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Original Research Article

Determination of final occlusal vertical dimension by cephalometric analysis

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Abstract

Introduction: Most of techniques for determining the occlusal vertical dimension (OVD) of edentulous patients are based on soft tissues references, which lead to measurement discrepancies. **Objective:** To propose a method to obtain the OVD of edentulous patients during the confection of complete dentures considering the lower facial height established by Ricketts (LFHr) or the lower facial height obtained from cephalometric analysis of dentulous patients (LFHd). **Material and methods:** The OVD of 11 edentulous patients was determined by the association of 3 clinical methods. On each patient's bite plates a metallic ball was fixed and the patient was submitted to lateral radiographic to obtain the lower facial height (LFHe) from cephalometric analysis. Additionally, from 40 lateral cephalograms of dentulous patients the LFHd was obtained. After that, the distance between metallic balls (DMB, in mm) was calculated to verify the linear difference when LFHe was changed to LFHd or LFHr, which provided the amount of wax to be added or removed from the bite plates, establishing a new method of OVD determination. LFHe, LFHd and LFHr values were submitted to t e z statistical tests and DMB differences were analyzed by Student's t-test (α=0.05). **Results:** LFHr ($47.0\pm4.0^{o\ a}$) was statistically higher than LFHd (44.9±5.6° [b]) and LFHe (43.5±3.5° [b]). There was statistical difference on linear discrepancies calculated between the LFHe and LFHd (1.7±4.1mm [a]) or LFHr (4.2±4.1mm [b]). **Conclusion:** The use of the cephalometric analysis showed to be a useful auxiliary tool in determining the intermaxillary relationship. However, this method must be associated with different clinical methods of OVD determination and it is recommended that regional references are used to calculate the linear discrepancies.

Introduction

The oral rehabilitation of edentulous patient can sometimes be impaired by the fact that all of the references used to determine the position, shape and size of the artificial teeth are essentially extra oral, such as the face contour and profile, the line between pupils, and the height of the lower facial third [20]. Linear measurements, as the occlusal vertical dimension (OVD), and angular measurements, as the lower facial height (LFH), are defined based on these references.

Due to this difficulty in establishing the correct OVD for edentulous patients, many researchers developed different techniques based on muscular posture positions [21, 22, 31], facial esthetics [20], oral function [25, 28], craniometry [8, 19], cephalometry [5, 9 10, 27, 30] and electromyography [12, 14]. The most used techniques for the OVD determination are those recommended by Willis (1930), by Niswonger (1934) and by Silverman (1952) [22, 28, 32]. The Willis technique is based on the fact that when the patient is at maximum habitual intercuspation (MHI) with the correct OVD, the distance between the corner of the eye and the labial commissure must be equal to the distance between the base of the mentum and the base of the nose [32]. During the oral rehabilitation with complete denture, at jaws relation record, this reference is determined using the Willis gauge to define the distance between the upper and lower jaws when the bite plates are in touch.

Based in clinical observations, Niswonger noticed that from the postural vertical dimension (PVD), the distance between the bases of the mentum and the nose while swallowing was 3.16 mm, ranging from 0.79 to 8.69 mm [22]. Thereby, for OVD determination it would be necessary to obtain the patient's PVD and subtract the distance determined by Niswonger, named as freeway space (FS). Moreover, a phonetic method was established by Silverman, who verified that the position of the mandible during the pronunciation of sibilant sounds coincide with the OVD position, determining then a physiological method to obtain the OVD [28].

Since all of these techniques are based on soft tissues references, leading to a high incidence of measurement discrepancies generated by operators, the association of different techniques to determine the correct patient's OVD has been recommended [6]. The cephalometric analysis allows the evaluation of bone growth alterations and the results of prosthodontics rehabilitations, i.e. it permits to verify the occlusal plane orientation, the curve of Spee, the anterior teeth position and the incisal guidance [7, 16, 23, 29]. Different analyses were proposed for cephalometric tracings [15, 18, 26]. The Ricketts analysis established that the LFH, an angular value, corresponds to the OVD [26]. The LFH is composed by two lines, which connect the following cephalometric points (figure 1): (i) the central point of the ascendant ramus of the mandible (Xi) and the anterior nasal spine (ANS); and (ii) Xi and the mental protuberance (Pm). Thus, the lower facial height determines the distance between maxilla and mandible when the patient's teeth are in contact.

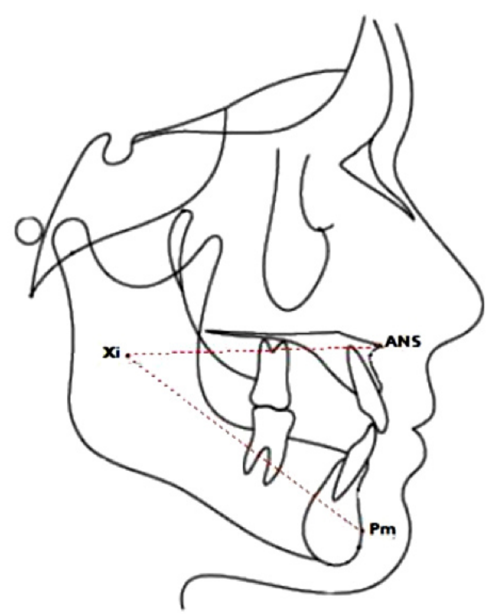

Figure 1 – Cephalometric lower facial height
Xi = central point of the ascendant ramus of the mandible; ANS = anterior nasal spine; Pm = mental protuberance

Recently, a research with 60 lateral radiographies of complete dentulous patients between 20 and 29 years-old established cephalometric indicators for OVD, in which the authors affirmed that the obtained data could be extrapolated to the general populations with 95% of accuracy [30]. Based on that, this study sought to propose an auxiliary method of OVD determination for edentulous patients during the fabrication of complete dentures, considering the lower facial height established by Ricketts (LFHr) and by a regional population reference obtained from an archive of 40 dentulous patients (LFHd).

Material and methods

The present study was approved by the Research Ethics Committee (protocol number: 109/2008) of the Positivo University (Curitiba, Brazil) following the guidelines of the Brazilian National Health Vigilance Agency and the Brazilian National Nuclear Energy Committee. Eleven female edentulous patients, between 44 and 67 years old, with no symptoms related to any joint or muscular dysfunction, were submitted to prosthetic treatment with upper and lower complete dentures. The complete dentures fabrication followed the conventional protocol described in table I, which were composed by five clinical sessions and four laboratorial steps [24].

Table I – Description of the clinical and laboratorial procedures for upper and lower complete dentures fabrication used in the present study

Clinical sessions	Laboratorial steps
1. Primary impression: edentulous stock tray with alginate (Jeltrate, Dentsply, Petrópolis, Brazil) for a custom acrylic tray fabrication.	1. Fabrication of the upper and lower custom trays with self-curing acrylic resin (VIPI Produtos Odontológicos, Pirassununga, Brazil).
2.1 Refining the custom trays' borders in the mouth (1 mm short of the depth of the vestibule; 2 mm short around frena and muscle attachments and the posterior extent should cover 2-3 mm beyond the vibrating line); 2.2 Border molding with stick modeling compound (Kerr, Orange, USA); 2.3 Secondary impression with zinc oxide eugenol impression paste (Lysanda Produtos Odontológicos, São Paulo, Brazil).	2. Fabrication of the upper and lower bite plates with thermo-curing acrylic resin (Palaton, Dencril, Caieiras, Brazil) and rolled wax (Epoxiglass, Epoxiglass Ind. Com. Ltd., Diadema, Brazil). A metallic ball (1.0 mm of diameter) into each rolled wax was inserted, at 2.0 mm of its border and 2.0 mm beside the midline (Figure 2A).
3. Jaw relation records: 3.1 Determination of lip support; 3.2 Occlusal plane orientation parallel to both Camper's Plane and interpupillary line; 3.3 References lines for the sizes of artificial teeth selection; 3.2 Determination of occlusal vertical dimension (OVD); 3.3 Centric relation registration; 3.4 Ear (face) bow transfer; 3.6 Color selection of the artificial teeth.	3.1 Fixation of the maxillary and mandibular casts into articulator; 3.2 Mounting the artificial teeth in the wax baseplate.
4. Artificial teeth in the wax baseplate trial (esthetics, phonetics and functional evaluation).	4. Flasking, wax boil-out, packing resin acrylic, recovery and polishing the complete dentures.
5. Occlusal adjustment for bilateral balanced occlusion scheme.	

For a preliminary OVD determination, the association of three clinical methods was used: facial measurement with Willis gauge [32], postural jaw position minus 2-4 mm (FS) [3] and phonetic test [28]. Both superior and inferior bite plates of each patient received a metallic ball at the midline front area (figure 2A). Wearing these plates, the patients were submitted to a lateral radiography (figure 2B) (Rotograph Plus, Villa Sistemi Medicali, Buccinasco, Italy) and the films were processed automatically (TEC X 6A, Tecmagem AS, Curitiba, Brazil). Cephalometric tracings were done with the aid of a computer program (OrtoManager, SoftManager, Curitiba, Brazil) in order to obtain the lower facial height for this edentulous group (LFHe).

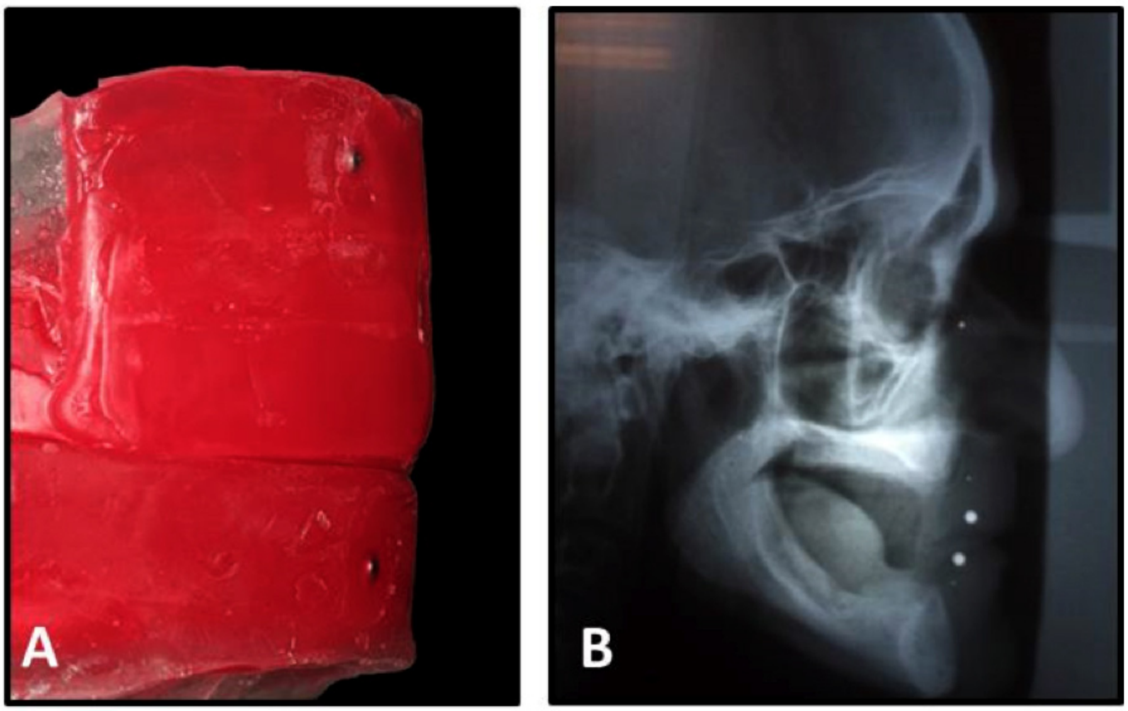

Figure 2 – (A) Metallic balls into upper and lower wax bite plates; (B) Lateral radiography of one patient with the bite plates in position

Lateral cephalograms from the Positivo University's archive (Curitiba, Brazil) of 40 patients with Ricketts analysis were selected. Females, with 20 years or older, less than five missing posterior teeth, with no symptoms related to any joint or muscular dysfunction and who had not been treated previously by orthodontics were the included exams. The average of all LFH was calculated to determine the dentulous regional population lower facial height (LFHd).

From the cephalometric tracing of LFHe group (Figure 3), the distance between the inserted metallic balls (DMB) was recorded (DMB1). New DBM measurements were found simulating the LFHd and LFHr conditions for each edentulous patient (DMB2). Linear DBM discrepancies at LFHd and LFHr were calculated. The result with the lowest linear discrepancy was suggested for the final DBM. Addition or removal of wax from the inferior bite plates were done to match the final DBM, and finally to achieve the ultimate OVD (figure 3).

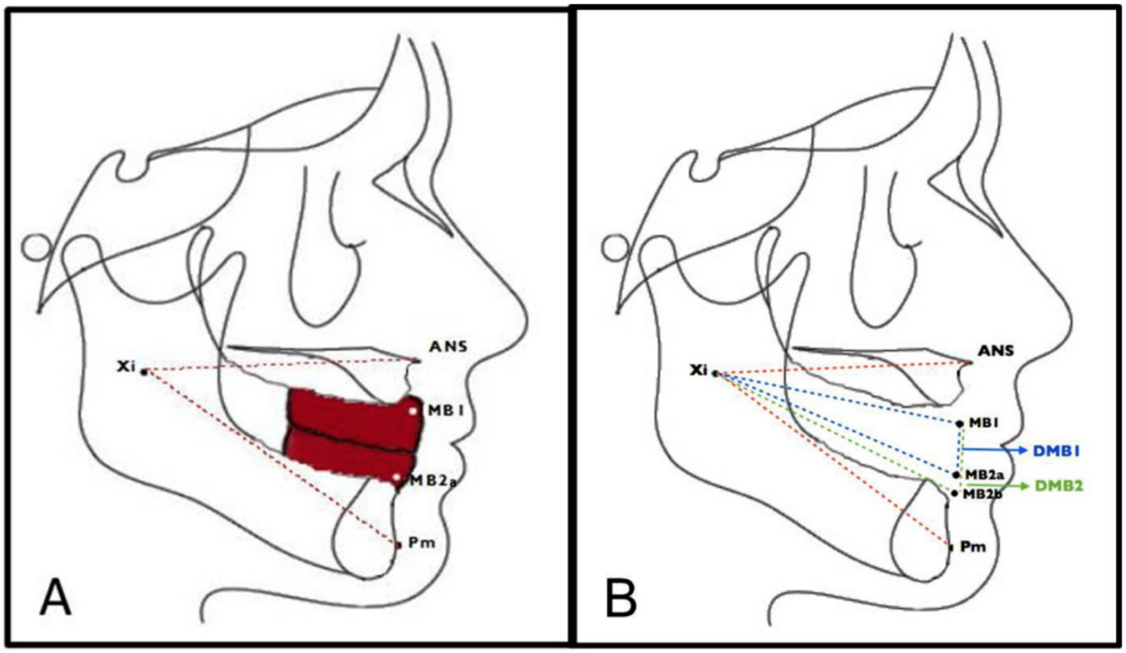

Figure 3 – A: Schematic representation of cephalometry with the bite plates in position for a lower facial height of an edentulous patient (LFHe) obtained by the association of three clinical methods. MB1 = Metallic ball 1, upper. MB2a = metallic ball 2, lower, initial position. B: DMB1 = Initial distance between metallic balls, at LFHe. MB2b = metallic ball 2, lower, final position. DMB2 = Desired distance between metallic balls, in this case by addition of wax on the lower bite plate, at lower facial height of dentulous population (LFHd) or at Ricketts (LFHr) to achieve the occlusal vertical dimension

The angular discrepancy among LFHe, LFHd and LFHr data was analyzed using the *t* and *z* statistical tests. The linear (DBM) discrepancy values were analyzed using the Student's t-test. All statistical tests were done at a 5% significance level.

Results

The table II shows the minimum and maximum values, the mean and the standard deviation of LFHd, LFHe and LFHr. There was no statistical difference between the LFHd and LFHe means ($p = 0.426$). However, the LFHr was statistically different from LFHe and LFHd ($p < 0.001$).

The mean DMB at LFHe was 18.8 ± 6.2 mm. The linear discrepancies calculated between the LFHe and LFHd or LFHr were 1.7 ± 4.1^{a} mm or 4.2 ± 4.1^{b} mm, respectively, which were statistically different ($p < 0.001$) (table III).

Table II – Minimum and maximum values, mean and standard deviation of lower facial height of dentulous patients (LFHd) (regional population reference), lower facial height of edentulous patients (LFHe) and the lower facial height established by Ricketts (LFHr)

Lower facial height	Minimum value	Maximum value	Mean*	Standard deviation
LFHd	33.6°	56.7°	$44.9^{\circ\, b}$	5.6°
LFHe	37.3°	49.7°	$43.5^{\circ\, b}$	3.5°
LFHr	-	-	$47.0^{\circ\, a}$	4.0°

* Different superscript letters indicate statistical difference according to t and z-tests ($p < 0.001$).

Table III – Values of linear discrepancy (distance between metallic balls, DMB) when the lower facial height of edentulous patients (LFHe) was changed to both mean lower facial height of dentulous patients (LFHd, 44.9º) or lower facial height by Ricketts (LFHr, 47.0º).

Patients	LFHe (º)	(DMB at LFHe) – (DMB at LFHd) (mm)	(DMB at LFHe) – (DMB at LFHr) (mm)
1	47.09	-2.0	0.0
2	43.92	+1.5	+3.5
3	37.28	+8.5	+11.0
4	43.24	+2.5	+5.0
5	46.67	-2.0	+0.5
6	43.36	+2.0	+5.0
7	40.57	+4.0	+7.0
8	40.04	+6.0	+9.0
9	44.72	+2.0	+4.0
10	49.72	-6.5	-3.5
11	42.14	+3.0	+5.0
Means and standard deviation*		1.7 ± 4.1^{a}	4.2 ± 4.1^{b}

* Different superscript letters indicate statistical difference according to Student's t-test for paired samples ($p < 0.001$)

Discussion

It has been proposed that OVD alterations must be done gradually in order to establish a new mandibular position in which the patient develop the functions normally [17]. A high OVD decrease might cause displacement of the mandible condyle and articular disk, clicks and articulation pain, whereas the accentuate OVD increase could generate phonetic and occlusal interferences by invasion of the FS [1, 2, 9, 11, 17]. Therefore, specific population references should be obtained to be used as a basis for the dental treatment planning of each patient. Also, individual factors such as physiology, genetics and appearance, should be taken into account [11].

The angle that determines the lower facial height in Ricketts analysis determines an upper and a lower references that established of a vertical line when the teeth are in occlusion, named OVD. The literature considers this angle as one of the most scientific reference for calculating the OVD [7, 23]. However, it should be complemented by other clinical methods, such as facial measurement with Willis gauge, 2-4 mm less than postural jaw position (FS) and the phonetic test [7].

In a previous study, a standard LFH of 44.5º ± 4.8 was established for females of 18 years old [13]. This value was different from that established by Rickets (47.0º ± 4.0), which determines the standard for Caucasian children of different ages and both genders [26]. These observations corroborate with the fact that the global standards should be moderately used or individualized standards for a specific geographic region should be determined to align the rehabilitation treatment according to the patients' own environment [13, 30]. For this reason, the present study also considered the LFHd to accomplish clinical results with local considerations.

No complaints were made by the rehabilitated edentulous patients, regarding signs or symptoms related to articulation problems or OVD alterations. The metallic balls added into each bite plate created two new radiographic points that could be analyzed in cephalometry. The absence of statistical difference between LFHd and LFHe means was related to the fact that the selection of the patients of both groups showed a similar craniofacial profile.

In the present study, LFHe was statistically different from LFHr. The same was found previously, in which the LFH obtained after the rehabilitation (45.0º ± 6.7) was also lower than LFHr [9]. Probably, the reason is that vertical and sagittal maxillomandibular relationship changes occur in patients wearing dentures for an extensive period [9].

The placement of metallic balls into each rolled wax allowed for the clinical measuring of the distance between them, facilitating the adaptation of a desired intermaxillary relation, using LFHd and/or LHFr as parameter. For example, during a second bite plate registration one subject that first presented the LFHe as 42.1° and the DMB as 12.0 mm, in order to match to LFHd (44.9°), the new DMB was achieved with the lowest linear discrepancy, without the need of a new lateral radiograph. Table III shows that the LFHd reference was used as the LFH parameter for OVD determination of 8 patients, and the LFHr reference value was used only for 3 individuals. Therefore, these results support the fact that the measures of a specific population can be relevant to the OVD reestablishing.

Conclusion

The use of the cephalometric analysis showed to be an important auxiliary method for jaw relation record during rehabilitative treatment using complete dentures, due to the bone bases references which allowed for a more precise determination of OVD. However, this method must be associated to different clinical methods, and the use of regional population reference is recommended to calculate the linear discrepancies in the determination of the ultimate OVD.

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