

**Neuromuscular re-equilibration of the stomatognathic system:**  
**The feedback system**

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#### INTRODUCTION

In recent years, the problem of craniofacial decontraction has been tackled many times by various Authors. The importance of this methodology in diagnosis and treatment of algodysfunctional affections is tremendous because, without relaxation, we would be unable to understand what type of rehabilitation must be adopted. This is basically due to a couple of reasons, namely:

- a) the patient is symptomatic and we are unable to predict what benefits can be expected from our intervention (1),
- b) the patient is symptomatic, therefore, his mandibulocranial relationship is already impaired and, still more, out of its adjustment range to such an extent that it triggers pain (2).

Many relaxation appliances have been suggested: from cotton wool rolls (3) to anterior jigs (4), to a wide range of upper, lower, partial, rigid, elastic plates (5), to electromyographic Biofeedback (6,7), and even to the use of T.E.N.S. (8). All these appliances may be, of course, successful, though they all involve some intrinsic difficulties that may limit their use in our studies (9-11).

#### THE PHYSIOLOGY OF OCCLUSION

A clarification of the mechanism for which our neuromuscular system becomes contracted may be useful before we review the aforesaid appliances. Proprioceptive awareness of occlusion is felt during deglutition, or rather whenever our dental arches come in contact with each other (12). This enables our brain always to know how to move our jaw to bite, chew or simply swallow. However, to obtain this and to protect our abutment teeth and joints, it is extremely important to make a continuous mental "refresh" of the actual situation. Why do we say continuous? It's simple, only think of the act of chewing. Food is progressively crushed, according to its size and resistance, with an ever growing strength until our teeth fit together, then the swallow reflex is evoked. In other words, our neuromuscular system will "test" the consistency of our food whenever we bite into it, thus becoming acquainted with what it is going to be faced with. Let's take for example biting into a roll: we gently bite into it first and then make a sufficient effort to cut it. The force applied mainly depends on its consistency, a toast will be seized with our teeth with lesser final force than a one-day stale roll, but the initial act is accomplished in the same way. Another example is given when chewing a bit of meat; after a few masticatory cycles the force we use is much stronger, but if we were to find a lead pellet in our food, we might even risk to break our tooth, and this because our system was not prepared to meet with such strong resistance. Instead, if we have just slightly perceived the presence of the pellet, then our chewing becomes softer and cautious, though never reaching maximum intercuspitation, until the foreign matter has been identified and removed; not only, but at this point we could detect the pellet between our teeth with no danger because its presence and size have been located by a simple, slight contact. This is why our refresh must be continuous (13). After we have thus explained how our system can control occlusion, we will understand how it may be subject to pathologic contraction. Let's take for example a fresh-made filling: the patient refers he feels it a little high, practically, in this situation, his dental arches fit together only on the filling point. It is well known that at least three points are required to find a stable rest position. Our system cannot remain in unstable equilibrium, but it must find a well balanced "rest" position, just like when we stand on tiptoe: after a while we are obliged to rest on our foot plant. Our mandible will then move imperceptibly whenever we swallow until it reaches at least three of the aforesaid points. Most of this movement is operated by the muscle systems involved in the spatial mandible posture, namely: the Temporalis and Internal/External Pterygoids. In this condition, the filling will no longer be perceived as too high. Unlike machines, this continuous adaptation system allows us to be able to "work" without failure even when there is some problem. We can thus compensate for wear, dental breaks, bridges, fillings, dysgnathiae; however, the more we try to compensate, the farther we move away from the starting point and the greater the risk to cause real disorders, resulting in severe algetic syndromes. An example is given by kyphoscoliosis, which may even cause a "hunchback", associated with painful movement restrictions. In the area of our concern, this may lead to cervical pain, headache, joint disorders, malposture, etc.

## CLINICAL APPLICATIONS

After this preamble, it seems obvious that all jig and plate types can produce a temporary effect by “breaking” our system programme; however, this will inevitably elicit a new adaptation pattern until a stable occlusal position is reached. If the plate is correctly positioned, everything is all right, otherwise a new adaptation mechanism will be triggered. A patient may frequently refer that his symptoms have clearly improved; however he may relapse just a few days later. The realization of a dental plate without interferences is quite difficult, almost as difficult as to calculate a correct mandibulocranial relationship in terms of neuromuscular equilibrium if the latter is strongly contracted (14).

In an early approach to these problems in 1969 (15-19) a completely new idea was developed, i.e. the implementation of a hydrostatic plate based on the “communicating vessels” principle, consisting of two interconnected soft liquid-filled pockets so that the fluid may freely flow from one side to the other. At every deglutition, our dysfunctional patient will then “feel” two soft pockets between his dental arches, allowing him to release from dental interferences. A stronger pressure on one side will cause the liquid to flow to the opposite side, thus triggering a feedback mechanism that will help normalize the muscles involved in a few minutes. The two pockets will practically restore the rest position that is indispensable for normalization of his muscular system. By using his own reflex functions, our Patient will gradually find, by himself and unconsciously, his correct equilibration. The only disadvantage of these really ingenious plates was their difficult implementation. Nowadays, thanks to the Aqualizer® system, all this is past history, since pre-molded plate-like elements of three different sizes have been manufactured, so that they can practically fit all dental arches, provided of course that sufficient dental elements are available. (Pictures 1 and 2)



**Fig 1: Aqualizer® in occlusion**



**Fig. 2: Aqualizer® applied with its winglets above the occlusal surface.**

## MATERIALS AND METHODS

To test the efficacy of this system, 60 patients were monitored and tested Without Aqualizer® (WAQ), a few minutes after application of the Aqualizer® (AQ) and after 12 hours (AQ12), on 31 different parameters. The patients were included in this survey without any preconceived instructions or restrictions. They were all dysfunctional patients who, being conscious of their problems, accepted to be recruited in the survey to solve their algetic syndrome. Test instrumentation: 4-channel Electromyograph Myotronics, Kinesiograph Myotronics K6I Diagnostic System (Picture 5), Scoliometer with weight record (20).



**Fig. 5: Kinesiography and EMG**

## Test methodology

Electromyography of Temporalis/Masseter Rest (TRP) (MRP), to assess variation of Right/Left electric activity, expressed in percentage.

Electromyography of Temporalis/Masseter Clench (TCL) (MCL), to assess variation of Right/Left electric activity, expressed in percentage.

Kinesiography and Electromyography for analysis of the deglutitory scheme (DEG), Visceral Swallow (VS), Atypical Swallow (AS), Somatic Swallow (SS) (21).

Kinesiography, Picture 1 (Scan 1), to detect movement disorders, like Open-Close Velocity (OCV) expressed as maximum value in cm/sec.), Frontal Crossover (FC), Sagittal Crossover (SC), and Internal Derangement (ID) expressed by Yes/No and +/-.) Mouth Opening Side Shift (MOSS), expressed in mm.

Objective examination of the Frenulum Medialis Alignment (FMA), expressed in mm

Max Mouth Opening (MMO), expressed in mm.

Intra-aural Palpation to assess Left/Right Condylar Retrusion (LCR) (RCR, expressed) by Yes/No (22).

Palpation of Right/Left-Opening/Closing Clicks (ROC) (LOC) (RCC) (LCC) in the first portion of the range of movement, expressed by Yes/No (23).

Internal/External Pterygoid Digital Palpation (IPD) (EPD), expressed as maximum pain levels 0 to 3 (0 No, 1 Trouble, 2 Pain, 3 Much pain) (24).

Differential diagnosis of Arthrogenous/Myogenous/Mixed Pain (AP) (MP) (AMP) (25).

Assessment of Muscular Headache (MH) and Cervical Pain (CP), expressed by Yes/No and +/- (26).

Psoas Applied Kinesiology (AK), expressed as levels of resistance 1 to 3 (1 Low, 2 Medium, 3 High). (2,27)

Leg Length (LL), expressed as P (Equal length) and D (Dysmetria).

Weight Distribution Scoliometer (WDS) expressed in Kg of Right/Left variation (20).

Head Rotation (HR) expressed in hypomobility levels 0 to 3 (0 Normal, 3 Very limited) (20).

## RESULTS

The table below shows the results of an analysis of 37 patients with myogenous or mixed pain. It features the mean of all results obtained.

	TRP	MRP	TCL	MCL	DEG	OCV	FC	SC	ID	FMA	MOSS	MMO	LCR	RCR	
WAQ	35	40	40	25	AS	219	S	S	S	1,5	2,5	27	N	S	
AQ	6	4	10	5	SS	326	N	S-	S-	0	1	42	N	N	
AQ12	11	12	10	5	SS	340	N	S-	S-	0	1	38	N	S-	
	ROC	LOC	RCC	LCC	IPD	EPD	AP	MP	AMP	MH	CP	AK	LL	WDS	HR
WAQ	S	N	S	N	3	2		X	X	S	S	1	D	7	2
AQ	N	N	N	N	1	1		0	X-	S	S	3	P	3	1
AQ12	S-	N	N	N	1	0		0	X-	N	S-	3	P	2	0

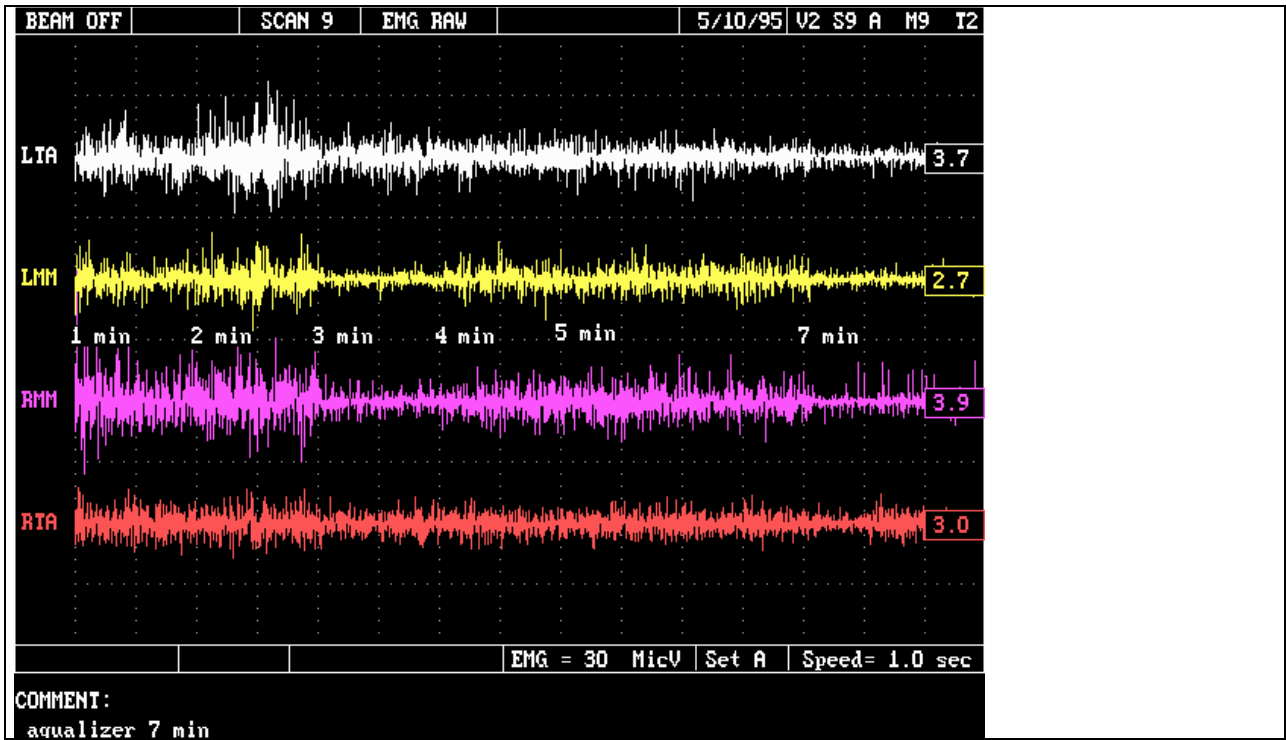
The table below shows the results of an analysis of 23 patients with arthrogenous pain. It features the mean of all results obtained.

	TRP	MRP	TCL	MCL	DEG	OCV	FC	SC	ID	FMA	MOSS	MMO	LCR	RCR	
WAQ	20	40	40	73	VS	140	S	S	S	2	8	16	S	N	
AQ	9	4	7	11	SS	240	S-	S-	S	1,5	6	30	S-	N	
AQ12	18	8	10	9	AS	185	S-	S-	S	1,5	6	15	S-	N	
	ROC	LOC	RCC	LCC	IPD	EPD	AP	MP	AMP	MH	CP	AK	LL	WDS	HR
WAQ	N	N	S	N	3	2		X		N	S	1	P	6	3
AQ	N	S	N	S	2	2		X-		N	S-	1	P	6	1
AQ12	N	S	N	S	3	2		X+		N	S	1	P	6	2

The figures in fuchsia indicate a pathology, in blue an improvement, in red a worsening, in green a moderate improvement.

## *LEGEND*

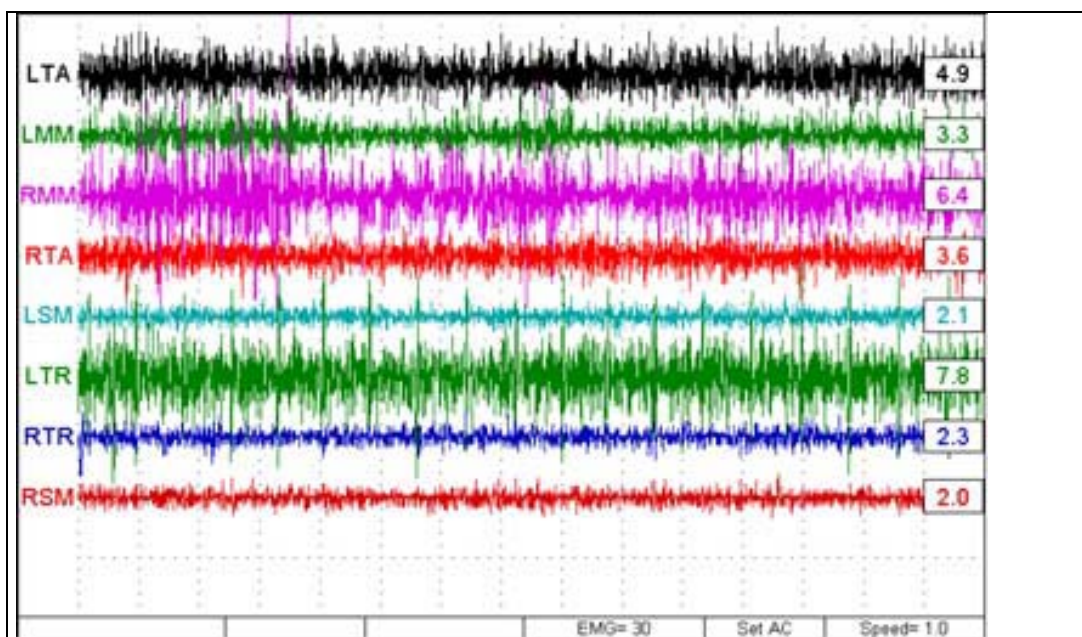
AP	Arthrogenous Pain
AMP	Arthrogenous and Myogenous Pain
AQ	Aqualizer®
AQ12	Aqualizer® per 12 ore
AK	Applied Kinesiology
AS	Atypical Swallow
CP	Cervical Pain
DEG	Deglutition - Swallowing
EPD	External Pterigoyd Digital palpation
FC	Frontal Crossover
FMA	Frenulum Medialis Aligment
HR	Head Rotation
ID	Internal Derangement
IPD	Internal Pterigoyd Digital palpation
LCC	Left Closing Click
LCR	Left Condylar Retrusion
LL	Leg Length
LOC	Left Opening Click
MCL	Masseter Clench
MH	Muscular Headache
MMO	Max Mouth Opening
MOSS	Mouth Opening Side Shift
MP	Myogenous Pain
MRP	Masseters Rest Position
OCV	Open-Close Velocity
RCC	Right Closing Click
RCR	Right Condylar Retrusion
ROC	Right Opening Click
SC	Sagittal Crossover
SS	Somatic Swallow
TCL	Temporalis Clench
TRP	Temporalis Rest Position
VS	Visceral Swallow
WAQ	Without Aqualizer® (habitual)
WDS	Weight Distribution Scoliometer



**Fig. 6: Typical Temporalis and Masseter relaxation in the course of time, starting from the habitual situation (WAQ) and then with application of Aqualizer®. A 2-second EMG reading has been taken every minute.**

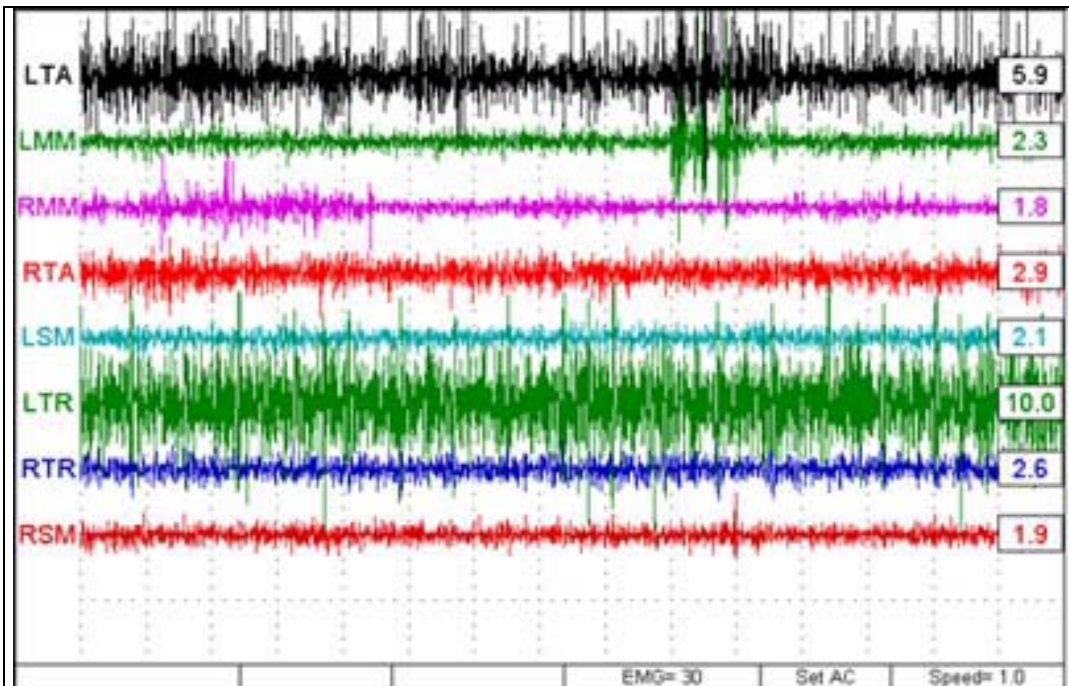
**CONCLUSIONS**

The results obtained for the cases of myogenous and myoarthrogenous pain were encouraging, to say the least: the re-equilibration of temporalis and masseters was achieved in a very few minutes, 8 on the average, and the muscle symmetry level was practically perfect: (Picture 6), much better than we could obtain from T.E.N.S., which we consider the best so far. Pterygoid Digital Palpation became less painful in an average 20-minute time, this result being partly superimposable on that obtained from our previous investigation on Jigs (28), although the latter seem to be more effective. At the EMG Clenching Test, we can notice the contemporary contraction of all four muscles, similarly to what happens with the cotton wool roll test, which means that a balanced rest position can be found (29). The EMG picture in rest position in relation to the type of relaxation applied is also significant.

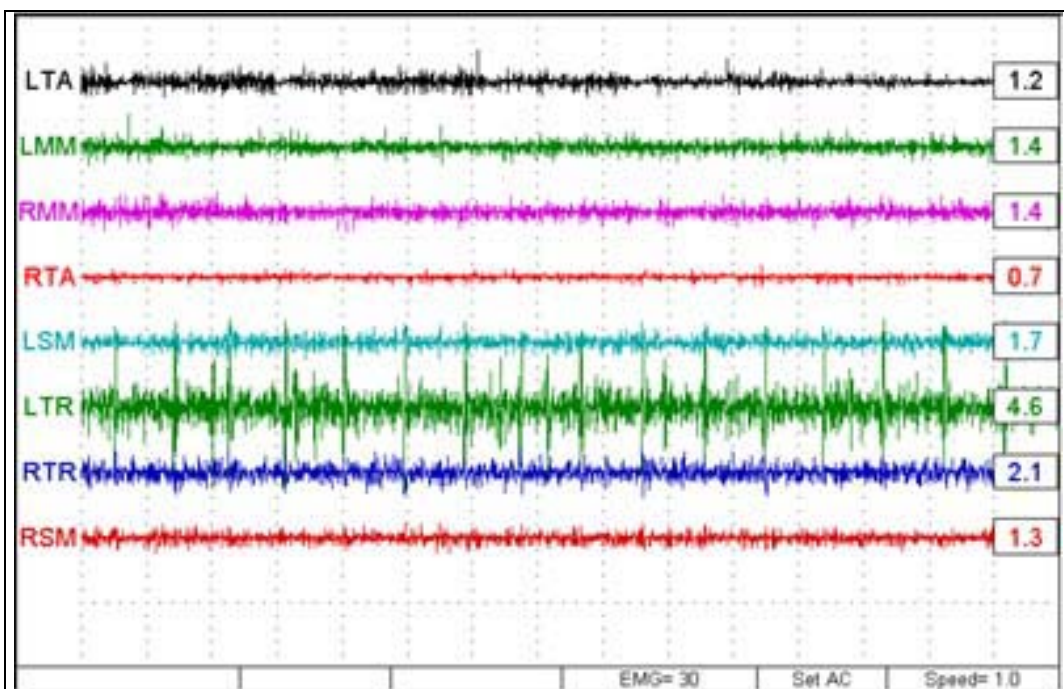


**Fig. 7: EMG situation with different relaxation types: WAQ (habitual).**

The WAQ situation with important asymmetries is monitored in picture 7, while the following (picture 8) shows the role played by 45-minute TENS with uncertain results: some muscles are certainly relaxed while others less, which causes a stronger difference, hence, a more important unbalance. Using Aqualizer® for 10 minutes (picture 9) the whole system becomes more homogeneous and, particularly, better balanced.



**Fig. 8: EMG situation with different relaxation types: 45-minute TENS on Kerr Occlusal Indicator**



**Fig. 9: EMG situation with different relaxation types: TENS is switched off after 45 minutes and Aqualizer® is applied for 10 minutes.**

In our opinion, kinesiographic information and EMG of the deglutitory scheme are also extremely important, since practically all patients with atypical or visceral swallow can correct this act, in most cases, by making normal type I swallows. This could oblige us to reconsider the real need for a remedial myofunctional exercise when a pathology is

present (30). Kinesiography Scan 1, again, shows an improved open-close velocity, a reduced internal derangement resulting in an improved frontal crossover with fewer derangements. Pictures 12 and 13, related to a Test patient, show an appreciable algiodysfunctional improvement after only 20 minutes. Less muscle pain, increased max mouth opening, reduced condylar retrusion and clicks, frenulum midline re-alignment, activation of the elevator muscles at clenching. The kinesiologic tests were always found to be positive, with an increased muscle resistance and tending to re-alignment of the legs (31). Picture 11 shows, on the scoliometer, important induced postural changes. On the left, our patient is WAQ, his head has a shift to the left with a 6-kg weight imbalance, however, at closer scrutiny, we will see that this is not the only change that can be observed, he is taller, has taken an upright posture and also his shoulders have a more correct posture (32), his arms look longer, his head has more rotation since he can see the vertical red lines behind him in a more central position (20). It must be noted that the patient has not moved from the platform during the test and that the variations were induced within a very short time through repeated swallowings. It is interesting to stress that all parameters have improved, more significantly during the first 20 minutes, while after 12 hours the improvement was often less significant. The patient wore his Aqualizer® overnight and came to our cabinet in the morning without removing it, he was instructed to do his dental care only with mouthwashes and to have only a liquid breakfast so as to prevent him from returning to his occlusion, thus avoiding a proprioceptive reconditioning. The “unexpected” effect of such specific appliance may well cause a false improvement, but we are more inclined to believe that the elastic effect obtained from the bite may lead the patient to a continuous chewing exercise, which will limit the effect of muscle relaxation, while reducing the thickness of the appliance and, therefore, the vertical space. Consequently, this may result in less improvement of the related diseases, like cervical pain, max mouth opening or open-close velocity. This would mean that this appliance is not suitable for a long-term treatment. However, in all cases in which it has been used as a diagnostic tool to test to what extent the pathology may be affected by occlusion, like for instance headaches and vertigo, excellent results were obtained with this appliance which, in some cases, caused almost a use-habit syndrome because of the important benefits it produced. The fact of being able to notice at once a potential disappearance of clicks and crepitation (33) was rated as very important. Furthermore, using an anterior jig, it was possible to transfer the “neuromuscular” Aqualizer® position to models for the manufacture of diagnostic rehabilitation plates, orthotics and night disengagement plates for bruxism (e.g. Bite-Plane, Night-Guard) with satisfactory results, definitely better than the those achieved by manipulation and resulting in fewer needs for re-adjustment and adaptation.

More conflictory results are available in case of overt arthropathy. A fact is that after 12 hours the improvement was often moderate, probably because of the aforesaid reasons. On the other hand, it is interesting to note that some parameters, i.e.: arthrogenous pain, max mouth opening and appearance of clicks, systematically worsen. As regards the first two, probably, the fact of being induced to chewing or simply the activation of Aqualizer® stabilization control systems by the tongue or by clenching, cause the mandible to make little movements resulting in increased pain and, consequently, in muscle contractions. The second case, instead, is probably a false worsening, since a joint in locking position with straightening of the discal ligament, will start working each time it re-captures the disk, at least partly, which will consequently click (13). It must be considered that these tests were intentionally conducted without trying to re-capture the disk in order not to alter the results. This seems to witness that Aqualizer® alone is unable to re-capture completely deranged joint disks; however, it is interesting to point out that after the canonical 20 minutes, this manipulation will be much easier and especially less painful, in confirmation of its relaxing effect on muscles.



**Fig. 11 Scoliometer and Aqualizer®-induced variation: the weight is re-distributed, the head is raised and allows for more rotation.**



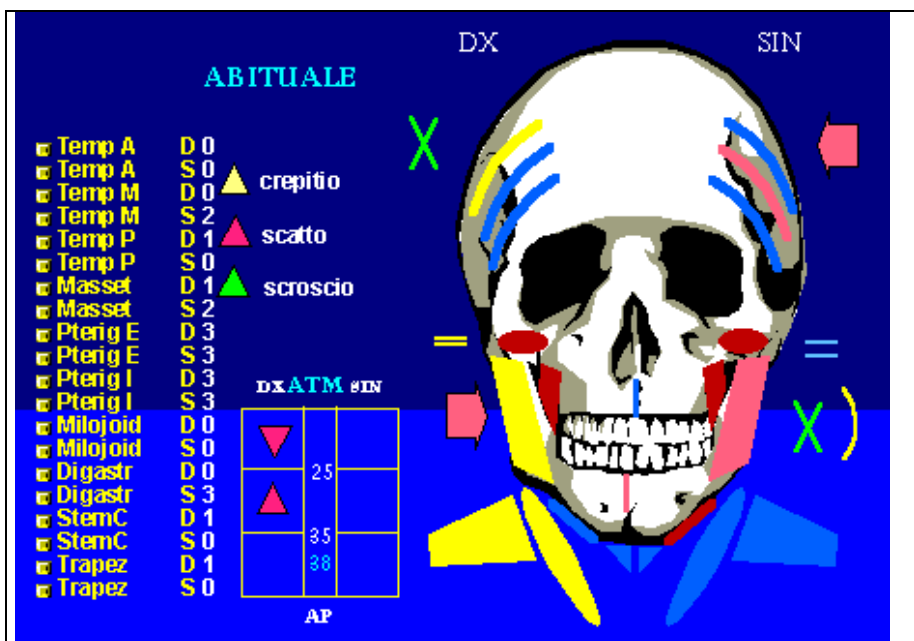


Fig. 12: A TEST-patient: a head and neck dysfunctional WAQ picture.

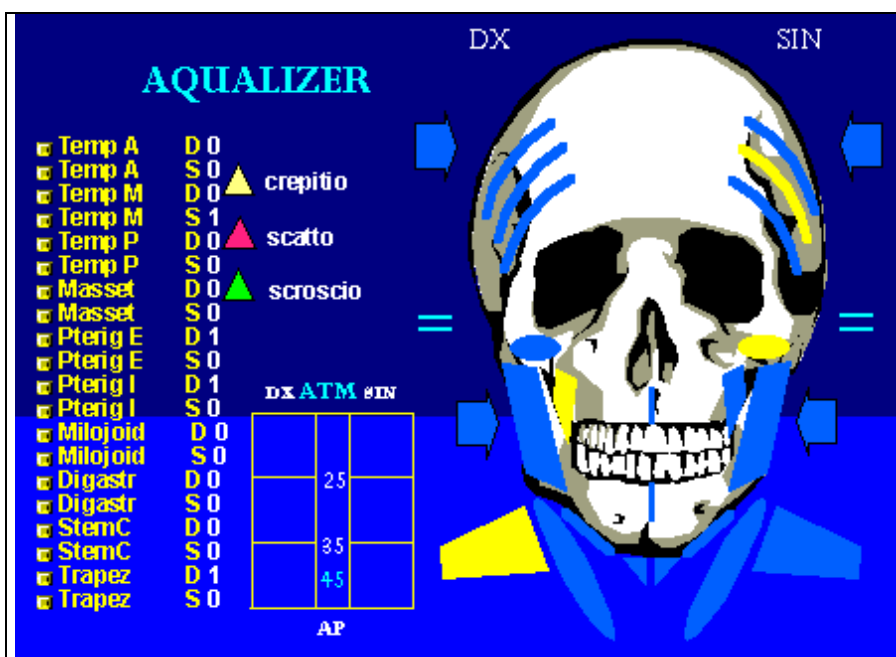


Fig. 13: Same patient: head and neck dysfunctional picture after 20-minute application of Aqualizer®.

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## Curriculum

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