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Occlusal Plane Orientation: A Statistical and Clinical Analysis in Different Clinical Situations

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Abstract

Purpose: Orientation of the occlusal plane is important in a number of clinical situations. Using the reported soft and hard tissue landmarks is difficult and requires experience, as the landmarks are located on the face or by use of a cephalometric radiograph. Improper use of these landmarks may compromise the functional and esthetic result of prosthetic restorations. This study evaluated the reliability of the hamular notch/incisive papilla plane (HIP) in establishing the occlusal plane.
Materials and Methods: Ninety healthy, Indian adults (60 dentate, 30 edentulous) participated in this study. The occlusal plane of the subjects was compared with their HIPs. In dentate subjects, the maxillary stone cast was mounted on the Wills surveyor with HIP, which was made parallel to the horizontal plane using the tripoding method. The vertical distance between the occlusal plane and floor of the surveyor was measured at four points. When the measured values were equal, the two planes were confirmed to be parallel for that situation. In turn, this relation confirmed the parallelism between the occlusal plane and HIP. In the edentulous subjects, the occlusal plane, established clinically using the ala tragal line, was compared with the HIP radiographically using lateral cephalograms. Paired *t*-test was used to test the equality of the mean differences at a 0.05 significance level.
Results: The mean differences from the right canine were: 0.055 cm at the left canine, 0.05 cm at the right molar, and 0.065 cm at the left molar in dentate subjects and 0.001 cm between the incisive papilla and hamular notch in edentulous subjects. The HIP appeared parallel to the occlusal plane as the paired *t*-test showed no statistically significant difference ($p > 0.05$).
Conclusion: In the population tested, the HIP was parallel to the occlusal plane. Therefore, this may be a viable reference in complete denture prosthodontics.

The occlusal plane is the average plane established by the incisal and occlusal surfaces of the teeth.[1]

The inclination of the occlusal plane (IOP) is one of the key factors governing occlusal balance.[2] Determination of the IOP is an important step in the construction of equilibrated complete dentures, because bilaterally balanced occlusion is the situation of choice.[3] Camper plane[4] and the inter-pupilary line are the usual morphologic guides[5] used with the Fox plane and Leary parallelometer.[3] Other landmarks are the height of the retromolar pad,[6-8] the lateral borders of the tongue,[7] the position of the parotid papilla,[6,9] commisures of the lips,[6] and buccinator grooves.[6,10] In dentate individuals, the IOP is generally compared with the Frankfort plane (FP) (porion-orbitale).[11]

If carefully noted, all the above-mentioned landmarks are located on the face except FP, which requires a cephalograph.[12,13] Arbitrary use of the reference planes may affect the 3D orientation of the maxillary cast. Hence, the functional and esthetic result of prosthodontic restorations may be compromised.[11] Due to this observation, the search was made to identify reference landmarks that can be recorded on the cast. Hamular notch/anterior nasal spine (ANS) plane and hamular notch/incisive papilla plane (HIP) are two planes reported in the literature.[14-17] HIP appears suitable for comparisons to the radiographic landmark, ANS.

The hamular notch is the palpable notch formed by the junction of the maxilla and the pterygoid hamulus of the sphenoid bone.[1] The incisive papilla is the elevation of soft tissue that

covers the foramen of the incisive or nasopalatine canal.[1] The purpose of this study was to assess the reliability of HIP in establishing the occlusal plane, by identifying the relationship between the two planes.

Materials and methods

The study was an analytical double-blind study, using a convenience sample and descriptive statistics. The study was comprised of two parts, examining the dentate and edentulous populations separately.

The dentate group consisted of 28 men and 32 women, between the ages of 20 and 33 years (mean, 25 years), who were selected from a group of 435 healthy dental students on the basis of a detailed questionnaire and thorough clinical examination. All subjects met the following criteria as recommended by Ferrario et al[18,19]: complete permanent dentition, including the second molars (at least 28 teeth) with bilateral angle class I first permanent molar and canine relationships, horizontal overlap and vertical overlap ranging from 2 to 4 mm, no temporomandibular or craniocervical disorders, absence of extensive restorations, cast restorations, or cuspal coverage, no previous or current orthodontic treatment, absence of anterior or lateral cross bite, absence of a pathologic periodontal condition, and clinically normal arch shapes with minimal dental crowding.

Dental casts were made using type III stone (Orthodontic Stone; Whip Mix, Louisville, KY) from irreversible hydrocolloid impressions (Alginoplast; Bayer, South Bend, IN). The deepest point of the hamular notches and the center of the incisive papilla were marked with an indelible marker on the stone casts. The vertical arm of the surveyor was held at a fixed position. The cast was tilted so all three marked points were in contact with the fixed vertical arm. This tripoding method established the HIP on the same horizontal plane on which the vertical arm was fixed (Fig 1). In addition, this made the HIP parallel to the floor of the surveyor. The vertical distance between the occlusal plane and the floor of the surveyor was measured and recorded from four points. Two of the four points were at the level of the canines, named points RC and LC (representing right and left canine levels, respectively), and the other two measured points were at the level of the last molars, named points RM and LM (representing right and left molar levels, respectively).

The edentulous group consisted of 18 men and 12 women aged 43 to 62 years (mean 53 years), free of oral and temporomandibular disorders. The stone casts were obtained using the standard selective pressure impression procedure advocated by Boucher.[20] The deepest point of the hamular notches and the center of the incisive papilla were marked with an indelible marker on the stone casts as in the dentate cast. Three spherical metallic balls were attached to the cast at the marked points, using cyanoacrylate resin. Then, autopolymerizing acrylic resin was adapted over the cast, using the sprinkle-on method, to construct the temporary denture bases. The resin was allowed to undergo complete polymerization. The wax occlusion rim was constructed over the temporary denture base.

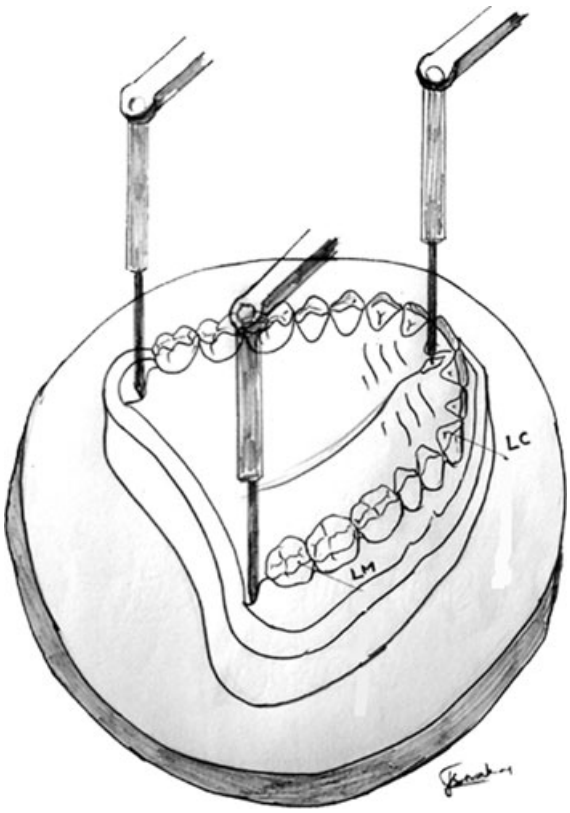

Figure 1 The cast fixed on the surveyor using the tripoding method.

The occlusal plane was clinically established using the ala tragal line posteriorly and the interpupillary line anteriorly. The mandibular occlusion rims were adjusted accordingly, and the jaw relation records were completed. The maxillary occlusion rim was removed, and the central bearing plate of the height tracer was embedded onto the occlusal surface. Care was taken not to disturb the established occlusal plane. A lateral cephalograph was then made with the occlusion rims in the mouth (Fig 2).

A different examiner did the cephalometric tracing. The HIP was established as a line joining the radiographic images of the anterior and posterior balls. The amount of enlargement of the ball that was away from the source of radiation was used as a guide in identifying the side. The radiographic image of the attached central bearing plate represented the occlusal plane. The vertical distance between the two lines in the anterior point (point IP representing incisive papilla) and the posterior point (point HN representing the hamular notch) were measured and recorded.

The data collected in both situations were statistically analyzed to test the equality of the mean differences using paired *t*-test at a 0.05 significance level.

The study was approved by the Ethical Committee Review Board of Annamalai University.

Results

In dentate individuals, the mean distance between occlusal planes was (in cm) 8.03, 8.035, 8.037, and 8.065 at points RC,

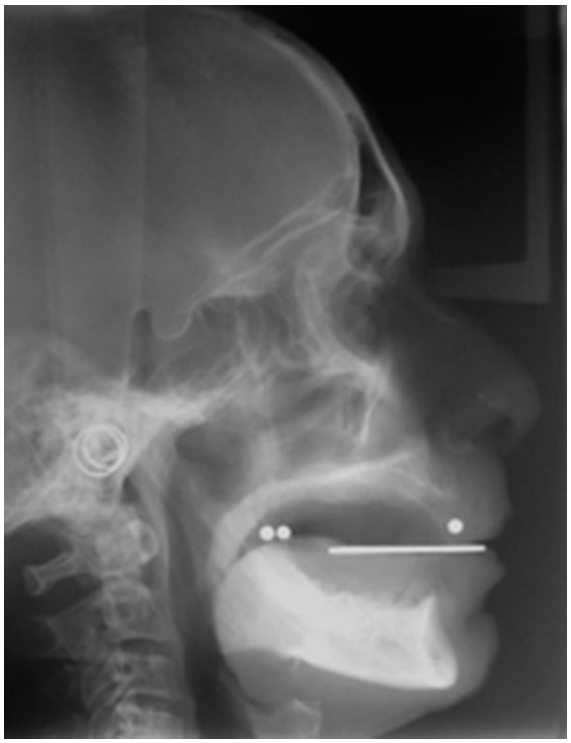

Figure 2 Lateral cephalograph of the edentulous patient with occlusion rims (metal balls and the central bearing plate attached to the maxillary record base and occlusion rim, respectively) in place.

LC, RM, and LM, respectively (Table 1). With the value at RC as standard, the mean difference from points LC, RM, and LM were (SD): 0.055 (1.1022), 0.05 (1.1186), and 0.065 (1.0442), respectively. Paired *t*-test showed no statistically significant difference ($p > 0.05$). In addition, 15% of the situations showed absolute parallelism, and 75% showed parallelism within the range of ± 2 mm.

In edentulous individuals, the mean distance between HIP and the occlusal plane at points IP and HN were 0.545 cm and 0.546 cm, respectively (Table 2). The mean difference calculated was 0.001 (SD: 0.0179). Paired *t*-test showed no statistically significant difference ($p > 0.05$). In addition, the occlusal plane established using the central point of tragus was found to have more of a parallel relation with HIP than with the superior and inferior edges.

Table 1 Distance between occlusal planes of the dentate casts to the floor at four points (values in cm)

Groups	Mean	SD	Maximum	Minimum
RC	8.03	0.7531	7.6	11
LC	8.035	1.1022	7.7	11
RM	8.0367	1.1192	7.6	11
LM	8.065	1.0442	7.9	10.8

RC = point at right canine; LC = point at left canine; RM = point at right molar; LM = point at left molar.

Table 2 Distance between HIP and occlusal plane in edentulous individuals at two radiographic points (values in cm)

Group	Mean	SD	Minimum	Maximum
IP	0.545	0.0165	0.5	0.59
HN	0.546	0.0197	0.48	0.6

IP = point at incisive papilla; HN = point at hamular notch.

Discussion

It has been postulated for almost a century that the occlusal plane is curved because of the sagittal inclination of teeth[19,21]; however, for practical reasons, a flat occlusal plane is formed as a reference during construction of complete dentures. A common method of establishing this tentative occlusal plane clinically is to make it parallel to Camper's plane. Camper's original plane was established from the ANS to the center of the external auditory meatus.[3] Clinically, however, the lower edge of the ala of the nose is considered. There is some controversy over whether to take the superior edge, the central point, or the inferior edge of the tragus of the ear.[12] Moreover, using Camper's plane appropriately depends on the operators' clinical experience.

By taking these factors into consideration, it was decided to look for landmarks that can better guide the clinician in establishing occlusal plane. HIP was reported in the literature to be used in establishing the occlusal plane.[14,16,17] This plane remains unaltered even with the loss of teeth,[14] as the incisive papilla remains in a constant position[22]; however, an exception occurs in the rare situation when excessive reduction or loss of alveolar bone is associated with the obliteration of the hamular notch.[4]

Rich[16] and Karkaziz and Polyzois[17] observed the parallel relation between HIP and the occlusal plane; however, they insisted on further evaluation considering the discrepancies in their methodology. Hence, this study was designed to identify the parallel relationship of the HIP and the maxillary occlusal plane. In dentate situations, the defined occlusal plane passes through the cusp tips of the posterior teeth and incisal edges of the anterior teeth[4]; and in edentulous situations, it is established using ala tragal-interpupillary reference plane.

During this study, the HIP was kept parallel to the floor at a particular height, and the tripoding method was used to fix the cast in the surveyor. This reduced human error to the minimum.

Two examiners made the measurements using the casts on the surveyor and using cephalometric tracings. Our results confirmed the observations of Rich[16] and Karkaziz and Polyzois[17] that the HIP tends to parallel the occlusal plane, which gives another guideline for occlusal plane determination. Further clinical application may be needed to establish this concept.

Conclusion

Within the studied population, the HIP tends to parallel the occlusal plane. Due to this observation, this plane may be used in the determination of inclination of occlusal plane

during complete denture construction. Further investigations may be indicated to support the concept, along with development of easier jaw relation procedures for complete denture construction.

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