller than 5 mm, especially in the clinical situation. This, in combination with the lack of a biological justification for the 5-mm criterion in the RDC/TMD, questions the clinical significance of this criterion.

Thus, the 5-mm criterion has probably no great additional value in the clinical recognition of ADDRs, especially not for those manifesting an early click on opening.

Elimination of Clicking Sounds on Protrusive Opening and Closing

The dislocation of the disc occurs in a restricted part of the closing trace, just before the condyle reaches its end position.^{18,24} Performing protrusive opening and closing movements (ie, movements which start from and end in a protruded incisal position) will prevent the condyle from reaching this end position. When the protruded incisal position is far enough in front of the end position, the closing movements will stop before the dislocation occurs. The disc will then stay in its normal, physiological relationship with the condyle during the whole range of protruded opening and closing

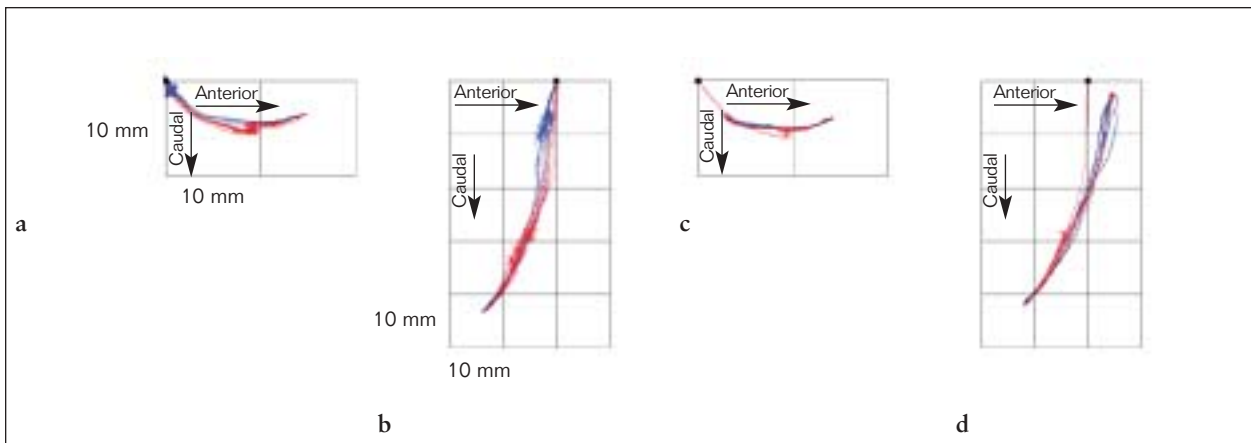


Fig 5 Example of the elimination test for an ADD with a late reduction during opening. Superimposed sagittal movement traces of the kinematic center of the TMJ (*a*) and of the lower incisal point (*b*) during five normal opening and closing movements. During protruded opening and closing movements (*c, d*), a clicking sound was detected only on the first opening movement, which started in the intercuspal position. No clicking sounds were observed in the subsequent movements, not even when the condyle passed the position where the opening clicks normally occurred. For further explanation, see Fig 1 legend.

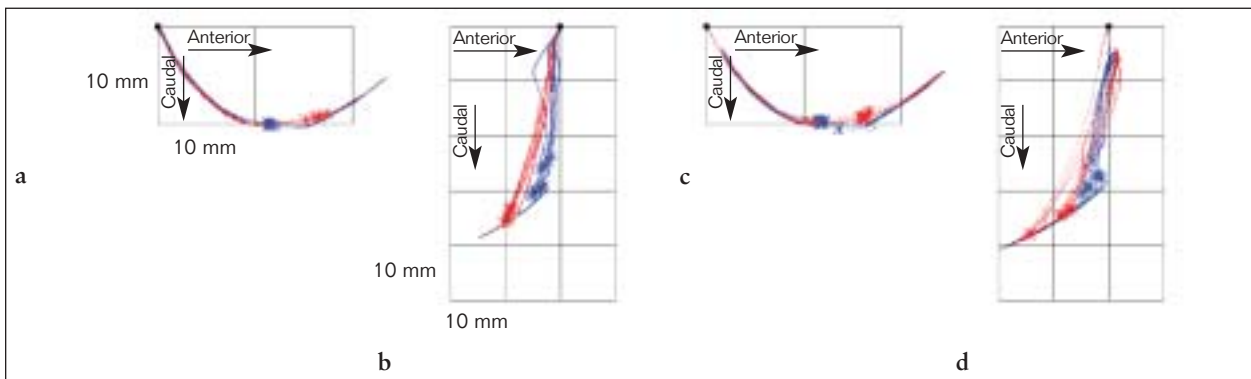


Fig 6 Example of the elimination test for a TMJ with symptomatic hypermobility. Superimposed sagittal movement traces of the kinematic center of the TMJ (*a*) and of the lower incisal point (*b*) during six normal opening and closing movements. During protruded opening and closing movements (*c, d*), clicking sounds were not eliminated. For further explanation, see Fig 1 legend.

movements and no clicking sounds will be heard, not even when the condyle passes the position where the opening clicks normally occur (Fig 5). Clicking sounds due to symptomatic hypermobility are not eliminated by performing protrusive opening and closing movements (Fig 6)⁶ and the use of this so-called elimination test offers the possibility to discriminate between the internal derangements of symptomatic hypermobility and ADDR.

For TMJs with an early opening click, the condyle's protruded end position may be located in front of the position in which the opening clicks normally occur (Fig 7). In this case, the condyle

does not pass this position any more during protruded opening and closing and no clicking sounds will be heard. This elimination of clicking sounds will happen for all clicking sounds, including those with a non-ADDR origin. Thus, the elimination of early opening clicks on protrusive opening and closing does not point exclusively to an ADDR origin of the click (risk of false positives).

Thus, elimination of late opening clicks on protrusive opening and closing offers the possibility to discriminate symptomatic hypermobility from ADDR.

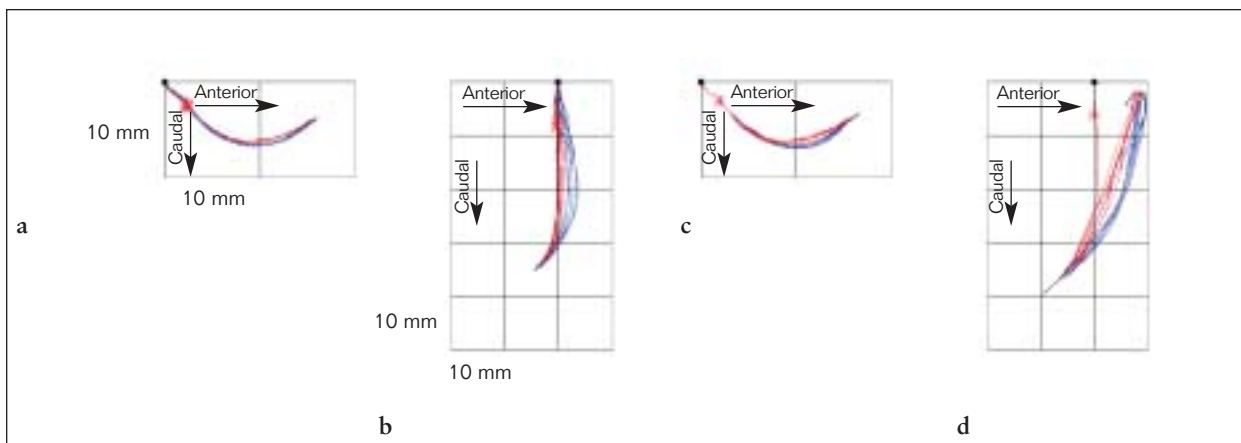


Fig 7 Example of the elimination test for a TMJ with an early click on opening. Superimposed sagittal movement traces of the kinematic center of the TMJ (*a*) and of the lower incisal point (*b*) during five normal opening and closing movements. The absence of the characteristic ADDR movement interferences suggest that the TMJ clicking had a non-ADDR origin. During protruded opening and closing movements (*c, d*), the condyle's protruded end position was anterior to the position where the opening clicks normally occurred. A clicking sound was only recorded on the first opening movement which started in the intercuspal position; no clicking sounds were observed in the subsequent movements. In this case, the elimination of clicking sounds erroneously suggested the presence of an ADDR (false positive). For further explanation, see Fig 1 legend.

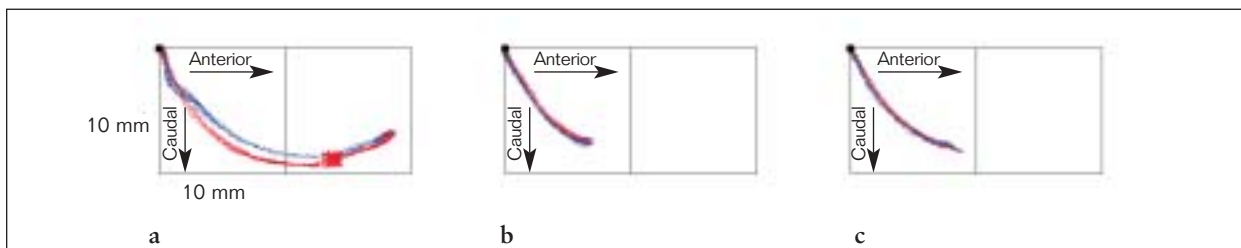


Fig 8 Superimposed sagittal movement traces of the kinematic center of a TMJ with a late reducing ADD (*a*) during opening and closing, (*b*) during protrusion, and (*c*) during laterotrusion to the contralateral side. Clicking sounds were only heard during opening (not during closing, protrusion, and laterotrusion). According to the RDC/TMD, no ADDR is present in the TMJ. For further explanation, see Fig 1 legend.

Only Clicking on Opening or Closing, and Clicking During Protrusive or Laterotrusive Movements

With the use of this criterion the presence of an ADDR is recognized in the case of a nonreciprocal clicking. It claims that when there is clicking only on opening or closing, an ADDR is nevertheless present when the clicking is also present during laterotrusion or protrusion. Generally, the movement traces of the TMJ's kinematic center are shorter during protrusive and laterotrusive movements than during opening and closing movements.

Therefore, for ADDRs with a late click on opening, the condyle may already stop moving forward during the excursive phase of protrusive or laterotrusive movements before the disc can reduce and, consequently no clicking sounds will be heard (Fig 8). Thus, according to the RDC/TMD, no ADDR is then present in the TMJ (risk of false negatives). Clicking sounds also during protrusion and laterotrusion are to be expected only for ADDRs with a relatively early click on opening (Fig 9).

Occasionally, the RDC/TMD criteria of clicking on opening or closing and clicking during protrusive and/or laterotrusive movements, are also met

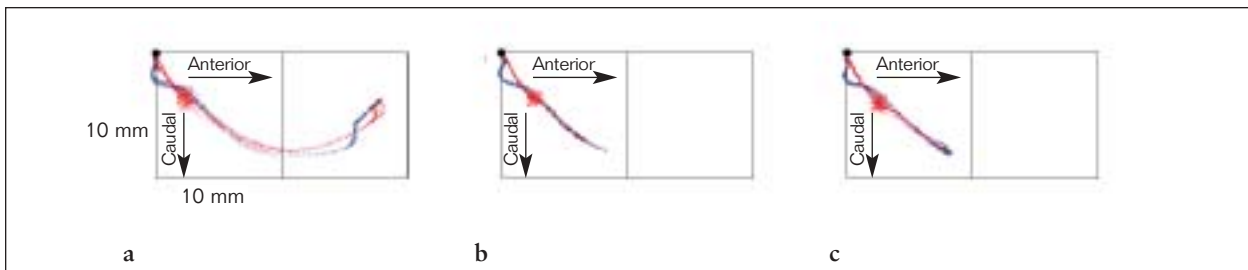


Fig 9 Superimposed sagittal movement traces of the kinematic center of a TMJ with an early reducing ADD (*a*) during opening and closing, (*b*) during protrusion, and (*c*) during laterotrusion to the contralateral side. Clicking sounds were heard during opening, protrusion, and laterotrusion, and not during closing. According to the RDC/TMD, an ADDR is present in the TMJ. For further explanation, see Fig 1 legend.

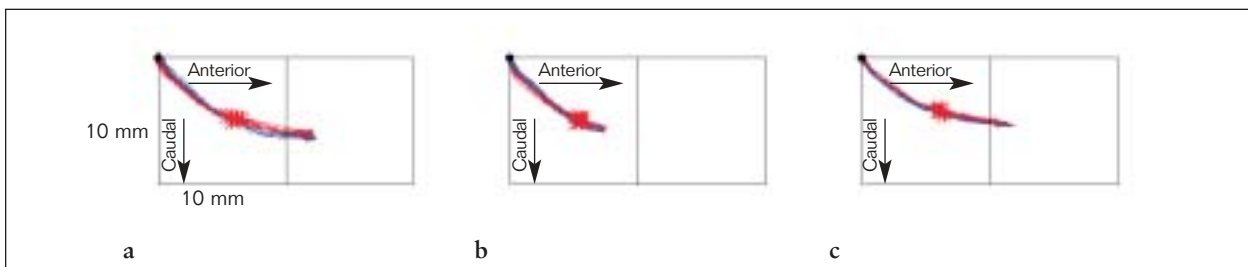


Fig 10 Superimposed sagittal movement traces of the kinematic center of a clicking TMJ (*a*) during opening and closing, (*b*) during protrusion, and (*c*) during laterotrusion to the contralateral side. The kinematic center movement traces did not show the interferences characteristic for an ADDR. Nevertheless, there was clicking on opening and on protrusion and laterotrusion and, according to the RDC/TMD, an ADDR is present (false positive). For further explanation, see Fig 1 legend.

for clicking with a non-ADDR origin (Fig 10). These criteria may give rise to a false positive result and this further limits the clinical significance of using protrusive and laterotrusive movements in the case of nonreciprocal clicking.

Thus, the examination of possible joint noises on protrusion or laterotrusion in the case of clicking only on opening or closing has no great diagnostic value. It is better to focus on the reciprocal nature of the clicking by lightly loading the mandible during opening and closing.

Further Considerations

It should be noted that this Focus Article is based upon the data and experiences obtained in one research center only. Moreover, the data given are mainly descriptive and were not collected blindly. For any set of clinical criteria to be accepted, its validity, sensitivity, and specificity should eventually be assessed blindly, against a “gold standard.” To our knowledge, only this article has evaluated the criteria proposed in the RDC/TMD to recognize ADDRs with the use of the data from

mandibular movement recordings as a reference. Thus, these findings and conclusions cannot be compared with those from other studies.

Clinically, it is a challenge to be able to discriminate between the two most prevalent internal derangements of the TMJ: ADDR and symptomatic hypermobility.¹⁰ It is due to the very nature of these internal derangements that they both show clicking on opening and closing (reciprocal clicking), making reciprocal clicking not a distinguishing feature between these two disorders. However, there is a difference in timing of their opening and closing clicks. Symptomatic hypermobility shows clicking at the end of opening and at the beginning of closing due to snapping of the condyle-disc complex over the apex of the eminence. ADDRs show reciprocal clicking as the result of the reduction and dislocation of the disc during opening and closing. The opening clicks occur in a broad range of the opening movements, the closing clicks occur in a narrow range just before the condyle reaches its end position. However, clinically it is not feasible to use these differences in timing of the clicks to distinguish between the two types of internal derangements. In a clinical setting, it is the amount

of mouth opening at the time of the clicking sounds which is noted, not the condylar translation, and mouth opening is only a poor reflection of the kinematics of the condyle.^{25,26} Two other criteria proposed by the RDC/TMD for the recognition of an ADDR, the 5-mm criterion, as a way to demonstrate that the opening clicks occur at a greater mouth opening than the closing clicks, and the detection of possible joint sounds on protrusion or laterotrusion in case of nonreciprocal clicking (only on opening or closing), run the risk of false positive or negative results and therefore have no great diagnostic value. Instead, it is recommended to use the elimination test. The elimination of opening clicks while performing protruded edge-to-edge open-close movements is characteristic for an ADDR and does not happen for clicking due to symptomatic hypermobility.

Therefore, the authors recommend the following clinical protocol to recognize ADDRs:

- Examine the reciprocal nature of the TMJ clicking
- If there is doubt about the presence of clicking on opening or closing, lightly load the TMJ on movement through the application of a small downwardly directed force (about 30 N) to the patient's chin
- Examine the elimination of clicking on protrusive opening and closing in order to distinguish ADDRs from symptomatic hypermobility

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