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Influence of Horizontal Cephalic Rotation on Mandible Deflection

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ABSTRACT

Introduction: It has been settled that the three-dimensional position of the mandible is directly affected by the head posture. Consequently, improper mandibular posture can cause teeth damage, along with a range of temporomandibular functional disorders altering both muscles and joints. This study is dedicated to shed light on the influence of the horizontal cephalic rotation on the mandibular deviation with reference to the three-dimensional positions of the incisal point.

Materials and methods: In order to evaluate the movement of the mandibular, a specific handmade device was created based on a facial arch and a tooth bite fork stabilized thanks to a mandibular impression. The subjects were asked to sit straight with their heads supported by the properly adjusted headrest of the dental chair which has been previously set in an upright position. The patients were then enjoined to horizontally perform a sequence of head rotation movements (0°: The reference angle, 10°, 20°, 30° and 60°) in the right or left direction.

Results: The results revealed the correlation between the horizontal rotation of the head and the deviation of the incisal point which simultaneously moves in the forward direction and in the opposite direction of the cephalic rotation. For instance, a significant incisal point deviation is mainly observed when angles exceed 20°. No significant differences by gender, morphological type and orthodontic history were observed.

Conclusion: The mandibular position varies according to the cephalic horizontal rotations mainly with over 20° angles. Therefore, it is crucial for dental practitioners to take into account the possibility of mandibular deviation during occlusal procedures within different dental specialties.

Keywords: Cephalic rotation; Mandible deflection; Temporomandibular functional disorders; Axiograph

INTRODUCTION

The posture of the head and neck has a complex relationship with the position of the mandible which requires special attention from the dentist, especially since the manducer is a fragile unit, since its health depends on the proper functioning of the components that make up it and that of the head and trunk. Thus, the position of the mandible plays an equally important role on the functional and aesthetic level as a major element of facial harmony and balance, which is determined by the skeletal structure of the face and its soft tissue drape [1].

The present study will be carried out with the aim of determining the factors influencing the variation of the mandibular position according to the horizontal cephalic rotation in a sitting position on the dental chair in order to improve the management of patients during a treatment

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aesthetic or occlusal in relation to the mandible and its position.

It is also being conducted to answer these questions:

- Does the mandibular position deviation when the head is resting on the dental chair differ from the measurements taken when the head is in a free position without support?
- Is there a difference in the measurement of variation between the female and male sex?
- Does the muscular typology influence the variation of the mandibular deviation during lateral rotation of the head?
- Is there a relationship between a history of orthodontic treatment and the lateral position deviation of the mandible?

MATERIALS AND METHODS

Type of Study

This is a prospective cross-sectional analytical study. The hospital center concerned is the Monastir university medical and dental surgery clinic.

Principles of the Experiment

In order to quantify the variation of mandibular deviation during horizontal cephalic rotation, an axiograph was made especially for the experiment with a weight of 48 g which is negligible as pressure exerted on the mandible [2]. A rectangle of mill metric paper glued to a wooden rectangle of the same size (from 7.5 cm to 5.5 cm), fixed to a facial arch with nasal support, will play the role of a table where the trace of the mandibular deviation is read and allow measurements of this.

The occlusal fork is stabilized in the mouth by a high-viscosity C-silicone imprint of the volunteer's lower teeth. We asked subjects to sit on the dental chair with their head resting on it without a forced support, mimicking the actual conditions of dental care on the chair. At first, the goniometer faces the subject with 0° as a reference so that rotation angles can be determined by locating the center of the subject's head. Then we choose the angle and ask the subject to rotate until it reaches it (**Figures 1 and 2**).

Figure 1: The head position in the angle of reference.

Figure 2: The cephalic rotation in the 30° angle reference.

Throughout the experiment, the subject maintains a predetermined mouth opening and the practitioner measures the mandible deflection at each angle after at least 5 seconds of stabilization of the head at the indicated position. This is done as experience develops [3].

Sampling and Target Population

This survey was carried out on a series of subjects between December 2021 and March 2022 in the hospital-university clinic of medicine and dental surgery in Monastir.

The Size of the Sample

After the clinical examination of 130 subjects, our sample will include 40 dental students who meet the study requirements.

Sampling Method

This is a simple random survey, each consenting subject with the inclusion criteria can be part of the sample from our experiment.

Criteria for Inclusion

Dentures with an age in the range presenting normal positional relations at maximum intercuspidation and no malfunction of the manductor apparatus, such as functional disorders of the temporomandibular muscles and joints, were selected for this study. They were fully informed of the purpose of the study and gave their informed consent to participate [4].

Criteria for Non-inclusion and Exclusion

Non-inclusion and exclusion are:

- Any subject absent during the experiment, refusing to perform the experiment or wanting to stop in the course of it no matter the moment.
- Patients undergoing orthodontic treatment with a multi-ring device are excluded due to the instability of the occlusion and possible eccentric reflexes.
- Any subject with known or discovered joint or muscle dysfunction during the clinical examination (complaining of pain or presenting gnathosonies and/or presenting a dyskinetics during the mouth opening or a bayonet opening, having a limitation of the mouth opening).
- Each volunteer reporting neck pain that they cannot perform the desired rotations or have any posture problem.
- People with a very strong nausea reflex or asthmatic subjects who cannot stand the imprint in the mouth for the time necessary for the experiment [5].

Contacts and Authorizations

Initially, a request for authorization through a detailed file was sent to the ethics committee proving that this experiment does not harm the volunteer in any way, neither physically nor psychologically and it is conducted with respect for human dignity.

Subsequently, a request for authorization was sent to the various heads of services in order to carry out the experiment within their departments.

The Experiment is Conducted

This experiment was conducted by a single practitioner and was performed for each volunteer 3 times, then averaging the measurement results.

Clinical Examination

A detailed and careful exo-oral and endo-oral clinical examination was performed for each patient before the start of the experiment using methods commonly used in the dental clinic.

Data Analysis

Following the determination of measurements, a comparison by sex, musculature and history of orthodontic treatment was performed to verify whether this variable influences the variation of mandibular deviation. The angles chosen in this experiment are: Angle 0° which represents the reference angle, the patient's head does not rotate in the horizontal direction but also no over or under extension. The angle 10, 20, 30 and 60 represent the rotation variable in both right and left sides. Clinical exam data and experiment results were captured and analyzed using IBM SPSS statistic base 22.0 software and Microsoft office excel 2016 software [6].

RESULTS

Descriptive Study

This sample of 40 students has an average age of 22 years and is composed of 72.5% women with a predominance of 87.5% of fine musculature. 27.5% of these students received orthodontic treatment, only one of whom was male.

The mean values of the mandible deviation according to the indicated angle of horizontal cephalic rotation were calculated for both sides: Right and left rotation, for our sample of 40 students (**Table 1**).

Table 1: Summary of mandibular deviation values.

	N	Minimum	Maximum	Moyenne	Ecart type
Right 30°	40	00	1.00 mm	4025	23369
Left 30°	40	00	1.00 mm	4325	21169
Right 60°	40	00	2.00 mm	8275	37002
Left 60°	40	00	2.00 mm	8500	36304
N valide (list)	40				

No deviation detected at the 10° angle with an average of 0 mm. From 20° lateral rotation a difference in the position of the mandible can be noticeable, the maximum recorded is 0.2 mm [7].

The largest value of the mandible variation was recorded in the 60° angle (Table 2).

Table 2: The average of the deviation measurements for all subjects in millimeters.

Subject	Subject 2	Subject 3	Orthod	Morpho type	10 R	10 L	20 R	20 L	30 R	30 L	60 R	60 L
1	M	22	No	Fine	0	0	0	0	1	0.8	2	1.5
2	M	21	Yes	Fine	0	0	0	0	0.5	0	1	1
3	M	21	No	Dense	0	0	0	0	0	0	1	0.5
4	W	21	Yes	Fine	0	0	0	0	0.2	1	0.5	0.6
5	M	21	No	Fine	0	0	0.2	0	0.5	0.3	0.8	0.8
6	M	23	No	Dense	0	0	0	0	0	0	0	0
7	W	22	No	Fine	0	0	0	0	0.3	0.3	1	0.8
8	W	20	Yes	Fine	0	0	0	0	0.4	0.4	0.5	0.6
9	W	22	No	Fine	0	0	0	0	0.5	0.4	1.5	1.2
10	W	22	No	Fine	0	0	0	0	0.3	0.2	0.5	0.3
11	W	21	No	Fine	0	0	0	0	0.4	0.3	0.5	0.5
12	M	21	No	Fine	0	0	0	0	0	0.4	0.5	0.8
13	W	24	Yes	Fine	0	0	0	0	0.3	0.3	0.4	0.5
14	M	24	No	Fine	0	0	0	0	0.4	0.3	1	0.8
15	W	23	Yes	Fine	0	0	0	0	0.3	0.3	0.3	0.3
16	W	24	Non	Fine	0	0	0	0	0.1	0.1	0.5	0.3
17	W	23	Yes	Fine	0	0	0	0	0.5	0.5	1	1.3
18	W	24	Yes	Fine	0	0	0	0	0.5	0.5	1	1
19	M	21	No	Dense	0	0	0	0	0.5	0.5	1	1
20	W	22	No	Dense	0	0	0	0	0.5	0.6	1	0.8
21	W	23	N	Fine	0	0	0	0	0.2	0.5	0.6	1
22	W	21	N	Fine	0	0	0	0	0.5	0.3	1	1.1
23	W	27	N	Fine	0	0	0	0	0.5	0.5	0.8	0.8
24	W	22	N	Fine	0	0	0	0	0.3	0.5	0.8	1
25	W	21	N	Fine	0	0	0	0	0.4	0.5	0.7	0.5
26	W	21	N	Fine	0	0	0	0	0.5	1	1	1.3
27	W	21	No	Fine	0	0	0	0	0.5	0.5	1	1
28	W	22	Yes	Fine	0	0	0	0	1	0.5	1	0.5
29	W	26	No	Fine	0	0	0.2	0.2	1	1	1.5	2
30	M	24	No	Fine	0	0	0	0	0.6	0.4	1	0.8

31	W	23	Yes	Dense	0	0	0	0	0.4	0.5	0.6	0.8
32	W	24	No	Fine	0	0	0	0	0.5	0.5	1	1
33	W	24	Yes	Fine	0	0	0	0	0.2	0.5	0.4	0.8
34	M	26	No	Fine	0	0	0	0	0.5	0.5	1	1.2
35	W	26	No	Fine	0	0	0	0	0.4	0.4	0.6	0.6
36	W	24	No	Fine	0	0	0	0	0.5	0.5	0.8	1
37	W	22	No	Fine	0	0	0	0	0.2	0.5	1	1.2
38	W	20	No	Fine	0	0	0	0	0.2	0.5	0.6	1
39	M	24	No	Fine	0	0	0	0	0.3	0.5	0.7	1
40	W	21	Yes	Fine	0	0	0	0	0.2	0.4	1	0.6

Analytical Study

Comparison of mean rotation values in the recorded 30° and 60° angles of mandible deviation according to gender showed a statistically non-significant variation for 30° and 60° angles on both right and left sides with p broadly greater than 0.05 [8].

The comparison of the determined mean values of the mandible deviation between the two types of musculature of subjects and between subjects who had or did not have orthodontic treatment before showed no statistically significant difference between the different groups since the sensitivity value p>0.05.

For the lateral rotation angles of the head, the two values where the variation in incisive points is remarkable and almost present in all subjects are the angle 30° and the angle 60°. Moreover, there is a significant correlation between the two angles in both sides of cephalic rotation at 0.01 level in bilateral.

DISCUSSION

In this study, we examined the influence of Horizontal Head Rotation (HHR) on mandibular position by examining incisive positions when the head is resting on the chair back. In accordance with this (R.C.H), the incisor point moved forward and to the side of the counter-rotation direction. For rotation angles greater than 20°, the deviation from the incisor point was significantly different from the reference position observed at an angle of 0°. Depending on the gender of the subjects, the comparison is not significant, men and women have the same mandibular deviation values at (R.C.H) even if for other research a significant variation between genders has been proven [9].

Indeed, according to the study by Kondrat et al. the axiographic evaluation of the function of the masticatory system in healthy volunteers, the graphs of opening and closing movements in a group of healthy women and men with no symptoms of the masticatory system showed a significant difference between the sexes. In addition, the reproducibility of condylar movement is not as consistent in women, which may indicate higher generalized joint hypermobility.

According to Woda and Fontanelle, head movements stimulate the vestibular receptors, neck receptors, joint receptors and muscle receptors. This receptor stimulation brings a regulation of the muscle tone and in particular of the masticatory muscles, thus contributing to the mandibular posture hence the choice of muscle typology as variable in our study. In the experiment, we noted that patients with a massive musculature showed a more stable mandible, fewer stylographic traces and sharper marks, although the comparison between the values of variation between those with a tenacious, dense musculature and those with a thin, fine musculature were non-significant.

Among other things, investigation into the history of orthodontic treatment as an operational variable showed that there was no significant difference between the two when deviating the mandible. According to the angulation of (R.C.H) in the present study, we determined a correlation between the deviation of the incisal point in the 30° angle and that in the 60° angle, meaning that mandibular variation in the 30° angle systematically induces a variation in the incisal point in the 60° angle [10].

As is well known, the majority of dental examinations and treatments are carried out when the dentist, whether right- or left-handed, is standing on one of the right or left sides or seated in front of and to one side of the patient in the dental chair. Hatano Y, Sakai T et al. showed that patients tended to rotate their heads significantly to the right within an instant of sitting on the unite. What's more, when the dentist stands next to a patient, the patient's head turns even more towards the doctor unconsciously. Sometimes, patients are very cooperative and turn their faces towards the dentist to get a good view of their mouths. In these situations, patients may eventually turn their heads to the side, inducing a deviation in mandibular position and potentially compromising the finesse of any subsequent treatment.

Thus, during dental treatment, it is essential to consider the posture of the cephalic end in the horizontal direction, as the deviation of the mandibular position in the 30° angle (easily reached by the patient and negligible by the practitioner) can reach 1 mm. In the case of prosthetic reconstructions, this deviation value can lead to errors in registration and/or occlusal adjustment, even resulting in the prosthesis having to be remade [11].

If the lower midline is used as a reference for aesthetic reconstruction of the upper anterior teeth, it is important to take into account the forward and counter-rotational incisal movement of the mandible during RCH, which could lead to non-coaptation or even obliquity of the upper inter-incisal midline: This would alter the desired aesthetic result of the smile even to a small extent.

The protocol used was inspired by the work of Japanese researchers in 2018 Katayama N. et al. who measured the variation of the mandible during (R.C.H) with the WinJaw system and an anterior jig. The aim was to have a lighter weight and less pressure on the head muscles. What's more, our experiment enabled the mandible to deviate freely, without the need for an anterior wedge that the subject could reflexively lean on. This is explained by the richness of muscle fibres and the possession of stretch receptors capable of producing a closure reflex in the elevator muscles, particularly the masseter and the absence of similar reflexes in the depressor muscles, so the presence of an object in the oral cavity stimulates the closure reflex more.

Studies such as those by Woda and Fontanelle and Kibana Y. et al aimed at demonstrating a link between cephalic position, occlusion and (A.T.M), have produced similar results, including the following: A shift to the right or left of the mandible influences the activity of (S.C.M) and the upper trapezius fibers. Izutani Y. and Nakajima Y. et al. have reported that lateral head tilt causes mandibular deviation in the direction of tilt. These authors suggested that the main factor contributing to mandibular displacement is the influence of gravity [12].

In addition to these objectives, the present study proposed to measure the values of variation of mandibular deviation when the head is supported on the dental unit simulating the real situation of treatment sessions at a dentist's office and compare them with previous ones. According to the results of both studies, no difference in movement and trajectory was detected.

All these experiments and research confirm the delicate relationship between cephalic posture and mandibular dynamics and enable us to warn odontologists in each specialty of the impact of mandibular deviation during (R.C.H) and other combined cephalic postures:

In occlusodontics, (O.I.M) dictates the most cranial position of the mandible. This determined position, in all 3 planes, must satisfy:

- Symmetry of the mandibular structures in relation to the skull (frontal plane).
- Condylo-disco-temporal coaptation (sagittal plane): Occlusion in Centric Relation (O.R.C.) or physiological offset.
- A vertical position in harmony with the osteo-muscular elements (Vertical Dimension of Occlusion (V.D.O.) (vertical plane).

A physiological temporo-mandibular joint relationship called “centric relationship”, defined in 1982 by the College National d'Occlusodontie as “the situation of high, simultaneous condylo-disco-temporal coaptation, recordable from a rotational movement, obtained by unforced guidance, precisely repeatable in a given time and for a given posture”. This physiological position is independent of occlusion and can therefore be used as a reference for evaluating the (O.I.M). A slight ORC-OIM shift is physiological in the sagittal and frontal directions, provided it is of low amplitude.

There is virtually no physiological transverse differential between (O.R.C) and (O.I.M) centric occlusion at the dental or condylar level so a lateral shift of the mandible, as determined by an I.M.O. occlusal analysis, in relation to the (O.R.C) position corresponds to a transverse mandibular centricity anomaly. This leads to condylar decentration, which can generate muscular disorders and joint compression and distension that can constitute a pathogenic risk factor. This transverse mandibular decentration is the anomaly with the most pathogenic consequences for the gnathological system compared with anomalies in the sagittal and vertical directions, which are better tolerated. In orthodontics, a balanced occlusion primarily meets the functional requirements of the gnathological system, but also corresponds to facial aesthetic criteria. Tooth alignment ensures symmetry between the midline, which is then confused with the inter-incisal line and the dental occlusal plane, which is parallel to the bi-pupillary axis, with the mouth appearing askew where appropriate. When the edges of the maxillary teeth, *i.e.,* the smile line, follow the natural curvature of the lower lip when the person smiles, the smile is perceived as particularly sympathetic with regard to removable prostheses, two stages can be altered mainly by the posture of the cephalic end: Occlusal registration of intermaxillary relationships is an essential clinical step in successful treatment, both functionally and aesthetically.

The aim of this research is to correctly assess the correct mandibular position and provide the laboratory with as much quality information as possible. The patient can sometimes make unintentional errors without our knowledge and the practitioner may miss an inaccuracy during the recording process. So choosing the right recording medium, reference position and rigorous implementation are the key to achieving the occlusal objectives of restorations with a minimum of clinical adjustment.

Balancing, defined as all the technical means used to ensure a satisfactory occlusion and articulation of already polymerized prostheses, primary balancing, which is limited to rectifying the mandibular closure path, is carried out directly in the mouth. The aim is to enable the immediate integration of the prosthesis, without allowing inflammation to set in. If the

patient deviates or tilts the cephalic end during the closing movement on the articulated paper, there is a risk that the marks will not correspond to the true interferences and the balancing act will be erroneous, resulting in a dynamic prosthetic imbalance.

In fixed prosthetics, (R.C.H) could induce prematurities, defined as occlusal contacts occurring on the mandibular ascent path in centric relation. In function, these ORC prematurities are avoided by a reflex deviation of the closure path, with the mandible leading directly to the IMO. This reflex deviation is produced by an increase in muscle activity during propulsion or deduction. In conservative dentistry, in addition to the same considerations already mentioned for setting, we need to take into account the consequences for guidance.

The hardening of the composite establishes new reference points and allows protective reflexes to be overcome. The simulation of mastication and the patient's perception then enable progressive coordination of guidance until the cycle and comfort are re-established. Restoration of the main guide rail should be preferred and achieved without difficulty if the anatomy of the antagonist tooth is optimal and the cephalic posture is ideal. After clinical testing, the optimal volume can be reconstituted identically on a new restoration. The aim of this study was to investigate mandibular deviation during horizontal cephalic rotation according to each of the variables already defined above, in order to emphasize the importance of horizontal head position during treatment sessions in taking the necessary precautions. However, like all research work, this study had a number of limitations [13].

The most important relates to the weight of the mandible, which, although negligible according to the aforementioned studies, is far from ideal. Due to a lack of resources, we were unable to carry out this research using the ModJaw system, the most reliable method available today.

The ModJaw system is a digital dentistry system that records the subject's mandibular movements in real time and visualizes them in 3D.

CONCLUSION

During horizontal cephalic rotation, compression seemed to be produced in the soft tissues associated with the mandible on the side of the direction of rotation and simultaneous extension could be produced on the side of the direction of counter-rotation. It has been shown that alterations in head position can lead to occlusal disorders; moreover, occlusal disorders can directly influence the growth of the mandibular condyle; requiring observation or appropriate care.

The results of this study clearly show that horizontal cephalic rotation at an angle of more than 20° leads to a considerable and increasing deviation of the incisal point as the angle increases.

Within the limits of the present study, we can conclude that the variation in mandibular deviation is similar in all subjects, depending on gender, type of musculature and occlusal stability established naturally or re-established by orthodontic treatment and that resting the head on the chair back does not influence mandibular deviation in the 0° reference angle. This study of the influence of R.C.H. on mandibular deviation using the ModJaw should be repeated and extended.

CONTRIBUTION FROM AUTHORS

SJ: Conceptualization; data retention; formal analysis; investigation; methodology; project administration; resources; software; supervision; validation; visualization; original draft; writing-editing and revision.

HF: Conceptualization; supervision; validation; drafting the original draft; revision and editing.

AB: Conceptualization; data retention; formal analysis; investigation; methodology; writing-editing and revision.

WR: Conceptualization; data retention; formal analysis; investigation; methodology; writing-editing and revision.

KM: Conceptualization; supervision; validation; original draft, revision and editing.

JJ: Conceptualization; supervision; validation; original draft, revision and editing.

All authors have read and approved the final version of the manuscript.

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CONFLICTS OF INTEREST

Authors declare that there is no conflict of interest.

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