Fundamental considerations on the morphophysiology and morphopathology of the temporomandibular joint (TMJ)

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Summary

The authors evidence the importance of being knowledgeable as regards the TMJ anatomy as well as its specific peculiarities are interpreted through the new intersystemic medical vision of contemporary Gnathology.
The nine essential features presented above open the perspective of assimilating morphophysiology and morphopathology knowledge on this articulation, which is a unique item in its capacity as the posterior anatomic determinant of functional occlusion.

Keywords: tmj morphophysiology and pathology, posterior anatomical determinant, functional occlusion..

- Note I -

1. The need of getting acquainted with the TMJ anatomy

One of the most significant conquests of contemporary Gnathology is the integration of all dental braches within the frame of Biology under the name of Dental Medicine.

Following the emergence and application of multiple technical means of macroscopic, microscopic and radiological clinical examination of TMJ, of refining the complex means of epidemiological investigation – analyzed by the help of anamnestic and objective indices, processed by computer programs – a ***new methodology*** was set up. It allowed extremely relevant results, by using an ***intersystemic medical reasoning***, which was able to assess the functional or dysfunctional status of the stomatognathic system, also termed orofacial (OFS), with or without discal-condylar implications (Ieremia et al., 1987, 1999, 2000).

Most often, the appearance of dyshomeostasis of this complex ensemble will directly or indirectly generate baneful consequences on other biosystems of the human organism as well. Due to its polymorphic symptomatology, usually characterizing a syndrome, and to an intracapsular or extracapsular pathology produced by predisposing, initiating or perpetual multicausal etiological risk factors (that can mix up and reciprocally condition themselves through different intimate mechanisms), the orofacial structures are equally affected, against the aggravating background of overlapping certain systemic diseases (Pullinger et al, 2000). Such ***craniomandibular dysfunction*** is the consequence of imbalance, having ***three basic origins***:

- postural, through the functional disturbance of the muscles which connect the mandible to the skull, the vertebral column and the shoulder girdle;

- ***lingual***, through the dyspraxia of infantile deglutition;

- ***dental***, through malocclusion with deviations in teeth gearing, due to traumatic occlusion (TO).

The correlation between posture and the mandible is observed through the reciprocal influence transmitted. For instance, when the mandible is imbalanced because of the tongue or teeth, it will systematically trigger posture alterations, converting into a source of individualized pathology. Equally, the posture acting on the mandibular bone can generate biomechanical changes, accompanied by TMJ pain.

Such significant observations derive from the ***concept of muscular, articular and facial integration***, which states that the three-dimensional equilibrium of the mandible as against the skull and face cannot be considered functional unless the elements that make up the OFS (TMJ, the muscles and aponeurotic network) do not cause any damage to the organism.

This ***concept named "of chains"***, elaborated by Fonder and May (cited by F. Serviere, 1989) and sustained by G. Struyf-Denys (1982) has three important corollaries:

- the functional imbalance of a muscular organ, characterized by spasm or hypotonia will cause, by contiguity, a similar reaction in the neighboring muscles, of the same dynamic system;
- an articular dysfunction generates another remote dysfunction, in respect to the convergence of main constraints induced by an initial lesion;
- aponeuroses constitute a systemic complex of tensions, at the level of which imbalances produced by constraints, trauma and inflammatory pathology reverberate.

Regardless of all the above-mentioned aspects, the assessment of temporomandibular disorders in literature, the systematization of pathology and the identification of etiology by explaining the pathology of morbid entities of the TMJ, still represent nowadays a controversial subject. It demands knowledge of the complex anatomy of this articulation, which actively takes part in achieving the essential functions of the stomatognathic ensemble, that R. Slavicek (1996) considers being a "cybernetic supersystem".

Not last, in our opinion, adequate importance should be given to the occlusal function (OF), which represents the physiological condition of dental arches confrontation during the functioning of the stomatognathic system, through mandibular chocking and guidance. Two significant capabilities are distinguished: masticatory and postural.

An optimal interarch gearing through stable, symmetrical and multiple occlusal stops will influence an adjusting modeling of the articular tubercle and of the mandibuar condyle head, thus achieving consistency between the condylar slope, the incisive slope and the skeletal frame.

This favorable correlation will allow the dental arches to withstand as much as possible the numerous parafunctional aggressions (bruxism, vicious habits), lying at the boundary between physiologic and pathologic.

According to M. Watanabe et al. (2001), B. Kazuyoshi et al. (2001), such statement can be considered as pertaining to the physiologic, by taking part in the maintenance of psychological balance of the individual in the OFS homeostasis.

If the intensity of parafunctional manifestations is important and repetitive, it becomes a pathological risk factor (Amemory, 1999; Alamaudi, 2001; Molina et al., 2001; Sari et al., 2001; Koyano et al., 2003), causing structural alterations (pathological dental abrasions, teeth drifting, myalgia, arthropathies) on the ground of remodeling the hard components of the TMJ with regressive, progressive or combined specificity (Kurita et al., 2000, 2001;

Ieremia et al., 2004 a, b, c).

According to H. A. Israel et al. (1999), K. Yamada et al. (2001), the excessive TMJ involvement in bruxism, generated by maxillary clenching and interarch constriction, brings about changes in the structure of the articular cartilage, with the specific biochemical consequences of intracapsular pathology of degenerative nature.

This conclusion was borne out by N. Stegena et al. (2000) and by other researchers as well (Lyons, 2001; Piotrowski et al., 2001). Although bruxism and certain vicious oral habits are reckoned as possible causes responsible for excessive dental wear, abfraction and TMJ dysfunction, unfortunately no cause has yet been established.

It seems though that personal dissatisfaction, psychological stress and even difficult social conditions can be considered risk factors that generate stomatognathic ensemble dyshomeostasis, with discal-condylar dysfunctional implications at the TMJ level (Macfarlane et al., 2002; Johansson et al., 2004).

Quite recently, the most plausible hypothesis is that of excessive pathological dental abrasion, of extended partial unrestored edentation or iatrogenically restored, on the priority background of psychogenic factors. This can reduce the adaptive capacity of the TMJ and associated tissues, mainly favorizing the evolution of nocturnal bruxism, generating tissular complications of the hard and soft articular components (Ieremia et al., 2001, 2002), and leading to diagnosis difficulties (Grumezescu et al., 2004).

As TMJ dysfunction is the main cause of nonodontogenic algia of the OFS territory and includes many morbid entities affecting the masticatory muscles, TMJ and other associated structures, according to De Boever at al. (2000 a, b), L. Ieremia et al. (2000), Alex. Rotaru et al. (2001), the need of detecting the clinical forms of manifestation of this pathology is required, by the correct assessment of evolutional stages of the craniomandibular painful dysfunctional syndrome (CMPDS).

Consequent to this estimation, the monitoring of individuals epidemiologically investigated, the choice and application of adequate therapy with individualized and prophylactic character, followed by the confirmation of treatment efficacy by the help of computerized medical programs, are performed.

2. Specific peculiarities of the TMJ

Willing to contribute to applying modern methodology of contemporary Gnathology through investigations, in order to trace out this pathology in human communities (quite frequent at all ages and sexes) we will demonstrate what the nine unique features of the TMJ consist of as compared to the rest of the articulations in the human body.

Such clinical functional morphology data, interspersed with notions of physiology, physiopathology and macroscopic biomechanics, colligated with light and electron microscopy and histochemical analyses, have opened new prospects towards unraveling intimate mechanisms of normal or pathological biological processes.

It is well known that the TMJ, as a posterior anatomical determinant of occlusion (*Figure 1*), contributes, through its anatomical and biomechanical peculiarities to carrying out OFS essential functions through the subsequent significant components: the articular surfaces, the disc, the capsula and its own intraarticular and extraarticluar ligaments and the dynamizing muscular complex.

This articulation is permanently exposed to the biological process of modeling under the action of morphological and functional variations at the level of other components of the stomatognathic system.

Thus, when the adjusting solicitation exceeds the TMJ possibilities, discal-condylar dysfunctions may surface, generating irreversible lesions in the hard articular components.

The maintenance of the individual functional constants in permanent change in biological balance, their conscious regulation demand of the dentist, apart from taking into consideration all morphology and morphopathology knowledge of this articulation, an outstanding capacity of analysis, correlation and synthesis, unlike with the technical professions – industry, electronics – where precise parameters are used (Costa, 1987).

According to my PhD supervisor, ***the specific features of the TMJ*** are:

1. It is a ***pluriaxial synovial diarthrosis of ginglymo-arthrodial character*** ensuring condylar dynamics through combined movements of rotation and translation, being very solicited in numerous functions indispensable to life, such as:

- mastication;
- deglutition;
- phonation;
- breathing.

Various functions are conditioned not only by mandibular kinematics, guided by the masticatory muscles contraction, but also through the synergic participation of other muscular organs of the cervico-cephalic extremity, which take part equally in voluntary or reflex actions (Ueda et al., 2002; Shiau et al., 2003), with the result that mandibular balance is subject to occlusal and muscular stability.

2. As it is a ***double articulation***, of condylar type, with a superior supradiscal compartment (disco-temporal) and an inferior infradiscal compartment (condylo-discal), having two separated synovias, the TMJ can be considered the most evolved articulation of the organism. It has a ***two-stage mobility***: **rotation** in the inferior stage and **translation** in the superior stage (Uram-Ţuculescu, 2001). Such combined dynamics induced certain specialists to regard them as ***Siamese articulations***, because the movements of both disco-condylar ensembles are symmetrical and compensatory, the mandible occupying an important place in the craniofacial bony massif, having complex functionality.

3. It is ***the only mobile articulation of the skull,*** ensuring the connection between its base and the mandible.

4. ***TMJ is suspended from the skull by the temporal and masseter muscles,*** being attached to the hyoid bone superiorly and to the air-digestive tract and to the occipital bone and cervical rachis posteriorly.

5. ***It is a unique articulation*** in the organism, since ***it has its own muscular insertion on the disc***. On its anteromedial part, the superior fascicle of the lateral pterygoid muscle attaches directly or indirectly and on the anterior and lateral part, the temporal and masseter fibers are attached (Ieremia et al., 1981, 1987). The main role of the disc is to turn the two incongruent articular surfaces (of the temporal bone and mandibular condyle) into congruent surfaces, thus contributing to the protection of the TMJ as against the occlusal forces (Isberg Annika, 2001).

6. By contrast to other synovial articulations, ***the contact surfaces of the osseous components*** of the TMJ ***are not covered by hyaline cartilage, but by dense fibrous connective tissue***, resistant to biomechanical stress (especially shearing), being less susceptible to aging and possessing greater healing capacity (Mărcăuţeanu Corina, 1998). The TMJ is protected thanks to the spatial disposition of the proteoglicans-collagen network and to its capacity of retain-

ing extracellular water through buffer effect osmotic forces (Burlui et al., 2000).

7. In rest posture of both TMJs, ***articular pressure*** is reduced, but it ***increases during mandibular dynamics and dental arch constriction***. This pressure varies individually and is of greater value in women as compared to men. Articular movements are limited by interdental contacts while closing the mouth while the occlusal relations condition the pressure transmitted to the articular components (Grumezescu Ana-Maria, 2001). According to R. Ciancaglini et al. (2002), the dentist is compelled to analyze the distribution of contacts in maximal intercuspidation in patients with TMJ disorders, in order to detect the premature contacts which are be removed through occlusal adjustment, as they represent sources of constraint for the articular components.

8. ***TMJ size is generally directly proportional to skeleton dimensions*** and the dimensions of its components tend to be reciprocally adapted.

9. ***The alteration of one TMJ will inevitably have consequences on the other TMJ articulation and on the occlusion.*** Reversely, an occlusal anomaly can generate temporomandibular disorders if the adapting possibilities of the articular components, through remodeling, are exceeded (Schifman et al., 2001; Celic et al., 2002; Horga, 2003; Totolici et al., 2004; Ieremia et al., 2004 a, b, c).

In note II we will describe macroscopically and microscopically the anatomofunctional components of the TMJ, with reference to certain biomechanical aspects of the hard articulary structures.

1. parietal bone
2. coronal suture
3. frontal bone
4. glabella
5. nasion
6. nasal bone
7. frontal process of the maxilla
8. anterior lacrimal crest
9. lacrimal fossa
10. posterior lacrimal crest
11. lacrimal bone
12. orbital part of the ethmoid
13. frontozygomatic suture
14. zygomatic bone
15. maxilla
16. anterior nasal spine
17. mandible
18. mandibular ramus
19. coronoid process

Figure 1. Skull, right view
(According to McMinn and R. T. Hutchinds, 1989)

20. condyle
21. mental protuberance
22. mental foramen
23. styloid process
24. tympanic part of the temporal bone
25. mastoid process
26. external acoustic meatus
27. zygomatic process of the temporal bone
28. squamous suture
29. zygomatic arch
30. greater wing of
31. the sphenoid bone pterion
32. inferior line of the temporal bone
33. superior line of the temporal bone
34. occipital bone
35. external occipital protuberance

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