International Journal of Medical and Health Research
ISSN: 2454-9142
www.medicalsciencejournal.com
Volume 4; Issue 8; August 2018; Page No. 52-56

Estimation of effectiveness of different anatomical landmarks in re-establishing lost occlusal plane in edentates: An all-inclusive review of literature

Davinderjit Kaur Shergill[1*]
[1] Senior Lecturer, Department of Prosthodontics, Maharaja Ganga Singh Dental College, Sriganganagar, Rajasthan, India

Abstract
In both natural and artificial dentitions, the plane of occlusion plays an important role in fulfilling the important criteria of function and esthetics. During teeth arrangement, it is generally advised that the artificial teeth be placed in the positions previously occupied by the natural teeth. This literature review has attempted to explore chronological perspectives, past researches, various concepts, dilemmas and modern outlooks for re-establishment of lost occlusal plane in completely edentulous patients. A widespread literature search was done using MEDLINE/PubMed database and other research bibliographic databases using Medical Subject Headings (MeSH). All papers including original studies, case series and case reports were obtained and examined from 1967 to 2018. Many of the researchers evidenced to use Camper's plane for re-orientation of occlusal plane though there is considerable deficiency of authentic research studies and reliable data that possibly will recommend a single consistent marker for perfect occlusal plane reorientation in diversity of patients.

Keywords: Frankfort horizontal plane, occlusal plane, camper plane

Introduction
Determining the plane of occlusion is an important step in complete denture therapy. Due to absence of any concrete intraoral or extraoral anatomical landmark, its determination is prone to subjective variation. Different authors have advocated the use of various landmarks for its determination. In completely edentulous patients, re-establishment of new occlusal plane is one entity that has received several theories and postulations over the years in the literature [1]. In complete denture fabrication the Prosthodontist is solely responsible for rehabilitating natural form and function and for developing an Occlusion that is most compatible to the craniofacial structures and neuromuscular mechanism. The Glossary of Prosthodontic terms defines occlusal plane as "the average plane established by the incisal and occlusal surfaces of the teeth [2]. The determination of occlusal plane is one of the most important clinical procedures in the prosthodontic rehabilitation of edentulous subjects. According to contemporary concepts, position of the occlusal plane in denture wearer should be same as it was present in their dentulous state. Ala tragus line is one of the common extra oral soft tissue land mark utilized in dental clinics for occlusal plane orientation. The specifically formed occlusal complex becomes the foundation for normal basic functioning of the stomatognathic system, particularly the functions of mastication and articulation. Most of the studies regarding the establishment of artificial occlusal plane in edentulous patient's advocate placement of the artificial teeth in natural position [3]. In the non-natural occlusal plane orientation, clinician could face complexity in perfectly locating the occlusal plane in every edentulous patient using the reported soft tissue landmarks. Furthermore, wrong selection of these landmarks may further compromise and deteriorate the functional as well as esthetic outcomes of the intended prosthodontic rehabilitation [4-6]. This review is an attempt to explore various theories for occlusal plane re-orientation wherein we expect to have some innovative clinical trials on larger scale to substantiate some valid norms in it.

Methods of Literature Search
Different internet based trendy search engines (Google, Google Scholar, Yahoo), scholarly search bibliographic databases (PubMed, PubMed Central, Medline Plus, Cochrane, Medknow, Ebsco, Science Direct, Hinari, WebMD, IndMed, Embase) and textbooks were searched until June 2018 using MeSH (Medical Subject Headings; PubMed) based keywords such as "Complete Denture", "Esthetics", "Occlusal plane", "Frankfort Horizontal plane", "Camper plane". We had made sure restrict the searches only to reviews, systematic researches, meta-analyses and clinical guides in various dental journals published over the last 50 years in English. A total of 97 articles were identified however after examining the titles and abstracts, this number was finally reduced to 39 articles.

Systematic Literature: Discussion
One of the greatest problem of Prosthodontic rehabilitation is to establish a functional occlusal plane in harmony with the dento-facial structures. In the past many investigators have tried to relocate the occlusal plane by using different methods. None of the methods used in the past have been accurate in locating the lost occlusal plane. Ismail and Bowman explored and compare the occlusal plane in natural and artificial dentition. They obtained pre-extraction lateral cephalograms and after removal of all teeth, complete dentures were constructed keeping the height of the maxillary occlusal rim 1-3 mm below the resting lip anteriorly. The height of the lower occlusal rim was modified according to the patients esthetic

requirement and the posterior height was established at the middle 1/3 of retromolar pad Lateral cephalograms were made after the complete denture were inserted. Both these lateral cephalograms were traced and superimposed. On statistical analysis, the results showed that the location of artificial Occlusal plane was at a lower level than the naturally existing occlusal plane.[7-8] Ismail and co-workers performed a cephalometric study to investigate the gradual changes that can occur in face height (determined by occlusal position of mandible), rest face height (determined by postural position of the mandible) and interocclusal distance in the same patient before extraction of their teeth, and after the insertion of complete dentures [9]. Once the denture insertion done, cephalograms were taken and superimposed on pre extraction cephalograms to access and compare the changes in occlusal facial height. The results confirmed an increase in occlusal facial height. This increase was followed by a gradual reduction, which was greater during the first 6 months than the second 6 months of the post insertion phase. They also stated that by the end of 12 month period of wearing the dentures, the occlusal face height and rest face height were reduced to almost the same height that existed before the remaining teeth were extracted. Nikzad conducted short survey study on the usefulness of a "J' shaped aluminium device in correct establishment of occlusal plane in edentulous patients.[10-11] He first positioned a fox plane on the Occlusal surface of the upper occlusal rim followed by placing the 'J' plane against the Nasion with its long axis passing through the interpupillary line. The position of the anterior part of fox plane should be parallel with the border of the J plane. The posterior part of occlusal rim was adjusted parallel to the J plane by holding the fox plane on the occlusal surface of upper occlusal rim, and holding the curved side of the J plane against the cheek, one end on lower border of the Ala of the nose and the other end on the middle of the Tragus. Razak postulated that there is widespread controversy regarding the exact location of the plane of occlusion and introduced a simple orofacial device for recording both the inclination and height of the occlusal plane [12-13]. The device consisted of a protractor shaped right angle plastic triangle with a metal rod on the pointed end (to be placed on the skin over the infraorbital foramen). The device is placed by the side of the face with pointed end with metal rod facing towards infra orbital foramen for recording the exact occlusal plane angulation and occlusal vertical dimensions. The device was simple and the records are reliable as they are based on landmarks which do not change with the patient ages. Kapur and associates studied dentate patients of age group 25-75 years, to evaluated the relationship of the occlusal plane with Sella-Nasion (SN), Palatal plane (PL), Facial plane (FL), and mandibular plane (ML). Cephalometric analysis and results showed high degree of correlation between occlusal plane and Palatal plane [14]. Therefore it worth to state that there is considerable individual variability in the occlusal plane establishment in edentulous patients which could be due to the inconsistency of the structural parameters in population.

Niekerk and co-workers evaluated the reliability of Ala-Tragus plane in occluusal plane orientation. The occlusal plane was established on the basis of patient's esthetic, function and comfort and parallel to the Ala-Tragus plane [15-16]. A lead foil was adapted to the Occlusal surface of the mandibular right posterior teeth indicating the occlusal plane. A strip of lead foil was also taped to the face joining the inferior border of the Ala to the inferior border of Tragus. The majority of points, planes and angular measurements were indicated on the cephalometric tracings. Results showed inconsistency in parallelism of occlusal plane with Ala-Tragus plane in majority of patients making it an unsatisfactory landmark in accurate occlusal plane establishment. Monteith studied and evaluated the reliability of Po-N-ANS angle in reproducing correct occlusal plane orientation [17]. He measured the occlusal plane-Frankfort Horizontal plane angulation on pre extraction cephalograms and used this angulation to establish the occlusal plane during denture fabrication by changing the inclination of Maxillary master cast (with the occlusal plane-Frankfort Horizontal plane angle) on the articulator after the Face Bow transfer. Lateral cephalograms were made for all subjects in centric occlusion with wire in wax denture base (to appear radio-opaque). The statistical comparison of pre treatment occlusal plane-Frankfort Horizontal plane angulations with post denture insertion occlusal plane-Frankfort Horizontal plane angulations was not significant. Therefore, authors concluded that Po-N-ANS angle can serve as a reliable guide for the establishment of lost occlusal plane in edentulous patients. Karkazis and Polyzois investigated dentulous and edentulous subjects to determine the location of the natural and artificial occlusal planes as related to Camper's plane using fox plane [18]. They used to attach small radiopaque ball-shaped pellets (1mm. in diameter) to the lower border of the Ala of the nose with adhesive tape, to the mesioincisal angle of maxillary central incisors and the mesiopalatal cusp of the maxillary first molar on the upper complete denture with wax respectively. Cephalometric tracings were done and it was concluded that the natural occlusal plane was not parallel to the Campers plane, also the artificial occlusal plane determined at the time of complete dentures insertion was not parallel to Camper's plane.

Karkazis and Polyzois conducted a cephalometric study to explore the relationship between the Cook's plane (Hamular Notch-Incisive papilla) and the occlusal plane. In dentulous subjects, occlusal plane were identified on the cephalometric radiographs by attaching the metal pellets to the upper incisal tip and first molar buccal cusp tip [19-20]. In edentulous subjects, determination of artificial occlusal plane was made according to the Ala-Tragus plane running from the lower border of the Ala of the nose to the middle of the Tragus of the ear. The cephalograms were obtained and the incisive papilla was located by drawing a line perpendicular to the occlusal plane 10 mm distal to the incisal tip. The point of intersection between this line and the lower border of the hard palate was identified as a landmark i.e.; incisive papilla. They concluded that the Cook's plane (Hamular notch–Incisive Papilla) plane tends to almost parallel to the natural occlusal plane, giving one more guideline for the occlusal plane establishment in edentulous patients. Later to this Kazanoglu and Unger introduced a simplified device for the accurate establishment of occlusal plane, called 'Camper's plane indicator' having an upper and a lower plate on a vertical arm which was designed to place the upper plate on the Camper's

plane on patient's face and the lower plate on the occlusal rims.[21] Methodology includes positioning of Camper's plane indicator device with the lower plate placed against the occlusal surfaces of the maxillary occlusal rim; and to move upper plate up and down until it is parallel to the Camper's plane. It will also indicate whether the anterior occlusal rim is parallel with the patient's interpupillary line. D'Souza and Bhargava assessed the reliability of Camper's plane for the establishment of occlusal plane in dentulous and edentulous subjects. Occlusal plane was oriented parallel to the Camper' plane during denture fabrication following which cephalograms were obtained after marking the Ala-Tragus points and occlusal plane with radiopaque lead beads [22-23]. They compared the occlusal plane- maxillary plane angle and occlusal plane-mandibular plane angle to check for similarities in dentulous and edentulous subjects. Results revealed that occluso-maxillary plane angulation was higher and occluso-mandibular plane angle was unchanged in edentulous group than that of dentulous group. Thus the authors concluded that the reliability of Camper's plane as a guideline to simulate the natural occlusal plane is questionable which was quite controversial. Seifert and co-workers assessed the relations of various anatomic reference planes for establishment of the occlusal plane in edentulous patients. On 60 cephalograms of dentulous subjects, the Frankfurt horizontal plane, Camper's plane, palatal plane, occlusal plane, mandibular plane were traced to measure the angulations and variation between different anatomic reference planes with occlusal plane.[4] The results and basic statistics revealed significant difference in the angulations of the occlusal plane with other reference planes. The highest level of significance was found for the Camper's plane-occlusal plane angle which indicates that the use of Camper's plane to establish the occlusal plane is unreliable. They concluded that the occlusal plane is not parallel to the Frankfurt plane and Camper's plane and thus no one parameter could be chosen for establishment of the occlusal plane in edentulous patients.

Vukusic studied dentate subjects and evaluated the angle between occlusal plane and various craniofacial planes on cephalometric tracings. The results of correlation of occusal plane and other reference planes showed anterior rotation of occlusal plane during growth with no significant differences between sexes [24]. Moreover, all reference planes showed no significant difference when compared with occlusal plane, therefore they concluded that occlusal plane-Frankfort Horizontal plane, occlusal plane-Palatal plane, occlusal plane-Camper's plane could be used for establishment of the lost Occlusal plane in edentulous patients. Shigli and associates planned to establish the relationship of intraoral and extraoral soft tissue landmarks in determining the occlusal plane (viz. retromolar pad, parotid papilla, commissure of lip and buccinator groove). A total of 30 dental students in the age group 19-23 years were selected for the study.[5-25] The relationship of the occlusal plane to the parotid papilla, commissure of lips and the buccinator groove was determined by using a special 'intraoral vestibular impression technique'. From this study authors concluded that no single method was found to be ideal for determining the occlusal plane. Therefore, one or more of the above mentioned parameters along with the clinical judgment, will be helpful in determining ideal occlusal plane level for edentulous patients. Mittal compared the occlusal plane in dentulous and edentulous patients to determine the location of occlusal plane using hard tissue references (i.e; Craniometric landmarks like FH plane, Maxillary plane). Lead foil were placed at upper and lower right central incisors, the apex of the mesiobuccal cusp of the lower right 1st molar of dentures in edentulous subjects. In dentulous subjects, significant associations were found between occlusal and maxillary plane whereas in edentulous subjects there was marked parallelism of the occlusal plane and the maxillary plane [26-27]. It was concluded from this study that significant correlation was found between the angulations of occlusal-maxillary plane in both dentulous and edentulous subjects therefore the occlusal-maxillary plane may be considered as a reliable guide for occlusal plane establishment. Petricevic evaluated the reliability of digital photography for the establishment of lost occlusal plane in edentulous patients. A Quick Mount Face Bow and Fox Plane was positioned on dentulous subject and lateral digital photograph were taken from a distance of 1.5 m. in a natural head position. Following the Quick Mount Face Bow transfer and mounting of Maxillary cast on the articulator, the articulator horizontal plane-occlusal plane angulation (AHP-OP) was measured using calliper [28]. On printed photographs, the angles between the Face Bow and the Fox Plane (FB-FP) were measured and compared with articulator horizontal plane-occlusal plane angulation (AHP-OP). There was no significant difference between AHP-OP and FB-FP angles and thus the digital photographs is reliable method and could be helpful in establishment of lost occlusal plane. Sadr aimed to define the posterior reference point of Ala-Tragus line for correct orientation of occlusal plane in complete denture fabrication. The Left profile photographs was taken in natural head position of dentate subjects and occlusal plane, Camper's plane with superior, middle and inferior border of Tragus were marked on the printed photographs [29]. The occlusal plane was identified by placing Fox plane while taking the photograph. Results showed no parallelism between the occlusal plane and Ala-Tragus line with three different posterior ends however the superior border of Ala-Tragus line had the lowest mean angle of 0.80° and was almost parallel to the occlusal plane. Hindocha conducted a study to determine the validity of Camper's plane (Ala-Tragus plane) after outlining the superior, middle and the inferior border of the Tragus and the base of the Ala of the nose with radio-opaque markers (lead wire and barium sulphate dye).[30-31] On statistical analysis, the results showed that the Tragal reference in this study population was more towards the inferior of the Tragus, with most of the times being below the inferior border, therefore, the orientation of the plane of occlusion with the posterior landmark as superior of Tragus (Camper's plane) may be considered as questionable based on the findings of this study. It was also be concluded that no single Tragal reference could fulfil the criteria of being the posterior landmark for the establishment of plane of occlusion. Hence, the reliability of the Tragus as a posterior landmark for the orientation of the Camper's plane (and hence the occlusal plane) is questionable. Singh evaluated the reliability of the Camper's plane as a guide to determine the occlusal plane in edentulous patients. He has chosen the methodology similar to Hindocha to mark

superior, middle and inferior border of the Tragus of the ear and on Ala of the nose. It was concluded that the inclination of Ala-Tragus (inferior margin) plane is parallel to the Occlusal plane and in 80% of cases it fall within the range of $\pm 5^0$ which indicates that this Camper's plane (Ala-Tragus's inferior margin), can serve as a guide for establishment of lost Occlusal plane in edentulous patients.[32] Shetty and associates studied different anatomic landmarks for occlusal plane establishment.[33] Literature has identified that in the mandibular arch there are only few landmarks which could be used to orient the occlusal plane like the retromolar pad, corner of the lips (lower lip length) but the maxillary arch has several landmarks, of which the Ala-Tragas line is the frequently used and the same being the most controversial [34-39].

Conclusion

The present paper has shown the extensive work done in the literature on the relationship of occlusal plane with anatomic reference planes in dentulous and edentulous subjects. Majority of the studies showed that the Frankfort Horizontal plane is reliable skeletal landmark while Camper's plane is reliable clinical landmark for the establishment of lost occlusal plane in edentulous subjects with various Angle's jaw relationship. Therefore using the Camper's plane as a landmark for the establishment of occlusal plane along with Face bow to transfer Frankfort Horizontal plane would serve as a definite guide for the occlusal plane establishment. However various parameters such as increase in tongue size, loss of neuromuscular control, variability in resorption in both Maxilla and Mandible, sequel of natural tooth extraction, are variables which are difficult to standardize in patients. Yet, further studies on longer scale with definite inclusion criteria need to be conducted to get more comprehensive understanding.

References

1. Swenson MG. Complete denture 2nd ed St Louis. Mosby Company, 177-80.
2. Glossary of Prosthodontic Terms. 8th ed St Louis. CV Mosby, 2005.
3. Zarb GA, Bolender CL, Carlsson GE. Boucher's Prosthodontic treatment for edentulous Patients 11th ed St Louis. Mosby Company. 2003; 46:183-96.
4. Seifert D, Jerolimov V, Carek V, Ibrahimagic L. Relation of the reference planes for Orientation of the Prosthetic plane. Acta Stomatol Croat 2000; 34:413-6.
5. Shigli K, Chetal BR, Jabade J. Validity of soft tissue landmarks in determining the occlusal Plane. J Indian Prosthodont Soc 2005; 5:139-45.
6. Karkhazis HC, Polyzois GC. A study of the occlusal plane orientation in complete denture construction. J Oral Rehab 1987; 14:399-404.
7. Hartono R. The occlusal plane in relation to facial types. J Prosthet Dent. 1967; 17:549-58.
8. Ismail YH, Bowman JF. Position of occlusal plane in natural and artificial teeth. J Prosthet Dent. 1968; 20:407-11.
9. Ismail YH, George WA, Scott RH, Sassouni V. Cephalometric study of changes occurring in the face height following prosthetic treatment Part I: Gradual reduction of both occlusal and rest face heights. J Prosthet Dent. 1968; 19:331-7.
10. Lundquist DO, Luther WW. Occlusal Plane determination. J Prosthet Dent. 1970; 23:489-98.
11. Nikzad JS. A technique for determination of occlusal plane. J Prosthet Dent. 1974; 31:270-3.
12. L' Estrange PR, Vig PS. A comparative study of occlusal plane in dentulous and edentulous subjects. J Prosthet Dent. 1975; 33:495-507.
13. Razek A, Abdul LM. Pre-extraction records of the Occlusal plane and vertical dimension. J Prosthet Dent 1977; 38:490-3.
14. Lestrel PE, Kapur KK, Chauncey HH. A cephalometric study of mandibular cortical bone thickness in dentulous persons and denture wearers. J Prosthet Dent. 1980; 43:89-94.
15. Williams DR. Occlusal plane orientation in complete denture construction. J Dent 1982; 10:311-6.
16. Niekerk FWV, Miller VJ, Bibby RE. The Ala-Tragus line in complete denture Prosthodontics. J Prosthet Dent 1985; 53:67-9.
17. Montieth BD. Evaluation of a Cephalometric method of occlusal plane orientation for complete dentures. J Prosthet Dent. 1986; 55:64-9.
18. Karkazis HC, Polyzois GC. Cephalometrically predicted occlusal plane: Implication in removable prosthodontics. J Prosthet Dent. 1991; 65:258-64.
19. Sinobad D. The position of the Occlusal plane in dentulous subjects with various skeletal jaw relationships. J Oral Rehab. 1988; 15:489-98.
20. Karkazis HC, Polyzois GC. Cephalometrically predicted occlusal plane: Implication in removable prosthodontics. J Prosthet Dent. 1991; 65:258-64.
21. Kazanoglu A, Unger J. Determining the occlusal plane with the Camper's plane indicator. J Prosthet Dent. 1992; 67:499-501.
22. Hall SJ. The maxillary-mandibular plane angle (MM^O) bisector : A new reference plane for anteroposterior measurement of the dental bases. Am J Orthod Dentofac Orthop. 1994; 105:583-91.
23. D'Souza N, Bhargava K. A cephalometric study comparing the occlusal plane in dentulous and edentulous subjects in relation to the Maxillomandibular space. J Prosthet Dent. 1996; 75:177-82.
24. Vukusic N, Lapter M. Changes in the inclination of the occlusal plane during craniofacial growth and development. Antropol. 2000; 24:145-150.
25. Nissan J, Barnea E, Zeltzer C, Cardash HS. Relationship between occlusal plane determinants and craniofacial structures. J Oral Rehab. 2003; 30:587-91.
26. Jayachandran S, Ramachandran CR, Varghese R. Occlusal plane orientation: A statistical and clinical analysis in different clinical situations. J Prosthodont 2008; 17:572-5.
27. Mittal R. Comparison of the occlusal plane in dentulous and edentulous patients: A Cephalometric study. J Indian Prosthodont Soc. 2008; 8:195-200.
28. Petricevic N, Guberina M, Celic R, Mehulic K, Krajnovic M, Antonic R, *et al.* of digital photography in the

reconstruction of the occlusal Plane orientation. Medicinski Glasnik. 2009; 6:243-4.
29. Sadr K, Sadr M. A study of parallelism of the occlusal plane and Ala-Tragus line. J Prosthodont. 2009; 3:107-9.
30. Firas AM, Quran AL, Hazza A and Nahass NA. The position of the occlusal plane in natural and artificial dentition as related to other craniofacial planes. J Prosthodont. 2010; 19:601-5.
31. Hindocha AD, Vartak VN, Bhandari AJ and Dudani M. A cephalometric study to determine the plane of occlusion in completely edentulous patients. J Indian Prosthodont Soc. 2010; 10:203-7.
32. Singh G. Ala Tragus line - A cephalometric evaluation. Int J Prosthodont. 2010;1:1-5.
33. Shetty S, Zargar NM, Shenoy K, Rekha V. Occlusal plane location in edentulous patients: A Review. J Indian Prosthodont Soc: Online First, 2013.
34. Rathod N, Sood P, Pasam N. Analysis and Comparison of Correlation between Camper's Plane and Natural Occlusal Plane in Normal Dentulous Subjects. Int J Prosthodont Restor Dent. 2017; 7(3):81-85.
35. Tantray MA, Bali SK, Shah SA. A study comparing the occlusal plane in dentulous and edentulous subjects in relation to maxillomandibular space in Kashmiri population. Int J Applied Dent Sci. 2017; 3(4):96-102.
36. Sherry SA, Jain AR. Reliability of various craniofacial reference planes with occlusal plane in Dravidian population. J Pharmacy Res. 2017; 11:1503-5.
37. Kaur K, Nelogi SY, Patil R. Comparative evaluation of the most reliable posterior reference point of Camper's plane in relation with hamular notch-incisive papilla plane with change in gender of edentulous subjects: A cephalometric study. Indian j health sci. 2016; 9:165-9.
38. Gandhi N, Daniel S, Kurian N. Cephalometric study of the position of ala-tragus line in relation to Frankfort horizontal plane and Occlusal plane among Ludhiana population. Indian J Dent Sci. 2017; 9:165-9.
39. Saha MK, Dhariwal P, Vinod V, Jindal A, Dave M, Agrawal P. A comparative evaluation of the parallelism of the occlusal plane with different levels of the tragus forming the ala-tragal line in Indore-Malwa dentate population – A Photographic study. J Applied Dent Med Sci. 2017; 3:1-7.