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Effect of Mesiodistal Angulation of the Maxillary Central Incisors on Esthetic Perception of the Smile in the Frontal View

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Abstract

Objective: *To evaluate the effect of the mesiodistal angulation of the maxillary central incisors on the esthetic perception of the frontal smile view in young Saudis.*

Material and Methods: *One-hundred and ninety-nine raters evaluated the clinical smiling photographs of one young male and one young female who were chosen according to certain criteria. Frontal smiling photographs of subjects were digitally modified to create 32 photographs of differing mesiodistal angulations of maxillary central incisors. An online survey was formulated, 100 laypeople and 99 dental professionals participated in the rating of photographs using VAS. Statistical analysis was done using independent sample t-test and Dunnet t-test.*

Results: *Statistically significant differences were found between modified incisors angulations scores and the undeviated incisors scores where the undeviated images were more attractive in all photographs for males and females ($p<0.05$) except for the following angulations: female full face +4°, +8° and -4° and female lower facial third +4° and -4° ($p>0.05$). Differences between laypeople and dental professionals scores were found in the following angulations: female full face 0° and -8° and female lower facial third 0°, +4° and +8° ($p<0.05$). Full face images scores and lower facial third images scores were different in the following angulations: male -8°, +8° and +16° and female 0° ($p<0.05$).*

Keyword*- Orthodontics, Incisors, Smile, Esthetics.*

Introduction

The dentofacial appearance is one of, if not the most important factor determining a person's attractiveness, thus having an important social and psychological impact.[1] In a study by Shaw, positive traits were attributed to children with normal dentofacial appearance as they were perceived to be friendlier and more intelligent.[2]

Esthetic improvement is a chief motive for the majority of people seeking orthodontic treatment, and so, improving patient's appearance should be one of the treatment goals.[3-5] As treatment is often dictated less by need than by demand.[6] In a study by Mertens et. al, it has been stated that people tend to focus on the structures in the middle of the face including the mouth and the nose when looking at a person.[7]

Smile enhancement relies on many factors including the positioning of maxillary anterior teeth.[8] Many studies have reported the effect of maxillary incisor labiolingual and anteroposterior position on smile esthetics, especially in the profile view.[9-11] Schlosser et. al. found that there was no statistically significant difference in preference for the AP position of the maxillary incisors between orthodontists and laypeople.[10]

On the other hand, the mesiodistal aspect of the maxillary anterior teeth is not as much explored. Yang et. al. studied the effect of mesiodistal angulation of the maxillary central incisors on smile esthetics in the frontal view and concluded that the mesiodistal angulation of these teeth should be taken into consideration when putting an orthodontic treatment plan.[12]

Apart from the esthetic role of the mesiodistal positioning of the maxillary anterior teeth, it has a functional impact as it determines the space occupied by anterior teeth which in turn affects the space available for posterior dentition.[13]

The primary aim of our study was to evaluate the effect of the mesiodistal angulation of the maxillary central incisors on esthetic perception of the smile in the frontal view in

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young adults. The secondary aims were to compare the perception of dental professionals with that of laypeople and to compare the perception of full face image with the lower facial third image for each angulation.

Materials and Methods

24-year-old male and a 25-year-old female were selected according to the following selection criteria: permanent dentition, Class I occlusion, normal hard and soft tissues as of lateral cephalometric radiographs analysis and normal horizontal and vertical overlap.

Using a digital camera (Canon EOS 500D; Tokyo, Japan), frontal smiling photographs were taken in the neutral head position. Informed consents for the use of the subjects' photographs were obtained from both subjects. The photographs were edited using image editing software (Adobe Photoshop CC, 2015.1.2; Adobe, San Jose, Calif). The angulation of the maxillary central incisors' clinical crowns relative to the transverse plane was altered thus producing distally and mesially inclined crowns by up to 29° (-12° to +16°). The distal angulation was labeled as positive while mesial angulation negative. Eight angulations were obtained, 4 distally inclined images (+4°, +8°, +12°, +16°), 3 mesially inclined images (-4°, -8°, -12°) and one unchanged (0°). Photographs were also cropped into lower facial third images in addition to the full facial ones, thus producing 16 images per subject, as shown in **Figure 1** and **Figure 2**.

An online survey was formulated. The survey started with some basic demographic information. Then, images were randomly placed within each image group to eliminate any source of bias that may arise if the images were sorted ascendingly or descendingly. Each participant was asked to rate each image using visual analog scale (VAS). The scale ranged from (0) as least attractive to (100) as most attractive.

Statistical analysis

IBM SPSS Statistics (version 24.0; SPSS, Chicago, Il) was used for the statistical analysis. Dunnet t-test was used to investigate the difference in perception between the undeviated angulation (0°) and each modified angulation. Independent sample t-test was used to investigate any differences in perception between laypeople and dental professionals for each angulation and to investigate differences between full face and lower facial third images for each angulation. The cut-off value was set as ($p<0.05$) for all statistical tests.

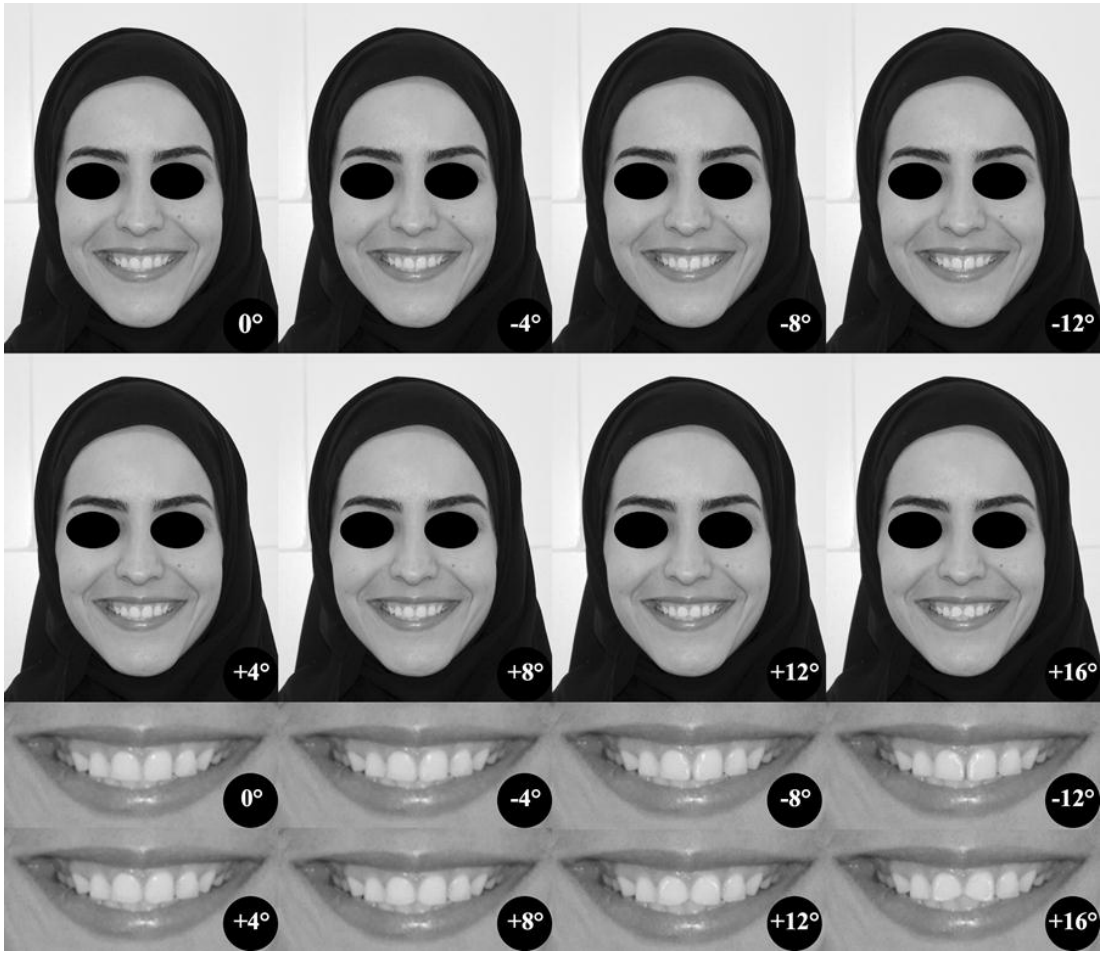

Figure 1: Male full face and lower facial third photographs showing different maxillary central incisors mesiodistal angulations (digitally modified).

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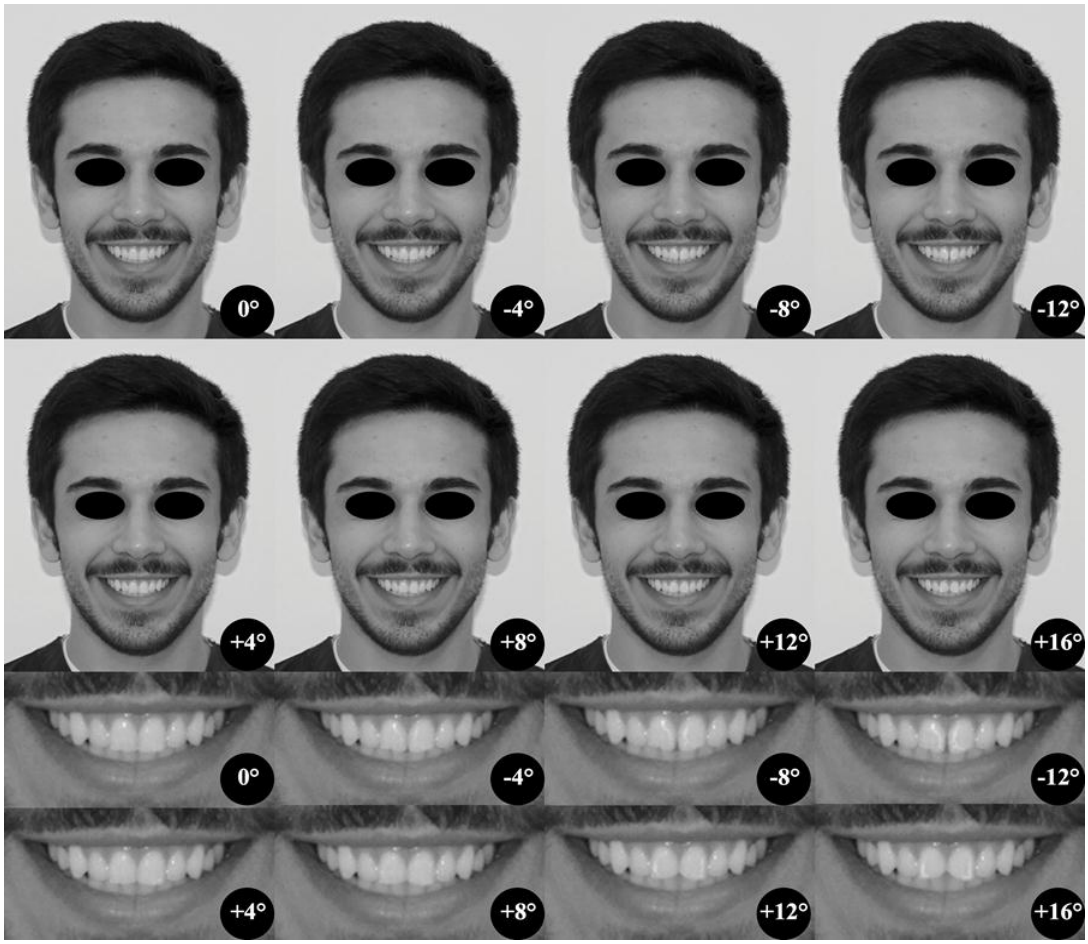

Figure 2: Female full face and lower facial third photographs showing different maxillary central incisors mesiodistal angulations (digitally modified).

Results

199 raters participated in the study including 100 dental professionals and 99 laypeople. Ranking by score for each angle deviation from high to low were as follows: male lower facial third: 0°, +4°, -4°, +8°, -8°, +12°, -12°, +16°, male full face: 0°, +4°, -4°, +8°, -8°, +12°, -12°, +16°, female lower facial third: +4°, -4°, 0°, +8°, -8°, +12°, -12°, +16° and female full face: 0°, +4°, -4°, +8°, -8°, +12°, -12°, +16° (Figure 3).

Statistically significant differences were found between professionals and laypeople in the following angulations: female full face 0° and -8° and female lower facial third 0°, +4° and +8° (Table 1).

Comparing each angulation to the undeviated control (0°) showed statistically significant differences between the control and the following angulations: male full face +4°, +8°, +12°, +16°, -4°,-8° and -12°, male lower facial third +4°, +8°, +12°, +16°, -4°, -8° and -12°, female full face +12°, +16°, -8° and -12° and female lower facial third +4°, +8°, +12°, +16°, -4°, -8° and -12° (Table 2).

Statistically significant differences were found between full face images and lower facial third images in the following angulations where full face images were judged better than lower facial third images for the same angulation in male -8°, +8°, +16° and female +16°. Only female 0° was found to be more attractive in the lower facial third image than the full face image (Table 3).

Table 1: Comparison of attractiveness scores rated by professionals vs laypeople for mesiodistal angulation of maxillary central incisors using independent sample t-test.

Photograph	Angulation	Professional panel (n=99)		Lay panel (n=100)		P-value
		Mean	SD	Mean	SD	
Male full face	0°	68.69	21.46	67.20	24.25	0.648
	+4°	60.51	18.76	61.70	24.54	0.700
	+8°	52.83	19.33	55.60	26.60	0.402
	+12°	41.21	20.96	40.00	21.84	0.690

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	+16°	31.62	24.06	32.50	23.97	0.795
	-4°	57.78	18.82	56.20	25.61	0.621
	-8°	48.69	21.32	45.60	23.80	0.336
	-12°	38.18	21.59	38.80	24.26	0.850
Male lower facial third	0°	67.37	22.16	70.70	27.20	0.346
	+4°	59.80	21.43	62.20	27.47	0.493
	+8°	44.55	21.30	50.70	27.50	0.079
	+12°	35.56	22.14	36.90	23.90	0.681
	+16°	26.36	19.14	26.70	21.04	0.906
	-4°	51.92	20.44	56.30	25.09	0.179
	-8°	38.89	22.36	37.20	25.94	0.623
	-12°	35.66	19.75	35.60	22.84	0.985
Female full face	0°	49.09	23.04	59.10	27.42	0.006**
	+4°	51.72	19.69	62.20	26.50	0.198
	+8°	46.47	20.91	51.40	25.23	0.210
	+12°	36.16	21.89	37.30	24.32	0.729
	+16°	27.37	21.17	29.50	24.96	0.518
	-4°	51.01	21.88	58.00	25.39	0.220
	-8°	43.94	20.94	48.80	24.38	0.039*
	-12°	43.13	22.84	44.90	25.80	0.609
Female lower facial third	0°	55.76	24.75	64.90	27.58	0.015*
	+4°	51.41	21.19	59.70	24.51	0.012*
	+8°	44.34	20.26	51.00	26.15	0.046*
	+12°	31.11	20.15	33.90	23.26	0.367
	+16°	26.16	20.44	27.40	23.94	0.695
	-4°	53.94	21.32	60.10	25.49	0.066
	-8°	48.18	19.97	52.20	25.76	0.221
	-12°	42.02	21.14	45.50	25.99	0.302

Table 2: Comparison of attractiveness scores rated by the undeviated control (0°) versus other degrees of maxillary central incisors angulation using Dunnett t-test.

Dependent Variable	Angulation	Control	Mean Difference (Angulation-Control)	P-value
Male full face	+4°	0°	-6.834	0.016*
	+8°	0°	-13.719	0.000***
	+12°	0°	-27.337	0.000***
	+16°	0°	-35.879	0.000***
	-4°	0°	-10.955	0.000***
	-8°	0°	-20.804	0.000***
	-12°	0°	-29.447	0.000***
Male lower facial third	+4°	0°	-8.04	0.004**
	+8°	0°	-21.407	0.000***
	+12°	0°	-32.814	0.000***
	+16°	0°	-33.417	0.000***
	-4°	0°	-14.925	0.000***
	-8°	0°	-31.005	0.000***
	-12°	0°	-33.417	0.000***
Female full face	+4°	0°	2.864	0.726
	+8°	0°	-5.176	0.148

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	+12°	0°	-17.387	0.000***
	+16°	0°	-25.678	0.000***
	-4°	0°	0.402	1.000
	-8°	0°	-7.739	0.007**
	-12°	0°	-10.101	0.000***
Female lower facial third	+4°	0°	-4.774	0.202
	+8°	0°	-12.663	0.000***
	+12°	0°	-27.839	0.000***
	+16°	0°	-33.568	0.000***
	-4°	0°	-3.317	0.573
	-8°	0°	-10.151	0.000***
	-12°	0°	-16.583	0.000***

Table 3: Differences between full face and smile view for each angulation using independent sample t-test.

Angle	Photograph	Mean	SD	P-value
0°	Male full face	6.794	2.28583	0.644
	Male lower facial third	6.9045	2.48143	
-4°	Male full face	5.6985	2.24498	0.209
	Male lower facial third	5.4121	2.29427	
-8°	Male full face	4.7136	2.25929	0.001**
	Male lower facial third	3.804	2.41769	
-12°	Male full face	3.8492	2.29126	0.197
	Male lower facial third	3.5628	2.13078	
+4°	Male full face	6.1106	2.18069	0.966
	Male lower facial third	6.1005	2.46182	
+8°	Male full face	5.4221	2.32525	0.007**
	Male lower facial third	4.7638	2.47401	
+12°	Male full face	4.0603	2.13588	0.05
	Male lower facial third	3.6231	2.29925	
+16°	Male full face	3.206	2.39586	0.013*
	Male lower facial third	2.6533	2.0064	
0°	Female full face	5.4121	2.57632	0.018*
	Female lower facial third	6.0352	2.65409	
-4°	Female full face	5.4523	2.39032	0.292
	Female lower facial third	5.7035	2.36505	
-8°	Female full face	4.6382	2.28074	0.098
	Female lower facial third	5.0201	2.30931	
-12°	Female full face	4.402	2.43277	0.917
	Female lower facial third	4.3769	2.37063	
+4°	Female full face	5.6985	2.38885	0.552
	Female lower facial third	5.5578	2.32367	
+8°	Female full face	4.8945	2.32551	0.593
	Female lower facial third	4.7688	2.35849	
+12°	Female full face	3.6734	2.30915	0.061
	Female lower facial third	3.2513	2.1759	
+16°	Female full face	2.8442	2.31177	0.466
	Female lower facial third	2.6784	2.22181	

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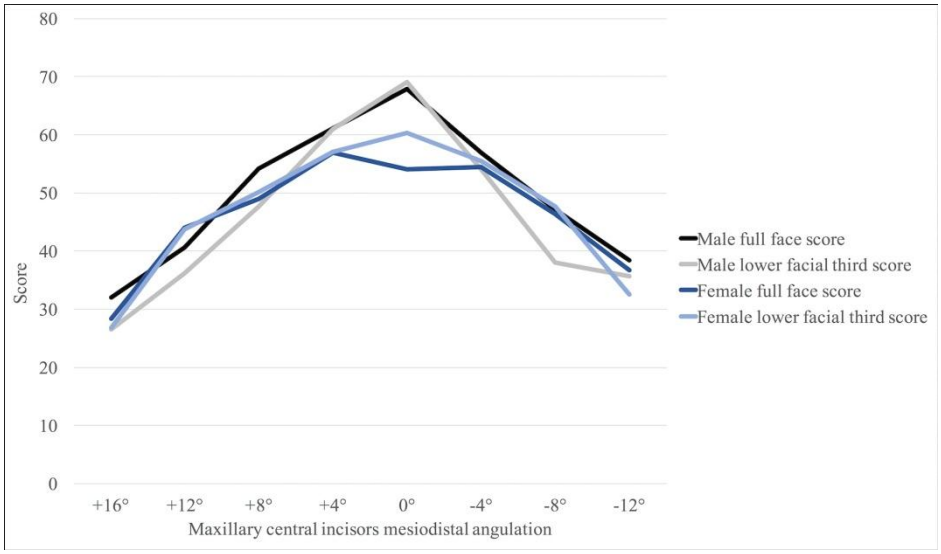

Figure 3: Means of attractiveness scores for both male and female full face and lower facial third photographs.

Discussion

The aim of this study was to analyze the effect of mesiodistal angulation of the maxillary central incisors on the smiling esthetics in young adults. The position of maxillary central incisors is of paramount importance in any orthodontic treatment plan hence the numerous studies on the anteroposterior position and labiolingual angulation of these teeth. To get more insight, we conducted this study about the other dimension regarding the position of the maxillary central incisors, the mesiodistal angulation.

The primary aim of this study was to examine the effect of mesiodistal angulation of the maxillary central incisors on facial esthetic evaluations. The results showed that different mesiodistal angulations did affect the esthetic perception of the smile. In general, the greater the angulation whether negative or positive, the less favorable. There's a statistically significant difference when comparing the unchanged angle (0°) with all other angulations except in the female full face with +4°, +8° and -4° angulations and female lower facial third with +4° and -4° angulations. These findings come in line with the findings of Yang et. al. where they also found that the change in mesiodistal angulation of the maxillary central incisors can affect smile esthetics.

On the other hand, Kokich et. al. examined mesiodistal angulation of central incisors but only in one direction where both maxillary central incisors were intentionally angulated to right of the patient with increments in millimeters. They reported that the threshold where the angulation was spotted by raters was 2 millimeters from ideal incisor angulation.[14] Another study stated that midline angulation can affect smile esthetics negatively.[15]

The second aim was to study the effect of the judges' professions on smiling evaluations in the frontal view. While Yang et al did not find a significant difference, our results showed a statistically significant difference between professionals and laypeople when rating female full face photograph at 0° and -8° angulations and female lower facial third photographs at 0°, +4° and +8° angulations where professionals gave lower scores than laypeople.

The third aim was regarding the effect of different photograph framings on the smile esthetic evaluation. There was a statistically significant difference between full-face and lower facial third photograph framings of four angulations, male: -8° +8° and +16° and female: 0°. It was also noticed that when the angulation increased (whether positive or negative), lower facial third photographs were rated less than their full-face counterpart. This may be due to the focused effect perceived by the lower facial third photographs as Flores-Mir et al concluded in their study about laypeople's perception of smile esthetics in different views.[16]

Both male and female subjects were selected based on the inclusion criteria mentioned earlier. However, the female subject's smile possessed some qualities that affected the ratings when compared with the male, such as buccal corridors, excessive gingival display and short clinical anterior teeth.

In a review study done by Dong et al about the esthetics of the smile, a full display of maxillary anterior teeth was present in what was perceived as an attractive smile.[17] Thus, achieving optimum mesiodistal angulation of central incisors during orthodontic treatment is critical for esthetic perception of smile. Symmetry of the smile is a crucial element in smile analysis, further studies are recommended to test the effect of differential mesiodistal angulation between right and left maxillary dental incisors as it was reported that the closer the asymmetry to the midline, the less attractive the smile.[18] This study sheds the light on the

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importance of mesiodistal angulation as it was previously reported by Yang et al. The limitation of this study is that it was conducted in a specific geographic area.[12] More studies in different geographic areas are recommended.

Conclusions

1. Undeviated photographs were rated most attractive in all photograph except female full face.
2. Statistically significant differences were found between the control in each photograph and all angulations except: female full face +4°, +8° and -4° and female lower facial third +4° and -4°.
3. Full face photographs were judged better than lower facial third photographs for the same angulation in male -8°, male +8°, male +16° and female +16° while only female 0° was found to be more attractive in the lower facial third image than the full face photograph.
4. Achieving optimum mesiodistal angulation of central incisors during orthodontic treatment is critical for esthetic perception of smile.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Appendices

2/25/2016

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كليات الرياض
لطب الأسنان و الصيدلة
اشراف وزارة التعليم العالي

Approval letter by the Institutional Review Board (IRB) of Riyadh Colleges of Dentistry and Pharmacy (RCsDP)

Dear Reema Alsaif

The Research Proposal submitted to the Research center by you and co-investigator titled **"Effect of mesiodistal angulation of the maxillary central incisors on esthetic perceptions of the smile in the frontal view"** with a registration number **FUGRP/2016/255** has been reviewed by the IRB of RCsDP.

The Board observed that you have complied with the Ethics Codes if the Scientific Research specified by the RCsDP has approved your proposal.The IRB approval number is **RC/IRB/2016/219** which you may use as needed in future for conferences,poster presentation and publications.

You are allowed to start your investigation starting **12-25-2016**,please comply with the recommendations specified by the IRB.We wish you a successfull project.

-There has to be submission of completed proposal at the commencement of the study to research center.

Thank You

Sincerely yours

Dr. Jamal Al Sanea BDS,MSc,ABO
Chairman,Institutional Review Board
Riyadh Colleges of Dentistry & Pharmacy

For the use of the Research Center office

Type of Research Group: Mixed
Name of Primary Investigator: Omar AlKadhi
Name of Co investigators:
Name of Research supervisor: Omar AlKadhi
Expiration date of this letter (if applicable): 12-25-2017

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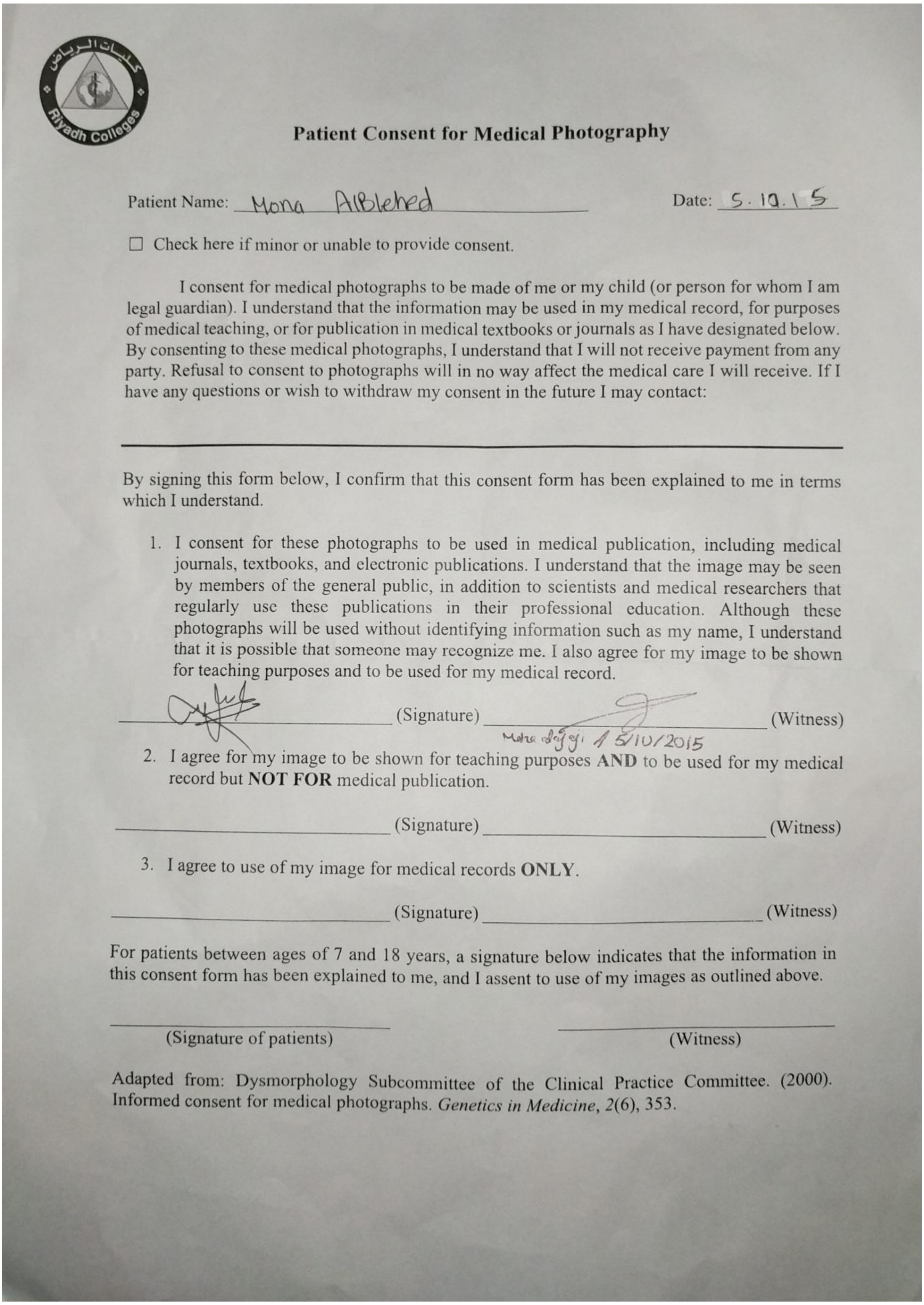

Riyadh Colleges

Patient Consent for Medical Photography

Patient Name: Mona Alblehed Date: 5.10.15

☐ Check here if minor or unable to provide consent.

I consent for medical photographs to be made of me or my child (or person for whom I am legal guardian). I understand that the information may be used in my medical record, for purposes of medical teaching, or for publication in medical textbooks or journals as I have designated below. By consenting to these medical photographs, I understand that I will not receive payment from any party. Refusal to consent to photographs will in no way affect the medical care I will receive. If I have any questions or wish to withdraw my consent in the future I may contact:

____

By signing this form below, I confirm that this consent form has been explained to me in terms which I understand.

1. I consent for these photographs to be used in medical publication, including medical journals, textbooks, and electronic publications. I understand that the image may be seen by members of the general public, in addition to scientists and medical researchers that regularly use these publications in their professional education. Although these photographs will be used without identifying information such as my name, I understand that it is possible that someone may recognize me. I also agree for my image to be shown for teaching purposes and to be used for my medical record.

______________ (Signature) ______________ (Witness)

5/10/2015

2. I agree for my image to be shown for teaching purposes **AND** to be used for my medical record but **NOT FOR** medical publication.

______________ (Signature) ______________ (Witness)

3. I agree to use of my image for medical records **ONLY**.

______________ (Signature) ______________ (Witness)

For patients between ages of 7 and 18 years, a signature below indicates that the information in this consent form has been explained to me, and I assent to use of my images as outlined above.

______________ ______________
(Signature of patients) (Witness)

Adapted from: Dysmorphology Subcommittee of the Clinical Practice Committee. (2000). Informed consent for medical photographs. *Genetics in Medicine*, 2(6), 353.

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Patient Consent for Medical Photography

Patient Name: Mohammad ALTwijri Date: 5/10/2015

☐ Check here if minor or unable to provide consent.

I consent for medical photographs to be made of me or my child (or person for whom I am legal guardian). I understand that the information may be used in my medical record, for purposes of medical teaching, or for publication in medical textbooks or journals as I have designated below. By consenting to these medical photographs, I understand that I will not receive payment from any party. Refusal to consent to photographs will in no way affect the medical care I will receive. If I have any questions or wish to withdraw my consent in the future I may contact:

By signing this form below, I confirm that this consent form has been explained to me in terms which I understand.

1. I consent for these photographs to be used in medical publication, including medical journals, textbooks, and electronic publications. I understand that the image may be seen by members of the general public, in addition to scientists and medical researchers that regularly use these publications in their professional education. Although these photographs will be used without identifying information such as my name, I understand that it is possible that someone may recognize me. I also agree for my image to be shown for teaching purposes and to be used for my medical record.

Mohammed Zahid 5/10/2015

_____ (Signature) _____ (Witness)

2. I agree for my image to be shown for teaching purposes **AND** to be used for my medical record but **NOT FOR** medical publication.

_____ (Signature) _____ (Witness)

3. I agree to use of my image for medical records **ONLY**.

_____ (Signature) _____ (Witness)

For patients between ages of 7 and 18 years, a signature below indicates that the information in this consent form has been explained to me, and I assent to use of my images as outlined above.

_____ (Signature of patients)

_____ (Witness)

Adapted from: Dysmorphology Subcommittee of the Clinical Practice Committee. (2000). Informed consent for medical photographs. *Genetics in Medicine*, 2(6), 353.

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