An assessment of facial asymmetry in Karnataka population

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Abstract
Asymmetry of dento-facial complex influences diagnosis, prognosis and treatment plan. Facial asymmetries are very often present with dental asymmetries and are of clinical importance in the treatment of malocclusion of teeth. Postero-anterior cephalogram of 120 subjects (males and females) were analyzed in order to detect the asymmetries and their correlation with malocclusion. The analysis for assessment of transverse frontal facial asymmetry was done by using frontal asymmetry analysis suggested by Groummons (1987). Most of the findings showed that the asymmetry decreases in magnitude as we approach higher in the craniofacial skeleton.

Keywords
Facial asymmetry, Craniofacial skeleton.

Introduction
The study of orthodontics is indissolubly connected with that of art related to the human face. Therefore, the subject of facial esthetics is of paramount importance to orthodontists. Facial esthetics means symmetry and balance. It is the state of facial equilibrium, the correspondence in size, form and arrangement of facial features on the opposite sides of the median sagittal plane (Shah and Joshi, 1978)*.

The variability is most commonly manifested in the plants and animal kingdom. The similarity between, different individuals of the same species are only relative. No two individuals of same or different species will be similar. This is called biologic variation. The genetic variations are due to differences in the genes in the gametes and it is the gene combination of the individual that decides its development in essential respect. In mammals, for instance, there is marked asymmetry is shape and location of the visceras, especially as regards the organs, the organs of the alimentary canal and the circulation. Phylogenetically, these asymmetries are of a secondary nature, that is, they have developed from an original bilateral symmetry. The asymmetry of the heart and of the blood and lymph vessels system will have developed as a result of the different functional requirement on the left and right side of heart.

Review of Literature
McCoy (1931)* stated that the absolute symmetry is a normal condition so that one side of the face mirrors the other side. Simon (1968)* considered that bilateral symmetry is a most manifest morphological characteristic of the body. But some degree of asymmetry does exist in a normal face. It serves to characterize and to individualize the esthetically pleasing face rather than to disfigure it.

Symmetry may be defined as "equality or correspondence in form of parts distributed around a center or an axis, at the two extremes or poles or on the two opposite sides of the body". Clinically symmetry can be taken as balance and significant
asymmetry means imbalance (Fischer B., 1978). However, as reported in the literature some degree of asymmetry does exist in the normal face (Shah and Joshi, 1978; Sheldon P., 1991).

Asymmetry in the craniofacial region was first recorded by an artist Hasse (Mulik, 1965). There have been several studies related to facial asymmetries investigating their pattern, prevalence and distribution in human beings by several researchers (Thompson, 1943; Hewitt 1974; Peck et al., 1991). In the literature much of the attention has been given to dento-facial deficiencies and the asymmetries commonly seen with normal faces, which are esthetically acceptable. Barring few exceptions facial asymmetries associated with the malocclusion and the influences malocclusion have on the pattern and type of asymmetries of the craniofacial complexes (Alavi et al., 1988; Letzer and Kronman, 1967).

From the orthodontic aspects the, the asymmetries that are of special interest are those which might involve the occlusion. Facial asymmetry may be associated with a mandibular displacement and abnormal path of closure of the mandible is usually due to an occlusal pre-maturity.

Present study was done to assess the facial and dental asymmetries associated with different malocclusions. Main objective was to analyze the nature of asymmetry, in face and jaws with an effort to find the source of the problem.

Materials and method

The sample consisted of 120 adult subjects (Table 1) aged 13 – 33 years. All the patients were taken from the daily out patients of the Department of orthodontics, P.M.N.M. Dental College and Hospital in Bagalkot (Karnataka).

The subjects selected had Angle’s class I, Class II or Class III molar relationship, who required orthodontic treatment, had full complement of teeth, no history of orthodontic treatment and no gross deformity of facial skeleton present.

Postero-anterior cephalograms of the 120 subjects with teeth in centric occlusion were taken using standardized cephalometric technique. All cephalograms were taken on “Trophie’s odontorama PC Mixte” cephalometric x-ray machine.

- The head of the subject was fixed with ear rods of cephalogram machine and oriented in the Frankfurt horizontal plane. The distance between the transportorial axis and the film was kept constant at 60 inches, to minimize the magnification error.
- The landmarks identified and traced (Fig. 1).

The analysis for assessment of transverse frontal facial asymmetry was done by using parts of the frontal asymmetry analysis suggested by Grummons (1987).

![Anatomical landmarks](image)

**Table 1:** Number of patients according to Angle’s molar relationship:

<table>
<thead>
<tr>
<th>Group</th>
<th>Class</th>
<th>No. of patient</th>
<th>Mean age</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Class I</td>
<td>53</td>
<td>20.77</td>
<td>32</td>
<td>21</td>
</tr>
<tr>
<td>II</td>
<td>Class II</td>
<td>41</td>
<td>20.63</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>III</td>
<td>Class II sub div.</td>
<td>13</td>
<td>20.3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>IV</td>
<td>Class III</td>
<td>13</td>
<td>20.3</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>120</td>
<td>20.62</td>
<td>69</td>
<td>51</td>
</tr>
</tbody>
</table>
Construction of MSR

The MSR is constructed by running a vertical line from Cg to the chin area passing through ANS. An alternate method of drawing MSR is to draw a line from the midpoint of Z-plane through ANS (Fig. 2).

According to Grummons (1987), MSR closely follows visual plane formed by subnasal and the midpoint between the eyes and eyebrows, so MSR was selected as the key reference line.

I. Horizontal planes

Three planes were used to show the degree of parallelism and symmetry of the facial structures (Fig. 3).

II. mandibular morphology (Fig. 4)

Two triangles (right and left) were formed by joining the Go, Me and Co points on both sides, representing the mandibular morphology. The linear measurements for all the three sides of the triangles were recorded along with the measurements of the angles formed by joining Co, Go and Me points on both sides.

III. Linear asymmetry (transverse) (Fig. 5)

Six linear distances were measured from MSR to different anatomical (bilateral) points to assess the transverse linear asymmetries in the cranial base and the lower facial region.
IV. Mandibular deviation

To assess the amount of deviation exhibited by the mandible to the left or to the right side, linear distance between the mental (Me) point and the point where MSR joins the lower border of mandible i.e., mandibular offset at Me-point. The reading was taken as positive (+) when the Me-point fell on left side of MSR and as negative (-) when the Me-point fell on right side of MSR.

- The data calculation was done as follows:
- The distance between each bilateral landmark, right and left and the MSR line was recorded. The difference between each pair of measurement was also recorded in millimeters as left side minus right, in this way sidedness in facial asymmetry could be evaluated. The total width between the bilateral landmarks was calculated.
- The absolute value of the left and right difference was used to compute the mean absolute asymmetry (MMA) for each of the dimension studied.
- The error was determined by randomly selecting a sample of 10 PA cephalograms for retracing. The error was found to be 0.4 mm for linear and 0.6° for angular measurements, which was within normal limits.

Results

Table II shows the bilateral facial widths observed at Z, ZA, Co, NC, I and Go distances, as total width, right and left side for group I, II, III and IV.

<table>
<thead>
<tr>
<th>Skeletal dimension</th>
<th>Group</th>
<th>No. of patients</th>
<th>Total bilateral widths</th>
<th>Right side</th>
<th>Left side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=</td>
<td>X</td>
<td>SD</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Z-distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>53</td>
<td>97.42</td>
<td>5.01</td>
<td>48.69</td>
<td>2.81</td>
</tr>
<tr>
<td>Group II</td>
<td>41</td>
<td>97.52</td>
<td>5.60</td>
<td>48.92</td>
<td>3.40</td>
</tr>
<tr>
<td>Group III</td>
<td>13</td>
<td>98.46</td>
<td>4.75</td>
<td>49.46</td>
<td>2.56</td>
</tr>
<tr>
<td>Group IV</td>
<td>13</td>
<td>102.45</td>
<td>6.65</td>
<td>51.07</td>
<td>3.06</td>
</tr>
<tr>
<td>Co-distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>53</td>
<td>104.82</td>
<td>7.76</td>
<td>54.15</td>
<td>4.82</td>
</tr>
<tr>
<td>Group II</td>
<td>41</td>
<td>104.43</td>
<td>6.66</td>
<td>53.56</td>
<td>4.49</td>
</tr>
<tr>
<td>Group III</td>
<td>13</td>
<td>104.68</td>
<td>6.56</td>
<td>52.38</td>
<td>4.51</td>
</tr>
<tr>
<td>Group IV</td>
<td>13</td>
<td>105.15</td>
<td>6.63</td>
<td>53.69</td>
<td>4.19</td>
</tr>
<tr>
<td>ZA-distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>53</td>
<td>132.28</td>
<td>7.37</td>
<td>67.28</td>
<td>4.14</td>
</tr>
<tr>
<td>Group II</td>
<td>41</td>
<td>131.28</td>
<td>6.97</td>
<td>65.70</td>
<td>5.34</td>
</tr>
<tr>
<td>Group III</td>
<td>13</td>
<td>130.99</td>
<td>9.40</td>
<td>64.92</td>
<td>7.6</td>
</tr>
<tr>
<td>Group IV</td>
<td>13</td>
<td>132.78</td>
<td>14.31</td>
<td>67.32</td>
<td>9.05</td>
</tr>
<tr>
<td>NC-distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>53</td>
<td>32.02</td>
<td>3.13</td>
<td>16.16</td>
<td>1.88</td>
</tr>
<tr>
<td>Group II</td>
<td>41</td>
<td>31.80</td>
<td>5.77</td>
<td>15.80</td>
<td>2.67</td>
</tr>
<tr>
<td>Group III</td>
<td>13</td>
<td>32.46</td>
<td>3.04</td>
<td>16.69</td>
<td>0.94</td>
</tr>
<tr>
<td>Group IV</td>
<td>13</td>
<td>30.99</td>
<td>3.51</td>
<td>16.30</td>
<td>2.59</td>
</tr>
</tbody>
</table>
Table III shows the mean absolute asymmetry (MAA) for the six lateral (transverse) craniofacial dimensions studied. The Z distance showed a MAA of 5.01 mm, which was the highest. ZA distance showed a MAA of 3.37 mm, the NC distance showed a MAA of 1.77 mm, which was least in the group. I and Go distance showed MAAs of 2.18 mm and 4.32 mm respectively for group I. In group II the Co distance showed a highest MAA of 6.14 mm which was statistically significant. In group III Go distance showed a MAA of 4.46 mm, which was highest. In group IV all the dimensions investigated showed right side dominance but none of them were statistically significant.

Table III: Skeletofacial asymmetry: Mean absolute values and sidedness (in mm)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Group</th>
<th>Absolute Value</th>
<th>Sidedness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Z-distance</td>
<td>Group I</td>
<td>1.84</td>
<td>1.52</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>2.02</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>2.15</td>
<td>2.11</td>
</tr>
<tr>
<td></td>
<td>Group IV</td>
<td>1.23</td>
<td>1.09</td>
</tr>
<tr>
<td>Co-distance</td>
<td>Group I</td>
<td>5.01</td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>6.14</td>
<td>3.97</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>4.53</td>
<td>3.64</td>
</tr>
<tr>
<td></td>
<td>Group IV</td>
<td>3.46</td>
<td>1.85</td>
</tr>
<tr>
<td>ZA-distance</td>
<td>Group I</td>
<td>3.37</td>
<td>2.63</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>4.60</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>4.69</td>
<td>6.06</td>
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<tr>
<td></td>
<td>Group IV</td>
<td>4.76</td>
<td>3.63</td>
</tr>
<tr>
<td>NC-distance</td>
<td>Group I</td>
<td>1.77</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>1.51</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>2.38</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>Group IV</td>
<td>2.53</td>
<td>2.02</td>
</tr>
<tr>
<td>J distance</td>
<td>Group I</td>
<td>2.18</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>2.56</td>
<td>2.84</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>1.84</td>
<td>2.19</td>
</tr>
<tr>
<td></td>
<td>Group IV</td>
<td>1.53</td>
<td>0.96</td>
</tr>
<tr>
<td>Go-distance</td>
<td>Group I</td>
<td>4.32</td>
<td>4.14</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>4.70</td>
<td>3.84</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>4.46</td>
<td>4.37</td>
</tr>
<tr>
<td></td>
<td>Group IV</td>
<td>3.00</td>
<td>2.23</td>
</tr>
</tbody>
</table>
Table IV shows the MAA recorded for the mandibular offset at menton which came out to be 2.13 mm group I. In group II MAA for the mandibular offset at menton was 3.26 mm showing right side dominance. In group III, it was slight towards right sidedness and in group IV it showed very slight right side dominance.

Table V shows MAAs for the dimensions representing the mandibular morphology. Go-Me length showed a MAA of 5.11 mm which was the highest recorded in the group I. In group II and III all the dimensions showed right sidedness bias but only Me-Go length showed statistically significant right sidedness. In group IV, the Co-Go length showed left side bias and rest all the dimensions showed right sided bias but none of them was statistically significant.

Table IV - Mandibular deviations: Mean absolute value and sidedness.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Group</th>
<th>Mean absolute value</th>
<th>Sidedness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Go - angle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>3.67</td>
<td>2.54</td>
<td>0.50</td>
</tr>
<tr>
<td>Group II</td>
<td>3.43</td>
<td>2.52</td>
<td>0.26</td>
</tr>
<tr>
<td>Group III</td>
<td>2.53</td>
<td>1.76</td>
<td>0.53</td>
</tr>
<tr>
<td>Group IV</td>
<td>3.30</td>
<td>2.13</td>
<td>0.07</td>
</tr>
<tr>
<td>Co-Go length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>4.43</td>
<td>4.27</td>
<td>1.56</td>
</tr>
<tr>
<td>Group II</td>
<td>2.92</td>
<td>3.54</td>
<td>0.48</td>
</tr>
<tr>
<td>Group III</td>
<td>2.00</td>
<td>1.58</td>
<td>0.30</td>
</tr>
<tr>
<td>Group IV</td>
<td>2.00</td>
<td>1.47</td>
<td>0.15</td>
</tr>
<tr>
<td>Co-Me Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>3.94</td>
<td>3.21</td>
<td>1.98</td>
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<tr>
<td>Group II</td>
<td>2.46</td>
<td>4.13</td>
<td>2.60</td>
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<td>Group III</td>
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<td>3.00</td>
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<tr>
<td>Group IV</td>
<td>2.00</td>
<td>2.76</td>
<td>2.07</td>
</tr>
<tr>
<td>Me-Go</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>5.11</td>
<td>4.37</td>
<td>4.01</td>
</tr>
<tr>
<td>Group II</td>
<td>5.75</td>
<td>5.31</td>
<td>3.17</td>
</tr>
<tr>
<td>Group III</td>
<td>4.53</td>
<td>3.71</td>
<td>3.61</td>
</tr>
<tr>
<td>Group IV</td>
<td>2.69</td>
<td>3.19</td>
<td>3.07</td>
</tr>
</tbody>
</table>
Table VI shows mean angles formed by Z, occlusal and Go planes with MSR and there was no statistically significant canting observed in group I, II, III and IV.

Table VI - Vertical asymmetries: Mean angles formed by Z, occlusal and Go planes to MSR.

<table>
<thead>
<tr>
<th>Angle</th>
<th>Group</th>
<th>Absolute value</th>
<th>Standard Deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(in deg.)</td>
<td></td>
</tr>
<tr>
<td>Z - Plane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>90.00</td>
<td>1.58</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>90.04</td>
<td>2.02</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>89.84</td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td>Group IV</td>
<td>89.53</td>
<td>1.98</td>
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<td>Group I</td>
<td>89.66</td>
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<td>Group II</td>
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<td></td>
</tr>
<tr>
<td>Group III</td>
<td>88.53</td>
<td>3.45</td>
<td></td>
</tr>
<tr>
<td>Group IV</td>
<td>90.15</td>
<td>2.33</td>
<td></td>
</tr>
<tr>
<td>Occl. Plane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>90.18</td>
<td>2.80</td>
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<td>Group II</td>
<td>89.95</td>
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<td>Group III</td>
<td>88.61</td>
<td>1.93</td>
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</tr>
<tr>
<td>Group IV</td>
<td>90.92</td>
<td>1.55</td>
<td></td>
</tr>
<tr>
<td>Go Plane</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Asymmetries in the human craniofacial skeleton are a rule rather than exception. This has been verified and stressed upon by many researchers (Peck et al., 1991; Garn et al., 1996; Thompson, 1943; Lundstrom, 1961; Shah and Joshi, 1978). Asymmetries are invariably present even in the most pleasing of faces. There are various reasons, which have been suggested as the possible causative factors. These include genetic as well as non-genetic and environmental influences. Few studies have been done to study association of the craniofacial skeleton asymmetry with various types of malocclusions.

In this study, the frontal asymmetry analysis suggested by Grummons in 1987, was partly used to assess the patients for the transverse facial asymmetries. The analysis was modified according to the needs of the present study.

The MAAs for Z, NC and J distances are less than those for Go and Co distances. Peck et al. (1991) found the MAA in the upper facial region to be 0.87 mm. The MAA observed for Z distance in our study (1.84 mm, 2.02 mm, 2.15 mm and 1.23 mm for group I, II, III and IV respectively) were higher. This suggests that asymmetries are higher in patients with malocclusion in this region. The finding in our study are in agreement with the findings of Letzer and Kronman (1967), Alavi et al. (1988) and Peck et al. (1991). In this study subjects with 2 mm or more asymmetry in cranial base region were above 50%.

The MAAs for Za distance was found to be higher in all groups when compared to other parameters in the upper and mid-facial region. Peck et al. (1991) found a MAA of 2.25 mm in a study of pleasing faces. In malocclusion cases, this was found to be between 3.37 mm to 4.76 mm in various groups. Further investigations are needed to confirm whether asymmetries are higher in malocclusion patients.

The MAAs for Go-angle, all groups were in the range of 2.5° to 4°. Hardlicka (1940) reported an asymmetry of 4° - 10° in 13% of mandible measured. Go-angle asymmetry of 4° or more were found to be 43.3%, which is much higher than that reported by Rogers (1958). The possible cause for asymmetry in gonial angle are asymmetric functional patterns such as muscular atrophies and unilateral chewing patterns as suggested by Rogers (1958) and Shah and Joshi (1978).

The MAAs for condylar distance in this study indicate the mandibulo-facial region exhibit the highest asymmetries in patients with malocclusions. Similar findings were reported by Farkas and Cheung (1987) in normal population.

Mandibular deviations showed a MAAs of 2.13 mm, 3.26 mm, 2.84 mm, and 2.23 mm in groups I, II, III and IV respectively. This is in agreement with Severt and Proffit (1997) who found an incidence of 74% of chin deviation. This high incidence of chin deviation may be due to the asymmetries of mandibular length, which also showed high incidence.

Few researchers have reported sidedness in the past. In this study a consistent right side dominance has been found in all the groups and measurements (Co distance in group I and II showed a statistically significant right sidedness at P < 0.001 and P < 0.05). Za distance showed statistically significant right sidedness in group I at
P<0.01; Go distance in group I showed statistically significant right sidedness at P<0.01, Me-Go length in group I, II and III showed P<0.01, P<0.05 and P<0.05 respectively. Shah and Joshi (1978)\textsuperscript{5}, Farkas and Cheung (1981)\textsuperscript{6}, Peck et al. (1991)\textsuperscript{8} and Ferrario et al (1994)\textsuperscript{9} also found similar results. Melnick (1992)\textsuperscript{9} found that the left side was larger at 6 years of age but later right side became larger by age of 16 years. Chin deviations in our study showed a left sidedness which is in agreement with findings of Severt and Proffit (1997)\textsuperscript{10}. The possible reason given by Woo (1931)\textsuperscript{11} is the increased size of right hemisphere of brain. This right side dominance in brain affects the functional activities and facial structures.

The mean values obtained for the angles formed by the various planes used in the analysis, did not show much canting and were more or less parallel to each other. The total number of subjects with 3° or more canting of occlusal plane was 28% of the sample.

In the present study it has been observed that the malocclusions present with different types of significant asymmetries, which should be addressed upon while treatment planning is done. Our study clearly indicates that asymmetries are much higher in subjects with malocclusion, but still there is a need for standardizing the method for quantification and classification of facial asymmetries. More studies in future with standardized methods to assess the asymmetries in subjects in malocclusion need to be carried out.

**Summary and conclusion**

Asymmetries are common finding in cases of all types of malocclusions. The asymmetries decrease in magnitude, as we approach higher in the craniofacial skeleton. The upper facial region presents with asymmetries having the least magnitudes. Mandibular region shows the asymmetries of highest magnitudes. According to this study asymmetries in malocclusion cases are significant and must be taken into account while diagnosis and treatment planning.

**Communications**

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