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An innovative method to standardize facial photographs in frankfort horizontal plane

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Abstract:

Aims and Objectives: To take facial photographs in a standardized manner, eliminate intra observer errors and observe the reliability, repeatability and variability of the same in successive visits.

Materials and methods: A sample of 10 adults were selected, sequence of photographs were taken in frontal and profile views at two-time intervals. Previously in a study, a specially fabricated device horizontal orientation tool (HOT) was used to help in standardization of facial photographs. In the current study a novel standardization method was used to position the patient's head with Frankfort's Horizontal (FH) plane parallel to the floor by a specially fabricated device consisting of self levelling laser (GLL 3X professional), cannon EOS 1300D DSLR camera on a single base plate attached to the tripod.

Results: The results of the current study advocates that the mean angle comparison of the frontal and profile photographs taken initially and after a week interval, shows no statistical significant difference. Intra class

correlation coefficient values shows excellent reliability and coefficient of variability test shows less variability in both frontal and profile views.

Conclusion: This novel technique enables us to take facial photographs in a standardized setup of the camera as well as the patient's head in profile and frontal views.

Key words: standardization, Frankfort horizontal plane, self levelling laser, reliability and variability.

Introduction

Esthetic facial goals can be optimized in orthodontics with the standardized facial analysis which identifies positive and negative facial traits, dictating the way to correct the bite. This facial analysis helps in treatment decision with the help of pre-treatment and post-treatment facial photographs. But, this documentation with pre and post - treatment photographs can be misleading if the facial orientation of patient is different in the successive photographs regardless of the time interval or treatment sessions.

Pioneers like Simon [1] and Graber [2] have given enormous importance to clinical and facial photography as an essential diagnostic aid for better clinical diagnosis, planning of treatment, case documentation in modern orthodontics. This importance is attributed to the objective interpretation of soft tissues enabling the efficient treatment planning and meticulous evaluation of the patient at the end of the treatment.

Unnatural position, flexion or extension of the facial orientation of the patient during the clinical photographs gives altered results in diagnosis and treatment planning. Inconsistent head position of the patients in case of class II and class III malocclusion leads to a possibility of distortion in appearance of the patient portray. Thus, after treatment, patients with class II malocclusion with head tilted up in clinical photographs might reinforce the correction of mandibular retrognathism and those with class III malocclusion with head tilted down might imply a correction of mandible prognathism.[3] Hence, absence of reasonable standardized protocol will lead to failure of accuracy in the original anatomic features and their relative proportions in the individual and comparison photos of the patient before and after treatment.

Standardization is following a particular protocol everytime when we are taking photographs for any patient, which includes standardization of patient position, posture and appearance, Camera, Tripod and Background.

The natural head position (NHP) is considered the most appropriate reference for orthodontic diagnosis and the planning of treatment. NHP is a standardized, reproducible position with the head in upright posture and eyes focused on a point in the distance at eye level such that the visual axis is horizontal. NHP can also be estimated, and these estimates are remarkably reproducible for experienced observers who have the necessary judgment. For analysis of treatment results one photograph out of the serial photographs of a patient, with good registration of natural head position, should be used to standardize natural head position. [4] FH plane can be used with an advantage of projection on to the patient's face in a standardized manner in successive visits. There are some studies suggesting that FH plane is closely oriented to the NHP among other horizontal reference planes. [5-6]

Previously, devices like HOT (Horizontal orientation tool) [7] have been developed using FH plane for taking photographs in a standardized manner. In the current study we have conceptualized on a novel method to position the patient's head with Frankfort's Horizontal (FH) plane parallel to the floor by a specially fabricated device consisting of laser, camera on a single base plate attached to the tripod.

The purpose of this study was to determine if the novel positioning setup helps us in standardizing extraoral photographs. Photographs taken at successive visits were compared for intra observer reliability and variability.

Materials & methods

A total of 10 subjects (n=10, 6 males, 4 females) aged 20-25 years who volunteered were explained about the study and written informed consent was obtained from them.

Equipment and design

1) A Bosch GLL 3X professional non-hazardous self-leveling class II laser (<1mW) to project horizontal and vertical reference lines onto the subjects face (fig 1).

2) A Digital SLR camera (Cannon EOS 1300D) with 18-55 mm f 1: 4 - 5.6 IS zoom lens set at 55mm in Manual Mode with an aperture speed of F11, ISO 800 and shutter speed adjusted to 1/60th second. The camera was positioned in such a way that the center focus point coincides with the soft tissue nasion (fig 2).

3) An assembly, consisting of a wooden base plate mounted on a tripod, locked with the help of screws, placed at a 5 feet distance from the patient (fig 3).

4) Wooden base plate contained both camera and the laser source side by side. The height of the laser source coincides with the center of the camera lens to ensure that there is no perspective distortion (foreshortening and elongation). The midline of the camera and lens are oriented on a reference line drawn on the wooden base plate to ensure that there is no lateral distortion. A 2-axis bubble level was used to ensure parallelism of the whole assembly to the floor on the tripod. All of these measures result in standardization of the position of the camera and eliminates pitch, roll and yaw errors (fig 4a and 4b).

5) Two auxillary light sources placed in two separate soft boxes were used to eliminate the shadows. The light from the soft boxes makes the laser line on the subjects face invisible in the photographs (fig 5).

6) As a background for the photographs, a negatoscope was used at a distance of 30cm from the patient and a black cotton string (0.5mm thick) was attached to the negatoscope with a plumb. This was used as a vertical reference line (VL) (fig 6).

Tocol for taking photographs

For intra observer reliability, 10 sets of photographs were taken in frontal and profile views at two time intervals. Initial five sets of photographs were taken in the first visit (frontal F, n=50; profile P, n=50). After one week, second set of photographs were obtained using the same protocol in frontal (frontal F', n=50) and profile (profile P', n=50) views for the 10 subjects. To check for reproducibility of the method used for the study, the standardization protocols were kept same for both the observations. Patient's head was positioned in the following manner–

- In frontal view, the infra orbital line (line joining the inferior borders of both orbits), mid-sagittal line coincides with the horizontal and vertical projected laser lines on the subject's face (fig 7a).
- In profile view, the clinical FH plane (line joining the superior border of external auditory meatus and inferior border of orbit) coincides with the horizontal projected laser line on the subject's face (fig 7b).

Angular measurements

-In frontal view the angle between vertical reference line and the line joining the outer canthi (fig 8a).

- In profile view the angle between the vertical reference line and soft tissue line joining Pn –

pog (Pronasale –tegumentar pogonium) were measured on the photographs (fig 8b).

Statistical analysis

Collected data was entered in Microsoft excel sheet and analysed by using Statistical Package for Social Sciences (SPSS) version 22.0. Intra group variability is checked by comparing the mean difference of the angles in frontal and profile views for initial (F,P) and after one week (F',P') by using Coefficient analysis, respectively. Paired t test was used to compare the mean difference of the angles in frontal and profile views between initial observation (F,P) and after one week (F',P') respectively. P value of <0.05 is considered as statistically significant.

Results:

Table 1: Coefficient of variability in frontal view at initial (F) and at interval of one week (F').

Measurements		N	Mean	Standard deviation	Coefficient of variability
Frontal View	F	50	89.9800	0.91451	1.01%
	F'	50	89.9800	0.93656	1.04%

N-number

Frontal data values at F0 & F1 were analysed for variability. The coefficient of variability was 1.01% & 1.04% respectively implying low level of dispersion and less variability. (Table 1)

Table 2: Coefficient of variability in profile view at initial (P) and at interval of one week (P').

Measurements		N	Mean	Standard Deviation	Coefficient Of Variability
Profile View	P	50	19.7600	4.69720	23.78%
	P'	50	19.5200	4.55909	23.36%

N-number

When the profile measurements at P0 &P1 were analysed for variability, the coefficient of variability were 23.78% and 23.36% respectively implying less variability and acceptable dispersion of data.(Table 2)

Table 3: Intraclass Correlation Coefficient values in frontal view at initial (F) and at interval of one week (F').

Frontal intraclass correlation coefficient (ICC)							
	Intra class Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.385	0.119	0.599	2.229	49	49	0.003*
Average Measures	0.556	0.213	0.749	2.229	49	49	0.003*

p<0.05*-statistically significant

Intra class correlation Coefficient (ICC) values of Frontal view measurements, wherein, a moderate intra observer reliability is seen (r=0.556) and a high statistical significance (p=0.000) is seen between initial (F) and one week interval (F') in frontal view measurements.(Table 3)

Table 4: Intraclass Correlation Coefficient values in profile view at initial (P) and at interval of one week (P').

Profile intraclass correlation coefficient (ICC)							
	Intra class Correlation (r)	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.966	0.942	0.981	59.752	49	49	0.000*

Average Measures	0.983	0.970	0.990	59.752	49	49	0.000*

p<0.05*-statistically significant

Intra class correlation Coefficient (ICC) values of Profile view measurements, wherein, the intra observer reliability is excellent (r=0.966) and a high statistical significance (p=0.000) is seen between initial (P) and one week time interval (P') of profile view measurements. (Table 4)

Table 5: Comparison of mean angles in frontal view at initial (P) and at interval of one week (P').

Frontal view Measurements	Mean	N	Sd	P-Value
Intial (f)	89.98	50	0.91	1.000
After a week interval (f')	89.98	50	0.94	

(p>0.05- Not Significant)

N- Number

The comparison of mean angles between initial and after one week time interval in frontal view, wherein, same mean is seen in the frontal view at initial (89.98 + 0.91) and at an interval of one week (89.98 + 0.94), hence no significant difference (p=1.000) is seen between initial and one week interval time measurements.(Table 5)

Table 6: Comparison of mean angles in profile view at initial (P) and at interval of one week (P').

Profile view Measurements	Mean	N	SD	P-Value
Intial (p)	19.76	50	4.70	0.159
After a week interval (p')	19.52	50	4.56	

(p>0.05- Not Significant)

N- Number

The comparison of mean angles between initial and after one week time interval in profile view, wherein, mean is higher initially (19.76 + 4.70) than at an interval of one week (19.52 + 4.56), and no significant difference (p=0.159) is seen between initial and one week interval time measurements.(Table 6).

Discussion

A successful orthodontic treatment is dependent on a cornerstone process of a proper diagnosis. To obtain the consistent and predictable results, it is pertinent that the orthodontist follows a thorough and proper diagnostic protocol. Standardization of facial photographs is important for facial analysis and orthodontic diagnosis.[8]

Moorrees CF in his review [4], stated that if proper orientation of patient face during the photographic recording is not followed, misleading assumptions might occur due to improper placement of the patient's head such as accentuation of mandibular prognathism with upward head tilt and understatement of the same with downward head tilt.[3]

Natural head position as a reference system has been recommended because of its significant reproducibility, though its use is not prevalent possibly due to practical limitations such as equipment and staff training. Among all the reference planes FH plane most closely approximates the true horizontal and therefore it could be recommended as reference plane when radiographs are not recorded in natural head position.[7] FH plane can be easily noticeable by locating porion and orbitale and can be reproducible in following session. The device

and technique used in this study oriented the patient's head using the FH plane as the reference plane for standardization.

Previously, in a study conducted by Suresh G et al., a portable device known as horizontal orientation tool (HOT) was used to orient the patient's head with FH plane parallel to the floor.[5] Further it was modified by replacing the light source with the self levelling laser light which was mounted on Horizontal orientation tool (HOT) to take standardized facial photographs.[9] In the present study we have devised an assembly, consisting of a wooden base plate with both camera and the laser source side by side to facilitate in orientation of the subject's head with FH plane parallel to the ground as well as to standardize the camera position. To avoid problems of perspective distortion of foreshortening and elongation (pitch) the camera and the laser source are positioned on the wooden base plate in such a way that

a) Two-axis bubble level was perfectly centred

b) The centre focus point coincides with the soft tissue nasion in frontal and on the superior border of the external auditory meatus in profile,

c) The laser source coincides with the centre of the camera lens. A reference line is drawn on the wooden base plate which coincides with the midline of the camera and lens to avoid lateral distortion (yaw) (figure 9). The laser source used in the current study was a self leveling class II type which is not harmful if viewed for less than or equal to 1000 seconds.[10]

The results of the current study advocates that there was no statistically significant difference between the mean angles initially (89.98 + 0.91) and after one week (89.98 + 0.94) in frontal view and between the mean angles at initial (19.76 + 4.70) and one week interval (19.52 + 4.56) in profile view. Intra class correlation coefficient values shows excellent reliability and coefficient of variability test shows less variability in both frontal and profile photographs taken initially and at one week interval.

Conclusion

This novel technique enables us to take facial photographs in a standardized setup of the camera as well as the patient's head in profile and frontal views, minimizing errors in successive extraoral photographs, and also helps to superimpose the photographs on lateral cephalograms.

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Legends Figures

Fig. 1: Self leveling laser source.

Fig. 2: Camera

Fig. 3: Positioning of the patient.

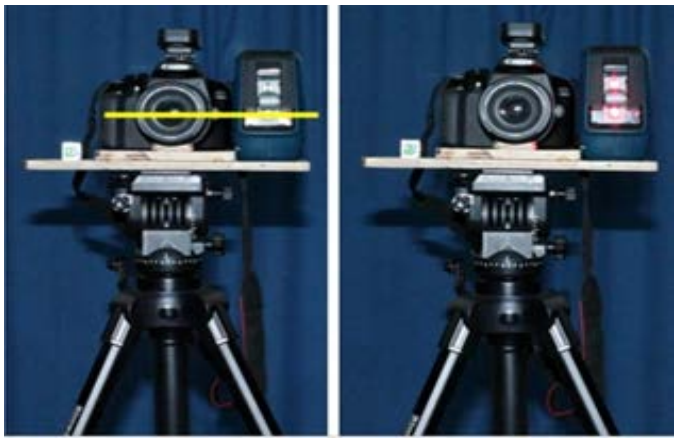

Fig. 4a and 4b: Mounting of wooden base plate with camera and the laser source.

Fig.5: Auxiliary light source.

Fig. 6: Negatoscope with plumb.

Fig. 7a and 7b: Frontal view with laser and Profile view with laser.

Fig. 8a and 8b: Frontal angle and Profile angle.

Fig. 9: Pitch, roll and yaw angles for camera.