

# Variation of Occlusal Contacts and Activity of Masticatory Muscles, In Relation to Increasing the Capacity of Movement of the Cervical Spine after Thrust Maneuver

## Abstract

The present study was carried out, to verify the immediate influence, not in the long term, on a sample of 90 asymptomatic (28 men 62 women), of the increased movement of the cervical spine on dental contacts. With an analogic inclinometer the breadth of the excursions of the cervical rachid was measured, it was ran a test has assessing digital dental contacts and the electromyographic activity of masticatory muscles (Teethan), the subjects were manipulated at the neck, with low amplitude high speed technique (HVLA). After handling the unblock, the movement of the cervical spine was measured again as well as the dental contact. All subjects have had an increase of the excursions of the cervical spine and a variation of occlusal contacts after the manipulation.

The work documents, how the unlocking of the cervical spine not always brings to advantages on the dental occlusion. In fact, it creates, as an overall concept, a variation and a consequent mandibular and contacts repositioning reaction. It modifies the occlusal adaptation of the subject, in some cases improving it, in others in a pejorative sense, confirming the close relationship between the two systems. There is a direct relationship between the mandibular barycenter and flax/extension, the asymmetry and the inclination between the torsion and the rotation of the column. To the decrease or increase of a specific cervical movement there is a specific occlusal orientation. The state of function of the column appears to influence the occlusion and vice versa. After the trust of the cervical spine the 55.5% of the cases got worse, 8.8% did not have variations, 35.5% had improved. In light of these results, the dentist who is facing rehabilitation procedures of the occlusion (orthodontic and / or prosthetic in particular), should take account of this intimate relation and consider a preventive control and treatment of the cervical spine before these therapies, to avoid that the variation of the cervical neuromotor ability, alter the stability and the occlusal references programmed or already obtained.

## Introduction

The relationship between occlusion and posture has been discussed and studied for many years. Numerous studies document the relationships that exist and the influences that a district has on another [1,2]. Even if this bond is well known, for a variety of reasons, it has a little consideration when it comes to daily dental practice, and some principles that should be usual in the functional correction of a temporary or definitive crown are absolutely do not consider those reports. In the forties Thompson and Brodie gave a definition of the occlusion of rest: the position in which the anterior and posterior muscles of the cervical spine were balanced [3,4]. Brill in 1959 describes that in relation to the flexion/extension of the head we have an increase or a reduction of the free way space. An anterior position of the head on the sternum produces a sliding back of the jaw, and a forward inclination of the head produces a mandibular advancement [5] and other Authors as Fink more recently were able to demonstrate how the cervical spine treatment alone works by creating a shift of the mandibular condyle [6]. Neck pain afflicts 30-50% of the general population every year [7] and is more

common in people with stomatognathic system disorders than the general population [8,9], it is impossible not to consider the cervical alignment if you want to optimise a dental finalization. The study aims to investigate the amount of influence that the instantaneous state of the cervical spine exerts on masticatory forces and occlusal contact. To do this we used a sample of subjects who were electromiographically tested before and after the release manoeuvre (trust) of the cervical spine.

## Methods

### Mesurement of the range of the cervical movements

For the measurement of the range of motion of the cervical spine, we used an analogic inclinometer (chinesport© 2016) (Figure 2). Starting from a defined static position, thanks to reference levels, this device three-dimensionally allows to measure: the flexion/extension, left-right rotation and right-left inclination [10-12]. Mixed roto/inclination movements were deliberately not evaluated.

## Research Article

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## Evaluation of the variation of the dental contact

For the determination of the occlusal variation a digital Synchronomyography was used (@ Teethan© Teethan Spa© BTS Spa) (Figure 1). The system detects the parameters of dental occlusion with four probes applied on the surface of the anterior temporal and masseter muscles of the patient. The device is an eight-analogic channel EMGS with amplified signals (increased amplifier set to 100) and digitally filtered. The device is connected wirelessly, with interference filters to the surrounding devices, on a selective channel that can vary if needed. During the examination, the device translates EMG signals in five reference indexes.



Figure 2: Analogic inclinometer.

The indexes are:

- Poc Ta/Poc Mm masseters-temporals (Percentage of Overlapping Coefficient)
- Barycenter (Ant/Post Relation)
- Torsion (Mediolateral Relation)
- Impact (Strength of the Force)
- Asymmetry (Dominant Side)

**Poc:** Indicates the relation between the two temporal and masseter muscles on the same side, identifying which is hyperactive in the pair; in case of imbalance this determines the side with the most number of contacts. According to the parameters of reference, the overlapping coefficient percentage indicates the influence of dental contact in the right muscle compared with the left one. The value considered to be within the normal range should be greater than 83% (normal average rate 85% +2) in a range between  $83 \leq \% \leq 100$  [13]. For example, if the imbalance involves one of two masseter muscles in the posterior part of the mouth, the patient will have a prevalence of contacts on the side of the more active muscle. The contact will be in the front in case of the temporal muscles.

**Barycenter:** Represents the anteroposterior relation of the occlusion. If in a patient the masseter muscles are more active, you will have a posterior barycenter. If on the contrary, the temporal muscles prevail, we will have an anterior barycenter. Also for this parameter, the value considered to be within the normal range should be greater than 90% (normal average range 95% +2) in a range between  $90 < (\%) < 100$ .



Figure 1: synchronomyography.

**Torsion:** Evaluates the cross activity of the two pairs of muscles. Represents the mandibular torsion on the horizontal plane. Normal value should be greater than 90% (normal average 95% +2) in a range between  $90 < (\%) < 100$ .

**Impact:** Evaluates the intensity of muscular work, returning a parameter closely related to bite force, it can also be the reference of the vertical dimension. This index, detect dental nociceptive reflexes, in case of low working capacity. The index Impact (IMP) was calculated in order to evaluate the work of every muscle with the following relation: where t stands for time (in this 3 seconds analysis). The index IMP indicates the ability to develop energy from every muscle per unit of time and was measured in  $\mu\text{V/s}$  where normal values are between 1500-2000  $\mu\text{V/s}$ . The device samples the single muscle signal per unit of time and provides two values for the IMP; a recording is measured with cotton rolls and the others without cotton rolls. This index is considered normal if it exceeds the 85% (normal average range 100% +2) in a range between  $85 < (\%) < 115$ . According to some Authors, it is also the most important index in the determination of the vertical dimension. In therapeutic terms: in the presence of a total IMP of less than 80%, we must increase the vertical dimension; however if the total IMP exceeds 120% we must decrease the vertical dimension [14] (Figure 3).

**Asymmetry:** Indicates the possible asymmetry between the right and left side and allows identifying any dominant side on the occlusal plane of the patient. It also is in correlation with all other indexes. The absence of asymmetry is  $10 \leq \% \leq 10$ . For simplicity the system revises the data through a logarithm that shows the global index of neuromuscular balance that encloses the totality of the datas obtained in a simple icon for both operators and patients.

Indici	Prova	Normalità
POC TA	74.02% L	83≤(%)≤100
POC MM	63.03% R	83≤(%)≤100
BAR	67.45% A	90≤(%)≤100
TORS	71.18% L	90≤(%)≤100
IMP	63.41%	85≤(%)≤115
ASIM	-3.20%	-10≤(%)≤10

Figure 3: Index.

### Global Index of neuromuscular balance

The synchroniograph, presents an icon of a dental lower arch, inside of this arch three bands are drawn: one vertical and two horizontal, they identify the medio lateral and antero posterior balance ranges, and 2 small spots: one red referred to the masseters and one blue referred to the temporal muscles. The intersection between the bands is the ideal position for the application point of the force carriers of the masseter muscles and the temporal muscles. The location of the spot and the presence within it of an arrow indicates the point of application of the forces and the direction of the carrier resulted from the muscle pairs in relation to tooth contact. A circular diagram that changes color represents the Global index of Neuromuscular Balance.

- It is red until 74% and this means absence of neuromuscular balance
- It is yellow if it is between 75% and 82% Range below the level of normality
- It is green if the overall balance is higher than the 83%-normal Range

### Materials

The subjects were randomly selected, using the below inclusion/exclusion criteria, among those who have come spontaneously at the "Physiotherapy Gnathological Office" in Rome between November 2015 - August 2016. No considerations were made on the occlusal class and on the determinants of occlusion of the subjects, only inclusion/exclusion criteria were considered. The subjects were aged between 20 and 55 years, fully dentate, with an occlusion without prosthesis, no dental-skeletal malformations and did not have or have ever had any signs or symptoms of DTM (valued according to the DC/TMD). All subjects express written consent to participate in the study. The study sample is formed by 90 subjects.

### Evaluation of the cervical spine

A sample of 90 asymptomatic patients was evaluated. Each patient has been placed upright on a hard chair with arms resting on legs, neck free of ties and clothing and shoulders draped in a stable way to the backrest. The inclinometer was carefully placed and adjusted on the position of two static reference levels. It was asked to the patient, without any interference of the operator, to do the flexion/extension, right-left rotation and right-left inclination [15-17]. Mixed roto/inclination movements were expressly not

evaluated. The operator has made sure that no compensation movements were made. A measurement of the ability of the movement of the rachid on three planes of space has been done. Every measure has been photographed and transcribed before and after trust manouver of the cervical spine (Figure 4 & Figure 5).



Figure 4: Eval. Cervical spine. Figure 5: Eval. of dental contacts.

### Evaluation of dental contacts

After measuring cervical movements EMG Teethan probes have been applied to the patient. For all subjects and muscular surfaces ECG electrodes ARBO Diam. 24 mm-H124SG El disposable with hydrogel adhesive "fast" and conductive attached to a button, sensor Ag/AgCl, and foam support were used. Before placing the electrodes, the skin was cleaned with a specific detergent without parabens, no perfume, no sulfate (SkinClor skin prep lotion. Leicestershire, United Kingdom). In addition, all males had no beard and females had no make-up. The electrodes were placed parallel to the muscle fibres, at the level of the anterior temporal muscles, along the anterior margin of the muscle, following the fibers highlighted by the clenching, in front of the coronal suture and above and below the sfeno-frontal suture. At the level of the masseters, the others electrodes were placed parallel to superficial fibers of the muscle, highlighted by the clenching; the upper electrode 2 cm above, the cephalometric Xi point as reference, the caudal electrode 1 cm above the gonion. The symmetry of the electrodes arrangement has been checked also to highlight specific anatomical differences of the subject. The reference of the patient was first normalized, making it dimensionless through the bite of two cotton rolls positioned between the arches at the level of the mandibular second premolar and first molar. For each registration two acquisitions lasting 5 seconds each have been made, one with cotton rolls and the second with no cotton rolls in the position of maximum voluntary clenching (MVC). After the calibration, without cotton rolls, the patient was made clench in 2 sequences of which always the 2° was chosen. The electromyographic signal off-line has been analyzed v (t) from the Teethan™ version 1.0.3.0.1 software, in order to obtain a standard electromyographic potential. For every muscle the average potential measured for 5 seconds with cotton rolls between the first molars was set at 100% of the value and all potentials measured afterwards were normalized to this value V set by the device [19,20]. The system automatically omits, the first and last second of the statistical analysis, it appraises the 3 central seconds of the acquisition and divides each new signal of 3s in

120 series of 25 ms and –for each series- calculates the average point and the rms (root mean square) of every muscle normalized to V [21]. Between the reference indexes of the system, we mostly considered the global index of neuromuscular balance. To have in just one percentage number, that instantly gave the perception of the variation (Figure 6).

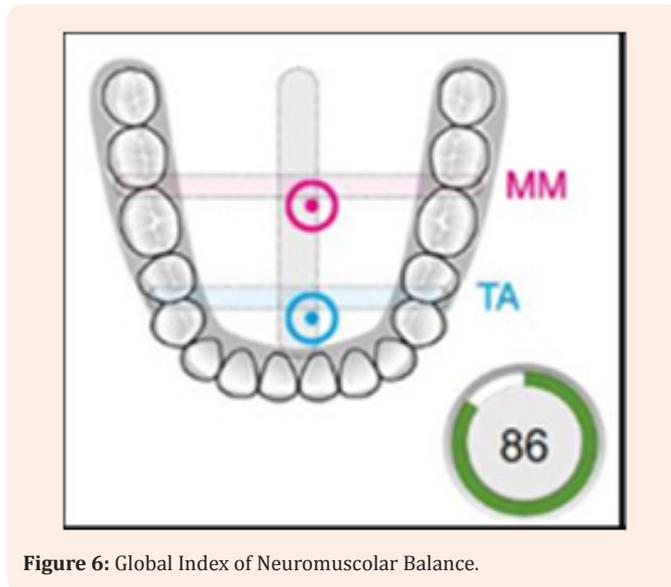


Figure 6: Global Index of Neuromuscular Balance.

### Technique of trust

Without removing any electrodes, a trust release manoeuvre of the cervical spine was made with the spinal manipulation technique: High-Velocity low amplitude (HVLA). The technique of high-speed, low amplitude (HVLA) is among the oldest and most frequently used chiropractic techniques. Most of the clinical chiropractic research has focused on evaluating the effectiveness of this form of manipulation [22,23]. In this technique, the manipulators apply a short (low amplitude) quick boost (high velocity) on the joints in adherence, aiming to regain the normal range of motion of the joint. The patient's body is placed specifically to optimize the adjustment of the spine. In this case the operator is behind the person who is sitting. The two hands of the operator holding the head of patient are placed at the level of the mandibular angle on one side and at the nape on the other. The operator asks the patient to release the muscles, gently moves the head in roto-inclination on the side where the operator's hand is placed at the corner of the mandible, making a small fast trust with hand on the chin, supported and accompanied by the hand resting on the nape. To be certain of the asintheomaticity of the subject, the manoeuvre is carried out within the boundary created by the receptorial and antalgic reaction created by the muscles [24,25]. After the manipulation, the measurement protocol was repeated under identical conditions. It was again made an acquisition with digital synchroniograph (clenching on cotton rolls for 5 seconds to normalize the signal, removing the rolls other 2 clenching tests of 5 seconds were made and the last acquisition was chosen), taking off the electrodes, the cervical spine motility was again measured, always with the same previous criteria used (Figure 7).

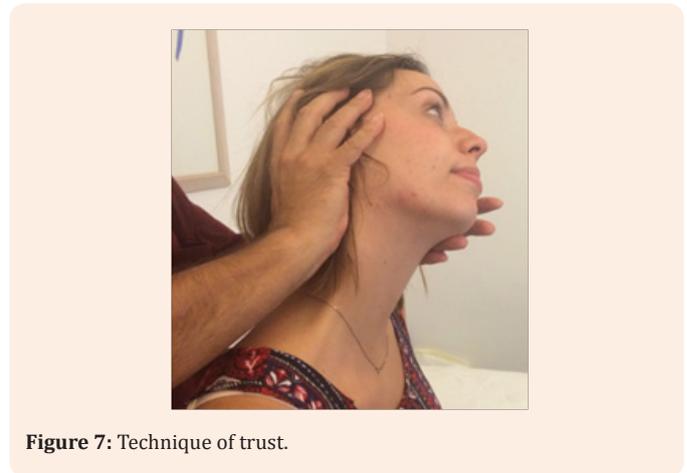


Figure 7: Technique of trust.

### Results

For the occlusal-muscle assessment, the indexes considered were: impact, barycenter, torsion, asymmetry, GIMB; the values of the above parameters were provided by the electromyography software and compared before and after the cervical manipulation. For cervical assessment 6 movements were analyzed: inclination DX SX, flexion / extension and rotation DX SX.

#### Increase of the excursion of the column after trust

The degrees of the individual movement were summed, and divided in six to have the average variation of the single subject. The average of each subject was used to calculate the total average of the variation of all subjects. The average of individual variation was an increase of 8° degrees of excursion. Individually: the subject who has had the lower variation was 2.5°, the subject who had the higher variation was 23.3°.

#### Impact- Intensity of the muscular work

Of the 90 subjects before trust 27 (30%) had a normal muscular work, after trust they were 17 (18.8%).

Before unlocking	After unlocking
High work 27	High work 28
Normal work 27	Normal work 17
Low work 36	Low work 45

32 (35%) subjects had a change of muscular work - 58 (64.4%) have maintained the same sort of impact and of muscular work they had before the release of the cervical spine.

#### Torsion

Of 90 subjects, before the trust 16 subjects did not have torsion, after trust 12 subjects did not have torsion.

Before unlocking	After unlocking
Right torsion 33	Left torsion 45
No torsion 16	No torsion 12
Left torsion 41	Torsion 32

27 (30%) subjects had a change of torsion - 63 (70%) have maintained the same sort of torsion that they had before unlocking the neck.

### Asymmetry

Of 90 subjects, before trust 37 subjects had no asymmetry, after unlocking 42

Before unlocking	After unlocking
Right Asymmetry 26	Right Asymmetry 19
No Asymmetry 37	No Asymmetry 42
Left Asymmetry 27	Left Asymmetry 29

39 (43.3%) have had a change of symmetry - 51 (56.6%) have maintained the same symmetry they had before the release of the cervical spine.

### Variation of the occlusal barycenter

Of 90 subjects, before trust only 2 had a normal barycenter, after trust it was just 1 person

Before unlocking	After unlocking
Posterior Barycenter 55	Posterior Barycenter 36
Normal Barycenter 2	Normal Barycenter 1
Anterior Barycenter 33	Anterior Barycenter 53

21 (23.3%) had a change of barycenter - 68 (75.5%) have maintained the same barycenter they had before the release of the cervical spine.

### Global index of neuromuscular balance

Of 90 subjects, before trust GINB of 28 subjects was green, after trust it was green in 26 subjects.

Before unlocking	After unlocking
GINB Red 39	GINB Red 48
GINB Green 28	GINB Green 26
GINB Yellow 23	GINB Yellow 16

On about 90 patients, 50 (55.5%) got worse, 8 (8.8%) have had no changes, 32 (35.5%) improved

## Discussion

### Cervical

In all 90 subjects, after the release manoeuvre of the cervical spine, there was an increased range of motion, even in those in which the trust did not produce any "noise". The change of occlusal contact has always taken place, none of the subjects remained with the same dental contact after the release manoeuvre of the column, although in some cases there was no change of the global index of neuromuscular balance. Some patients have had instant perception of having a variation of the dental contact together with a feeling of lightness when moving the neck.

### Impact-the muscular work

The 35% of subjects had a variation of muscular work. The

IMPACT index is affected by occlusal stability. There is an intimate connection between muscle activity and the amount of occlusal contacts [26,27], a greater contact area creates a better muscle activity [28]. This direct correlation between occlusal stability and muscle performance [29], can make us understand how this index can be a great help when researching the vertical dimension of the occlusion [14].

### The torsion

Seems to have something to do with variations in the rotation. Infact -without torsion- the difference between left and right rotation was minimal. In the right torsion, the rotation of the right side had a smaller excursion than the left. In the left it was the opposit. The variation of the torsion (from left to right) is related to the smaller excursion in the rotation in which there is torsion. For this reason, for a better interpretation of the table, joint excursions of left and right rotation were put close to torsion values. The data was repetitive in 98% of cases (Table 1).

### The asymmetry

Seems to have something to do with changes of lateral inclination. Infact in normal asymmetries the difference between left and right inclination was minimal, in the right asymmetries, the inclination of the right side had smaller excursion than the left one; in left asymmetries it was the contrary. The change of symmetry (from left asymmetry to right) is related to a smaller excursion in inclination of the side where there was asymmetry. For this reason -for a better interpretation- in the table, left and right inclinations joint excursions were put close to the index of asymmetry. The data was repetitive in 97% of cases.

### The barycenter

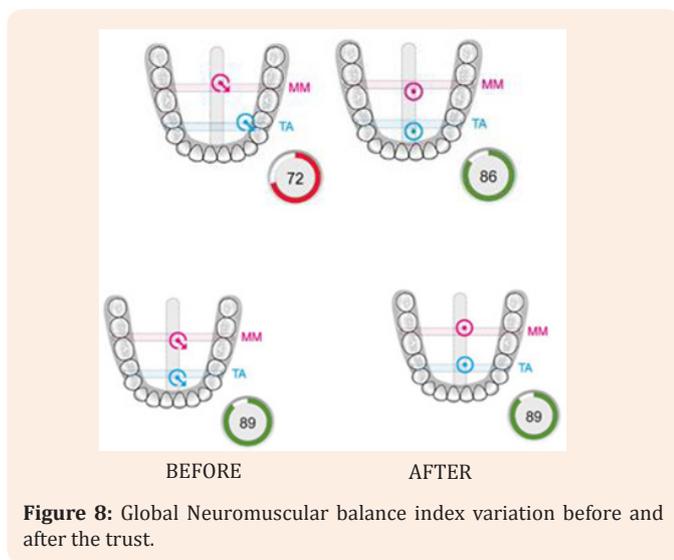
Seems to be in relation with the flexion/extension of the head. A reduced flexion appears to induce a posterior barycenter. A reduced extension seems to be more present in the anterior barycenter. This happens when the spine joint capacity is reduced by 1/3 of the standard only. Flex and extension datas, are not comparable to each other because the theoretical standard of the maximum values are not equivalent, 45 degrees for flexion and 60 degrees for the extension. The datas are repetitive at 41% for the relation of the Flexion-posterior/barycenter and 31% for the relation between extension- anterior/barycenter. The barycenter is slightly influenced only by changes of cervical mobility; infact after unlocking of the flexion/extension, the barycenter does not change in 75.5% of the subjects.

### Global neuromuscular balance index

It encloses all other indexes and it was our reference to consider in a global sense the change produced on the dental contacts and on the muscles from a trust. Considering the single subject, the variation of GINB has occurred always, in some cases within the same reference range (red-yellow-green), in others not numerically but within the range of application of the forces vector orientation. For better understanding, if a subject had a 68 GINB before the manoeuvre (red) and after the manoeuvre has become 50 (red, too) the range remained the same but the GINB had worsened (Figure 8).

## Conclusion

Over the years many articles on the occlusion/posture relation were subjected to the scientific community, some of them validated the thesis of the existence of such relations and others denied it decidedly [30,31]. In the comparison we always looked, precautionally, trying to mediate between the various positions and concluding that it was necessary to proceed with further research that would clarify the topic. After almost 20 years since the first Italian consensus conference [32], which denied any link between the districts, there is no doubt that diagnostic tools have evolved and that we now have more certainties supported by the literature. This study is aligned to the literature which considers the relation between occlusion and posture, not only present, but essential. All subjects, after handling, have had an increase of the excursions of the cervical spine and a variation of the occlusal contacts; in some subjects for the better, in others for the worse. Besides, the main data that this study demonstrates is the direct relation between mandibular barycenter and flexo/extension, asymmetry and inclination, and between torsion and rotation of the cervical spine. The State of function of the spine appears to influence the occlusion and vice versa. In the common therapeutic thought, doing therapy for the cervical spine is always considered an advantage from an occlusal point of view and, under certain conditions it is, but not always. In fact the general concept is that the trust creates a variation and a consequent reaction of repositioning of the mandible and dental contacts. The occlusal adaptation of the subject gets modified and not always for the better. Of 90 patients, 50 (55.5%) got worse, 8 (8.8%) have had no changes, 32 (35.5%) improved. Dental contact evaluation performed either sitting or lying down, from different occlusal positions, is necessary because we need to standardize a well-defined dental chair backrest position in which a detection or occlusal calibration can be made. Also the ability of movement of the cervical spine of the patient has to be detected and we have to inquire about the health of the patient's neck with some simple questions. In some very sensitive subjects, with little adjustment range, this can make a difference in the development of symptoms or not. In light of all the above documented, we hope for further studies.



**Figure 8:** Global Neuromuscular balance index variation before and after the trust.

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