

# Systematic Assessment of the Various Controversies, Difficulties, and Current Trends in the Reestablishment of Lost Occlusal Planes in Edentulous Patients

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## Abstract

Accurate occlusal plane orientation is an essential factor in the fabrication of complete denture prosthesis. Over the years, it has received a number of methodologies by several researchers utilizing various anatomical landmarks however none of them is considered as perfect that could orient ideal occlusal plane. The presented literature review is an attempt to enlighten historical perspectives, pioneer researches, different controversies, difficulties and current trends for re-establishment of lost occlusal plane in edentulous patients. An extensive literature search was performed using Medline/PubMed interface and other scholarly research bibliographic databases using Medical Subject Headings. Studies describing research studies, case series and assorted clinical reports were retrieved and evaluated from 1963 to 2013. Most of the studies have suggest and evidence to consider Camper's plane for artificial orientation of occlusal plane however there is a substantial lack of genuine long term studies and authentic data that could recommend a single reliable landmark for perfect occlusal plane reorientation in a variety of cases.

**Keywords:** Camper plane, Complete denture, Esthetics, Frankfort horizontal plane, Occlusal plane

## Introduction

Smile is one of the most eminent expression and universal welcoming greeting in all cultures and ethnicity. With aging subsequent and loss of teeth, smile is severely compromised and no more pleasant. The artificial replacement of teeth primarily aimed to restore patient's previous natural appearance, function and smile. 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.<sup>[1]</sup> 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".<sup>[2]</sup> One of the greatest challenges in prosthetic rehabilitation of edentulous patient is to accurately establish lost occlusal plane. Due to its highly subjective nature, no single method seems to be perfect for its re-establishment however Camper's plane and Frankfurt Horizontal plane has gained privileged popularity with this context.

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 a natural position. According to Boucher, "it seems to be obvious that if the soft tissue surrounding the denture is to work around as they did around natural teeth, occlusal plane should be oriented exactly as it was when the

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natural teeth were present”.<sup>[3]</sup> The meticulous reconstruction of the “natural level” of the occlusal plane in the edentulous mouth enables the normal function of cheek and tongue muscles and other surrounding structures. Furthermore, it has been suggested that such position of the occlusal plane enhance denture stability and functional value. Occlusal plane forms a basis for ideal teeth arrangement and also fulfills the necessary mechanical, esthetic requirement and aid in deglutition.

The location of occlusal plane in complete denture fabrication is incredibly subjective and it is widely variable depending upon the uncertainty of reference landmarks and the individual judgment. Literature has evidenced a number of principles and anatomical landmarks to clinically determine the most appropriate and favorable position of the occlusal plane. These includes are the upper lip, corners of the mouth, lateral margins of the tongue buccinator grooves, two-thirds of the height of the retromolar pad, parallel to the Camper’s plane or ala-tragus line, hamular notch-incisive papilla (HIP) plane.<sup>[4-6]</sup> Camper’s plane has been used to approximate the occlusal plane for the past 100 years. Nevertheless, the Frankfort horizontal (FH) plane was also reported more than 100 years ago. During the systematic literature search, authors identified the clinical applicability of FH plane (in establishing occlusal plane) mostly in last 4-5 decades. This actually led the basis to limit the literature search in last 50 years. In the artificial occlusal plane establishment, one may find difficulty in accurately locating the occlusal plane in every edentulous patient using the reported soft tissue landmarks. Moreover, inappropriate selection of these landmarks may further compromise and deteriorate the functional as well as esthetic outcomes of the intended prosthodontic rehabilitation. This review is an endeavour to present an overview on the different methods and theories for occlusal plane orientation and authors look forward for some new-fangled clinical studies on wider parameters to authenticate and establish certain concrete guidelines in this perspective.

## Materials and Methods

Various internet based popular 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 May 2013 using Medical Subject Headings (PubMed) based keywords such as “Complete Denture”, “Esthetics”, “Occlusal plane”, “FH plane”, “Camper plane”. The search was limited to reviews, systematic researches, meta-analyses and clinical guides in various dental journals published over the last 50 years in English and Spanish. A total of 108 articles were identified. After examining the titles and abstracts, this number was finally reduced to 40 articles.

### Orientation of the occlusal plane: Results of systematic literature search and clinical perspectives

The construction of life like complete dentures for patients who have lost their natural teeth is often the most fascinating

and personally satisfying part of dentistry. 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.

Hartono conducted a study on 53 dental students to establish a correlation between the occlusal plane and facial types and also to determine the part of Tragus for posterior reference point of Camper’s plane.<sup>[7]</sup> The different facial types studied were maxillary protrusion, maxillary retrusion, bimaxillary protrusion, mandibular protrusion and mandibular retrusion. Occlusal plane inclination with respects Ala-Tragus plane was measured on lateral profile photographs. Statistical analysis and results of the study indicate that, among the different facial types studied, the plane connecting the lowest point of the Ala of the nose to the inferior margin of the Tragus is nearly parallel to the occlusal plane and this plane is referred to as Camper’s plane when used by the Prosthodontists. Such occlusal plane inclination in patients with mandibular retraction was found to be steeper as compared to what found in mandibular protraction cases. He concluded that a correlation exists between facial types and the location of the occlusal plane. Ismail and Bowman further explored and compare the occlusal plane in natural and artificial dentition.<sup>[8]</sup> 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.

Ismail *et al.* 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.<sup>[9]</sup> Once the denture insertion done, cephalograms were taken and superimposed on pre extraction cephalograms to access and to 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. Moreover, Lundquist and Luther had further investigated whether intraoral anatomic landmarks (Retromolar pad, Parotid papilla, commissure of

the lips) could accurately predict the location of occlusal plane.<sup>[10]</sup> Cast models were made to analyze these relationships along with the clinical evaluation. The results confirmed that (1) the occlusal plane was terminating on the lower half of the retromolar pad in 75% cases while it was 25% in the upper half. (2) Parotid papilla was adjacent to the mesiobuccal cusp of maxillary second molar with an average distance of 4.2 mm. (3) Commissure of the lip showed a correlation to the location of the occlusal plane within a range of 1-3 mm.

Nikzad conducted a short survey study on the usefulness of a “J” shaped aluminum device in correct establishment of occlusal plane in edentulous patients.<sup>[11]</sup> He first positioned a fox plane (FP) 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 FP 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 FP on the occlusal surface of upper occlusal rim and holding the curved side of the J plane against the cheek, one end on the lower border of the Ala of the nose and the other end on the middle of the Tragus. L’Estrange and Vig had further explored the dilemma related to artificial occlusal plane orientation in edentulous patient by studying dentulous and edentulous cephalograms.<sup>[12]</sup> The occlusal plane in this study was located as a line between the incisal tips of the mandibular incisors to the mesiobuccal cusp of the mandibular first permanent molars for the dentulous group. The authors concluded that angulations of occlusal plane and maxillary planes was relatively consistent in both dentulous and edentulous group and may be used as a reliable guide to establish the lost occlusal plane in edentulous patients.

Aboul-Ela and Razek 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.<sup>[13]</sup> 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 the pointed end with a 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. Lestrel *et al.* studied dentate patients of age group 25-75 years, to evaluate the relationship of the occlusal plane with Sella-Nasion, palatal plane (PL), facial plane and mandibular plane (ML). Cephalometric analysis and results showed a high degree of correlation between occlusal plane and PL.<sup>[14]</sup> 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. Williams invited dental professionals to investigate the orientation of occlusal plane in complete denture construction.<sup>[15]</sup> They have been

asked to complete a short questionnaire and to draw, on a photograph, the Ala-Tragus Line. They have also been asked “Do you use Ala-Tragus Line for orientation of the occlusal plane during the construction of the complete dentures?” “What is the main method for the establishment of the occlusal plane?” The answers by the majority of dental surgeons were “By Eye”, Parallel to ridge/bisect inter-ridge space, retromolar pad, parallel to FH plane and Lingual Posture. Consequently, success in complete denture and establishment of occlusal plane depends largely on patient’s tolerance and manipulative ability or a form of guesswork rather than on the intelligent application of sound scientific principles.

van Niekerk *et al.* evaluated the reliability of Ala-Tragus plane in occlusal plane orientation. The occlusal plane was established on the basis of patient’s esthetic, function and comfort and parallel to the Ala-Tragus plane.<sup>[16]</sup> 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 were showed inconsistency in parallelism of occlusal plane with Ala-Tragus plane in the majority of patients making it an unsatisfactory landmark in accurate occlusal plane establishment. Monteith studied and evaluated the reliability of Porion-Nasion-Anterior Nasal Spine angle in reproducing correct occlusal plane orientation.<sup>[17]</sup> He measured the occlusal plane-FH 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-FH plane angle) on the articulator after the face bow (FB) 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-FH plane angulations with post denture insertion occlusal plane-FH 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 FP.<sup>[18]</sup> They used to attach small radiopaque ball-shaped pellets (1 mm 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 mesio palatal 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 Camper’s plane, also the artificial occlusal plane determined at the time of complete dentures insertion was not parallel to Camper’s plane.

Sinobad did a cephalometric study to determine the inclination of the occlusal plane in dentulous subjects with various skeletal jaw-relationships (Angle’ Class I, II, III) with the

aim to find more reliable guides for establishing the occlusal plane in edentulous patients.<sup>[19]</sup> The occlusal plane and the two reference planes (maxillary and ML) were marked on the cephalograms and the values of the obtained data were subject to statistical analysis. The results were showed that the level of the occlusal plane was closer to the Maxillary plane than the ML in all subjects (Angle' Class I, II, III). In addition, the occlusal plane-Maxillary plane is not affected by the tooth loss and bone resorption pattern so it could be used as an important aid for establishing the occlusal plane in the prosthetic treatment of edentulous patients. Karkazis and Polyzois conducted a cephalometric study to explore the relationship between the Cook's plane (HIP) 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.<sup>[18]</sup> 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 (HIP) 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.<sup>[20]</sup> 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. Hall evaluated the clinical usefulness of the maxillo-mandibular bisector plane, as a reference plane for the establishment of the occlusal plane.<sup>[21]</sup> They measured the angulations between occlusal plane and Maxillo-mandibular bisector on cephalograms of dentates. Results showed that the maxillo-mandibular bisector lies inferior to the occlusal plane at a mean angle of 2.7° in dentate children group and 6.3° in dentate adult group reflecting the divergence of the two planes with growth. He further noted that maxillo-mandibular bisector is easier to define than functional occlusal plane and measurements made to it are more accurate and less varied than those made to the occlusal plane. In addition, the measurement made to the maxillo-mandibular bisector is not obscured by the outline of the teeth so it could be helpful in estimating the orientation of lost occlusal plane in edentulous patients.

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.<sup>[22]</sup> They compared the occlusal plane-maxillary plane angle and occlusal plane-ML angle to check for similarities in dentulous and edentulous subjects. Results were revealed that occluso-maxillary plane angulation was higher and occluso-ML 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 *et al.* assessed the relations of various anatomic reference planes for the establishment of the occlusal plane in edentulous patients. On 60 cephalograms of dentulous subjects, the Frankfurt horizontal plane, Camper's plane, PL, occlusal plane, ML were traced to measure the angulations and variation between different anatomic reference planes with occlusal plane.<sup>[4]</sup> The results and basic statistics revealed a 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 the establishment of the occlusal plane in edentulous patients.

Vukusić *et al.* studied dentate subjects and evaluated the angle between occlusal plane and various craniofacial planes on cephalometric tracings. The results of correlation of occlusal plane and other reference planes showed anterior rotation of occlusal plane during growth with no significant differences between sexes.<sup>[23]</sup> Moreover, all reference planes showed no significant difference when compared with occlusal plane, therefore they concluded that occlusal plane-FH plane, occlusal plane-PL, occlusal plane-Camper's plane could be used for the establishment of the lost occlusal plane in edentulous patients. Nissan *et al.* studied 34 complete denture wearers in whom the occlusal plane of the dentures was established at the level of 1 mm below the height of the upper lip anteriorly and two-third the height of the retromolar pad posteriorly. A 1 mm diameter metal ball was fixed to the occlusal surface of each side of the mandibular denture at two-third the height of retromolar pad.<sup>[24]</sup> On the basis of the results and clinical correlations the authors concluded that (1) Camper's plane is a reliable guide for the establishment of lost occlusal plane in edentulous patients (2) Cephalometric analysis alone cannot determine the location of occlusal plane in edentulous patients and intraoral structures should also be considered.

Shigli *et al.* 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.<sup>[5]</sup>

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. Jayachandran *et al.* clinically established the occlusal plane in edentulous patients using the Ala-Tragal plane and compared it with HIP using lateral cephalograms with metal balls and central bearing plate attached to the maxillary record base and occlusal rim respectively.<sup>[25]</sup> In dentate subjects, the maxillary cast was placed on Wills surveyor with HIP, which was made parallel to the horizontal plane using the tripod method. The vertical distance between occlusal plane and floor of the surveyor was measured at four points. When these measured values were equal, the two planes were confirmed to be parallel for that situation, which confirmed the parallelism between occlusal plane and HIP. Results and statistical analysis confirmed the parallelism between HIP and occlusal plane hence HIP may be used as a guide to relocate the occlusal plane.

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 such as 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 1<sup>st</sup> 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.<sup>[26]</sup> It was concluded from this study that significant correlation was found between the angulations of the 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 *et al.* evaluated the reliability of digital photography for the establishment of lost occlusal plane in edentulous patients. A Quick Mount FB and FP 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 FB transfer and mounting of Maxillary cast on the articulator, the articulator horizontal plane-occlusal plane angulation (AHP-OP) was measured using calliper.<sup>[27]</sup> On printed photographs, the angles between the FB and the FP were measured and compared with AHP-OP. There was no significant difference between AHP-OP and FB-FP angles and thus the digital photographs is a reliable method and could be helpful in the establishment of lost occlusal plane. Sadr and 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.<sup>[28]</sup> The occlusal plane was identified by placing FP whereas 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. Al Quran *et al.* determined the most reliable Ala-Tragus line which could be used as a guide for the orientation of the occlusal plane in completely edentulous patients. The occlusal plane and Camper’s plane angles was related on lateral cephalometric radiograph taken for 47 dentate adults.<sup>[29]</sup> The superior, middle and inferior border of the Tragus of ear was compared and analyzed separately and it was concluded that the superior border of the Tragus with the inferior border of the Ala of the nose was the most accurate in establishing the lost occlusal plane edentulous patients.

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 sulfate dye).<sup>[30]</sup> On statistical analysis, the results showed that the Tragal reference in this study population was more toward 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 fulfill the criteria of being the posterior landmark for the establishment of the 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  $\pm 50$  which indicates that this Camper’s plane (Ala-Tragus’s inferior margin), can serve as a guide for the establishment of lost occlusal plane in edentulous patients [Table 1].<sup>[31]</sup>

Lahori *et al.* conducted a study on the relationship between this plane with ala-Tragus and Camper’s lines in soft-tissue among individuals with class I, class II and class III occlusion.<sup>[32]</sup> Lateral cephalograms and related tracings were completed and statistical analysis of different angulations, measurements were performed. In class I subjects, it was evaluated that in 75% individuals, the posterior reference point was found to be the mid-tragus; of class II subjects, in 60% individuals, the posterior reference point was found to be the mid-tragus; and of class III subjects, in 75% individuals, the posterior reference point was found to be the inferior border of tragus. Shetty *et al.* studied different anatomic landmarks for occlusal

**Table 1: Different ala-tragus reference points as reported by various authors**

Authors	Tragus (posterior) references	Anterior references
Dalby	Lowest point of external auditory meatus	Lowest point of ala
Clapp and Trench	Superior border of external auditory meatus	Ala of nose
Prothero	Tragus	Ala of nose
Landa	Middle point of tragus	Ala of nose
Hartono	Inferior margin of tragus	Lowest point of ala of nose
Nikzad Javid	Middle of tragus	Under ala of nose
Niekerk, Miller, Bibby	Inferior border of tragus	Ala of nose
Winkler, Heartwell	Superior border	Inferior border of ala
Xier, Zhao	Midpoint of tragus	Ala of nose
MCGergor	External auditory meatus of ear	Inferior border of ala of nose
Glossary of Prosthodontics term	Tip of tragus (ala-tragus line) superior border of tragus Campers line	Inferior border of ala
Sharry	Tragus	Ala of nose
Boucher Co	Superior border	Inferior of border of nose
Spartely	Centre of tragus	Centre of ala of nose
Hickey Zarb, Bolender	No mention of exact part of tragus	Ala of nose
Neil and Narin	Centre of tragus	Ala of nose

plane establishment.<sup>[33]</sup> They 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-Tragus line is the frequently used and the same being the most controversial.

## Discussion and Conclusive Remarks

The occlusal plane is defined as “the average plane established by the incisal and occlusal surfaces of the teeth” and is highly significant in achieving esthetics, phonetics and lost vertical dimension.<sup>[4]</sup> Most of the studies regarding the establishment of artificial occlusal plane in edentulous patient’s advice placement of artificial teeth in a natural position. The reconstruction of the “natural level” of the occlusal plane in the edentulous mouth enables the normal function of cheek and tongue muscles and other surrounding structures.<sup>[34,35]</sup> There is widespread discrepancy in angulations of occlusal plane with other reference plane as studied by various authors. A cephalometric study done by van Niekerk *et al.* on 33 edentulous patients, found the angulations of occlusal plane to Camper’s plane as 3.45° whereas Koller *et al.* and Karkazis and Polyzois reported it as 7.00° and 10.00° respectively.<sup>[6,18,36]</sup> Seifert *et al.* has concluded occlusal plane-FH plane angulations as 11.42° in dentulous subjects whereas Celebic *et al.* proposed it as

9.43° and 8.53° in dentulous and edentulous subjects.<sup>[4,27]</sup> As study done by Ow reported the angulations of occlusal plane to Camper’s plane in edentulous patients as 2.1° and 8.3° in Angle’s class I and II whereas Sinobad reported 9.68° and 9.28° angulations for occlusal plane-PL and 12.87° and 11.19° angulations for occlusal plane-ML in dentulous Angle’s class I and class II subjects respectively.<sup>[19,37]</sup> Recent studies have advocated the use of Cephalometrics in determining and evaluating the position of the occlusal plane in dentulous and edentulous patients.<sup>[8,18,38,39]</sup>

The present study has shown the extensive work done in the literature on the relationship of occlusal plane with anatomic reference planes in dentulous and edentulous subjects in Angle’s class I, Angle’s class II and Angle’s class III maxillomandibular relationship. Majority of the studies showed that the FH 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. Though, from this study it appears that the following planes viz.; Camper’s plane, FH plane and PL are sensible guides for the establishment of occlusal plane. Therefore using the Camper’s plane as a landmark for the establishment of occlusal plane along with FB to transfer FH plane would serve as a definite guide for the occlusal plane establishment. However, despite the best measures adapted, there is no scientific method for the establishment of the occlusal plane. It is a highly subjective relation. Since the occlusal plane has to be established on an established vertical dimension, the occlusal plane itself can be variable.

Though an effort was put to correlate certain anatomical planes as an anatomical guide (from the literature) to ease the establishment of the lost occlusal plane, we still cannot say any reference plane to be definitive. If the concept that the occlusal plane has to be based on what existed naturally, then the three anatomical planes (i.e., Camper’s plane, FH plane and PL) are accurate. 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.

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