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Research Article

Functional Implications of Minor Mandibular Asymmetry: Clinical and Digital Research on a Sample of Healthy Patients

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Abstract

Objective: The aim of the study is to evaluate the influence that the mandibular asymmetry could have towards the other components of the Stomathognatic system and to further related structures from a functional point of view.

Materials and Methods: A sample of 18 young asymmetric patients, in healthy status, was investigated with clinical evaluation and questionnaires and digital devices such as Electromiography, Stabilometry, T-scan and Formetric. Descriptive and quantitative statistical analysis were performed.

Results: ASIM electromyography index was significant only in a short percentage of the sample. Hypertonia of temporalis muscle in the same side of mandibular deviation and the cross-activation of the contralateral masseter were present. The data of the stabilometric platform showed that only 33% of patients had a load discrepancy between right and left side. All patients presented similar and limited postural anomalies during the Formetric examination. No significant results emerged from statistics.

Conclusions: From the emerging data, mandibular asymmetry does not seem to be considered a potential risk factor for the development of functional anomalies both in the stomatognatic system and in the postural one. The only issue that should be considered is the condylar retrusion of the mandibular shortest side that is a possible destabilizing factor of the TMJ condyle-disc coordination.

Keywords: Mandibular asymmetry, TMJ, , Stomatognatic functionality, Body posture, Digital device

Introduction

Mandibular asymmetries are defined as dissimilarity between some corresponding parts in the two opposite sides of this bone [1]. A complete bilateral symmetry is rarely found in living organisms, in fact many studies highlight how a difference between the right and left side of the face is very common in the population around the world [2]. These minimal "natural" variations make mandibular asymmetry aesthetically acceptable; on the contrary, facial types with more asymmetrical component may have a larger proportion of aesthetic problems. From a therapeutic point of view, as in the past as today, the correction of these asymmetries are considered significant not only to obtain a balance of the aesthetic sets but also to prevent functional alterations in the cranium-cervical-mandibular district. In fact there was a common belief that asymmetry was a predisposing factor of dysfunctions in this area [3]. Some researchers think that the mandibular asymmetry represents a possible risk factor for developing of functional alterations [4,5]. Some scientific publications report that the facial asymmetry, due to mandibular deviation, has a correlation with Temporomandibular Disorders [6]. According to these researchers, temporomandibular joints development could be influenced by the displacement of the mandible and it could be a risk factor for disc-condyle incoordination [7,8]. Furthermore, many studies showed functional connection between the stomatognatic system and the cervical system so that the alterations of the "mandibular system" seem to influence also the postural stability [9]. To better understand if a mandibular asymmetry can be considered a predisposing factor to a malfunction of the Stomatognathic and Postural systems, a sample of young asymmetric patients was investigated with clinical and digital findings comparing the data with statistical analysis.

The range of mandibular asymmetry analyzed was > 4mm and < 10mm, because,

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as reported in the literature this alteration was considered significant for a " conservative ", not surgical, treatment under an aesthetical and functional profile [10-12].

Materials and Methods

The study was approved by the Institutional Human Ethics Committee.

Sample assessment

Patients were selected from those come to the Department of Oral and Maxillo-facial Sciences (division of Orthodontics and Gnatology) at Sapienza University of Rome (Rome, Italy), between January 2016 and March 2017 (7 clinical evaluations a day per 5 days at week).

Inclusion criteria: malocclusion IOTN- Index of Orthodontic Treatment Need - 1 to 3; - mandibular asymmetry > 4mm and < 10mm (the literature reports that asymmetries less than 4 mm are to be considered without clinical significance and greater than 10mm surgical) [10-12]; - growing patients (from 7 to 15 years old); general and dental good health.

Exclusion criteria: Adult patients; - Syndromic cases of asymmetry; - TMD symptomatology referred; previous trauma; - previous orthodontic treatment; - systemic diseases; - tumors; - acute and chronic muscular-skeletal disease; - total or partial lack of radiographic assessments required.

Clinical evaluation and cephalometric evaluation of radiograms were performed as a measure of mandibular asymmetry. The clinical protocol consisted in: anamnesis, extra oral and intraoral clinical evaluation. Anamnesis was conducted with medical questionnaire to investigate patients'general health status and to find familiar cases of asymmetry. The patients were observed in the frontal view and from top to bottom to evaluate the lines of symmetry on the coronal plane (orthogonal to the bi-pupillary line passing through glabella and the nose line) and on the vertical one (un-leveling of gonial angles), to analyze the mandibular bodies length and the direction of mandibular deviation. The intraoral examination consists in general dental, periodontal and orthodontic analysis.

Radiographic evaluation of the asymmetry range. The cephalometric analysis on Orthopantomography (OPT) was conducted using Haberts and Saglam methods [13,14] in order to compare the two right and left sides of the mandible in terms of height and length. The cephalometric analysis on Postero Anterior skull radiograph was conducted on the basis of the guidelines suggested by Silvestri [15]. This exam is based on transverse and vertical measurements of one-sided dento-facial structure in relation to reference planes and compared with the contralateral. The further evaluation of the "splitting" of mandibular bodies could also be seen on Lateral skull radiograph. Radiographic data have been used only for the evaluation of the asymmetry level, given that the sample is composed of healthy patients.

In order to evaluate the presence/absence of TMJ, Diagnostic Criteria for temporomandibular disorders were used [16-18]. They provide an assessment including the most common TMD conditions. They consist of a valid and reliable Axis I screening questionnaire for identifying pain-related TMD and Axis I diagnostic algorithms for pain-related TMD, as part of a comprehensive TMD taxonomic classification structure. The Axis I diagnostic criteria are collected from the specified examination protocol and from the self-report issues. Axis II has not been evaluated.

Thirty patients were included but only 18 (8 male and 10 female aged between 8 and 15 years) agreed to take part in the scientific protocol. 8 patients did not partecipate for lack of parents' availability, 6 patients because they reside outside the city. Every patient submitted the informed consent.

Study design

After the first screening, the 18 patients recruited for the study were examined. Clinical and anamnestic DC/TMD evaluations [16-18], performed during the preliminary phase, were useful to highlight eventual functional alterations in the Stomatognatic system. The examination was comprehensive of muscular pain analysis (myalgia and myofascial pain), during jaw movements and occurring with provocating test, applying manual pressure, in particular to masseter and temporalis muscles. Also other muscles and tendon insertions, such as frontalis m., pterygoideus lateralis m., pterygoideus medialis m., trapezius m., sternocleidomastoideus m., coronoid process and mastoid processes were evaluated. Moreover intra-articular disorders and the type of mandibular movement (such as the presence of limitations/ abnormal excursion/ deflections) were analyzed. The clinical evaluation of trigger points, joint excursion and pain provocation of the cervical spine has also been done.

In order to evaluate some possible positional head anomalies due to visual defects, patients' parents had to fill in an orthoptic questionnaire edited by our equipe on the basis of the principal ocular defects and to test specific "behaviors" occurring in the growing patients.

Electromyography of the masseter muscles and the anterior bundle of the temporal muscle with BTS TMJOINT were applied. The following indexes were considered: POC = muscular activity index with a percentage report of every muscle (normal range 83</= and </= 100%)

IMP = fatigue index and parafunction (normal range % 85-100)

ASIM = asymmetry index. Evaluation of balanced muscular activation between both sides (normal range % -10 and +10)

TORS = activation of couple of muscles who expresses mandibular rotation on the transversal plane (normal range % 90 -100%). BAR = muscular center of gravity.

The assessment of muscular balance and adaptability to a "minor" skeletal asymmetry is been evaluated with TORS and ASIM index; the evaluation of occluso-muscular center of gravity is been evaluated with the POC index.

Tek-Scan III software 8.0 Windows PC for the analysis of the occlusal center of gravity and masticatory load discrepancies. Although T-scan is usually tested in patients with permanent dentition without dental loss, the evaluation is evenly been done.

A statokinesigram, which represents the projection to the ground of the center of gravity and pressure, for the evaluation of

plantar support forefoot / hindfoot and load distribution between the left and right side has been conducted with the stabilometric platform DIASU.

A rasterstereography (Formetric3D) for qualitative evaluation of the spinal column anomalies has been performed. The following indexes were considered:

Pelvic Torsion: normal range (0-1, 9°- according to Harzmann) [19]

Antero-posterior bend VP-DM* (individual range)

Lateral bend VP-DM* (individual range)

Lateral deviation VP-DM* (0-5mm according to Harzmann) [19]

Kyphotic Angle: normal range (47-50° according to Harzmann) [19]

Pelvic rotation: (individual range)

Pelvic inclination: (0-4 mm according to Harzmann) [19] *VP-DM. VP is the prominent vertebrae at the cervical level and DM is the middle point of the straight line joining the left and right lumbar dimples.

Analysis of the data

All data were analyzed by means of descriptive percentages, mean, median and standard deviation systems. Afterwards, the results emerging from the Stomathognatic system evaluation were cross-linked with the postural data through quantitative and qualitative statistics value, c2 and T-student test were used. Based on the electromyographic evaluation, the sample was divided in two "groups": 1.patients with significant ASIM index, 2. patients with normal ASIM. This further detailed analysis is been done to better understand the relationship between asymmetry and functional anomalies.

The same operator, previously calibrated, carried out all the clinical and instrumental evaluations. Another operator controlled all the data to verify their reliability.

Results

In view of the great amount of data emerging from research, the results were divided into three sections, a) results emerged from the clinical evaluation, b) results emerged from second level examinations, c) results emerged from quantitative cross-linked examinations. Records without any statistical significance have not been reported.

Clinical results

Clinical evaluation results, as reported, include number and type of muscles positive to the palpation test, trigger points and excursion of cervical rachis, orthoptist questionnaire answers (Table 1).

second level examinations results

Analysis of TORS, POC and ASIM index (EMG scores). Assessment of muscular balance and adaptability to skeletal asymmetries.

The 83% of patients (15 patients) had a TORS index score out of normal range that confirmed the presence of a significant mandibular deviation on the transversal plane and the presence of peculiar occlusal patterns, related to the skeletal structure. For what concerning the side of mandibular deviation, the TORS index scores of these patients are compatible with the clinical and radiographic data.

Table 1: Clinical evaluation tests and questionnaires.

Patient #	TTS score (maximum score 54)	PI (Extraoral muscles)	PI (intraoral muscles)	PI (neck muscles)	Cervical trigger point	Orthoptic questionnaire
B.M	7	7	4	0	/	/
C.M	7	7	1	8	SCM	Familiar Refractive defects + Close an eye to light and head tilted posture
C.E.	6	6	4	3	SCM	Close an eye to light and refractive defects
D.C	10	5	5	4	SCM	Familiar refractive defects and look at he objects nearby
D.G.S	6	6	4	6	SCM	Familiar Refractive defects
F.E.	12	10	4	7	SCM	Familiar refractive defects, myopia and close an eye to light, head tilted posture and look at the objects nearby
F.C.	7	6	5	2	/	/
N.G	10	7	5	4	SCM	Familiar refractive defects, eyewear prescription and close an eye to light
L.M.	9	3	2	6	SCM	Close an eye to light
N.G.	16	8	5	9	SCM	Familiar refractive defects, eyewear prescription and close an eye to light
O.S	9	4	3	5	SCM	/
P.F.	6	5	5	5	SCM	Familiar refractive defects and close an eye to light and llok at the objects nearby
S.S.	12	12	2	8	SCM	Familiar refractive defects and farsighted and head tilted posture
S.F.	6	5	5	4	SCM	/
T.S.	10	6	4	4	SCM	Close an eye to light and head tilited posture
U.L.	11	3	4	6	SCM	Familiar Refractive defects
M.A.	8	2	2	6	SCM	Close an eye to light
M.V.	16	8	6	10	SCM	Close an eye to light and look at the objects nearby

Table 2: Digital results. EMG, t-scan, stabilometry scores.

Patiens #	Sex age	Poc TA	Poc MS	BAR	ASIM	TORS	t-scan BAR	Right occlusal contact %	Left occlusal contact %	Rightfoot (stabil Ometry)	Left foot (stabil Ometry)	BAR body
B.M	F 14 yrs	28,95% right	73,13%	88,27 P	20,24%	55,27% right	Posterior / right	74,50%	25,50%	33,90%	66,10%	Right
C.M	F 9 yrs	88,36% right	88,67% right	88,93%A	0,45%	92,66%	Centered	49,30%	50,70%	43,10%	56,90%	Posterior
C.E.	M 14 yrs	84,70% left	88,42% right	88,05%P	-2,73%	89,94% left	Centered	48,40%	50,60%	44,80%	55,20%	Right
D.C.	F 15yrs	78,08% left	78,73% left	82,59% A	-13,41%	86,59% right	Anterior	49,50%	50,50%	47,40%	52,60%	Centered
D.G. S.	M 9yrs	80,40% left	78,73% left	90,48% P	-7,94%	88,97% left	Posterior / left	85,60%	14,40%	49,40%	50,60%	Posterior
F.E.	M 9yrs	86,98% right	60,78% right	28,71% P	-34,18%	66,99% left	Anterior / left	54,90%	45,10%	41,40%	58,60%	Posterior
F.C.	F 14yrs	82,26% left	86,88%right	84,52% P	-0,95%	86,37% left	Right	61,70%	35,70%	47,60%	52,40%	Posterior
N.G	M 13yrs	75,25% left	84,77% left	83,66% A	-16,94%	87,25% left	Right	75,40%	24,60%	49,20%	50,80%	Centered
L.M.	M 10yrs	69,94% right	67,57% left	55,00% A	-16,94%	72,55% right	Centered	49,50%	50,50%	45,30%	Centered	Centered
N.D.	M 10yrs	83,38% left	3,47% right	55,01% P	67,19%	29,74% left	Centered	41,10%	58,90%	40,30%	59,70%	Posterior
O.S.	F 15yrs	85,83% right	88,80% right	91,29% A	6,95%	92,51%	Centered	55,20%	44,80%	52,10%	47,90%	Posterior
P.F.	F 8yrs	85,71% left	78,81% left	76,79% P	-3,56%	85,65% right	Centered	52,50%	47,50%	48,00%	52,00%	Posterior
S.S.	F 10yrs	82,82% right	83,32% left	88,36% P	2,84%	88,21% right	Posterior	52,50%	47,50%	44,10 %	55,90%	Posterior
S.F.	F 11yrs	87,76% right	89,49% right	88,62% A	1,76%	92,09%	Anterior /left	20,10%	79,90%	47,20%	52,80%	Centered
T.S.	M 15yrs	74,79% right	86,78% right	85,77 %A	4,37%	85,99% right	Centered	41,10%	58,90%	52,10%	47,90%	Posterio
U.L.	F 15yrs	71,63% left	85,17% left	82,95% A	-11,60%	84,39% right	Anterior	53,50%	46,50%	47,10%	52,90%	Posterio
M.A	M 11yrs	73,60% left	86,74%	84,30% A	-13,60%	87,00% left	Anterior /left	33,80%	66,20%	51,50%	48,50%	Centered
M. V.	F 14yrs	85,71% right	88,42% right	88,05% P	-9,00%	89,00% right	Centered	52,20%	47,80%	48,50%	51,50%	Centered

The evaluation of the activation of each muscle with the POC index showed in all these patients the predominance of temporalis muscle in the same side of mandibular deviation, as well as the cross-activation of the contralateral masseter. In a physiological muscular behavior, the vector moment generated by opposite muscles pairs is equal to 0. In cases of mandibular asymmetry, "muscular vector moment" could be the expression of mandibular deviation (as showed with the TORS index) versus the temporalis muscle side (as showed with the POC index). TORS index also expresses the predominance of anterior occlusal contact in the side of mandibular deviation or lack of posterior occlusal contacts.

On the contrary, the evaluation of the muscular functionality and balance with the ASIM index revealed how only the 39% of the patients (7 patients) with a clinical and radiographic mandibular asymmetry had an abnormal score. These patients with significant ASIM index were also analyzed with the T-SCAN to compare the different muscular work on both side and the distribution of occlusal contacts and load. The results were discordant and irregular because of the limits linked to the device not calibrated on mixed dentition (Table 2).

Evaluation of muscular Center of Gravity (CG) position. Ten patients showed the center of gravity in anterior position while eight in posterior one. The evaluation of the CG, as well as in the literature, has led to these results [20]. As the POC index showed, an anterior occlusal CG is related to the main activity of the anterior temporalis muscle bundle; a posterior occlusal CG is related to the main activity of the masseters. Occlusions characterized by a posterior CG are the most functional from the biomechanical point of view because it keeps the condylar load within normal limits and the lever arm in the sagittal plane is contained within physiological limits. The opposite situation happens in cases of occlusal anterior CG [21] (Table 2).

At the stabilometric platform qualitative analysis, only 33% of patients had a load discrepancy between right and left side. 50% of patients highlighted a posterior center of gravity, 17 % an anterior one and the 33% centered (Table 2).

Formetric qualitative analysis, comparison between the direction of mandibular deviation and related postural changes. Almost the totality of the patients showed the contralateral foot opening to the direction of the mandibular deviation. In 7 patients (38%) the pelvis was tilted and had a torsion contralateral to the direction of mandibular deviation, in 3 patients (17%) was ipsilateral, 7 patients have not shown any anomaly. In 8 patients (44%) the VPDM lateral deviation at the thoracic level was

Table 3: Formetric descriptive analysis.

Patients #	Formetric Descriptive analysis
B.M	non significative VP-DM bending Right foot opening;
C.M	non significative VP-DM bending; no significative postural alterations
C.E.	Significative left thoracic and right lumbar VP-DM bending.
	Right foot opening and both feet shift the weight to the heel level.
	Pelvis tilt and torsion absent.
D.C.	Significative left thoracic VP-DM bending; left foot opening
D.G.S.	Non significative VP-DM bending; right foot opening; left pelvis tilt and torsion
F.E.	Significative right thoracic and left lumbar VP-DM bending. Right foot opening. Right pelvis tilting.
F.C	non significative VP-DM bending
	Right foot opening; significative right pelvis torsion .
N.G.	Significative right thoracic VP-DM bending Right foot opening; both feet shift the weight to the heel level; significative
	right pelvis torsion. In the dynamic part tibiotarsal rigidity.
L.M	non significative bending, Right foot opening;
N.D.	Significative right thoracic VP-DM bending; right foot opening; right pelvis tilt and torsion.
O.S.	Non significative VP-DM bending.
P.F.	Significative right lumbar VP-DM bending; significative pelvis tilt on the left.
S.S.	Significative right thoracic VP-DM bending Right foot opening; right pelvis tilt and torsion
S.F.	Non Significative VP-DM bending.
T.S	Significative right thoracic VP-DM bending; left foot opening; right pelvis tilt and torsion.
U.L.	Significative left thoracic VP-DM bending; left foot opening; left pelvis torsion
M.A.	Significative right thoracic VP-DM bending.Significative left pelvis torsion
M.V.	Significative left thoracic VP-DM bending and right lumbar VP-DM bending ;Left foot opening non- significative;
	cervical spine (neck left rotation ; significative left pelvis rotation and tilt.

contralateral to the direction of mandibular deviation. 66% of patients (12 patients) had a scoliotic postural behavior (Table 3).

cross-linked examination analysis

Quantitative statistical analysis to evaluate the correspondence between mandibular asymmetry and potential change of postural scheme. We have compared the patients who have an initial imbalance of muscular and occlusal assessment and who have not, cross-linking the data obtained from stabilometry platform and EMG. The c2 test was used. The c2 value (0,37) of the postural examination showed that there wasn't any significant difference between the frequencies of the two samples. The Formetric and EMG scores were compared using T-student test. No significant results occurred from each parameter of the Formetric evaluation. Therefore the relationship between the mandibular asymmetry and postural changes was not found.

Discussion

The idea, which still influences clinician's mind, that the mandibular asymmetry represents locus minoris resistentiae for the development of a correct functionality of the stomathognatic and the correlated systems [4,5], was moving over time.

The intermediate level, between 4 and 10 mm, of mandibular asymmetry was analyzed in patients without any other specific disease. In fact the type of asymmetry investigated is not associated to syndromic growth anomalies, tumors, inflammatory or traumatic process. It is already known that these specific pathological alterations have "dysfunctional aspects" due to the greater asymmetrical component, involving also other facial/cranial structures, and the systemic implications [22].

The perception of the asymmetry is more of 6mm for common people, around 4mm for the orthodontist, under this threshold it has no clinical significance, while over 9mm surgical treatments was indicated [10-12]. According to some authors [4,5,23], the asymmetry not only gives an aesthetic discomfort but also it may be involved in functional mechanisms. Other authors didn't report cases of mandibular asymmetry with a significant functional impact [14]. Because of these dissonant data, this research protocol was performed to observe the features of the asymmetrical patients from a functional (muscular, articular) point of view in both the Stomatognathic and Spine system.

In order to assess it, DC/TMD have been considered for the screening of the intensity and sites of perceived pain. Confirming the criteria used for the screening, in the sample nobody reported pain during functional movements or palpation test, but only mild discomfort, not considered as a dysfunction. Furthermore, the emerging data are overlapping with the natural variability present in the non-asymmetric population.

Cervical trigger point test highlights the positivity mainly for the SCM. In view of the functional characteristics of this muscle [24], the single data cannot be directly and exclusively attributed to the mandibular asymmetry, because there are too many variables that can cause such a response. It is customary to note that children take on spoiled habits when performing homework or sports, habits considered by the neuromuscular system to be normal. Another reason may be the presence of refractive defects, emerged from the Orthoptic questionnaire, that it is compatible with this clinical context [25].

Regarding the results obtained from the second level examinations, the EMG scores have allowed to express some clinical considerations. 15 patients (88%) showed the correspondence between the verse of the mandibular symphysis deviation and the predominant activity of both the anterior bundle of the omolateral temporalis and the contralateral

masseter. An asymmetrical mandible presented a long side (balancing side) where the masseter has the dominant activity and a short side (working side) where the temporalis activity is prevalent. According to EMG scores, in a deviated mandible, there is a "crossed muscular pair's vector moment", given by temporalis muscle on one side and masseter muscle on the opposite one. The verse of mandibular deviation has a correspondence with the dominant temporalis muscle side. On the sagittal plane, this could express a retro positioning of the condyle of this side and, when the resulting muscular center of gravity was anterior, it could increase the articular load. Even though the patients have not reported any symptom from a clinical point of view, this may be a possible risk factor for the condylar-disc incoordination, as confirmed in the literature [26,27].

The clinical evaluation showed, without any statistically meaning, a similar scheme for the trapezius and scalene muscles. This data was well matched with what occurred from the trigger points at the cervical level. Otherwise, in literature, as reported by Korbmacher [28], there was a less evidence of relationship between mandibular position and vertebral posture in regions below the cervical spine [29,30]. Therefore, these results suggested the clinicians to take into account this particular muscular behavior in both systems when patients with asymmetry have been analyzed.

Even if the presence of an anterior CG should be considered as a biomechanical risk factor for eventual joint and muscular dysfunction [2,20,21], no significant data emerged; in fact 10 patients (55%) have an anterior center of gravity and 8 (45%) a posterior one. These results follow the natural distribution of the healthy population.

Analyzing with the EMG a sample of patients homogeneous for skeletal asymmetry, the expected results should have showed a similar homogeneity under a functional profile, instead, only the half of the patients has a significant ASIM index. This apparently contradictory evidence indicated that a bone asymmetry not necessarily produced a functional altered behavior.

For what concerning postural qualitative analysis, data emerging from the stabilometry showed that only 33% of the entire sample (6 patients) had a load discrepancy between right and left side. It would seem that the asymmetry of postural load was not necessarily evident in patients with mandibular asymmetry. On the contrary, the data emerged from the qualitative analysis of the Formetric scores, showed that all patients presented the same limited anomalies, among which the presence of a scoliotic postural behavior contralateral to the direction of mandibular deviation. The analysis of these latter results needs further detailed studies also by other specialists.

On the basis of the ASIM index scores, the sample of patients was divided in two groups (1.patients with significant ASIM index and 2.patients with ASIM index normal). The comparison was made in order to notice an eventual difference in postural behavior between these two groups. The analysis has not carried out statistically significant results. In the light of the data emerging from the sample examined, the hypothesis that a mandibular asymmetry could produce a postural anomaly, cannot be accepted.

No clinical and digital data supported the hypothesis that the "minor" mandibular asymmetry in growing patients necessarily lead to a muscular functional imbalance. The only data that could be considered a potentially critical factor for a development of a TMJ dysfunction was the retrusive position of the short side of the asymmetrical mandible [31,32]. A further observation to underline is the extreme adaptability and plasticity present in the growing patients that could underestimate some possible functional anomalies.

Conclusions

The present examination was conducted to achieve a greater knowledge about the possible functional alterations that a mandibular asymmetry could produce in both the stomatognatic and postural system. The results suggest that a minor mandibular asymmetry should not be always considered as a locus minoris resistentiae in the functional development of these systems. Although it cannot be ruled out that some anomalies may occur, at the time of evaluation, no patient showed any specific functional alterations. As mentioned above, a condyle retrusion of the shortest side of asymmetric mandibular should be considered as a possible cause of TMJ instability particularly in growing age patients [27,32]. Despite the negative results, a great care was recommended for the clinicians who intercept mandibular asymmetry in these patients; because it must also considered that, the extreme plasticity of the systems can make asymptomatic some negative compensations. For what concerning the postural development, no significance associations with mandibular asymmetry were found from a statistical point of view. Considered the complexity of the topic, further researches are requested.

Statement of Interests

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

References

1. The glossary of prosthodontic terms. *J Prosthet Dent*. 2005;94(1):10-92.
2. Ferrario VF, Sforza C, Colombo A, Ciusa V. An electromyographic investigation of masticatory muscles symmetry in normo-occlusion subjects. *J Oral Rehab*. 2000;27(1):33-40.
3. Slavicek R. The stomatologic system. 3. *Zahnarzt*. 1983;27(4):211-219.
4. Gagey PM. Posturology. Adjustment and perturbations of the standing station. Marrapese. 2000.
5. Bracco P, Deregibus A, Piscetta R, Ferrario G. Observation on the correlation between posture and jaw position: a pilot study. *Cranio*. 1998;16(4):252-258.
6. Boel T, Sofyanti E, Sufarnap E. Analyzing Menton Deviation in Posteroanterior Cephalogram in Early Detection of Temporomandibular Disorder. *Int J Dent*. 2017.
7. M Purbiati, Purwanegara, Miesje Karmiati, Kusdhany Linda, Himawan, Laura Susant. Prediction of mandibulofacial asymmetry using risk factor index and model of dentocraniofacial morphological pattern. *Journal of International Dental and Medical Research*. 2016;9(3):195-201.
8. Xie Q, Yang C, He D, Cai X, Ma Z. Is mandibular asymmetry more frequent and severe with unilateral disc displacement? *J Craniomaxillofac Surg*. 2015;43(1):81-86.

9. Ries LG, Bérzin F. Analysis of the postural stability in individuals with or without signs and symptoms of temporomandibular disorder. *Braz Oral Res*. 2008;22(4):378-83.

10. Condurú Fernandes da Silva N, Barroso de Aquino ER, Ribeiro Mello KCF, Rufino Mattos JN, Normando D. Orthodontists and laypersons perception of mandibular asymmetries. *Dental Press J Orthod*. 2011;16(4):38 e1-8.

11. Peck S, Peck L, Kataja M. Skeletal asymmetry in esthetically pleasing faces. *Angle Orthod*. 1991;61(1):43-48.

12. Ercan I, Ozdemir ST, Etoz A et al. Facial asymmetry in young healthy subjects evaluated by statistical shape analysis. *J Anat*. 2008;213(6):663-669.

13. Habets LL, Bezuur JN, van Ooij CP, Hansson TL. The orthopantomogram, an aid in diagnosis of temporomandibular joint problems. I. The factor of vertical magnification. *J Oral Rehabil*. 1987;14(5):475-480.

14. Saglam AA, Sanli G. Condylar asymmetry measurements in patients with temporomandibular disorders. *J Contemp Dent Pract*. 2004;5(3):59-65.

15. Silvestri A, Incisivo V, Mariani G. Treatment of mandibular hypercondylia in developmental age (clinical case). *STOMATOLOGICAL MINERVA*. 2000;49(10):501-510.

16. Peck CC, Goulet JP, Lobbezoo F, et al. Expanding the taxonomy of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). *J Oral Rehabil*. 2014;41(1):2-23.

17. Steenks MH, de Wijer A. Validity of the Research Diagnostic Criteria for Temporomandibular Disorders Axis I in clinical and research settings. J Orofac Pain. 2009;23(1):20-23.

18. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, et al. International RDC/TMD Consortium Network, International association for Dental Research; Orofacial Pain Special Interest Group, International Association for the Study of Pain. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group. *J Oral Facial Pain Headache*. 2014;28(1):6-27.

19. Harzmann HC. Stellenwert der Videoraserstereographie als schulärztliche Screeningmethode von skoliotischen Fehlhaltungen und strukturellen Skoliosen. Dissertation. München: Ludwig-Maximilians-Universität München. 2000.

20. Rodrigues-Bigaton D, Berni KC, Almeida AF, Silva MT. Activity and asymmetry index of masticatory muscles in women with and without dysfunction temporomandibular. *Electromyogr Clin Neurophysiol*. 2010;50(7-8):333-338.

21. De Felício CM1, Mapelli A, Sidequersky FV, Tartaglia GM, Sforza C. Mandibular kinematics and masticatory muscles EMG in patients with short lasting TMD of mild-moderate severity.J Electromyogr Kinesiol. 2013;23(3):627-633.

22. Bishara SE, Burkley PS, Kharouf JG. Dental and facial asymmetries: a review. *Angle Orthod*. 1994;106(2):191-200.

23. Klobas L, Gambardella U, Hansson TL. A 5-year follow-up of temporomandibular disorder treatment emphasizing condylar asymmetry. Cranio. 2006;24(4):265-273.

24. Travell and Simons'. Myofascial pain and Dysfuntion: the trigger point manual. Upper half of body. Lippincott Williams and Wilkins. 1996.

25. Cigada M, Redana M, "Postura ed occhio", Bibliografia Diasu, Roma. 2003.

26. Inui M, Fushima K, Sato S. Facial asymmetry in temporomandibular joint disorders. *J Oral Rehabil*. 1999;26(5):402-406.

27. Buranastidporn B, Hisano M, Soma K. Temporomandibular joint internal derangement in mandibular asymmetry. What is the relationship? *Eur J Orthod*. 2006;28(1):83-88.

28. Korbmacher H, Eggers-Stroeder G, Koch L, Kahl-Nieke B. Correlations between anomalies of the dentition and pathologies of the locomotor system - a literature review. JOrofac Orthop. 2004;65(3):190-203.

29. Lippold C, Danesh G, Hoppe G, Drerup B, Hackenberg L. Sagittal spinal posture in relation to craniofacial morphology. *Angle Orthod*. 2006;76(4):625-631.

30. Lippold C, Danesh G, Hoppe G, Drerup B, Hackenberg L. Trunk inclination, pelvic tilt and pelvic rotation in relation to the craniofacial morphology in adults. *Angle Orthod*. 2007;77(1):29-35.

31. Maglione HO, de Zavaleta LA, Laraudo J, Falisi G, Fernandez F. Temporomandibular Dysfunction: Internal deragement associated with facial and /or mandibular asymmetry. *Cranio*. 2013;31(4):276-282.

32. Di Paolo C, D'Ambrosio F, Panti F, Papa M, Mancini P. The condyle-fossa relationship in temporomandibular disorders. Considerations on the pathogenetic role of the disc. *Minerva Stomatol*. 2006;55(7-8):409-22.