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Temporomandibular Joint

The images in this section were kindly provided by Dr Piero Silvestrini Biavati, dental specialist, gnathologist, and posturologist.

The concepts presented are also the result of his teaching and of the interdisciplinary collaboration developed over the years.

1. From local symptoms to systemic causes

Symptoms of the temporomandibular joint manifest locally.

The application of the physical principles examined in the previous sections shows, however, that dysfunction of the TMJ constitutes, in the majority of cases, the final manifestation of alterations originating in other body districts.

Excluding specific diseases such as rheumatoid arthritis and articular rheumatism, TMJ dysfunction is in fact mechanically sustained from a distance.

For this reason, it is more appropriate to speak of **cranio-cervico-mandibular disorders**, a term that reflects the systemic nature of these manifestations.

Biomechanical analysis makes it possible to identify three ways in which cranio-cervico-mandibular disorders may manifest.

The first originates from an alteration in the mandibulo-cranial skeletal relationship.

When a structural problem exists at the dental level, muscular compensation is activated and determines mandibular deviation.

This deviation produces articular compression that generates TMJ symptoms: the structural alteration, in this case occlusal, forces the musculoskeletal system to adapt.

The second originates from disorders of sensory input, visual or auditory.

Altered sensory information determines cranio-cervico-scapular muscular compensations that modify the position of the vertebrae and the hyoid bone.

These modifications secondarily involve the muscles of the TMJ, producing articular problems.

The third originates directly in the muscular system.

Cranio-cervico-scapular muscular shortening, without identifiable structural or sensory causes, alters the position of the vertebrae and the hyoid bone.

As in the previous pattern, this determines secondary involvement of the TMJ muscles.

In the first two patterns, muscular shortening is **secondary**: the muscular system adapts to problems of another kind.

In the third pattern, shortening is **primary**: the muscular system is the source of the problem.

This distinction, already encountered in the analysis of previous sections, determines the therapeutic strategy.

2. Clinical examples

Let us imagine a patient with cervical pain.

On clinical examination, rotation with consequent convexity of the cervical vertebrae is found.

Treatment of vertebral rotation through rebalancing of the muscular vectors of the scalenes and levator scapulae produces regression of the symptoms.

At subsequent sessions, however, symptoms and vertebral alterations are present again.

The instability of the results indicates the existence of a triggering factor that continues to interfere with the muscular system.

The cervical muscles, therefore, are not the primary cause but the pathway through which a problem of another nature manifests.

If, for example, further diagnostic evaluation identifies a dental problem, the asymmetrical activation in shortening of the mandibular closing muscles at each swallow will induce shortening imbalance in the cranio-vertebro-hyoid muscles.

In this case, gnathological treatment on the teeth, by removing the structural cause of the secondary muscular shortening, allows resolution of the symptoms.

If muscular shortening has become chronic, after solving the dental problem it may still be necessary to intervene on the muscles as well, but correction of the vertebrae and of the hyoid bone will finally become stable.

Now consider a patient with TMJ pain in whom stomatognathic, visual, auditory, or other disorders have been excluded.

The objective examination shows cranio-vertebro-hyoid-scapular skeletal misalignments in the sagittal and frontal planes, induced by primary muscular vector imbalance: this is the case in which work on the muscles may produce resolution of the symptomatology.

3. Structural anatomy and biomechanics

The temporomandibular joint has the particularity of being a double joint.

The disc, interposed between the condyle and the temporal bone, does not act only as a shock absorber but has a true articular function.

The physiological position of the mandibular condyle, with the teeth in contact, should not be inside the temporal fossa but on the eminence.

It is therefore a double articulation: **condylo-discal** and **disco-temporal**.

Articular stability is provided by both the ligaments and the muscles acting at that level.

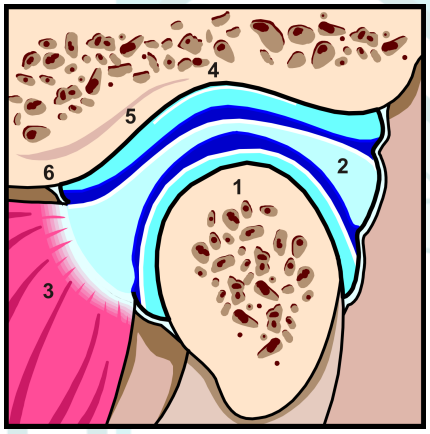


Figure 1 - Temporomandibular joint in section with the teeth in contact, lateral view, occiput on the right side of the image and nose on the left.

1: mandibular condyle; 2: articular disc; 3: infratemporal head of the lateral pterygoid; 4: temporal fossa; 5: temporal eminence; 6: temporal crest.

During mouth opening, a roto-translation movement occurs.

The condyle moves along the temporal eminence while the rotational movement occurs in the direction opposite to the translational movement.

The muscles acting on the joint are: the masseters, temporalis, and medial pterygoids with closing function; the lateral pterygoids, with a control function for mandibular positioning movements and lateral movements; and the suprahyoids and infrahyoids to open the mandible.

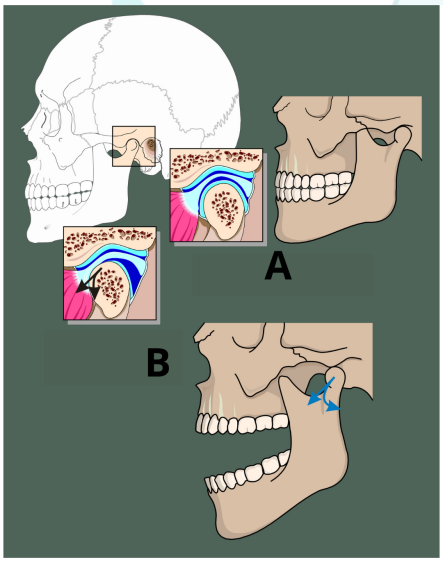


Figure 2 - A: position of the mandibular condyle with the teeth in contact. B: during mouth opening, the condyle moves in roto-translation along the temporal eminence.

4. Physiology of swallowing

Swallowing is an involuntary movement that occurs several times per minute.

The masticatory muscles contract, bringing the teeth into contact.

If the dentition is correctly positioned, the masticatory muscles act with equal intensity on both sides, using the minimum force necessary, and dental intercuspation does not influence other body districts.

Physiologically, there should be no connection between dental occlusion and distant skeletal districts.

If, however, the dentition is pathologically positioned, this connection may become active.

The way in which even a modest occlusal imbalance may have repercussions on the entire body alignment follows non-linear principles.

In linear mathematics, there is a direct proportion between stimulus and effect.

In non-linear mathematics, a small variation may produce significant effects.

From a linear point of view, occlusal imbalances should not determine displacement of body masses.

From a non-linear point of view, this becomes possible.

Because this is a non-linear relationship, not all people with occlusal problems present alterations of articular axes or symptoms.

5. Occlusal problems and systemic consequences

Angle's classification distinguishes three classes of occlusion based on the relationship between the upper and lower molars.

The first class represents the physiological relationship in which the upper and lower teeth meet correctly.

In the second class, the relationship between maxilla and mandible is altered by mandibular retrusion.

This may derive from a purely dental problem, when the teeth are malpositioned on normal bony bases, or from a skeletal problem, when the mandible is underdeveloped relative to the maxilla or the maxilla is excessively developed.

In the second class, with the teeth in contact, upward migration of the mandibular condyle toward the temporal fossa is frequently observed, with consequent compression of the articular structures.

In the third class, the relationship is altered by mandibular protrusion, which may be due to excessive mandibular development or underdevelopment of the maxilla.

This class too may have either a dental or a skeletal origin.

Pathological classes determine alterations in the distribution of muscular and articular forces that may propagate to the entire cranio-cervico-scapular system.

In addition to alterations related to dental class, there are three other occlusal problems that may determine systemic skeletal alterations:

- difference in tooth height, premature contact
- excessive freeway space
- reduction or absence of freeway space

5.1 Difference in tooth height, premature contact

When a dental arch contains teeth that are too short or too long, during mouth closing the masticatory muscles act asymmetrically and with greater intensity than is physiologically necessary.

The mandibular condyle on the side of the "short" teeth, in order to allow contact, must position itself beyond the physiological position, rising toward the temporal fossa.

The mandible thus performs a torsional movement.

Inside the mandibular fossa there are many receptors.

Their compression may trigger painful symptoms localized at the TMJ, the ear, and the head.

Figure 3 - Crossbite with lateral deviation of the mandible. On the patient's right side, the aphysiological dental contact determines upward displacement of the mandibular condyle with anterior projection of the articular disc.

Asymmetrical and excessive muscular activation determines involvement of other muscular districts through the action of the hyoid muscles.

The cervical vertebrae lose their symmetry, the shoulder may become elevated, and if the process persists over time, a complex series of skeletal alterations may be produced throughout the entire body alignment.

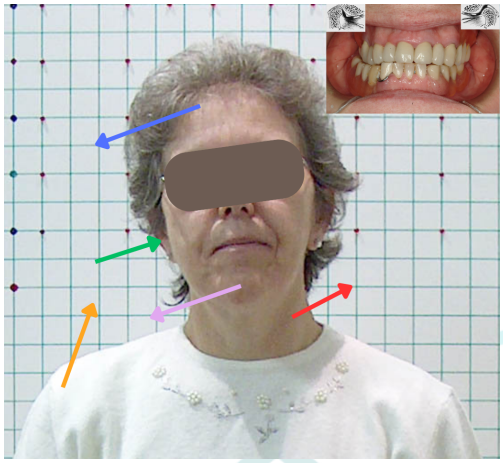


Figure 4 - Same patient as in Figure 3 with crossbite, showing skeletal alterations in the cranio-vertebro-scapular region: cranial tilt, blue arrow; condylar rise into the temporal fossa with anterior projection of the articular disc, green arrow; lateral deviation of the mandible, pink arrow; shoulder elevation, orange arrow; lateral deviation of the hyoid bone and convexity of the cervical vertebrae, red arrow.

5.2 Excessive freeway space

At rest, with the masticatory muscles relaxed, as occurs between one swallow and the next, the posterior teeth should not be in contact but should physiologically present a **freeway space** of about 2 millimetres.

When the freeway space is excessive, for example because the teeth are overall too short, the masticatory muscles would have to remain permanently under tension in order to maintain the correct space.

To avoid this continuous effort, the muscles anterior to the cervical spine, taking the third thoracic vertebra as a fixed point, shift the entire head forward, with synergic help from the scalenes.

The dental arches move closer together, unloading the work of the masticatory muscles.

The anterior displacement of the head, however, modifies the body barycentre and, in order to avoid loss of balance, the underlying muscular districts are activated, modifying the course of the whole vertebral sinusoid and the physiological skeletal relationships.

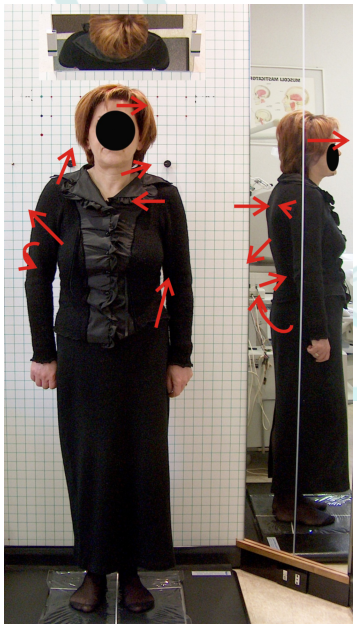


Figure 5 - The red arrows indicate skeletal elements mainly misaligned in a patient with excessive freeway space. FRONTAL: left head translation; right shoulder elevation; left cervical vertebral convexity; left scapular adduction; right lateral thoracic convexity; right humeral internal rotation; left hemipelvic elevation. SAGITTAL: anterior head projection; scapular adduction; reduction of physiological kyphosis with apex at T5; posterior projection of vertebrae T7-T9; lumbar hyperlordosis; anterior pelvic tilt.

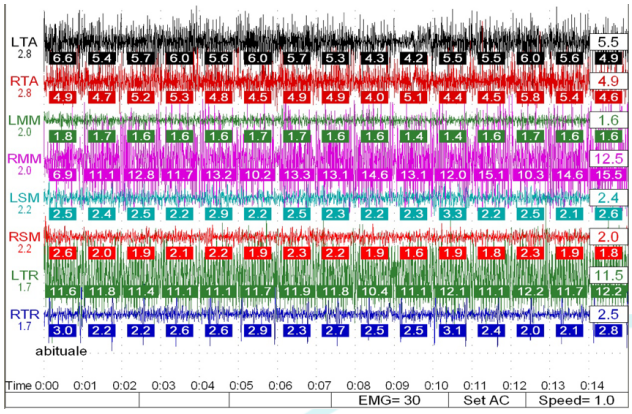


Figure 6 - Electromyographic tracing of the patient in Figure 5. L: left; R: right; TA: anterior temporalis; MM: masseter; SM: sternocleidomastoid; TR: upper trapezius fibres.

5.3 Reduction or absence of freeway space

This is the opposite problem: the muscles posterior to the cervical spine become activated to extend the cranium posteriorly and allow mouth opening, increasing the distance between the dental arches and unloading the work of the hyoid muscles.

The overall body barycentre undergoes displacement.

The muscles below are activated to maintain equilibrium, acting on the whole vertebral column and altering the verticality of the individual body barycentres.

All the imbalances analysed may in turn generate, through secondary muscular shortening, the onset of orthopaedic pathologies, low back pain, neck pain, and others, which may be defined as secondary to a primary pathological involvement of the stomatognathic system.

6. Gnathological intervention

When differential analysis highlights a problem of stomatognathic origin, the primary intervention belongs to dentistry.

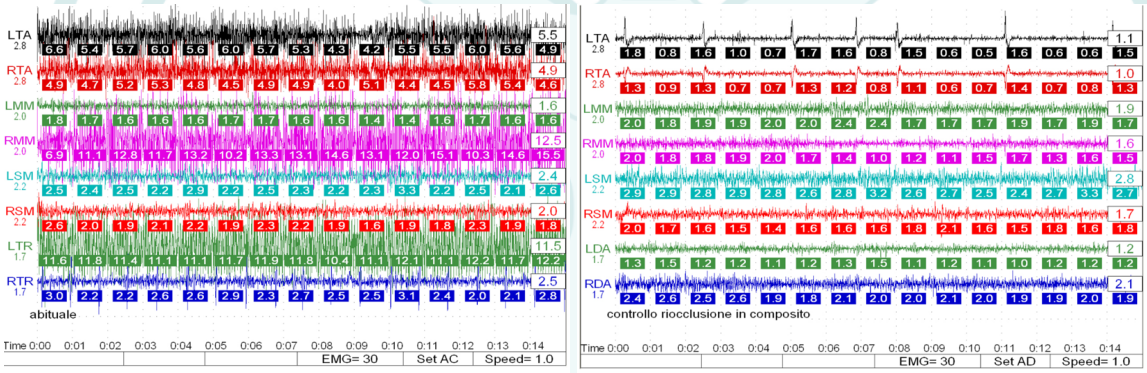
The bite splint is the initial tool.

It prevents the patient's habitual pathological occlusion, reprogramming mandibular movement at each swallow, with correction of temporomandibular joint positioning.

At a later stage, the advisability of definitive dental intervention is evaluated in order to stabilize the results.

Figure 7 - Intercuspal bite splint, orthotic.

Figure 8 - After three months of myocentric orthotic treatment, all body parameters show more or less marked improvement.



Figures 9 and 10 - More evident improvements induced in the tension of the temporalis, masseter, sternocleidomastoid, and upper trapezius fibres, as shown by electromyography after three months of treatment with the bite, right side.

Figures 9, 10, and 11 show how alteration of the structure, tooth height, produced secondary muscular shortening and how resolution of the primary problem induced skeletal improvement.

These improvements could not have been obtained through work on the muscular system alone.

This does not necessarily mean that working on the teeth corrects all skeletal parameters or achieves total remission of symptoms, especially if expressed in body regions distant from the TMJ.

It means that in order to obtain further improvement in skeletal relationships, it may be necessary to add work on muscular balancing, but only after removing the causes triggering the secondary muscular shortening, which is the true cause of the problem.

Otherwise, improvement could neither be refined nor stabilized.

Some symptoms may indicate skeletal problems deriving from the stomatognathic circuit with consequent TMJ involvement:

- ear pain, in the absence of otorhinolaryngological problems
- joint noises and difficulty opening and/or closing the mouth
- headache
- cervicobrachial pain, with the head projected forward or backward
- lumbar and/or thoracic pain, with the head projected forward or backward

The analysed mechanisms may also act in reverse: that is, it may occur that a muscular imbalance originating from other body districts determines, through mechanisms of muscular interconnection, occlusal problems that generate condylo-menisco-temporal conflicts.

7. Analysis of the muscular system of the TMJ

As already mentioned, the muscles acting on the temporomandibular joint are: the masseters, temporalis, and medial pterygoids, with closing function; the lateral pterygoids, with a control function in mandibular positioning movements and lateral movements; and the suprahyoids and infrahyoids for mandibular opening.

The closing muscles are vectorially dominant relative to the other muscular groups.

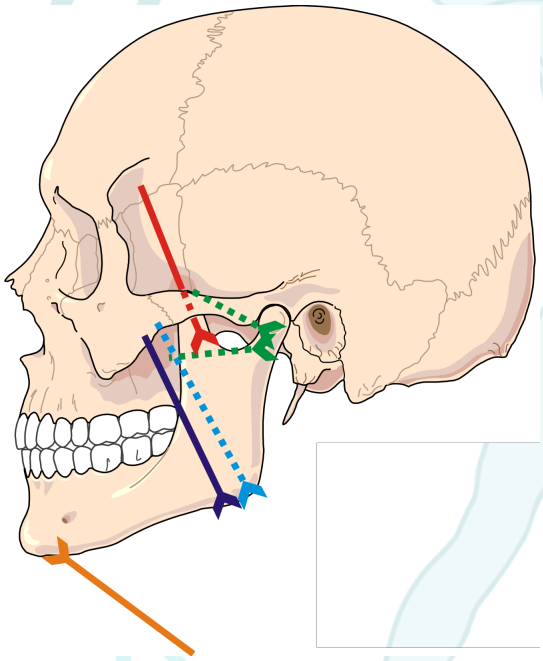


Figure 11
Temporalis: red;
lateral pterygoid: green;
masseter: dark blue;
medial pterygoid: blue;
supra- and infrahyoids: orange.

The lateral pterygoids insert both on the neck of the condyle and on the articular disc. During swallowing, through proprioceptive information coming from dental contacts and in particular canine guidance, they memorize and automatize with great precision the closing position of the mandible, without conscious searching for dental contact.

During mastication, they control lateral displacements of the mandible.

During physiological opening of the mandible, the hyoid muscles determine descent of the condyle along the temporal eminence in roto-translation.

The lateral pterygoids maintain contact of the condyle with the articular disc.

If the closing muscles are shortened because of a problem intrinsic to the muscles themselves or because of a dental problem, mouth opening becomes limited or impossible, temporomandibular locking, because the closing muscles are vectorially dominant over the hyoids.

In this case, therefore, the mouth could no longer open.

Since mouth opening is, however, an overriding function, a compensatory strategy is used involving partial or total substitution of the hyoids by the lateral pterygoids.

Instead of limiting themselves to a control function, the lateral pterygoids, taking the cranial insertions as the fixed point and the insertions on the mandibular condyle as the mobile point, pull the condyles forward and determine a "jerking" opening of the mandible.

Opening thus occurs in subluxation, in the direction of the temporal crest.

If the crest is exceeded, dislocation occurs.

In these cases, subluxation may represent the secondary product of the strategies used to resolve the primary problem, namely incarceration of the mandibular condyle by the closing muscles.

8. Clinical tests

Two clinical tests will now be described, one in mandibular closing and one in mandibular opening, which provide information on both structure and muscular component.

A further test will then be proposed to evaluate occlusal interference on the skeletal system.

8.1 Closing test

The operator places the little fingers in the patient's auditory canals while the patient keeps the mouth open.

When the patient is asked to close the mouth, the operator may perceive skeletal contact of the condyles rising toward the temporal fossa.

Under physiological conditions, with the teeth in occlusion, the operator's finger should not perceive any contact with the mandibular condyle.

Contact with the mandibular condyle may sometimes be only slight, while in other cases the pressure on the finger may become substantial.

If the condyle passes beyond the operator's finger, this is a sign that the condyle enters the fossa at each swallow.

Upward displacement of the condyle toward the temporal fossa is always determined by dental problems.

To obtain further information on muscular coordination of the closing muscles, the operator then places the hands over the patient's temporalis and masseter muscles and asks the patient to clench rhythmically.

The observation is aimed at detecting simultaneity and equal intensity of muscular contraction on the two sides.

If asymmetrical contraction is detected in terms of activation time or intensity, this may be the expression of a muscular problem that is either primary or secondary to a dental problem.

8.2 Opening test

The operator places the hands on the outside of the joint and asks the patient to open the mouth in order to perceive mandibular movement.

If, at a given moment, acceleration of the movement is detected, this is the sign of intervention of the lateral pterygoids in substitution for the hyoids in order to resolve a locking problem.

The earlier this acceleration occurs, the more severe is the problem induced by shortening of the closing muscles.

Locking may occur both in the presence and in the absence of occlusal problems.

During opening, intra-articular noises may also be detected, the most significant of which is the **click**, which reveals condylo-discal incoordination.

This occurs when the condyle positions itself in the fossa, losing total or partial contact with the articular disc positioned in front of the condyle.

During mouth opening, the mandible encounters the resistance of the disc and, when recapture occurs, that is, when the condyle rises back onto the disc, a sharp sound is heard.

Condylo-discal incoordination is also caused by ascent of the condyle into the temporal fossa, and that ascent is in turn determined by a gnathological problem.

8.3 Test of dental interference on the muscular system

A thickness of about 2-3 millimetres is placed between the posterior dental arches, simulating the presence of a bite splint.

The thickness may be made manually from any material or, to increase test accuracy, a diagnostic hydraulic bite with communicating vessels may be used, consisting of two trays containing saline solution connected by a small tube.

The bite, by preventing the patient's habitual dental occlusion, reprograms mandibular movement and, if a hydraulic bite is used, reprogramming occurs at each swallow because the water, moving from one tray to the other, compensates for dental asymmetries and makes it more likely that occlusion will occur in muscular equilibrium.

With the bite in the mouth, worn for 15-20 minutes, three cases may be distinguished on the basis of bodily reactions:

Negative bite
No evident variation in skeletal body relationships.
This is the physiological condition: the teeth do not interfere with the myofascial system.

Positive bite with correction
Evident improvement of skeletal relationships and verticality, accompanied by subjective sensations of well-being reported by the patient, “as if I had taken a backpack off my shoulders,” and/or noticeable reduction of symptoms.
In this case, the teeth interfere with the myofascial system and referral to the specialist is appropriate.

Positive bite with worsening
This is the signal that tooth position is not the primary problem but that, at that moment, intervention on gnathological problems would create an additional disturbing factor.
In this case, the therapeutic strategy is to work on the myofascial system or to search for other possible matrices of the patient’s symptomatology.
After a period of treatment, the bite test is repeated and, if the therapies carried out have been effective, a change in reactions will be observed, shifting either toward point 1, no correlation between the teeth and the underlying structures, or toward point 2, gnathological problems are present and, having previously addressed other priorities, can now be treated.

9. Summary

The TMJ as a systemic manifestation
Dysfunction of the temporomandibular joint is rarely a primary cause and is more often the consequence of alterations originating elsewhere. For this reason, the more appropriate term is cranio-cervico-mandibular disorders.

Three modes of development
These disorders develop through structural dental alterations, secondary shortening, sensory visual or auditory disturbances, secondary shortening, or primary muscular problems, primary shortening. The distinction between primary and secondary shortening determines the therapeutic strategy.

Functional anatomy
The TMJ is a double articulation, and the disc has a true articular function. With the teeth in contact, the condyle is positioned on the temporal eminence, not in the fossa.

Occlusal problems
Three principal situations alter the system: difference in tooth height, causing asymmetrical muscular activation; excessive freeway space, causing anterior head projection; and reduced freeway space, causing posterior head projection. Each alteration produces systemic compensations through the hyoid muscles.

Mechanism of locking
The closing muscles are vectorially dominant over the hyoids. Their shortening prevents physiological opening of the mandible. The lateral pterygoids compensate by pulling the condyle anteriorly in a jerking movement, producing subluxation. Subluxation is therefore a consequence, not the cause, of the problem.

Diagnostic tests
The closing test evaluates upward displacement of the condyle into the fossa, always caused by a dental problem.
The opening test identifies compensatory intervention of the lateral pterygoids.
The bite test distinguishes between dental interference that is present and correctable, absent and physiological, or currently contraindicated because other problems must first be addressed.

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