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Continuing diagnostics and therapy of the temporomandibular and musculoskeletal system (TMS/MSS)

The rest position of the temporomandibular joint (TMJ) and the therapeutic construction bite vs. the centric bite

Key words *centric bite, construction bite, occlusion, rest position, temporomandibular disorder (TMD), temporomandibular joint (TMJ)*

The rest position of the temporomandibular joint (TMJ), the so-called 'centric relation', is discussed controversially. As yet there is no clear definition. According to current understanding, the condyles are bilaterally in the most anterosuperior position over the articular tubercle. The ligaments of the capsule are maximally relaxed. In rest position of the TMJ, the integral of the muscle activity is at the lowest level. The rest position of the joint is a probability and derives from mutual dependencies. Therefore an exact definition is difficult, if not impossible. Finding the rest position, especially in a pathological situation, is difficult. Various procedures are described, but none has proved to be the only true method. The determination of the rest position in a pathological situation can only determine a starting point for reversible therapy by an occlusal splint. This rest position can be defined by palpation of the condyles within the inner ear canal to gain more information of the tissue situation, especially the bilaminar zone, the movement pattern, the symmetry of the right and left sides and the position of the condyles while taking the therapeutic construction bite. The centric bite is easier to take and shows the relation of the mandible in a rest position in healthy joints.

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Introduction

For all joints, control and positioning take place via the central nervous system. The muscles move the joints and fix the joint position, with one exception: the temporomandibular joints (TMJs). Although these are also moved by the masticatory muscles, the final position of the TMJs during fixed biting (habitual intercuspation position [HIP]) is clearly determined by the contact of the maxillary and mandibular teeth, i.e. the occlusion. The musculature can only bring about jaw closure; the joint position in HIP is largely determined by the teeth. Accordingly, in HIP not only the neuromuscular system but also the occlusion determines the joint position[1-4]. If the condylar position in HIP does not correspond to the physiological resting position, a variety of pathologies can develop[5]. Hence, there is a need to find a therapeutic condylar position.

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Discussion

There are few concepts in dentistry that are currently discussed as much as the theory of centric jaw relation. Can centric relation be defined globally for all individuals in the same way?

What is certain is that for treatment, definition is required of 'centric' relation, i.e. a physiological jaw relation or, as in manual medicine, a 'rest position'. This position is an individual, unique condyle position. The position can change in an individual case within a small range from day to day, due to altered muscle tension, posture, tongue and hyoid position, and is determined by manual therapy and also by psychological factors[6].

In practice, the main focus should be on finding a condyle position that fits the temporomandibular and musculoskeletal system (TMS/MSS) within a narrow range. This position will always be individual.

Resting position of the TMJs

Despite intensive research on joint position in recent years, only a few factors emerge regarding the three-dimensional physiological position of the condyle to the fossa. In the two-dimensional and most frequent analysis methods used in the past, the condylar position was usually determined and analysed by a subjectively selected sagittal section plane. In this projection, a significant change from posterior to cranioventral condylar position was observed over the last decades[1]. A retruded contact position (RCP) of the condyle was often equated with a centric location of the TMJs, on the basis of which teeth were then ground or restored. This not infrequently led to damage of the thereby compressed joint structures[7,8]. The RCP is not bearable from a functional point of view[9]. Kubein-Meesenburg[9] assigns the condyle in the HIP to the transition from the fossa to the mental protuberance, from which retrusive movements are possible in the first place[10].

According to current knowledge, an ideal condylar position can be described as follows: The condyles are located on both sides in the most anterosuperior position in relation to the eminentia articularis in a loose-packed position[11]. Here, according to Rocabado[11], there is a 'range of motion', a free space in the sagittal, but not in the vertical, which is why (according to Rocabado[11]) in TMJ pathology, the compression should be eliminated as a priority[11,12]. In the resting position of the TMJs, the integral of muscle activity is at the lowest level[8,13]. If a joint is at rest, the capsuloligamentary structures are maximally relaxed and agonists and antagonists are in balance[14]. The rest position of the TMJs, also called centric or centric condylar position in dentistry, is a probability and derives from mutual dependencies.

The centric bite

To determine the jaw relation, or give the definition of the rest position of the TMJs, many different methods have been specified. So far, no method has proven to be the only true one[15]. Even digital measuring methods are still lacking in accuracy, as some manufacturers have attested. No method is completely reliable. Globally, the jaw relation determination described below prevailed, with diverse modifications.

Jaw relation recording

Centric jaw relation recording

Preparatory measures for determination of the jaw relation

A centric registration is always a 'blueprint', a snapshot. In order to achieve a physiological jaw relation, it is necessary to remove as many proprioceptive disturbances as possible from the TMS and the MSS before performing a jaw relation determination, in order to come as close as possible to the physiological jaw relation.

Ideally, the patient is scheduled for treatment of the MSS at a manual therapist before the registration.

An Aqualizer dental splint is often used; the patient is asked to wear it the night before the jaw relation recording and to keep wearing it the next day when arriving for the appointment. Shortly before taking the centric bite record the patient is asked to remove the Aqualizer and to not bring teeth into occlusal contact.

The centric bite record is taken with the patient in a seated position. There should be no manipulation of the mandibular position.

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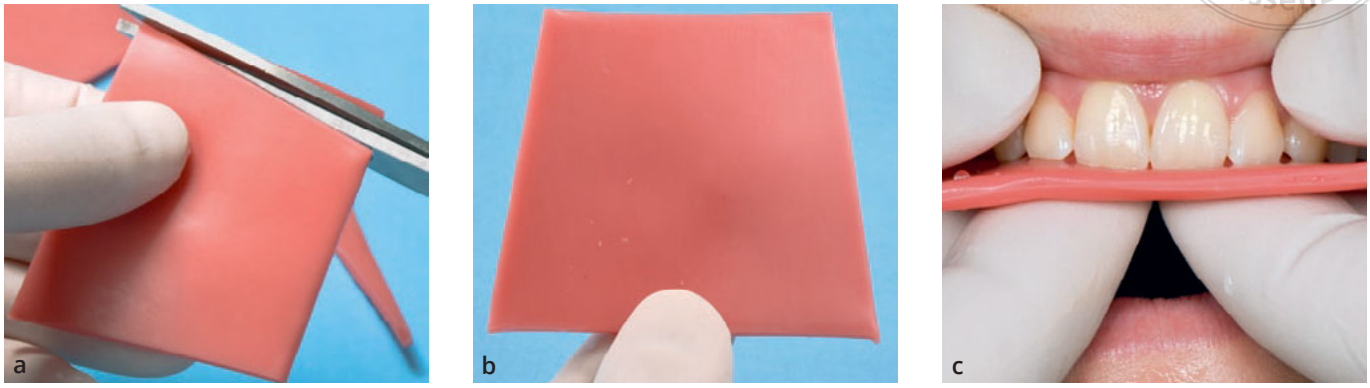

Fig 1a to c Trapezoidal trimming and adaptation of the warm wax on the maxillary teeth.

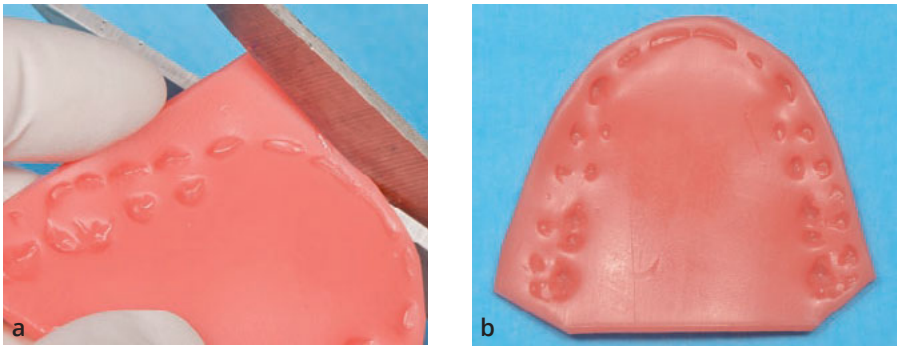

Fig 2a and b The trimmed plate with the maxillary impressions.

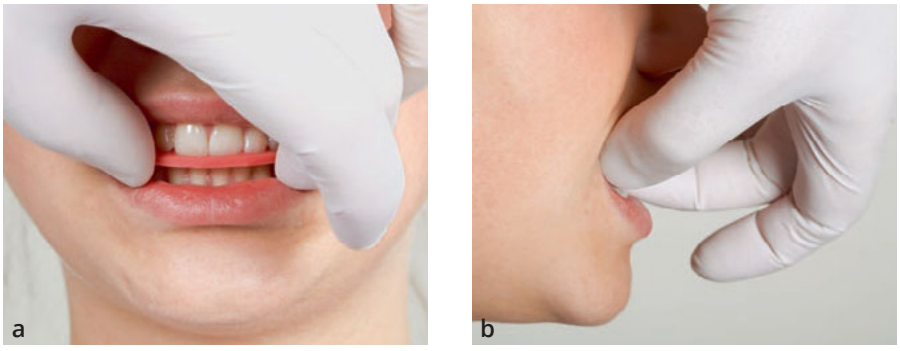

Fig 3a and b Upright head position while occluding into the still warm wax plate. There is no manipulation of the mandible.

Recording the maxillomandibular relationship in centric relation

A centric bite record is made using a 3-mm Beauty Pink wax plate (Integra Miltex, York, PA, USA). The wax is heated in a water bath at 52°C, trimmed with scissors into a trapezoid shape (Fig 1a and b), adapted to the maxillary arch and pressed on the palate to leave room for the movement of the tongue (Fig 1c).

The wax is then trimmed in such a way that it reaches only slightly beyond the occlusal and incisal areas of the maxillary teeth and fits stress-free on the maxillary arch (Fig 2).

The patient sits completely upright in the treatment chair, not leaning on the backrest, but with the head inclined slightly forward. The patient is asked to occlude into the still soft wax plate, until the mandibular teeth also penetrate the wax (Fig 3).

The practitioner holds the wax with his/her left hand. The patient is seated in an elevated position, to make it possible for the practitioner to check if the teeth hit the wax

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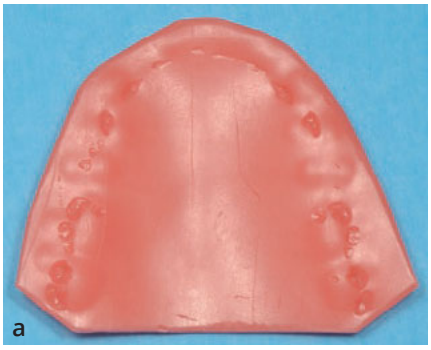

Fig 4a to c After cooling, the mandibular impressions are completely trimmed back.

Fig 5 Lower surface of the trimmed wax plate.

Fig 6a and b Assessment of the mandibular occlusal contacts with black occlusion foil.

Fig 7a and b Repeated reduction of the contacts until a uniform impact of the mandibular anterior teeth exists.

evenly or with a sliding movement. The latter is unfavourable and indicates that the plate needs to be altered so that it can compensate for this sliding movement.

Immediately afterwards, a second wax plate is fabricated in the same way.

The wax plate is subsequently cooled in ice water (box with water and ice cubes) and all the mandibular impressions are trimmed back with a knife (X-acto knife No. 5, blade No. 22; X-Acto, Westerville, OH, USA) until only traces of the impressions are recognisable.

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Fig 8a to c Application of aluminium wax for the representation of the anterior teeth impressions.

Fig 9a to c Application of aluminium wax for the representation of posterior teeth impressions.

In the anterior region, this trimming should form a plateau to ensure that the mandibular incisors are positioned perpendicularly to the wax plate (Figs 4 and 5).

The mandibular occlusion is checked with black occlusion foil.

It is important to continuously pay attention that the patient keeps an upright position and a straight head (Figs 6 and 7). Under no circumstances may the patient turn the head to the clinician. The legs should lie side by side.

The contacts of the posterior region are removed. The contacts are further reduced until ultimately only a contact plateau in the region of the mandibular canine to canine (teeth 33 to 43) remains (Fig 7). Perforations of the wax in the posterior region are not problematic. The process is repeated until the occlusion appears stable.

In the meantime, the patient must not occlude with his /her teeth.

Finally, the mandibular occlusal contacts are made visible in the anterior region (Fig 8), and simultaneously in the posterior region (Fig 9) with aluminium wax.

The therapeutic construction bite

Any record of jaw relation, including that described herein, is an approximation to a rest position of the TMJs during the course of the treatment. The rest position of the TMJs, especially in the case of pathologically altered joints, takes time and can be determined by means of occlusal splints. The use of a craniomandibular orthopedic positioning appliance (COPA) in conjunction with manual osteopathic treatment[1,8] may be helpful. Each manual examination of a joint always includes checking the muscle function[16]. In particular, trigger points should be treated before recording the jaw relation[1].

Procedure for taking the therapeutic construction bite under manual medical criteria

During palpation of the condyles at the external auditory meatus, the range of motion of the TMJs and the tissue condition, especially in the bilaminar zone, can be assessed. Since the TMJs are paired joints, symmetry and positioning

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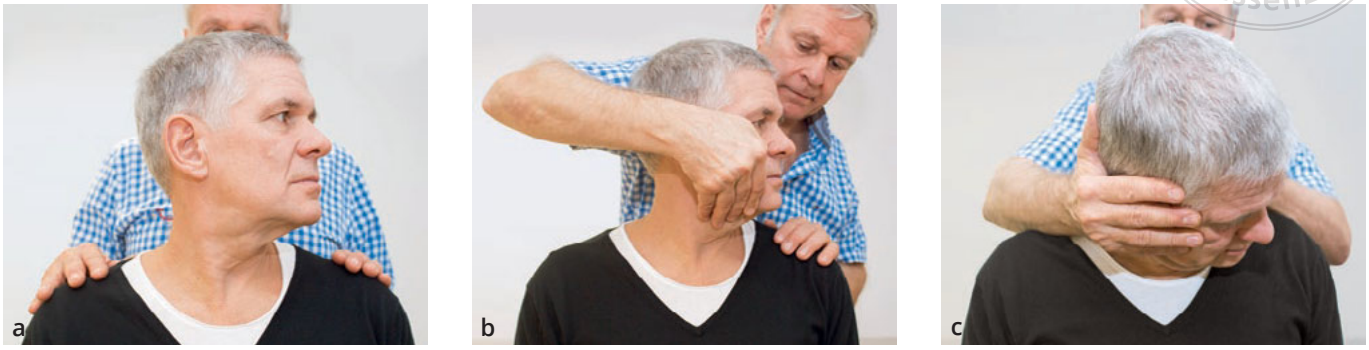

Fig 10a to c To check the initial situation, the musculoskeletal system is examined, here the active and passive rotation of the cervical spine and the passive rotation of the upper cervical spine.

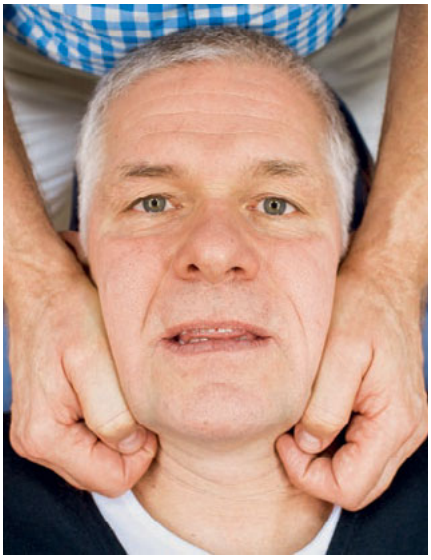

Fig 11 Prior to taking the construction bite, the temporomandibular joints are mobilized. The tongue is on the palate for relaxation of the elevators and the mandible is performing a small advancing movement. This 'piccolotraction' takes place over 10 to 15 respiratory cycles. This procedure does not apply to orthodontic or dental practice if a manual physician has treated the patient immediately prior to treatment.

Fig 12 Casts of the maxilla and mandible made of stone hard plaster class IV are available for the preparation of the construction bite. The maxilla is already mounted in the SAM articulator (Great Lakes Orthodontics, Tonawanda, NY, USA). In the water bath, a Beauty Pink X-hard wax plate of 3-mm thickness is heated at 52°C.

are also assessed. This requires a precise sense of touch and experience of the examiner. By palpating directly behind the condyles with the fingertips, the nature of the bilaminar zone can be assessed, including whether pain can be provoked by this palpation. A disc displacement from the condyle into the bilaminar zone is easy to detect. In particular, the position of the condyles can be further verified by means of cone beam computed tomography (CBCT)[17].

The therapeutic construction bite is controlled by manual medical examinations. For this purpose, the status of the patient is examined prior to the bite taking (Fig 10) according Marx[1,18], and can be controlled after preparation of the therapeutic construction bite. Before the bite is taken, the TMJs are mobilized[1,19], unless the patient has been pretreated by a manual physician immediately before the bite is taken (Fig 11).

For the therapeutic construction bite, Beauty Pink X-hard wax (Integra Miltex) can be used (Fig 12), as this wax becomes very firm when cooled and can therefore remain in the mouth for manual medical testing. Moreover, it is very precise. The wax plate is heated in a water bath at 52°C and adapted to the hard plaster cast. The anterior teeth remain free, so that the overjet remains assessable. The wax is adapted to the palate to allow tongue freedom (Fig 13).

For the palpation of the condyles with the finger tips at the external auditory meatus (Fig 14), the habitual intercuspation position (HIP) is recommended as a starting point. From this position, the patient opens and closes their

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Fig 13a to c The wax plate is adapted to the maxillary cast and cut to size. The anterior teeth remain free and are not covered by the wax. The wax plate is adapted to the palate to allow tongue freedom.

Fig 14a and b The palpation of the temporomandibular joints is carried out with the little fingers inside the external auditory meatus. Possibly existing joint noises (cracking, crepitus), pain and inflammatory swellings in the bilaminar zone, mobility during movement also in side comparison and the position of the condyles are examined.

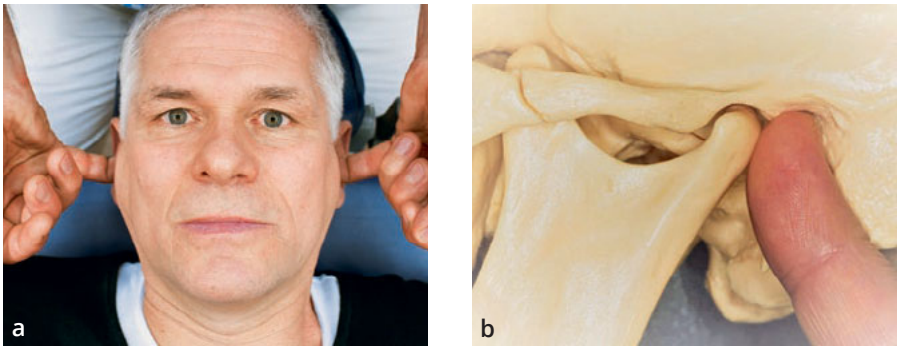

Fig 15a to c Palpation occurs first in habitual intercuspidation (HIP), followed by opening and closing movements. Then the patient is asked to move the lower jaw out of the HIP under tooth contact very slowly approx. 2 mm anteriorly and back into the HIP, from there into the most retral position. With this method, the condylar mobility and position can best be identified.

mouth, performs a movement of the mandible to the right and left, and protrudes and retracts maximally. Thereafter, the patient is again asked to take the HIP. From this position, he/she protrudes the mandible about 2 mm, maintaining slight tooth contact. During this movement, the details can be felt accurately during palpation (Fig 15).

The prepared wax plate is heated again in a water bath and adapted to the maxillary teeth. The patient is asked to occlude teeth habitually until he/she touches the wax with the mandibular teeth. From this position, the practitioner takes over the movement of the mandible (Fig 16). Except for an open bite, the goal is to have a physiological overbite at the end of the therapeutic bite. After mounting the mandibular cast in the articulator by means of this therapeutic construction bite, there is no change in the height of the support pin when a COPA is to be produced.

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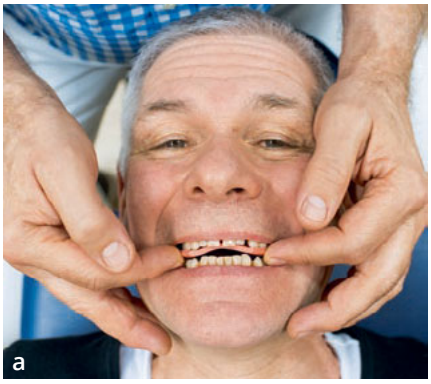

Fig 16a and b After determining the condylar position, the heated wax in the water bath is adapted to the maxilla. During palpation of the condyles by means of the little fingers inside the Pori acustici externi, the patient is asked to close slowly. Under palpation control, the patient is guided into the therapeutic rest position of the condyles by asking them to move the mandible according to the therapist's instructions. Except for an anterior open bite, an ideal overbite should be established, which can then be taken over into the occlusion splint / COPA and possibly later into the definitive treatment.

Fig 17a to c The therapeutic construction bite is checked on the maxillary and mandibular casts for a perfect fit, so that a later matching of the mandibular cast can be carried out. Thereafter, the wax is cooled in ice water for further examination on upright or standing patient.

After the therapeutic construction bite has been tested on the plaster cast for fit (Fig 17), the wax is cooled in iced water and placed on the relaxed upright sitting or standing patient in the maxilla. The patient should find the impressions of the mandibular teeth without hesitation (Fig 18). Subsequently, the therapeutic construction bite is tested by manual medical examination of the MSS (Fig 19)[1,18].

The therapeutic construction bite can also be applied to children and adolescents. A construction bite is needed to create a functional orthodontic appliance such as a functional regulator according to Fränkel, or a Balters' Bionator appliance. Again, the manual information from simultaneous palpation while taking the construction bite should be taken into account (Fig 20).

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Fig 18a and b The therapeutic construction bite is fixed in the maxilla. The patient is sitting or standing relaxed. Without any manipulation of the practitioner, the patient bites into the impressions of the wax bite several times. The patient should find these impressions easily and repeatedly. Otherwise, the bite taking must be renewed from step Fig 15.

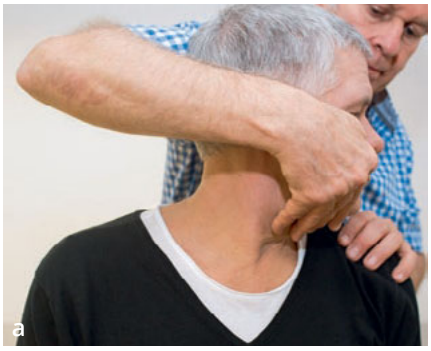

Fig 19a and b With an inserted, cooled therapeutic construction bite, the patient is asked to swallow for a neurological reorganization. Thereafter, the musculoskeletal system is rechecked. In a descending chain, the result should significantly improve with the therapeutic construction bite. The example shows the significant increase of the endfeel in joint play with the therapeutic construction bite.

Fig 20a to d The procedure shown above is applied in the same sequence also in children. After palpation of the temporomandibular joints in the external auditory meatus in habitual intercuspation and mandibular motion, the temporomandibular joints are mobilized and the therapeutic construction bite is taken with palpation of the condyles. This procedure is also recommended for the mounting of working casts for the production of functional orthodontic appliances such as the functional regulator or the Bionator, as shown here.

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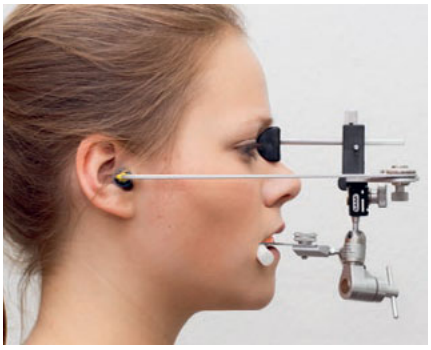


Fig 21 The arbitrary facebow is applied symmetrically to the anatomical structures.

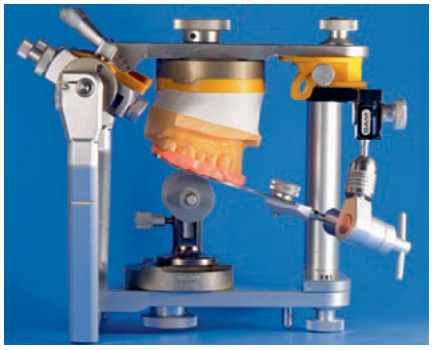


Fig 22 Mounting the casts.

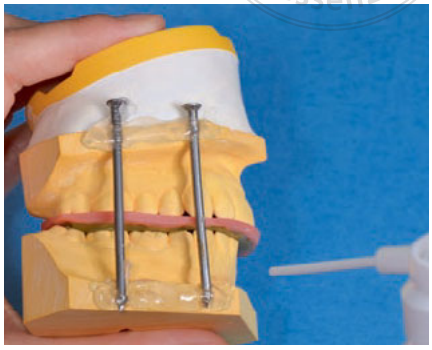
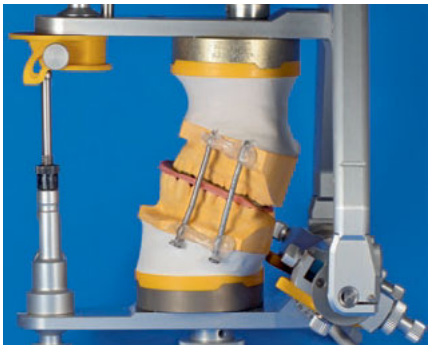


Fig 23 Stabilizing the split mounting with a wire nail on each side.



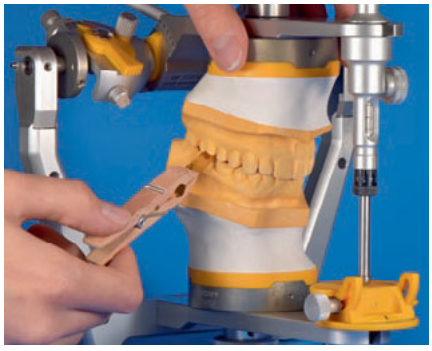


Fig 24 For large distance between dental casts and articulator, a two-stage mounting procedure is used.

Fig 25 The centric occlusal contacts are identified.

Model mounting for occlusion analysis and manufacture of a COPA

The mounting of casts is completed with a facebow transfer (Fig 21) and the therapeutic construction bite as described above. After mounting the maxilla (Fig 22), the bite registration is transferred to the mandibular cast (Figs 23 and 24). Without this capture, the positioning is inaccurate and cannot be used for the diagnosis or for the production of an occlusal splint.

The analysis of the static and dynamic occlusion takes place on the casts in the articulator using a 12-µm-thick occlusion foil (Fig 25), available in different colours.

Conclusions for clinical practice

The diagnosis and treatment planning pathway is described for a patient who presented with severe back pain, who in fact had TMJ anterior disc displacement with a posteriorly positioned condyle (Fig 26).

Articulated plaster casts mounted in therapeutic relation clarify problems of occlusion (Fig 27) that had looked reasonable visually. There is exclusively contact on incisors with an open bite in the region of molars and premolars. Under muscle forces, the TMJ condyle shifts posteriorly and upwards from the centric relation into HIP during jaw closure. Non-mounted, hand-held casts would not have been able to show more than the intraoral views in HIP.

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Fig 26a to e Initial intraoral views showing habitual intercuspation, which seems to be in a stable and functional Class I relationship with well-aligned arches[20].

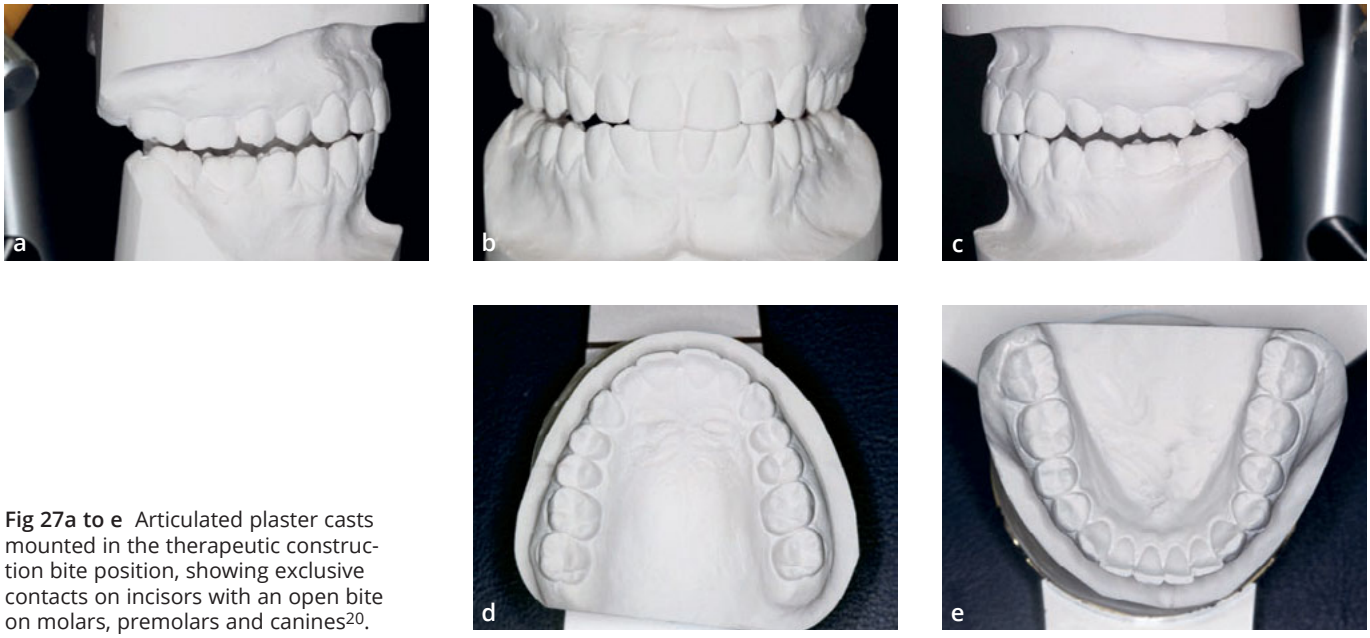

Fig 27a to e Articulated plaster casts mounted in the therapeutic construction bite position, showing exclusive contacts on incisors with an open bite on molars, premolars and canines[20].

If the components of the TMJ are considered as a 'black box', its opening is indispensable for the therapeutic approach (Fig 28). In this patient, if treatment, orthodontic or other, had been commenced without consideration of the TMJ and the MSS, the whole treatment would have failed. As Harold Gelb said in 1994, "Think orthopaedic first – then teeth." Figure 29 shows a treatment following these components.

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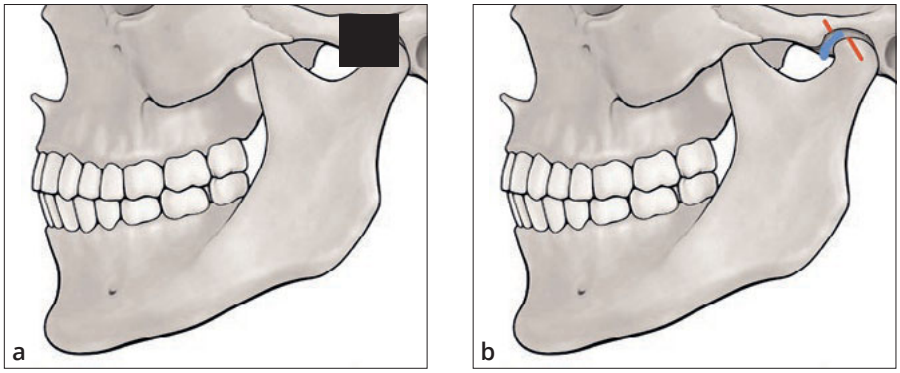

Fig 28a and b The 'black box' concept[20]. a) The TMJ 'black box'. b) Opening the black box shows a posteriorly displaced condyle and, therefore, an anterior displaced articular disc in habitual occlusion.

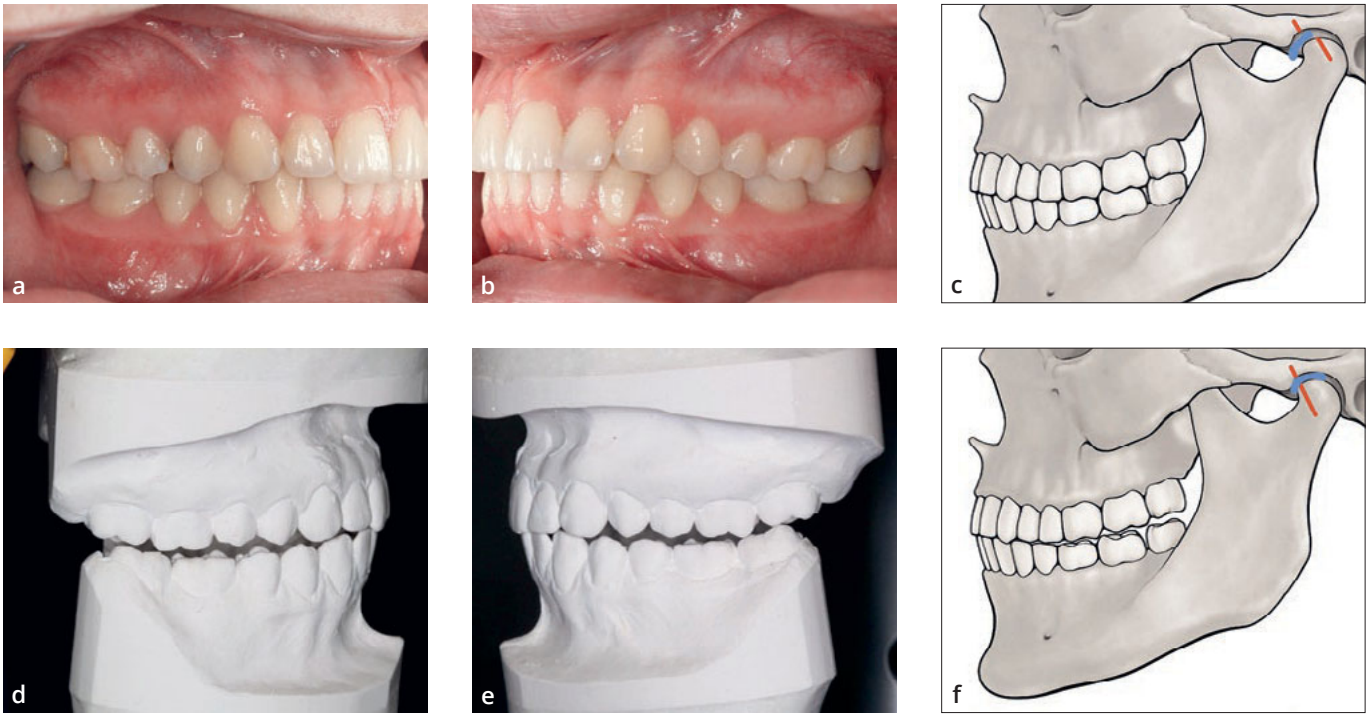

Fig 29a to f Treatment planning[20]. a and b) Intraoral views in habitual intercuspation. c) Representation of the habitual intercuspation, within the 'black box' opened to show the posteriorly positioned condyle with the anteriorly displaced disc. d and e) Mounted plaster casts showing the occlusion in therapeutic relation with a lack of posterior vertical support. f) Occlusion in centric relation with a physiological condyle, showing the disc position and lack of posterior support.

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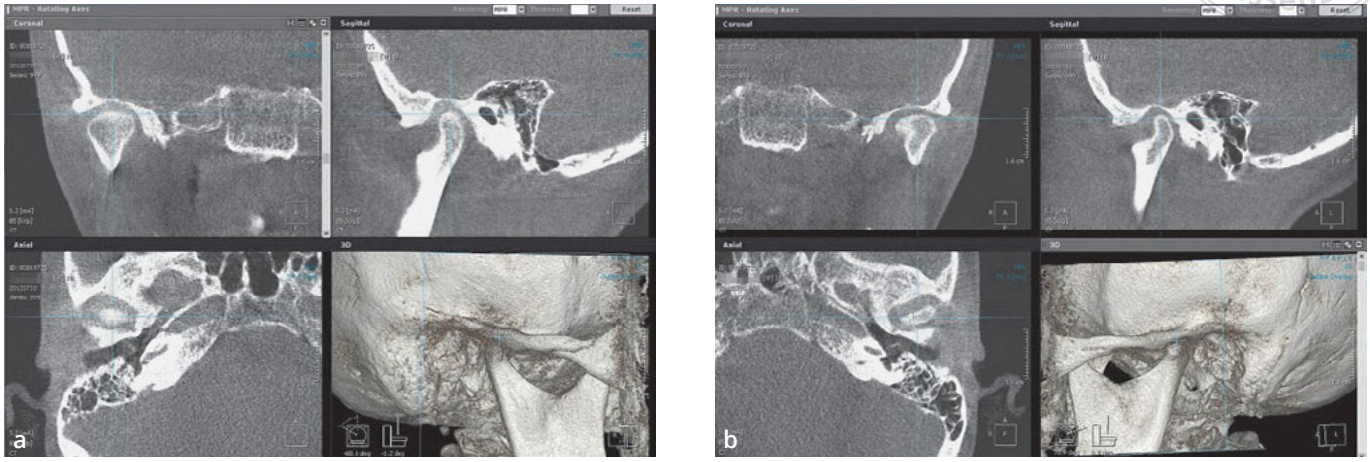

Fig 30a and b CBCT of the TMJs (Picasso, Orange Dental)[20]. a) Right side showing retruded codylar position. b) Left side also with retruded condylar position but more dislocation. No cortical bone pathology on either side.

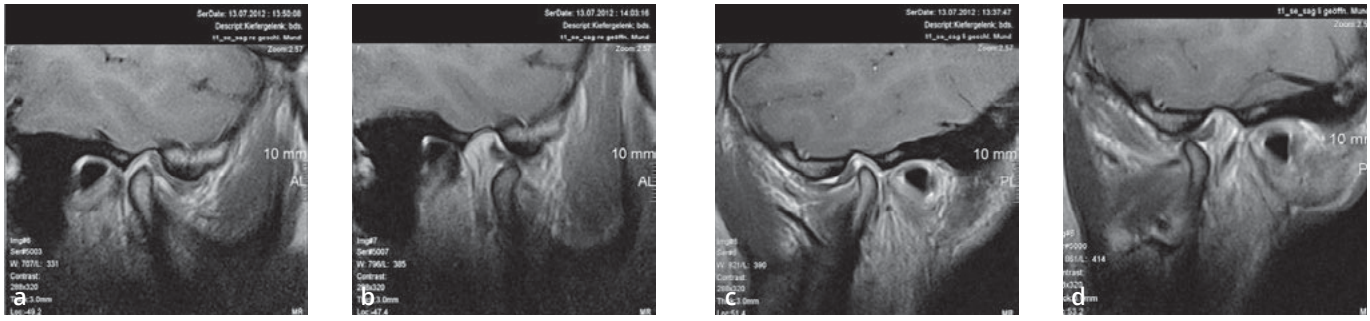

Fig 31a to d Magnetic resonance imaging (MediaPark Clinic, Drs Andersson and Steimel)[20]. a and b) Right TMJ with anteriorly displaced disc (a) that repositions during mouth opening (b). c and d) Left TMJ with complete anteriorly displaced disc (c) with repositioning during mouth opening (d). As with the CBCT findings, the condyle is more retruded on the left than on the right.

To assess the TMJ, open the 'black box':

- manual diagnosis
- mounted plaster casts in centric relation.

Depending on the findings, CBCT (Fig 30) and magnetic resonance imaging (Fig 31) may be needed.

Once the assessments had been completed, treatment of the patient commenced with a COPA in the mandibular arch (Fig 32). The patient was advised to wear the splint continuously apart from eating and tooth cleaning. Parallel treatment by a manual therapist or physiotherapist is indispensable (M Becker, Much, Germany). Manual treatment takes place first and then the COPA is adjusted for the changed contact points.

In the following weeks, the COPA is adjusted regularly according to the joint and neuromuscular changes.

The final CBCT shows the physiological condyle position achieved with the COPA in position (Fig 33). This patient commenced treatment with:

- back pain
- scoliosis
- leg length discrepancy (left + 1.5 cm)
- difference in Prien abduction test (left hard)
- pain and clicking of the TMJ
- deviation of the mandible during opening and closing.

After 5 weeks of treatment with the COPA and accompanying physiotherapy, the patient had no more back or TMJ pain[20].

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Fig 32a to d Treatment pathway[20]. a) Removable COPA for the mandibular arch made of resin without metal arch, light cured (Dreve). b to d) Initial intraoral situation with a therapeutic mandible position.

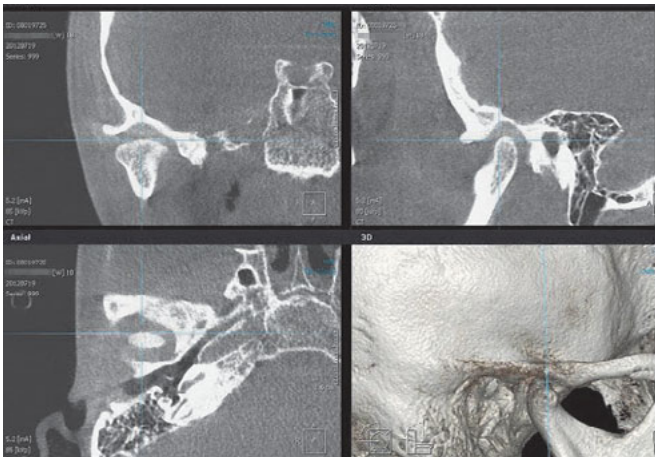

Fig 33 CBCT (Picasso, Orange Dental) with the COPA in place, showing a physiological condyle position[20].

With a COPA treatment, a pain-free position of the condyle and a physiological position of the mandible relative to the maxilla can be determined. From this condyle position, orthodontic treatment can be planned, which in this situation differed greatly from treatment planned using maximal intercuspation. This latter procedure will be described in a following article.

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