

## Objective smile analysis and its relationship with the lip length in an Indian population—An institution based study

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### Abstract

A smile is an integral part of the face and plays a definitive role in defining the facial aesthetics. An interdisciplinary approach including periodontal plastic procedures and orthodontic procedures are routinely performed to enhance aesthetics.

#### Aim

The aim of this study was the objective smile analysis based on the visibility of gingiva during natural smile and posed smile and the correlation of upper lip length with the smile line in patients visiting Government Dental College and Hospital, Mumbai.

#### Materials and Methods

The sample comprised of 150 participants (90 females, 60 males) between the age group of 18-25 years who were attending the outpatient department of Government Dental College and Hospital, Mumbai. Objective smile analysis was done with clinical photographs of the patients assessed by their natural and posed smile and analyzed according to Liebart's classification. The Lip length was measured from Subnasale to Stomium superioris with the help of calibrated digital Vernier callipers in presence of two examiners to verify the authenticity of the readings. Data analysis was done by SPSS 20.0 software.

#### Results

There exists a statistically significant difference between classes of gingival smile line during Natural and Posed smile, with Low smile line being most common during Natural smile and Posed smile in general population. On comparison of Upper lip lengths at rest, Liebart's Class 1, Class 2 and Class 3 and Class 4 displayed a statistically significant increasing order of lip length ( $p < 0.05$ ) suggesting that Very High smile line has the lowest upper lip length at rest and Low smile line having the highest lip length. However, no statistically significant difference was seen between the classes of gingival smile line in relation with upper lip length in posed smile ( $p > 0.05$ ).

#### Conclusion

This study has been an attempt to understand the dynamics of the smile line and its correlation with lip morphology in normal subjects.

**Keywords:** Dental aesthetics, smile, visual perception

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### I. Introduction

A smile forms an important integral part of the face for its end-point evaluation in facial esthetics and encompasses an interdisciplinary approach for optimal treatment outcomes. [1]

An esthetic smile is interplay of several factors like size, shape and colour of the displayed teeth, the gingival contour, the buccal corridor and the framing of the lips. However, an excessive gingival exposure during smiling is often an aesthetic challenge for the physicians. [2-4] There has been a paradigm shift in dentistry from a strictly restorative approach to a more cosmetic and aesthetic approach.[5] An aesthetically pleasing smile has a positive psychological impact on the patient. [6] According to Rickbee and Sarver, there are two forms of smiles: the enjoyment or Duchenne smile and the posed or the social smile. [7,8] The posed or forced smile is reproducible and can be generated on command. Hence, it is used routinely when evaluating facial aesthetics and smile characteristics. [9] The Smile line is defined as the position of the lower border of the upper lip during smile and thereby determines the display of tooth or gingiva at this hard and soft tissue interface [10].

Different classification systems are used for smile line analysis. Tjan *et al* classified smiles into three basic categories (high, average, and low) according to the exposure of the mid-facial cervical margin of the clinical crown relative to the vermilion border of the upper lip. [11] Liebart *et al* [12] classified the smile line on the basis of gingival display into the following categories:

Class 1. Very high smile line: more than 2 mm of marginal gingiva visible or more than 2 mm apical to the cemento-enamel junction visible for the reduced but healthy periodontium. This could be the ‘gummy smile’.

Class 2. High smile line: between 0 and 2 mm of marginal gingiva visible or between 0 and 2 mm apical to the cemento-enamel junction visible for the reduced but healthy periodontium.

Class 3. Average smile line: gingival embrasures only visible.

Class 4. Low smile line: gingival embrasures and cemento-enamel junctions not visible.

An aesthetic and harmonious smile also depends on variables like the shape, the thickness and the lip length and mobility. They complement other factors such as skeletal relationship in producing variable gingival and dental display by altering the position of the smile line [13].

Fonseca mentioned that normal upper lip length for females range from 18.0 to 22.0 mm and 20.0 to 24.0 mm in males [14]. A study by Hagai *et al.* in 2012 showed that there is sexual dimorphism in upper lip length measurements with the upper lip length measurements being 3.1mm shorter in woman than in men [15]. Some studies have shown that the prevalence of a high smile line is 2.5 times higher in females than male population with the low smile line being primarily present in the latter. They have also correlated the association of a high smile line with an anatomically shorter lip length. [15]

Hence the aim of this study was objective smile analysis during Natural smile and Posed smile and the correlation of upper lip length with the smile line in patients visiting Government Dental College and Hospital, Mumbai.

## **II. Materials and methods**

A pilot study was carried out on hundred and fifty patients comprising of 90 females and 60 males in the department of Periodontology, Government Dental College and Hospital, Mumbai. A written, informed consent was obtained for the same. They were selected based on the following inclusion criteria:

- Between 18-25 years of age.
- Presence of at least 8 continuous anterior teeth equally distributed between right and left side, i.e. teeth #14 to # 24.
- A healthy periodontium or a reduced but healthy one.
- No anterior teeth malocclusion
- Exclusion criteria were as follows:
- Participants with ongoing orthodontic treatment.
- Past surgical history in facial region, or major craniofacial anomalies
- Active periodontal disease, no ongoing restorative treatment for their anterior teeth.
- History of past prosthodontic treatment with respect to their anterior teeth.
- History of cosmetic or esthetic treatment or procedure in their anterior teeth or lips.

Two Frontal photographs of the subjects were taken in both Natural and Posed smiles with a digital single lens reflex camera (Canon USA) with the resolution of 24 Megapixels, 100 mm macro lens, aperture 8 with flash bounce light. The headrest in Frankfurt Horizontal plane was at a fixed distance of 25 cm with standardization in the height and orientation of the camera toward the participants. All photographs were taken in one room by the same investigator. To achieve the maximum smiling position, subjects were asked to smile wide and reproduce the same smile at least twice successively. Two examiners A and B evaluated the smile line based on the photographs taken during Natural and posed smile. The smile lines were analyzed based on Liebert’s classification. [Fig 1 a,b,c,d] The upper lip length was defined and measured as the distance between the base of the nose (subnasale) to inferior part of the upper lip (stomium superioris). [Fig 2 a&b] This was recorded in the presence of two examiners and three readings on the digital Vernier callipers were noted. Final recording was a mode of the three measurements.

Classification of the upper lip length was based on Fonseca *et al’s* study and categorized according to maxillary lip length as having a normal upper lip when they displayed an upper lip length between 18.0 and 22.0 mm for females and 20.0 and 24.0 mm for males.

### III. Data analysis

Chi-square test was used to determine possible significances. A P-level of  $<0.05$  was set as to be significant. A One-way analysis of variance (ANOVA) was used to evaluate statistically significant difference between the upper lip length at rest and the posed smile in comparison with classes of gingival smile line among participants. In the present study, we used a dependent t-test to understand whether there was a difference in upper lip length when the participant is in rest position or smiling.

Independent-samples t-test was used to determine correlation between upper lip length at rest and smile among males and females with possible significances. A P-value of  $<0.001$  was set as to be significant. Prevalence of type of smile line in the population, during Natural and Posed smile and its distribution among males and females was recorded in tabular format. Data was represented on frequency distribution bar graphs.

### IV. Results

The pilot study comprised of 150 participants including 90 females (60%) and 60 males (40%), between the age group of 18 to 25 years. During the Natural and Posed smile analysis of the 150 participants, maximum patients had a Low smile line. (30% & 44% respectively) [Table 1, Graph 1]. In females, the most frequent smile line for Natural smile was the High smile line (28.9%) and among males, a Low smile line (35%) was most commonly seen. However, the most frequent smile line for Posed smile was the Low smile line for both females (43.44%) and males (45%) [Table 2, Graph 2].

Statistically significant difference was seen between the classes of smile line and upper lip length at rest ( $p < 0.05$ ). Liebart's Class 1, Class 2 and Class 3 and Class 4 smile line displayed a progressively increasing order of lip length at Rest suggesting that Very High smile line has the lowest upper lip length at rest, followed by High smile line and Average smile line. It was found that the Low smile line had the highest lip length. However, no statistically significant difference was seen between the classes of smile line in relation with upper lip length in Posed smile ( $p > 0.05$ ). [Table 3, Graph 3] From the results, we can observe that the mean of upper lip length (ULL) in rest position was 18.297 whereas during smiling the mean was 13.545 and also there is statistically significant difference observed between them. ( $p < 0.001$ ) [Table 4]

The average (mean) upper lip length for the males was found to be 19.2mm at rest and 14.6mm during smile with a standard deviation of 2. The average (mean) upper lip length for the females as noted was, 17.6mm at rest and 12.2mm during smile with a standard deviation of 2.2. [Table 5, Graph 3]

### V. Discussion

Smile line plays a pivotal role in reconstruction of the Dento-gingival relationship to produce esthetic and functional harmony. The classifications of smile line by Tjan *et al* did not specifically mention about the type of smile [2] while studies by Jensen *et al* had its limitations in evaluating only the Natural smile. [16] Hence the classification by Liebart *et al* was more functional as it considered the smile line in both Natural and Posed smile positions. [12] There are several factors that will affect the smile line which include the strength of lip muscles and their mobility, lip length, crown height, and skeletal jaw relationship, specifically jaw length. [13] In our study, maximum patients had a Low smile line in Natural (30%) and Posed smile (44%) These studies are consistent with the studies by Dayakar *et al* in Indians where Low type of smile line was predominant in Natural smile (67%). However in their study, Average smile line was predominantly present in forced smile (44%). [17]

A similar study by Sapkota *et al* [18] in a Nepalese population showed the prevalence of Low smile line in Natural smile (59.1%) and an Average smile line in Posed smile. (44%)

Findings of the present study differed from the study done in Europe by Liebart *et al* [12] where most common type was the Average smile line for both Natural (44.79%) and Forced smile (45.49%). This variation may be attributed to the study being conducted in France. Gender plays an influential role in determining smile line. In our study, majority of the female participants had a High smile line during Natural smile (28.9%) and a Low smile line during Posed smile (43.44%). This is similar to a previous study by Dayakar *et al* [16] in which they found that 81.8 % females had a High smile line during Natural smile. However unlike our study, they reported that 76.2% females exhibited a High smile line even during Posed smile. Sepolia *et al* in 2014 concluded that regardless of the gender, most Indians (59%) had an Average smile line during forced smile. However, during Natural smile, a Low lip line was pre-dominantly present in the study. (49.5%) On considering gender bias, males had lesser gingival display (LSL) as compared to females (HSL), during Natural smile; this result coincided with work done by Jensen *et al*. who reported women had higher smile line in comparison with males [8]. But during posed smile both males (LSL) and females (LSL) were found to have majority prevalence of a Low smile line.

Previous research has shown that there are significant differences in the upper lip length and amount of tooth exposure between individuals with normal and short lip lengths [14,19] Modern psychological research

indicates that men and women possess different smile behavior. [20] Further, a significant difference in upper lip length has been noted between the sexes, with female subjects exhibiting an upper lip length approximately two mm shorter than male subjects at the rest position [20]. A study by Hagai, *et al.* in 2012 showed that there is sexual dimorphism in upper lip length with measurements being 3.1mm shorter in women than in men [15]. Our study yielded similar results with the upper lip length being approximately 1.6 mm and 3.1 mm respectively shorter in women than male subjects at the rest position and during smiling. [Table 5]

Some studies have shown the prevalence of a High smile line is 2.5 times higher in females than male population with the Low smile line being primarily present in the latter. They have also correlated the association of a High smile line with an anatomically shorter lip length [15]. This is in synergy with our results, as a direct relation of upper lip length with gingival smile line suggests that the higher the smile line, the shorter is the lip length, with one being attributable to the other. [Table 3]

The drawbacks in our study were that since this was an institutional- based study with convenience sampling procedure; there could have been a bias with respect to patients of similar ethnic background visiting the institute. Age plays a pivotal role in a patients smile and is a cumulative effect of gravity, progressive bone remodeling and decreased tissue elasticity. We had restricted our study to the age group between 18-25 years, hence, further research and longitudinal studies with a larger sample size and larger age group among general population would be recommended. Thus these results cannot be binding for the general population.

## VI. Conclusions

This study has been an attempt to record and analyze the smile of an individual, by objective analysis of the smile line in relation with upper lip lengths during rest and smile, and study any prevalence of sexual dimorphism in relation with the same. From the analysis of the above and obtained results, the following conclusions can be drawn:

1. There exists a difference between classes of gingival smile line during Natural and Posed smile, with High smile line being most common during Natural smile and Low smile line feature being most common during Posed smile in general population.
2. There exists a sexual dimorphism between smile lines of males and females during Natural smile, with High smile line being prevalent more in females as compared to Low smile line, which is more prevalent in males. However, there exists no difference between smile lines of males and females during posed smile with Low smile line present more in both males and females.
3. There exists a direct relation of upper lip length as Rest and smile in comparison with smile line. This suggests the higher the smile line of a patient, the shorter is his/her upper lip length. This could be used as a reliable parameter in esthetic smile, diagnostic and treatment planning.
4. This study has been an attempt to understand the dynamics of the smile line and it's correlation with lip morphology in normal subjects. It highlights the various types of smiles on the basis of gender and in relation to upper lip length in an Indian population sample.

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**TABLES**

**Table 1: Distribution of gingival smile line during natural and posed smile**

|                     |        | Natural smile |            | Posed smile |            |
|---------------------|--------|---------------|------------|-------------|------------|
|                     |        | Count         | Column N % | Count       | Column N % |
| Gingival Smile line | Class1 | 36            | 24.00%     | 14          | 9.33%      |
|                     | Class2 | 37            | 24.67%     | 23          | 15.33%     |
|                     | Class3 | 32            | 21.33%     | 47          | 31.33%     |
|                     | Class4 | 45            | 30.00%     | 66          | 44.00%     |
|                     | Total  | 150           | 100.00%    | 150         | 100.00%    |

**Table 2. Frequency Distribution of males and females according to smile line during Natural smile and Posed smile**

|                     |        | Gender- Natural Smile |            |         |            | Gender- Posed Smile |            |         |            |
|---------------------|--------|-----------------------|------------|---------|------------|---------------------|------------|---------|------------|
|                     |        | Males                 |            | Females |            | Males               |            | Females |            |
|                     |        | Count                 | Column N % | Count   | Column N % | Count               | Column N % | Count   | Column N % |
| Gingival Smile line | Class1 | 13                    | 21.70%     | 23      | 25.60%     | 8                   | 13.30%     | 6       | 6.67%      |
|                     | Class2 | 11                    | 18.30%     | 26      | 28.90%     | 6                   | 10.00%     | 17      | 18.88%     |
|                     | Class3 | 15                    | 25.00%     | 17      | 18.90%     | 19                  | 31.66%     | 28      | 31.11%     |
|                     | Class4 | 21                    | 35.00%     | 24      | 26.70%     | 27                  | 45.00%     | 39      | 43.33%     |
|                     | Total  | 60                    | 100.00%    | 90      | 100.00%    | 60                  | 100.00%    | 90      | 100.00%    |

**Table 3. One-way ANOVA between various classes of gingival smile line and upper lip length at rest and while smiling (\*p<0.05; statistically significant)**

|        | N  | Mean Upper lip length at rest | St d. Deviation | 95% Confidence Interval for Mean |             | p-value | Mean Upper lip length during smiling | Std. Deviation | 95% Confidence Interval for Mean |             | p-value |
|--------|----|-------------------------------|-----------------|----------------------------------|-------------|---------|--------------------------------------|----------------|----------------------------------|-------------|---------|
|        |    |                               |                 | Lower Bound                      | Upper Bound |         |                                      |                | Lower Bound                      | Upper Bound |         |
| Class1 | 36 | 17.328                        | 2.4639          | 16.494                           | 18.161      | 0.008*  | 13.192                               | 2.0697         | 12.491                           | 13.892      | 0.125   |
| Class2 | 37 | 18.163                        | 2.1253          | 17.454                           | 18.871      |         | 13.027                               | 2.7691         | 12.104                           | 13.95       |         |
| Class3 | 32 | 19.125                        | 2.1312          | 18.357                           | 19.893      |         | 13.672                               | 2.3633         | 12.82                            | 14.524      |         |
| Class4 | 45 | 20.596                        | 2.159           | 20.947                           | 20.244      |         | 14.164                               | 2.1729         | 13.512                           | 14.817      |         |

**Table 4. Paired sample t-test between upper lip length at rest and smiling**

|        |            | N   | Mean   | Std. Deviation | R      | p-value |
|--------|------------|-----|--------|----------------|--------|---------|
| Pair 1 | ULLRest    | 150 | 18.297 | 2.2901         | 0.662* | 0.000** |
|        | ULLsmiling | 150 | 13.545 | 2.3730         |        |         |

r=Pearson’s correlation; \*statistically significant; \*\*p<0.001

**Table 5. Measurement of Upper lip length at rest and during smiling in Male and Female population**

|            | Gender | N  | Mean   | Std. Deviation | p-value (Sig. 2-tailed) |
|------------|--------|----|--------|----------------|-------------------------|
| ULLRest    | M      | 60 | 19.258 | 2.0675         | 0.000**                 |
|            | F      | 90 | 17.657 | 2.2156         |                         |
| ULLsmiling | M      | 60 | 14.622 | 2.0851         | 0.000**                 |
|            | F      | 90 | 12.828 | 2.2900         |                         |

\*\*p<0.001(statistically significant)

**LEGENDS**

FIGURE 1(a). Class 1. **Very high smile line**: more than 2 mm of marginal gingiva visible or more than 2 mm apical to the cemento-enamel junction visible for the reduced but healthy periodontium.

FIGURE 1(b). Class 2. **High smile line**: between 0 and 2 mm of marginal gingiva visible or between 0 and 2 mm apical to the cemento-enamel junction visible for the reduced but healthy periodontium.

FIGURE 1(c). Class 3. **Average smile line**: gingival embrasures only visible.

FIGURE 1(d). Class 4. **Low smile line**: gingival embrasures and cemento-enamel junctions not visible.

FIGURE 2 (a). Lip length measured at rest with digital calipers from Subnasale to the most inferior point at the center of upper lip (Stomium superioris)

FIGURE 2 (b). Lip length measured at posed smile with digital calipers from Subnasale to the most inferior point at the center of upper lip (Stomium superioris)

FIGURE 3: Graph 1: Frequency distribution bar graph representing total number of participants and % prevalence of classes of smile line according to Liebart's classification during natural and posed smile.

FIGURE 4: Graph 2. Frequency distribution bar graph representing % distribution of males and females in relation with smile lines during Natural and Posed smile.

FIGURE 5 : Graph 3. Measurement of Upper lip length at rest and during smiling in Male and Female population.



**Fig 1a.**



**Fig 1b.**



**Fig 1c.**



**Fig 1d.**



**Fig 2a**



**Fig 2b**

Fig 3

Graph 1

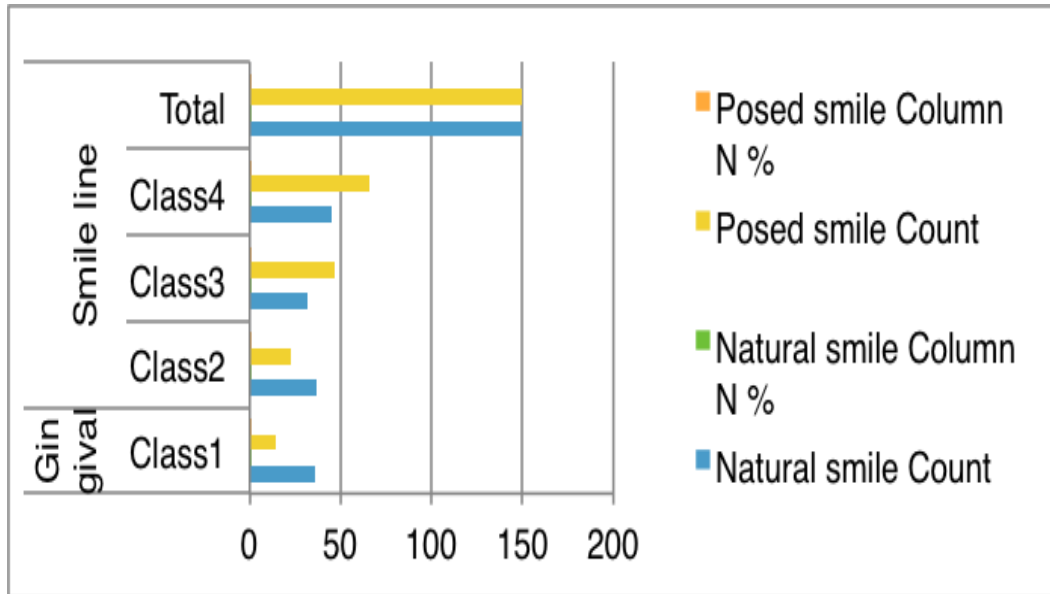


Fig 4

Graph 2

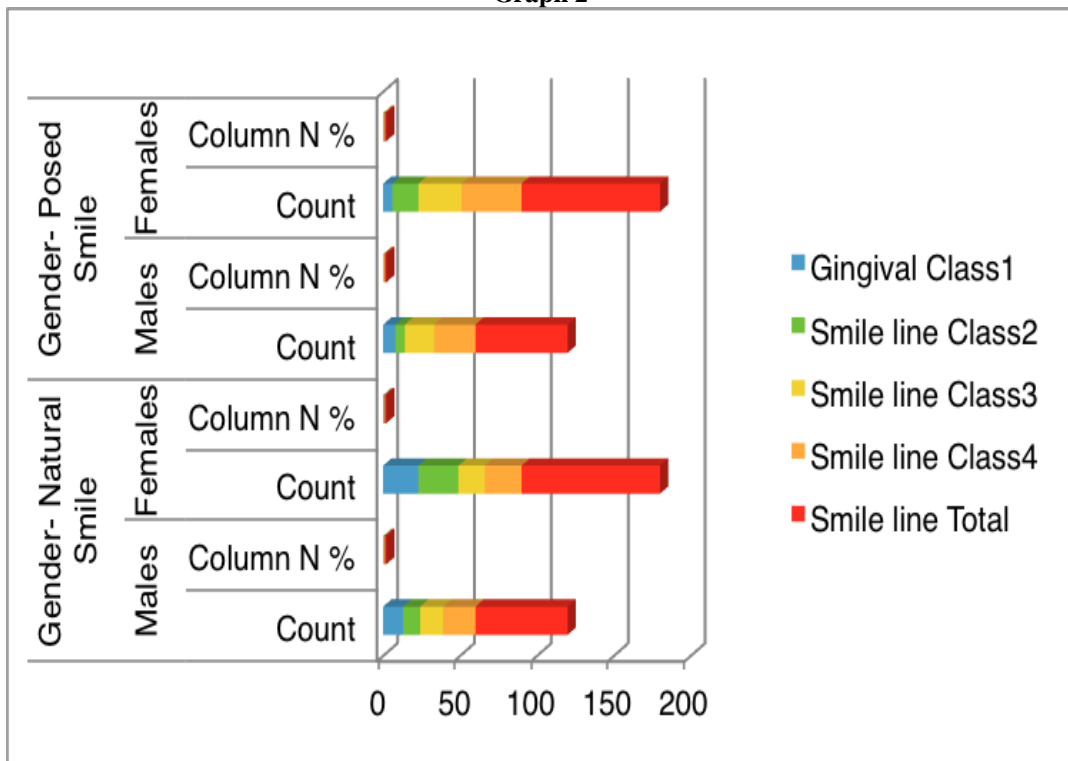
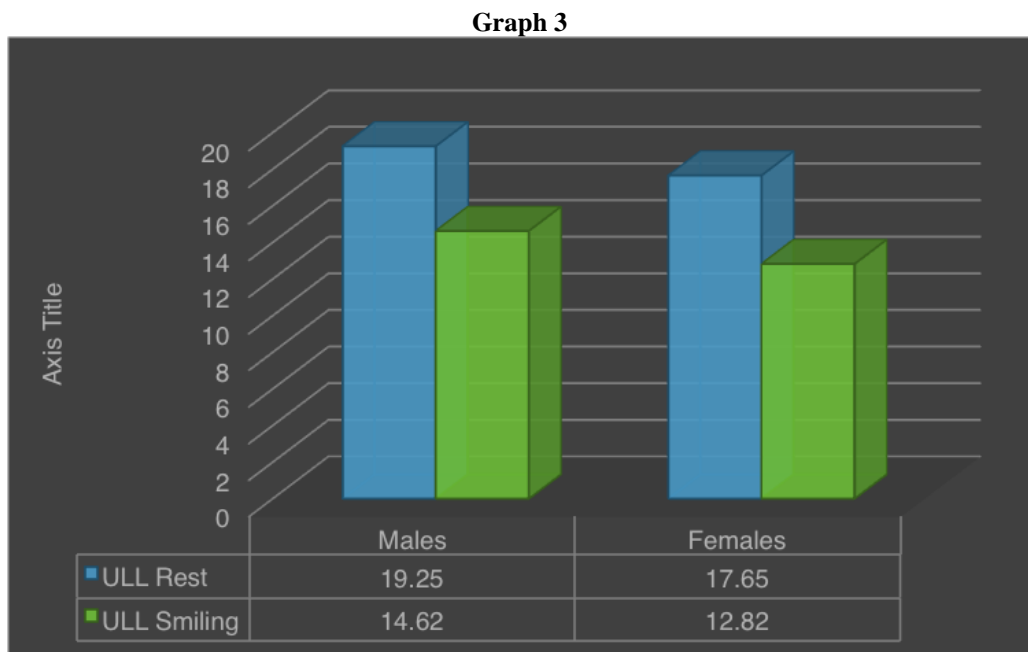




Fig 5



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