# Prosthodontist's ability to detect parallelism of two lines used in occlusal plane determination

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## ABSTRACT

Background: Prosthodontists estimated the parallelism of the occlusal plane to different anatomical landmarks, which was somewhat arbitrary and depended mainly on their vision. The aim of this research was to assess the degree of accuracy of prosthodontists in determining the parallelism of two lines. This research was aimed to assess which technique would be more accurate for the prosthodontist to distinguish parallelism; the comparison of the occlusal plane with the interpupillary line or with the inferior border of the earlobes.

Materials and methods: Twenty eight prosthodontic specialists were included in this research. Illustrations of two lines with different tilts were presented to the participants to distinguish whether parallel or not. These illustrations were divided into two groups; the first group was with lines close together, used with the earlobes and occlusal plane, and the second group was with lines farther apart, used for the interpupillary line and occlusal plane.

Results: Prosthodontists were accurate to a fraction of a degree in detecting non-parallel lines. Lines closer together were evaluated more accurately than lines farther apart. Males were slightly better when the lines were closer together. Age, experience, and post graduate degrees didn't seem to play any role in the judgment of the prosthodontist.

Conclusion: Prosthodontists were very accurate and reliable in judging parallel lines. Concerning the comparison of parallel lines, earlobes were better landmarks for orienting the occlusal plane than the interpupillary line.

Key words: Prosthodontist, parallel, occlusal, earlobes, interpupillary. (J Bagh Coll Dentistry 2010;22(2):16-21).

## INTRODUCTION

During the steps of complete denture construction, difficulties arose when orienting the occlusal plane of a completely edentulous patient. Some of these difficulties were associated with the facial landmarks used for orientation such as unexpected movement of the patient's eyes, head, or even movement of the practitioner's hands etc. Soft tissue landmarks could also be misinterpreted by the practitioner.[1-3]

Previous authors introduced devices and techniques to assist in determining the occlusal plane. Some authors made extra-oral devices to make the interpupillary line more obvious like Kazanoglu & Unger[4] who determined the occlusal plane with a Camper's plane indicator. Husseinovitch & Chidiac[5] used a modified occlusal plane indicator for illustrating the interpupillary and camper's lines. Nayer[6] pressed a piece of string, immersed in talcum powder or plaster of Paris, against the patient's cheeks to mark the Camper's line.

Several authors mentioned the use of different tissue landmarks to orient the occlusal plane like the camper's plane, interpupillary line, height of retromolar pad, the position of the parotid papilla, commissures of the lips, and buccinators groove, hamular notch and incisive papilla plane, anterior nasal spine and the hamular notch.[4,7-12]

Earlobes were recently introduced by Khalaf [1] as alternative landmarks to guide in the orientation of the occlusal plane, other than the inter-pupillary line.

The prosthodontist's vision played a significant role in the orientation of the occlusal plane by influencing his/her judgment of the relationship of the certain lines and anatomical landmarks with each other.[11-14]

The observation of lines or shapes was almost always an estimation which was to an extensive point vague when standardization was concerned.[15] In prosthodontics estimating the parallelism of the occlusal plane to the interpupillary line was somewhat arbitrary and depended mainly on vision.[12]

The aim of this research was to assess the degree of accuracy of prosthodontists in determining the parallelism of two lines. Also, this research was aimed to assess which technique would be more accurate for the prosthodontist to distinguish parallelism; the comparison of the occlusal plane with the interpupillary line or with the inferior border of the earlobes.

## MATERIALS & METHODS

A pilot study was carried out for 7 dentate participants, 3 males and 4 females with an average age of 37.86 years. It included measurement of the distance from the interpupillary line to the level of the occlusal plane. Also, measurement was taken for the distance from the inferior border of their earlobes to the level of the occlusal plane. Finally, the width of the face was measured at the level of the

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eyes. The average measurements were 6.29cm, 0.95cm, and 13.49cm, respectively. These measurements were used to make illustrations of two pairs of lines. The measurement 6.29cm represented the distance between the pair of lines for the first group (C), 0.95cm represented the distance between the pair of lines for the second group (E), and 13.49cm represented the length of the lines.

The illustrations consisted of the two lines placed horizontally on an A4 white blank paper; the upper line was zero tilted while the change in tilt was for the lower line. The tilt of the lower line was made randomly and not to one side only.

Group (C) included the illustrations in which the lower line was tilted at an angle of 0.2 degrees (C2), 0.4 degrees (C4), 0.6 degrees (C6), 0.8 degrees (C8), 1 degree (C10), and 1.2 degrees (C12). The tilt for the lower line in group (E) was 0.1 degree (E1), 0.2 degrees (E2), 0.3 degrees (E3), 0.4 degrees (E4), 0.5 degrees (E5), and 0.6 degrees (E6).

The number of prosthodontic specialists included in this research was 28, see table (1). Each specialist was shown the illustrations, one at a time. He/she decided whether the lines were parallel or not. The illustrations were held at a distance of 1-1.25 meters, perpendicular to their eyesight.

**Table 1: Data of prosthodontic specialists**

| | | |
|---|---|---|
| **Total number of participants** | | 28 |
| **Average age** | | 38.5357 |
| **Females** | | 15 |
| **Males** | | 13 |
| **Degree** | **Master's** | 22 |
| | **Ph. D.** | 6 |
| **Average years of experience in Prosthodontics** | | 13 |

Statistical analysis was conducted with Chi-square test and Spearman Correlation to analyze the data at a 0.05 significance level.

# RESULTS

The responses of the participants for both groups (E) and (C) were presented in table 2. The response "yes" indicated parallel lines and "no" indicated non-parallel lines.

In general for group (E) the participants considered the tilts of 0.1 and 0.2 degrees parallel (table 3). Tilt 0.3 degrees had no significant difference between both responses, while tilts 0.4, 0.5, and 0.6 degrees were considered not parallel. The responses of the participants for group (C) were parallel for tilts 0.2 and 0.4 degrees. It seemed insignificant for tilt 0.6 degrees, and tilts 0.8, 1.0, and 1.2 degrees were considered not parallel.

**Table 2: Participants responses**

| | | N | | | N |
|---|---|---|---|---|---|
| **E1** | yes | 26 | **C2** | yes | 22 |
| | No | 2 | | No | 6 |
| **E2** | yes | 23 | **C4** | yes | 22 |
| | No | 5 | | No | 6 |
| **E3** | yes | 17 | **C6** | yes | 16 |
| | No | 11 | | No | 12 |
| **E4** | yes | 5 | **C8** | yes | 8 |
| | No | 23 | | No | 20 |
| **E5** | yes | 1 | **C10** | yes | 2 |
| | No | 27 | | No | 26 |
| **E6** | yes | 1 | **C12** | yes | 2 |
| | No | 27 | | No | 26 |

**Table 3: Chi-square test for all test groups**

| | Chi-Square | Sig. |
|---|---|---|
| **E1** | 20.571 | .000(**) |
| **E2** | 11.571 | .000(**) |
| **E3** | 1.286 | .257 |
| **E4** | 11.571 | .001(**) |
| **E5** | 24.143 | .000(**) |
| **E6** | 24.143 | .000(**) |
| **C2** | 9.143 | .002(**) |
| **C4** | 9.143 | .002(**) |
| **C6** | .571 | .450 |
| **C8** | 5.143 | .023(*) |
| **C10** | 20.571 | .000(**) |
| **C12** | 20.571 | .000(**) |

*** Significant p<. 05, ** Highly significant p< .01**

There was no significant difference in the responses between males and females except for tilts 0.2 and 0.3 degrees for group (E) and tilts 0.2 and 0.4 degrees for group (C), as seen in tables 4 &5. It seemed that males were able to detect the non-parallelism more accurately for group (E), while females were more accurate for group (C).

Age didn't seem to have any effect on the evaluation of the lines. Only the outcomes of tilts 0.1 degrees of group (E) and 0.6 degrees of group (C) were affected (table 6).

In general there was no relationship between experience and the responses of the participants except for the responses for group (C) ( table 7). This was obvious for tilts 0.2 and 0.6 degrees. Although for tilt 0.2 the relationship was in favor of experience, it seemed that the relationship was not in favor for tilt 0.6.

**Table 4: Responses for males & females**

| | | male | female |
|---|---|---|---|
| **E1** | **yes** | 13 | 13 |
| | **no** | 0 | 2 |
| **E2** | **yes** | 8 | 15 |
| | **no** | 5 | 0 |
| **E3** | **yes** | 5 | 12 |
| | **no** | 8 | 3 |
| **E4** | **yes** | 2 | 3 |
| | **no** | 11 | 12 |
| **E5** | **yes** | 1 | 0 |
| | **no** | 12 | 15 |
| **E6** | **yes** | 1 | 0 |
| | **no** | 12 | 15 |
| **C2** | **yes** | 11 | 11 |
| | **no** | 2 | 4 |
| **C4** | **yes** | 12 | 10 |
| | **no** | 1 | 5 |
| **C6** | **yes** | 7 | 9 |
| | **no** | 6 | 6 |
| **C8** | **yes** | 3 | 5 |
| | **no** | 10 | 10 |
| **C10** | **yes** | 0 | 2 |
| | **no** | 13 | 13 |
| **C12** | **yes** | 0 | 2 |
| | **no** | 13 | 13 |

No effect on the overall responses was noticed when compared with the master's and doctorate's degrees of the participants except for group (E) tilt 0.4 (table 8).

# DISCUSSION

This study assessed the ability of prosthodontic specialists to identify the parallelism of different lines or landmarks. This was mainly made use of during orientation of the occlusal plane. Some techniques for orienting the occlusal plane depended on the interpupillary line while the earlobes were recently introduced as alternative landmarks.[1] Thus, two different distances between the lines in groups (E) and (C) were used. The distance for group (C) was between the interpupillary line and the occlusal plane, while for group (E) the distance was between the occlusal plane and the inferior border of the ear lobes.

The lines were presented on a white A4 paper in two-dimensions because the retina of the eye images the external world essentially in two-dimensions and perceives three-dimensional images depending greatly on experience and previous knowledge of the shapes of objects.[15]

**Table 5: Chi-square test for males & females**

| | | males | female |
|---|---|---|---|
| **E1** | **Chi-Square** | NA | 8.067(**) |
| | **df** | | 1 |
| | **Asymp. Sig.** | | .005 |
| **E2** | **Chi-Square** | .692 | NA |
| | **df** | 1 | |
| | **Asymp. Sig.** | .405 | |
| **E3** | **Chi-Square** | .692 | 5.400(*) |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .405 | .020 |
| **E4** | **Chi-Square** | 6.231(*) | 5.400(*) |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .013 | .020 |
| **E5** | **Chi-Square** | 9.308(**) | NA |
| | **df** | 1 | |
| | **Asymp. Sig.** | .002 | |
| **E6** | **Chi-Square** | 9.308(**) | NA |
| | **df** | 1 | |
| | **Asymp. Sig.** | .002 | |
| **C2** | **Chi-Square** | 6.231(*) | 3.267 |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .013 | .071 |
| **C4** | **Chi-Square** | 9.308(**) | 1.667 |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .002 | .197 |
| **C6** | **Chi-Square** | .077 | .600 |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .782 | .439 |
| **C8** | **Chi-Square** | 3.769 | 1.667 |
| | **df** | 1 | 1 |
| | **Asymp. Sig.** | .052 | .197 |
| **C10** | **Chi-Square** | NA | 8.067(**) |
| | **df** | | 1 |
| | **Asymp. Sig.** | | .005 |
| **C12** | **Chi-Square** | NA | 8.067(**) |
| | **df** | | 1 |
| | **Asymp. Sig.** | | .005 |

**NA: Not analyzed because all the responses were identical; either yes or no.**
*** Significant p<. 05, ** Highly significant p< .01**

Human vision was observed to be more sensitive to image symmetry than object symmetry.[16]

The results revealed that prosthodontisits were very accurate when examining parallel lines. It was noticed from the results that they could recognize non-parallel lines at a fraction of a degree. This manifested their ability to observe minute differences between the tilts of two lines. An explanation by Helmholtz[15] could be that the eye fixates first on the points of the first line, thereby falling along a definite row of photoreceptors on the retina of the eye. Then, the eye moves to fixate on the points of the second line. If the image of the second line falls along the same

set of photoreceptors of the first line, then the lines are considered parallel. Such a movement of the eye is not feasible with lines that are not parallel. There are studies that suggest that human beings are sensitive to image symmetry and a non-parallel line gives rise to an asymmetric image.[16,17]

**Table 6: Spearman Correlation regarding age**

| | | age |
|---|---|---|
| E1 | Correlation Coefficient | -.413(*) |
| | Sig. (2-tailed) | .029 |
| | N | 28 |
| E2 | Correlation Coefficient | -.237 |
| | Sig. (2-tailed) | .224 |
| | N | 28 |
| E3 | Correlation Coefficient | .014 |
| | Sig. (2-tailed) | .945 |
| | N | 28 |
| E4 | Correlation Coefficient | .017 |
| | Sig. (2-tailed) | .930 |
| | N | 28 |
| E5 | Correlation Coefficient | .143 |
| | Sig. (2-tailed) | .466 |
| | N | 28 |
| E6 | Correlation Coefficient | -.215 |
| | Sig. (2-tailed) | .272 |
| | N | 28 |
| C2 | Correlation Coefficient | .303 |
| | Sig. (2-tailed) | .117 |
| | N | 28 |
| C4 | Correlation Coefficient | -.016 |
| | Sig. (2-tailed) | .935 |
| | N | 28 |
| C6 | Correlation Coefficient | -.457(*) |
| | Sig. (2-tailed) | .014 |
| | N | 28 |
| C8 | Correlation Coefficient | -.083 |
| | Sig. (2-tailed) | .673 |
| | N | 28 |
| C10 | Correlation Coefficient | -.310 |
| | Sig. (2-tailed) | .108 |
| | N | 28 |
| C12 | Correlation Coefficient | -.276 |
| | Sig. (2-tailed) | .156 |
| | N | 28 |

*** Significant p<. 05**

The accuracy was affected by the distance between the lines. The participants were able to distinguish the non-parallel lines at a tilt of 0.4 degrees for group (E) and tilt 0.8 degrees for group (C). It appeared that this accuracy was best for group (E) in which the distance was less (0.95cm).

**Table 7: Spearman Correlation for effect of experience**

| | | experience |
|---|---|---|
| E1 | Correlation Coefficient | -.258 |
| | Sig. (2-tailed) | .184 |
| | N | 28 |
| E2 | Correlation Coefficient | -.249 |
| | Sig. (2-tailed) | .201 |
| | N | 28 |
| E3 | Correlation Coefficient | -.036 |
| | Sig. (2-tailed) | .854 |
| | N | 28 |
| E4 | Correlation Coefficient | -.156 |
| | Sig. (2-tailed) | .427 |
| | N | 28 |
| E5 | Correlation Coefficient | .275 |
| | Sig. (2-tailed) | .157 |
| | N | 28 |
| E6 | Correlation Coefficient | -.227 |
| | Sig. (2-tailed) | .245 |
| | N | 28 |
| C2 | Correlation Coefficient | .405(*) |
| | Sig. (2-tailed) | .032 |
| | N | 28 |
| C4 | Correlation Coefficient | -.027 |
| | Sig. (2-tailed) | .891 |
| | N | 28 |
| C6 | Correlation Coefficient | -.538(**) |
| | Sig. (2-tailed) | .003 |
| | N | 28 |
| C8 | Correlation Coefficient | -.044 |
| | Sig. (2-tailed) | .823 |
| | N | 28 |
| C10 | Correlation Coefficient | -.362 |
| | Sig. (2-tailed) | .059 |
| | N | 28 |
| C12 | Correlation Coefficient | -.336 |
| | Sig. (2-tailed) | .081 |
| | N | 28 |

*** Significant p<. 05, ** Highly significant p< .01**

For group (C) the distance was several fold more (6.29cm). The participants may have compared the distances between the two ends of the lines to assess their parallelism as suggested by Helmholtz [15]. Since the lines of group (E) were closer together, the participants were able to compare much more accurately. These findings were in agreement with the fact that the humans could estimate whether a line was vertical or horizontal very accurately, as stated in Encyclopaedia Britannica.[15] This was also in agreement with Khalaf[1] who stated that the earlobes were easier to compare with than the interpupillary line because they were closer to the occlusal plane than the interpupillary line.

**Table 8: Spearman Correlation for effect of Master's and Doctorate's degree.**

| | | degree |
|---|---|---|
| **E1** | **Correlation Coefficient** | -.145 |
| | **Sig. (2-tailed)** | .462 |
| | **N** | 28 |
| **E2** | **Correlation Coefficient** | -.243 |
| | **Sig. (2-tailed)** | .212 |
| | **N** | 28 |
| **E3** | **Correlation Coefficient** | .115 |
| | **Sig. (2-tailed)** | .562 |
| | **N** | 28 |
| **E4** | **Correlation Coefficient** | -.438(*) |
| | **Sig. (2-tailed)** | .020 |
| | **N** | 28 |
| **E5** | **Correlation Coefficient** | .101 |
| | **Sig. (2-tailed)** | .611 |
| | **N** | 28 |
| **E6** | **Correlation Coefficient** | .101 |
| | **Sig. (2-tailed)** | .611 |
| | **N** | 28 |
| **C2** | **Correlation Coefficient** | .152 |
| | **Sig. (2-tailed)** | .442 |
| | **N** | 28 |
| **C4** | **Correlation Coefficient** | -.061 |
| | **Sig. (2-tailed)** | .759 |
| | **N** | 28 |
| **C6** | **Correlation Coefficient** | -.276 |
| | **Sig. (2-tailed)** | .155 |
| | **N** | 28 |
| **C8** | **Correlation Coefficient** | .138 |
| | **Sig. (2-tailed)** | .485 |
| | **N** | 28 |
| **C10** | **Correlation Coefficient** | .145 |
| | **Sig. (2-tailed)** | .462 |
| | **N** | 28 |
| **C12** | **Correlation Coefficient** | .145 |
| | **Sig. (2-tailed)** | .462 |
| | **N** | 28 |

*** Significant p<. 05, ** Highly significant p< .01**

The results revealed the ability for males to detect difference in tilts more accurately for group (E), while females were better at detecting differences for group (C). The overall ability for male and female to detect the difference was better for group (E) so the emphasis was for that group. Thus males seemed to observe the difference in tilts better. This could be attributed to the differences in the eyes between both genders as suggested by Wagner, Fink, Zadnik [(18)] who found many gender-based differences associated with the eyes in health and disease. They studied gender-based differences in ocular anatomy, physiology, and disease susceptibility or manifestation.

Ogueta, Schwartz, Yamashita, and Farber[(19)] stated that the presence of the estrogen receptor alpha in the human eye implied that the sex steroid hormone may play a role in the pathogenesis of certain eye diseases. Thus, Vision was affected in menopausal women due to an abrupt decline in hormonal activity after the reproductive years. Male estrogen levels, on the other hand, remained unchanged throughout life.[(20)]

Age didn't seem to have any effect on the evaluation of the lines. Only the outcome of tilts 0.1 degrees of group (E) and 0.6 degrees of group (C) were affected (table 6) and these tilts were not critical when examining the whole group sample.

The findings of this study were in agreement with Norman, Norman, Craft, Walton, Bartholomew, Burton, Wiesemann, and Crabtree [(21)] who acknowledged in their results that older subjects, till age 83 years, were functionally comparable with young subjects in many aspects and exhibited similar abilities to distinguish depth and surface shape, although they mentioned that age related differences did exist and were obvious when the subjects were presented with images of multiple factors.

There was some difference with Fox [(22)] who stated that age had a profound effect. This was due to macular degeneration which was a common visual impairment, particularly in older people, and was associated with degeneration of the sensitive part of the retina and loss of clarity of vision. Neelam, Nolan, Chakravarthy, Beatty [(23)] also disagreed and found that several aspects of visual function were adversely affected in early stages of age-related visual degeneration. The results of this research were unaffected by age and this could be attributed to the fact that the lines were simple, thick, and separated by an adequate amount of distance to enable the eye's to distinguish each line adequately. Also, the responses of the participants were affected personal judgment.

The ability to detect non-parallel lines from those that were parallel in general was not affected by the participant's experience, or post graduate degrees, as seen in table (7 & 8). These variables were correlated and whether participants had many years of experience or just a few, played no role in judging the parallelism of the set of lines. This judgment seemed to be affected by individual abilities and not experience since visual sensitivity and accuracy were characteristic features of human eyes.[(15-17)]

These findings conflict with those of Nodine, Kundel, Mello-Thoms, Weinstein, Orel, Sullivan, and Conant [(24)] who stated that experience played a role in diagnosis and enhanced object

recognition skills. Although, their study concerned examination and diagnosis of malignant and malignant-free mammograms and this study was only associated with a simple diagram of two straight lines and this seemed to overthrow the effect of experience on the participant's response.

This research indicated that prosthodontists were very accurate in distinguishing tilts of a fraction of a degree for non-parallel lines. Also, this was more accurate for the lines closer together than the lines farther apart, suggesting that the earlobes were better landmarks for orienting the occlusal plane than the interpupillary line. Males were slightly better when the lines were closer together. Finally, age, experience, and post graduate degrees didn't seem to play any significant role in the judgment of the prosthodontist.

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