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RESEARCH ARTICLE
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NEW DEVICE: TO DETERMINE GRAVITY HORIZONTAL PLANE TO RESTORE OCCLUSAL PLANE IN RESTORATIVE DENTISTRY

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Abstract

Background: It is a goal of restorative therapy to rehabilitate patients with lost or compromised dentitions and restore them to a functionally and esthetically acceptable level. Correct occlusal plane orientation is very important in prosthodontic reconstructive treatment and it should closely resemble to the lostocclusal plane. Gravity horizontal plane is that plane which is perpendicular to the gravity line. From literature it is evident that gravity horizontal plane is most parallel to the occlusal plane than other reference planes which are used routinely.Therefore, there was a need to construct a device to locate the gravity horizontal plane which would help in orienting the occlusal plane correctly.**Method:** The study was conducted on 30 edentulous patients. A new device was fabricated to determine the gravity horizontal plane as a reference to restore the lost occlusal plane. Two sets of dentures were fabricated; one set by using camper's plane as reference and second setby using gravity horizontal plane as reference. EMG activity of the patient was recorded after wearing both the sets of dentures. **Results:** The dentures fabricated using gravity horizontal plane as reference were more satisfactory than the camper's plane. **Conclusion:** Gravity horizontal plane is a more reliable landmark than camper's plane to restore the lost occlusal plane.

Keywords: Occlusal plane, gravity horizontal plane, camper's plane, electromyography.

Introduction

The configuration of the occlusal plane is one of the most beautiful examples of design that can be found in nature{}.Occlusal plane is defined as the average plane established by the incisal and occlusal surfaces of the teeth; generally,it is not a plane but represents the planar mean of the curvature of thesesurfaces (GPT 9)[1].The occlusal plane is a magnificent example of the interplay between form and function.Occlusalplane in edentulous patients should be relocated in order to obtain a denture functionally and esthetically satisfactory.Correct Occlusal Plane orientation is very important in prosthodonticreconstructive treatment. Failure to do so may lead to damaging changes in the

stomatognathic system and related structures of the body causing a domino effect involving the neck, shoulders, muscle etc.

Till date camper's plane has been the most commonly used reference plane to restore the lost occlusal plane in dentistry. But various studies have concluded that camper's plane is not a reliable landmark[2-7]. Hence, there was a need to search for an accurate and reliable reference plane.

Gravity horizontal plane(GHP) is a plane which is perpendicular to the gravity line in sagittal section. GHP has been proved to be a reliable landmark since it was found to be the most parallel to the occlusal plane in dentulous patients[8]. But limited scientific data is available where GHP has been used as a reference plane to restore the lost occlusal plane. In this study an attempt is made to construct a new device to locate the GHP that would aid in restoring the lost occlusal plane.

Materials and methods

The study was conducted on 30 edentulous patients in the Department of Prosthodontics, MGV's KBH Dental College, Nashik. A new device was fabricated to locate the GHP of the patient. Two sets of dentures were fabricated for each patient.

1) One set of dentures using camper's plane as a reference to establish theocclusal plane.
2) Second set of dentures usinggravity horizontal plane as a reference to establish the occlusal plane.

The permission of the Ethical Committee was taken.Informed consent was obtained by the subjects. (MGV /KBHDC1107/2017-2018).

The Device

The device**(Figure 1)**was constructed by modifying the earpiece facebow. It consists of the following;

1) Horizontal arm-The horizontal arm of the device is represented by the earpiece facebow. A black line was marked at the centre of horizontal arm to represent the X- axis ie.Gravity horizontal plane.

2) Vertical arm- A flexible U shaped metallic frame was attached to the posterior end of the earpiece facebowfrom one side to the othercovering the patient's head. This represents the vertical arm of device. A black line was marked at the centre of vertical arm representing the Y- axis ie.Gravity line of the patient.

3) Protractor with suspended pendulum- A protractor with suspended pendulum was attached in the area where both the horizontal arm and vertical arm were joined posteriorly. The protractor coincided with the black lines of both arms.The suspended pendulum represents the continuation of gravity line of the vertical arm. Any deviation of patient's head from gravity line will be detected if the pendulum is not coinciding with the gravity line.

4) Bubble level – two bubble levels were attached to the device:

i. One at the centre of vertical arm in the sagittal plane (**Figure 2)**.
ii. Other at the anterior portion of horizontal arm near the locking device of earpiece facebow (**Figure 3)**.

The bubble level helps to determine whether surfaces are even and straight.

5) Bracing units to stabilize the assembly- the whole assembly was stabilized with the help of Velcro straps and elastic bands. The elastic bands were attached on the posterior end of the horizontal arm from one side to the other covering the occipital area. The velcro strap was attached anteriorly from close to the locking device area.It continued posteriorly to cover the head along the coronal suture and was attached to the elastic band in order to stabilize the facebow framework. It also covered the patient's head from one side to the other along with the vertical arm (**Figure 4)**.

Procedure

A) Denture fabrication using new device

- Diagnostic impressions were made using impression compound and primary cast were obtained.
- Border moulding was done and final impressions were made of maxillary and mandibular arches respectively. Master casts were obtained.
- Occlusion rims were prepared for both maxillary and mandibular archs.
- The device was adjusted on patient's head using Velcro straps and elastic bands respectively.

- The patient was asked to move head forward or backward. The position where the suspended pendulum continued with the gravity line became the reference position. Now the black line of vertical arm along with pendulum represents gravity line. The black line of the horizontal arm represents the GHP of that patient.
- Any deviation of the patient's head from gravity line will be detected if the pendulum was not coinciding with the gravity line.
- After obtaining the reference position and GHP of the patient, the head was oriented to adjust the bubble level in the centre.
- Now, the maxillary rim was adjusted in 2 parts, anteriorly it was made parallel to interpupillary line and posteriorly parallel to GHP using a fox plane.
- The orientation relation was recorded and transferred to a Hanau Wide–Vue (Whipmix, Louisville, KY, USA) articulator using a mounting jig.
- Vertical dimension was determined using Niswonger's method and combination method.
- Centricrelation record was obtained and mandibular cast was mounted.
- Teeth arrangement and try-in was done.
- The dentures were fabricated using compression moulding technique and were finished and polished respectively.
- Denture insertion was done.

B) Denture fabrication using conventional method

- Diagnostic casts were obtained, border moulding was done and master casts were prepared.
- In this method camper's plane was used as reference to restore the lost occlusal plane.
- Rest of denture fabrication procedure was same as above.

After fabrication of the denture following parameters were checked:

- Phonetics:
- EMGActivity : The EMG activity of masseter and temporalis were evaluated at rest and clenching position.
- Function: Patients were asked to clench while wearing both sets of dentures. It was observed that the muscle activity was increased after wearing new device denture. Thus function was better with new device denture.

Patient Preparation for EMG Recording

Electromyography (EMG) is a diagnostic procedure to assess the health of muscles.An electromyograph detects the electric potential generated by the muscle cells. The EMG signals can be measured by electrodes, directly in the muscle or on the skin surface over the muscle.Facial muscles are skeletal muscles, a striated type of muscle which contract as a result of action potentials in the cellular base of a muscle. They are divided in motor units and generate action potentials after the motor unit's fires. The sum of these potentials in 1 motor unit, is called a motor unit action potential (MUAP). Since the cells of 1 motor unit are often distributed through a larger part of the muscle, the firing of a motor unit and following MUAP can be observed as a wave from surface electrodes. The amount of muscle activity is expressed as integrated EMG activity. In the present study, nonpolarizing surface electrodes were attached 30 mm apart on the skin over the bilateral masseter muscles and the temporalis muscles. Theelectrical action potentials were amplified by the polygraph and recorded on the data tapes[9].

Patients were asked to shave their beard and clean their faces for good adhesion of surface electrodes. Duotrod silver surface electrodes were placed bilaterally on the masseter and temporalis area**(Figure 5)**. These gelled electrodes use an electrolytic gel as a chemical interface between skin and the metallic part of the electrode. The electrodes were placed along the length of the middle fibres of respective muscles. The electrodes were connected to the kinesiograph (K7) device. This whole assembly was connected to the computer system.

Patient positioning:
Patientwas seated in upright position such that his Frankfort horizontal plane was parallel to the floor. Patient was asked to keep his hands on the lap and close his eyes, swallow and relax.
Two EMG records were taken:
1. At Rest (scan no. 7)
2. On Clenching (scan no. 9)

At rest: EMG activity of masseter and temporalis muscle at rest was recorded.
On clenching: Patient was instructed to clench 5 times at an interval of 5 seconds.
The clenching had to be progressive and held for 2 seconds.
Graphs were recorded on the computer screen**(Figure 6)**and**(Figure 7)**.

Results
- Phonetics was better in New Device Denture.

- **EMG Results:**

The average measurements of EMG were taken at rest by using dentures made by conventional method and new device method. To find if there was any significant difference between these average measurements ANNOVA test was applied at 95% confidence level with 2 and 87 degrees of freedom. The calculated value of F test statistic 17.9808 was found significant with p value 0.0000.
Further to find which pair actually showed significant difference between the average measurement, unpaired 't' test was applied at 95% confidence level with 58degrees of freedom. The obtained results are shown in Table 1.
Further after clenching, the EMG function average measurements were taken of dentures made using conventional method and dentures made using new device method. To find if there is any significant difference between these values unpaired t test was applied at 95% confidence level at 58 degrees of freedom. The results obtained are shown in Table 2.
Hence, the data obtained showed that the dentures made using new device were better than the dentures made using conventional method at rest as well as on clenching**(Figure 8)**and **(Figure 9)**.

Discussion
A structurally stable body has parallel relationship of various body planes. The importance of occlusal plane orientation is well known in dentistry[10]. The inclination of the occlusal plane (IOP) is one of the key factor's governing the occlusal balance. Determination of IOP is an important step before equilibrating the complete dentures, comprehensive restorative dentistry and the orthodontic procedures. Traditional approach to restore the occlusal plane has been questioned by many authors[11]. This ledus to explore a new genesis for the present study. We know that harmony should be maintained with the human bodyplanes while restoring the occlusal plane. Gravity horizontal plane has been known to be one such plane parallel to the natural occlusal plane of dentate patients. The present study was conducted on 30 edentulous patients. A device was fabricated by modifying earpiece facebow. Dark lines were drawn indicating gravity line and gravity horizontal plane of the patient. We couldn't rely completely on patient's perception about the denture performance. This would also cause a bias in the study. By checking the muscle activity of the patient we could differentiate between both the dentures.
After fabrication of dentures, EMG activity was recorded bilaterallyof masseter and temporalis muscle. The patients were recalled after 1 month and 6 months respectively.
The results showed better EMG activity in the dentures fabricated using new device.

Conclusion
- Gravity Horizontal Plane has been used as a reference plane to restore the lost occlusal plane using a New Devicein our study.

- Dentures fabricated using gravity horizontal plane as reference plane were superior than dentures made using camper's plane as reference.
- This device is a simple, efficient, inexpensive, time saving (once learned) and reliable device that can be used to accurately establish the lostocclusal plane and will be useful in restorative dentistry.

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Conflict of interest: None declared.
Ethical approval: Ethical approval was taken from the institute.

Declearartion of patient consent –
The authors certify that they have obtained all appropriate patient consent forms. In the form the patients) has/have given his/ her/their consent for his/ her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Acknowledgment-
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Table 1: Comparison of EMG activity at rest.

Pair of comparison	Average value	S.D	SE	t value	p value	Remark
At rest & Conventional method	1.44	0.2236	0.2236	-0.8237	0.4135	Not significant
	1.48	0.2236				
At rest & New device method	1.44	0.2236	0.245	-5.4397	0.0000	Significant
	1.78	0.2646				
Conventional method & New device method	1.48	0.2236	0.245	-4.5893	0.0000	Significant
	1.78	0.2646				

From the table it can be seen that there is significant difference in the average measurement taken using dentures made by new device which are significantly higher than the average measurements at rest and also those taken using conventional method dentures.

Table 2: Comparison of EMG activity on clenching.

Pair of comparison	Average measurement	S.D	S E	t value	p value	Remark
Conventional method & New device method	14.28	1.8083	1.9026	-10.1967	0.0000	Significant
	19.28	1.9899				

From the table it can be observed that the average measurement of EMG function of dentures made using the new device were significantly higher than that of dentures made using conventional method

Figure 1: The device

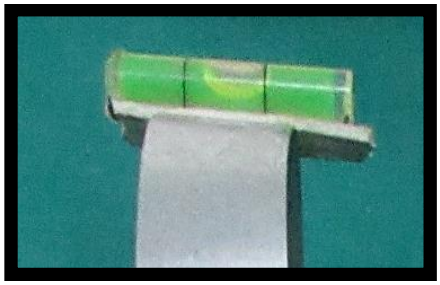

Figure2: Bubble level in sagittal plan

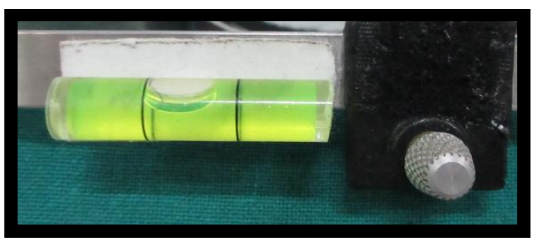

Figure3: Bubble level inhorizontal plane

Figure 4: Device in position

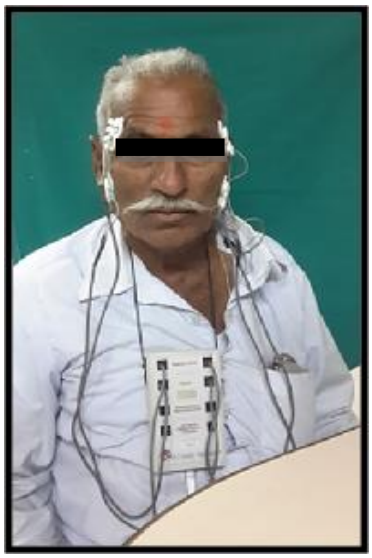

Figure 5: EMG electrodes placed on masseter and temporalis muscle

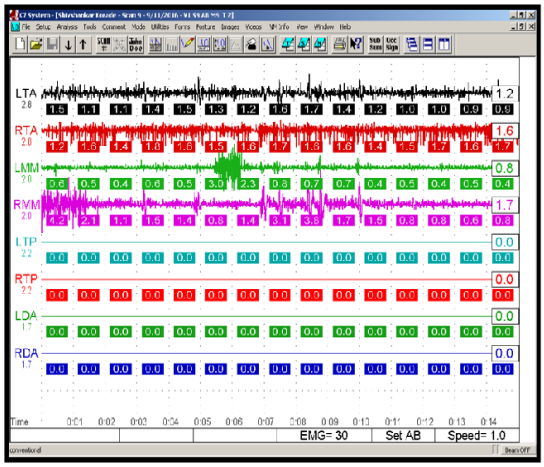

Figure6: EMG at REST Conventional Denture

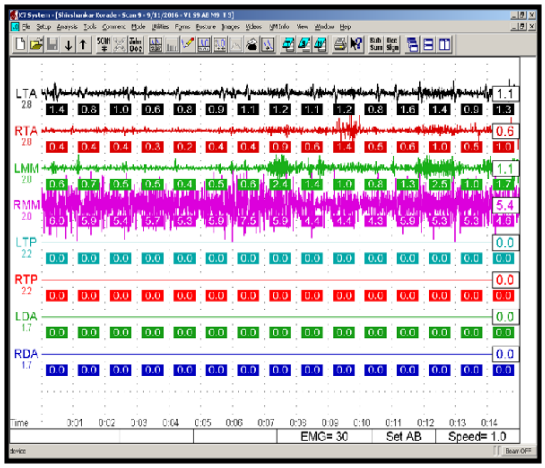

Figure 7: EMG at REST – New Device

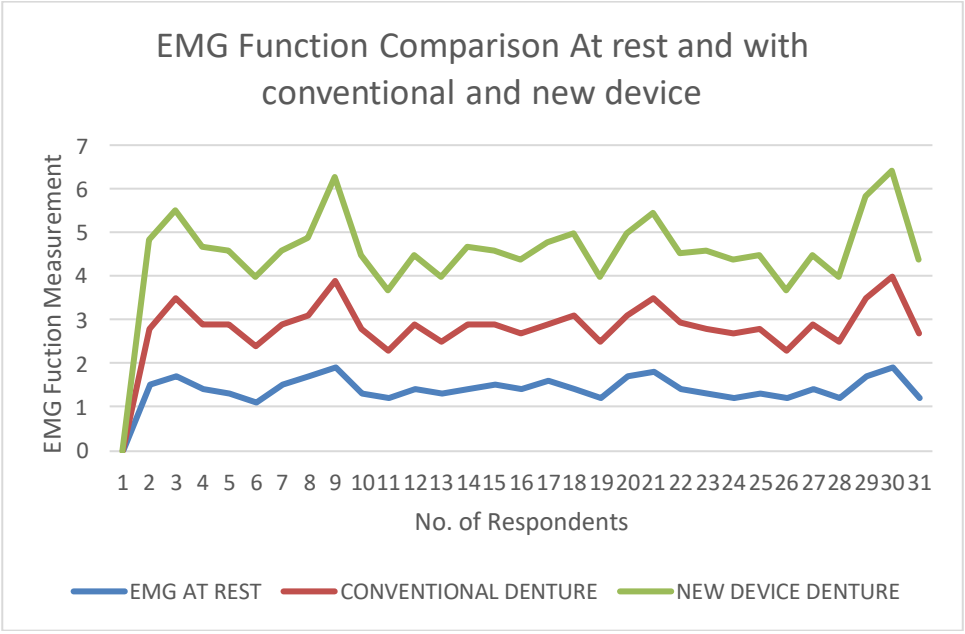

Figure 8: EMG function measurement between conventional and new device denture's at rest.

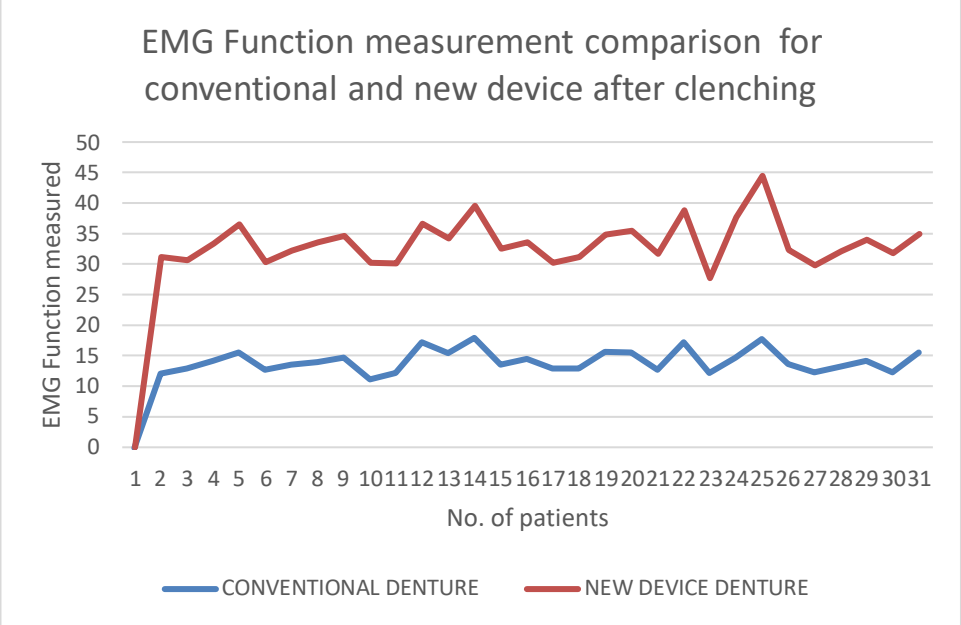

Figure 9: EMG function measurement between conventional and new device denture's after clenching.