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Original Research Article

Interrelationship of Various Reference Planes to Occlusal Plane in Completely Edentulous Patient: A Cephalometric Study

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Abstract:

Aim: The purpose of present study was to evaluate interrelationship of various reference planes to occlusal plane in completely edentulous patient.

Materials and Method: Forty completely edentulous subjects of age ranging from 55-65 years with Angle's class I relationship were included in the study. For all the subjects, left lateral cephalograms were taken and cephalometric analysis was done and data obtained from cephalometric tracing were then statiscally analyzed.

Result: Correlation of SN-OP and PP-OP to FH-OP was found to be statistically highly significant ($p<0.001$) whereas correlation of MP-OP to FH-OP was not statistically supported ($p=0.230$)

Conclusion: The palatal plane, Frankfort horizontal plane and Maxillary plane serve as a reliable guide to establish occlusal plane in edentulous subjects when two third of the retromolar pad area serve as a reference landmark.

Keywords: Frankfort Horizontal Plane, Occlusal Plane, Mandibular Plane, Reference Plane.

Introduction

The meticulous reconstruction of the natural level of the occlusal plane plays a vital role in optimal function and esthetics. Functionally, the occlusal table is a milling surface, strategically placed so that the tongue on the lingual side and buccinator muscle on buccal side are able to position the bolus of food onto it and hold it there during mastication [1,2-6]. In complete denture prosthesis faulty orientation of the occlusal plane would jeopardize the interaction between tongue and buccinators muscle causing cheek or tongue bite. Hence, after loss of all natural teeth correct orientation of occlusal plane becomes imperative for successful prosthodontic therapy.

Most of the studies regarding the establishment of an artificial occlusal plane in edentulous patients advocate the placement of artificial teeth in a natural position [7-9]. According to Boucher[4], "It seems to be obvious that if the soft tissue surrounding the denture is to work around as they did around natural teeth, the occlusal plane should be oriented exactly as it was when the natural teeth was present". It is generally recognized that vertical height of occlusal plane in anterior region is governed by aesthetic and phonetic requirements, though there are contrasting views on the orientation of artificial occlusal plane in posterior region [10,11,12-15].

According to current concepts, the position of the occlusal plane in a denture wearer should be same as it was in their dentulous state. Ow et al[2] advocated the use of lead foil while Karkazis and Polyzois[1] had used ill-defined radiopaque markers for occlusal plane location on the radiographs. Shigli et al [3] used several soft tissue landmarks for occlusal plane determination (retromolar pad, parotid papilla, commissure of lips, buccinator groove and Camper's plane) and they did not find any single soft tissue landmark that could be used as a reliable guide in determining occlusal plane. [17-19]

Cephalometrics is of special value to Prosthodontics in that it can be used to re-establish the spatial position of lost structures such as teeth [20,21,22]. In a Cephalometric study, it was revealed that in a dentulous patient there is specific angulation between various reference planes and occlusal plane, which orients the occlusal plane to create a pleasing profile and is in harmony with mastication, function and phonetics. Cephalometry is used as a diagnostic tool in Prosthodontics to evaluate the result of prosthodontic rehabilitation. Many reasearchers have established the occlusal plane in completely edentulous patients using the maxillary plane and Frankfort horizontal plane as maxilla is

the fixed entity and its plane remains constant even after loss of teeth.

Till date the mandibular plane has never been used as a reference to establish occlusal plane in completely edentulous patient. The structural and functional relationship of mandible changes with complete tooth loss. This entails a difficulty in establishing occlusal plane using mandibular plane as a reference guide. The present study was done to validate the interrelationship between various reference planes to the occlusal plane in completely edentulous patients using cephalometric analysis.

Materials and Method

A total of 40 subjects (20 male and 20 female) aged between 55 to 65 years were selected from the outpatient Department of Prosthodontics. Left lateral cephalograms were taken for all the subjects and cephalometric analysis was performed to evaluate interrelationship of various reference planes to occlusal planes in all the edentulous patients.

To standardize the selection of the study subjects and to avoid a bias in the study because of any skeletal abnormalities some inclusion and exclusion criteria were followed:

Inclusion Criteria

- Edentulous subjects in the age group of 55-65 years with healthy residual ridges in Angle's class I relationship.
- Selected subjects must have been edentulous for a period not more than one year and must be free of systemic ailments.
- None of the subject had undergone any prepros-thetic surgery.
- Bone mineral density must have been -1.0 or above which signifies normal bone density.

Exclusion Criteria

Subjects were excluded if he/she had a history of any craniofacial surgery/ trauma or TMJ disorder or any marked facial asymmetry.

Lead foil of thickness 0.002 inch was adapted on the occlusal surface of the mandibular occlusal rim at two third of retromolar pad area as a posterior reference landmarks and corner of lip as anterior reference landmark in all subjects (Fig. 1). A 8' x 10" green sensitive film was positioned parallel to the mid sagittal plane of the subject. The subject to source distance and the subject to film distance were adjusted and maintained to 5 feet 8 inches respectively. The radiographs were taken at a constant current of 10 mA and an exposure time of 18 sec and KV varied between 65 and 80 KV.

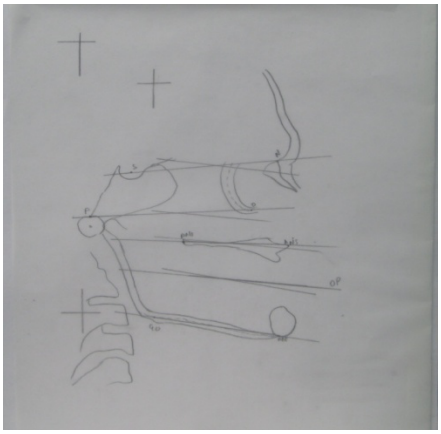
Lead foil adapted on the occlusal surface of mandibular occlusal rim was placed in the mouth of the subject following which, left lateral cephalograms were taken by a standard technique with the dentures closed in centric occlusion and lips in relaxed position (Fig. 2). The left side of the subject was kept towards the image receptor with the eyes looking towards infinity with the F-H plane kept parallel to the floor of the X-ray room .

For each subject (patient) one lateral cephalogram was taken at a constant current of 10 mA and exposure time of 18s, the KV varied between 65 and 80 KV. The radiographs with any exposure or developing artefact or superimposition were discarded.

Cephalometric Analysis: Tracing of all the cephalograms were traced on the standard acetate tracing paper of 5 micron thickness, with the help of 0.5 mm lead pencil. The following landmarks, angles, points and planes were traced and analyzed in the study (Fig.3a,b).

a. Skeletal landmarks: Anterior nasal spine (ANS), Posterior nasal spine (PNS), Gonion (Go), Menton (Me), Sella (S), Nasion(N), Porion(Po), Orbitale(Or).
b. Soft tissue landmarks: Inferior border of ala of nose and superior margin of tragus.
c. Anatomic Reference Planes:

- Frankfort Horizontal Plane: Plane drawn from the porion to orbitale
- Sella Nasion Plane: Plane drawn from sella to nasion.
- Maxillary Palatal Plane: Plane drawn from the anterior nasal spine to posterior nasal spine.
- Occlusal Plane: Plane established by joining the incisal and occlusal surfaces of the teeth in one plane.
- Mandibular Plane: Tangent to lower border of mandible at menton to gonion



Results

Angular measurements of each group are tabulated with their mean and standard deviation in Table 1 which shows angular variable of each plane to the occlusal plane. The comparison shows maximum variation in mandibular plane to occlusal plane followed by Sella Nasion plane, Frankfort horizontal plane and least variation seen in the palatal plane.

As shown in Table 2, Figure 5 & Figure 6 correlation between SN-OP, PP-OP and FH-OP was found to be moderate and on applying Bivariate correlation test it was statistically highly significant ($p < 0.001$). Hence, it can be said that all the three planes(SN plane, FH plane, PP plane) are related to each other and to the occlusal plane when two third of the height of retromolar pad is taken as intraoral reference landmark. Mandibular plane displayed a very weak correlation with other reference planes and was statistically insignificant ($p= 0.230$) (Figure 7).

In Table 3 & 4, a strong correlation was found between SN-OP, FH-OP, PP-OP which helps in finding a new regression formula between these planes excluding mandibular plane. Linear model was proposed in which FH-OP was considered as a dependent variable and SN-OP and PP-OP as independent variable, which culminated in the derivation of following equation respectively:

FH-OP (Y) = 2.684 + 0.477*SN-OP

FH-OP (Y) = 4.502 + 0.577*PP-OP

Therefore, the above study shows that there was a strong correlation between sellanasion plane, Frankfort horizontal plane, palatal plane to occlusal plane. Again it may show no correlation between mandibular plane to occlusal plane and with other reference planes.

Discussion

In complete denture fabrication ,the Prosthodontist is responsible for developing an occlusion that is most compatible with the craniofacial structures and the neuromuscular mechanism. To establish the lost occlusal plane in a completely edentulous patient is a daunting challenge in prosthetic rehabilitation. The orientation of the occlusal plane is lost in edentulous patients and therefore it needs be relocated if complete dentures are to be aesthetic and to function effectively. Where the occlusal plane is too high, the tongue cannot rest on the lingual cusps of the lower denture and prevent its displacement and there is also a tendency for accumulation of food in the buccal and lingual sulci. An occlusal plane that is too low could lead to tongue and cheek biting.

In the present study, 2/3rd of the height of retromolar pad was taken as the reference soft tissue landmark for orientation of occlusal plane. Boucher[4] and Hall[5] recommended placing the occlusal plane such that it terminates posteriorly at the medial two thirds of the retromolar pad while Rahn and Heartwell[7] said posterior height should not exceed half the height of the retromolar pad.

Cephalometric analysis has been used to investigate the relationship between the occlusal plane to sella-nasion plane, frankfort horizontal plane, palatal plane and mandibular plane. Recent studies have suggested the use of cephalometrics in evaluating and determining the position of occlusal plane in dentulous and edentulous patients [1,8]. However radiological cephalometry is limited by radiation exposure, cost and errors inherited due to distortion in form of magnification of image which is

inevitable[9]. Therefore, the cephalometric study was chosen as a method of investigation to examine the relationship of reference planes to occlusal plane, since other methods were not very reliable.

The position of occlusal plane in denture wearers should be as close as possible to the plane, which was previously occupied by the natural teeth . Such a position of the occlusal plane provides normal function of the tongue and cheek muscles, thus enhancing the denture stability. Faulty orientation of the occlusal plane will jeopardize the interaction between tongue and buccinators muscles.

Literature on growth and development of occlusion states that eruption of teeth takes place first in mandible followed by maxillary teeth [13]. Similarly the occlusal plane is established first in mandible and then in maxilla. Due to progressive loss of teeth structural and functional relationship of mandible changes which varies from patient to patient that is one of the reason the mandibular plane was taken as a reference guide to establish occlusal plane in completely edentulous patient. The other reason was that the occlusomandibular angle shows vertical dysplasia that was more expressive of the vertical position of teeth within the dentofacial complex of the edentulous patient.

In this study, age group of 55-65 years was preferred with equal number of male and female having healthy residual ridges exhibiting angles class I ridge relations. The selected subjects were edentulous for more than one year and did not undergone any pre prosthetic surgery. Subjects who had previous history of any craniofacial surgeries/ trauma or temporomandibular disorder or any marked facial asymmetries were not included in the present study because they would furnish false or distorted relationship of altered occlusion plane to sella-nasion plane, Frankfort horizontal plane, palatal plane, mandibular plane.

As shown in Table-1 and Figure 4, for each subject all the four planes (SN-OP, PP-OP, FH-OP, MP-OP) was measured with the help of set square and protractor and there mean was calculated . Results of the present study showed maximum variation in mandibular plane to occlusal plane followed by sellanasionplane, Frankfort horizontal plane and least variation in seen in palatal plane. Therefore, it is noteworthy to state that there was considerable individual variability in the occlusal plane establishment in edentulous patients, which could be due to the inconsistency of the structural parameters in study group. Previous studies which contradict the findings of this study and they states that S-N plane is considered as a genetic constant and embriologically belongs to the chondrocranium, and is influenced only by hereditary factorsand therefore shows no correlation between S-N plane and the occlusal plane[15].

Seifert et al [17] investigated the palatal plane to occlusal plane angle mean value was 7.58 degrees, whereas Sinobod[23] reported a value of 9.68 for the same angle, which is almost identical to the value from this study. Celebic et al [11]shows absence of strong linear correlation between the Maxillary plane (ANS-PNS) and the angle between maxillary plane and occlusal plane. In the present study, mean value angle between Frankfort horizontal plane to occlusal plane is 9.73 degree in edentulous patient. Celebic et al[11] proposed it as 9.43 degree and 8.53 degree in dentulous and edentulous subjects respectively.

As shown in Table 1 and Figure 4, maximum variation was seen between mandibular plane to occlusal plane. It was found to be deviated from mandibular plane which ranges from 5 degree- 16 degree with a mean of 11.18 ± 3.30 degree. In Table 2 , Figure 5 and Figure 6 correlation between SN-OP, PP-OP and FH-OP was statistically highly significant ($p < 0.001$) . Hence, it can be said that the all the three planes (SN plane, FH plane , PP plane) are correlated to each other and to the occlusal plane when two third of the height of retromolar pad is taken as intraoral reference landmark. whereas in Figure 7, it shows that mandibular plane shows a very weak correlation with other reference planes and was statistically insignificant ($p= 0.230$).

Hence, it can be stated that correlation of the mandibular plane to occlusal plane showed maximum variations compared to the other planes and minimum variation was observed when palatal plane to occlusal plane was compared when two third height of retromolar pad was taken as intraoral reference landmark. Previous studies have shown that even minor deviation of occlusal plane from sellanasion plane had an effect on the masticatory efficiency. The present study showed that establishing the occlusal plane using Frankfort horizontal plane, maxillary plane and sellanasion plane served as a definite guide for correct establishment of occlusal plane in edentulous patients. Establishing the occlusal plane using mandibular plane with two third height of retromolar pad as the intraoral reference landmark did not serve as a guide for correct establishment of occlusal plane in edentulous patient. This could be attributed to the fact that mandible is a mobile structure and with loss of teeth, structural and functional relationships of mandible changes which includes altered muscles to bone alignment, rotation and realignment of mandible, altered occlusal relationship, changes in size & form of mandible and changes in location of muscles attachment. Thus, mandibular plane showed deviation in establishing occlusal plane due to loss of teeth which varied with every individual. Hence, for subsequent prosthetic reconstruction

after teeth loss the maxillary plane was preferred to relate to the occlusal plane.

However, there are other variables which are difficult to standardize in patients such as loss of neuromuscular control, variability in resorption in both maxilla and mandible, increase in tongue size. Therefore, the need for three dimensional imaging modality and digitalization is necessary.

Conclusion

The following conclusion can be drawn from this study:

1. Among all the reference planes evaluated, only three planes i.e. SellaNasion plane, Frankfort horizontal plane and palatal plane showed a definitive relation with occlusal plane in edentulous subjects.
2. A strong correlation was found between the angle of maxillary plane, Frankfort horizontal plane, Sella - Nasion plane and the occlusal plane.
3. No correlation was found between the angle of mandibular plane to occlusal plane with other reference planes.

The results of present study therefore suggest that establishing the occlusal plane, using Frankfort horizontal plane, maxillary plane and Sellanasion plane when two third height of retromolar pad was taken as an intraoral reference landmark, served as a definite guide for correct establishment of occlusal plane in edentulous patients whereas mandibular plane did not guide correct establishment of occlusal plane in completely edentulous patients as mandibular plane varied in every individual with loss of teeth.

References

1. Karkazis HC, Polyzois GL. A study of the occlusal plane orientation in complete denture construction. Journal of oral rehabilitation 1987; 14: 399-404.
2. Ow RKK, Djeng SK, Ho CK. The relationships of upper facial proportions and the plane of occlusion to anatomic reference planes. J Prosthet Dent 1989;61(6):727-33
3. Shigli K, Chetal BR, Jabade J. Validity of soft tissue landmarks in determining the occlusal plane. J Indian Prosthodontic Soc. 2005; 5(3): 139-145.
4. Boucher CO. Swenson's complete dentures, 5th edn. The C. V. Mosby Company, St. Louis,1964: 246–251.
5. Hall WA. Important factors in adequate deture-occlusion. J Prosthet Dent. 1958;8(5):764-775
6. Nissan J, Barnea E, Zeltzer C & Cardash HS. Relationship between occlusal plane determinants and craniofacial structures. Journal of oral rehabilitation 2003; 30: 587–591
7. Rahn AO, Heartwell CM. Textbook of complete denture, 5th edition. Philadelphea: Lea and Febiger; 2002:270.
8. Ismail YH, Bowman JF. Position of the occlusal plane in natural and artificial teeth. J Prosthet Dent.1968; 20: 407-11
9. Veena H. Significance of the Frankfort mandibular plane angle in prosthetic management of partially or completely edentulous patients with Class II malocclusions. J Indian ProsthodontSoc 2005; 5:175-179.
10. Ahmad ZM, Jawad IA, Al-Ali AA. Clinical determination of the occlusal plane and its relationship with orofacial measurements. Al Rafidain Dent J. 2007;7(1):101-110
11. Celebic A, Brkic H, Kaic Z, Peruzovic MV, Vojvodic D. Evaluation of some lateral cephalometric methods for determination of occlusal plane determination. ActaStomatol Croat 1994; 28:11-18.
12. Kumar P, Prakash H, Bahrgava S, Gupta S, Bagga DK. Reliability of anatomic reference planes in establishing the occlusal plane in different jaw relationships: A Cephalometric study. J Indian Prosthodont Soc. 2013; 13(4): 571-577.
13. L'Estrange PR, Vig PS. A comparative study of the occlusal plane in dentulous and edentulous subjects. J Prosthet Dent 1975;33(5):495-503.
14. Monteith BD. A cephalometric method to determine the angulation of the occlusal plane in edentulous patient. J Prosthet Dent 1985; 54(1):81-85
15. Lestral PE, Kapur KK, Chauncey HH. A cephalometric study of the mandibular cortical bone thickness in dentulous person and denture wearers. J Prosthet Dent 1980; 43:89-94.
16. Jayachandran S, Ramachandran CR, Varghese R. Occclusal plane orientation: a statistical and clinical analysis in different clinical situations. J Prosthodont. 2008; 17(7): 572-75.
17. Seifert D, Jerolimov V, Carek V, Ibrahimagic L. Relations of reference planes for orientation of the prosthetic plane. Acta Stomat Croat 2000;34(4):413-416.
18. Shetty S, Zargar NM, Shenoy K, Rekha V. Occlusal plane location in edentulous patients: A Review. J Indian Prosthdont Soc. 2013; 13(3): 142-148.
19. Rajawat I, Venkataramana V, Patil P, Guram G, Gupta N, Lau M, Thakkar P, Shah DM, Kaur RK. A Cephalometric evaluation for co-relation of different facial types with occlusal plane in dentulous and edentulous patients. OHDM 2014;13(4):1188-1191.
20. Hindocha AD, Vartak VN, Bhandari AJ, Dudani M. A Cephalometric study to determine the plane of occlusion in completely edentulous patients: Part I. J Indian Prosthodont Soc. 2010; 10(4):203-207.

21. Bassi F, Deregibus A, Previgliano V, Bracco P, Preti G. Evaluation of the utility of cephalometric parameters in contructing complete denture. Part I: Placement of posterior teeth. J of Oral Rehabil: 2001; 28:234-8.
22. Mittal R. Comparison of the occlusal plane in dentulous and edentulous patients: A cephalometric study. J Indian Prosthodont Society 2008;8(4):195-200.
23. Sinobad D. The position of the occlusal plane in dentulous subjects with various skeletal jaw relationships. J Oral Rehab 1988; 15:489-98.