**Supplementary Table 1.** Cephalometric variables and their definitions.

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| **Category** | **Measurements** | **Definitions** |
| Maxilla to Cranial Base | SNA (˚) | The angle formed by connecting sella, nasion, and A-point |
| SN-Palatal Plane (˚) | The angle formed from the intersection of sella-nasion line and a line drawn connecting anterior nasal spine to posterior nasal spine |
|  | SN-Occlusal Plane (˚) | The angle formed from sella-nasion and occlusal plane |
|  | A-N Perpendicular (mm) | The linear distance from A point to the nasion perpendicular. |
| Mandible to Cranial Base | SNB (˚) | The angle formed by connecting sella, nasion, and B-point |
| SNPg (˚) | The angle formed by connecting sella, naison, and pogonion |
| FMA: MP-FH (˚) | The angle formed from the intersection of porion-orbitale line and a line drawn connecting gonion to gnathion |
| SN-MP (˚) | The angle formed from the intersection of sella-nasion line and a line drawn connecting gonion to gnathion |
| Mandibular Plane to Occlusal Plane (˚) | The angle formed by mandibular plane and occlusal plane |
| B-N Perpendicular (mm) | The linear distance from B point to nasion perpendicular |
| Pog-N Perpendicular (mm) | The linear distance from pogonion to nasion perpendicular |
| Y-Axis: SGn-SN (˚) | The angle formed by connecting nasion, sella, and gnathion |
| Maxilla to Mandible | ANB (˚) | The difference between SNA and SNB |
| Palatal-Mandibular Angle (PP-MP) (˚) | The angle formed from palatal plane and mandibular plane |
| Wits Appraisal (mm) | The distance between A point to Occlusal plane and B point to Occlusal plane |
| Maxillary Length: ANS-PNS (mm) | The linear measurement between anterior nasal spine and posterior nasal spine |
| Mandibular Length: Co-Gn (mm) | The linear measurement between condylion and gnathion |
| Cranial Base | Cranial Base Flexure Angle: Ba-S-N (˚) | The angle formed by connecting basion, sella, and nasion |
| Upper Incisors to Maxilla | U1-SN (˚) | The angle formed from a line connecting sella to nasion and a line connecting the upper incisor incisal tip to the root apex |
| U1-NA (˚) | The angle formed from a line connecting nasion to A-point and a line connecting the upper incisor incisal tip to the root apex |
| U1-NA (mm) | The linear measurement from the labial surface of the upper incisor to the line connecting nasion to A-point |
|  | U1-Palatal Plane (˚) | The angle formed by the position of maxillary incisor to palatal plane |
|  | U1 Protrusion (U1-APo) (mm) | The distance from maxillary incisor to the A point-pogonion reference line |
| Lower Incisors to Mandible | L1-MP (˚) | The angle formed from a line connecting the lower incisor incisal tip to the root apex and a line connecting gonion to gnathion |
| L1-NB (˚) | The angle formed from a line connecting the lower incisor incisal tip to the root apex and a line connecting nasion to B-point |
| L1-NB (mm) | The linear measurement from the labial surface of the lower incisor incisal to the line connecting nasion to B-point |
|  | L1 Protrusion (L1-Apo) (mm) | The distance from mandibular incisor to the A point-pogonion reference line |
| Incisors to Each Other | Interincisal Angle (˚) | The angle formed from a line connecting the lower incisor incisal tip to the apex and a line connecting the upper incisor incisal tip to the root apex |
|  | Overjet (mm) | The horizontal distance from maxillary incisor tip to mandibular incisor tip |
|  | Overbite (mm) | The vertical distance from maxillary incisor tip to mandibular incisor tip |
| Soft Tissue | Upper Lip to E-Plane (mm) | The linear distance from upper lip to a line connecting soft tissue pogonion and pronasale |
| Lower Lip to E-Plane (mm) | The linear distance from lower lip to a line connecting soft tissue pogonion and pronasale |
| ILG (HP) (mm) | The vertical distance from stomion superius to stomion inferius |
| Nasolabial Angle (Pn-Sn-UL) (˚) | The angle formed by pronasale, subnasale, and upper lip |
| H-Angle (Pg’UL-Pg’Na’) (˚) | The angle formed by soft tissue pogonion-upper lip to soft tissue pogonion-soft tissue nasion |
| Facial Height (Na’-Me’) (mm) | The linear measurement from soft tissue nasion and soft tissue menton |
| Soft Tissue Upper Face Height: G'-Sn' (mm) | The linear measurement between soft tissue glabella and soft tissue subnasale |
| Soft Tissue Lower Face Height: Sn'-Me' (mm) | The linear measurement between soft tissue subnasale and soft tissue pogonion |
| Hard Tissue Upper Face Height: N-ANS (mm) | The linear measurement between nasion and anterior nasal spine |
| Hard Tissue Lower Face Height: ANS-Me (mm) | The linear measurement between anterior nasal spine and menton |
| UFH (N-ANS/(N-ANS+ANS-Me)) (%) | The ratio of the upper face height to facial height |
| LFH (ANS-Me/(N-ANS+ANS-Me)) (%) | The ratio of lower face heigh to facial height |
| Posterior Face Height: Ar-Go (mm) | The linear measurement between articulare and gonion |
|  | PFH:AFH (Co-Go:N-Me) (%) | The ratio of posterior facial height to anterior facial height |
| Profile | Convexity: NA-APo (˚) | The angle formed by connecting nasion, A-point, and pogonion |
| Facial Angle: FH-NPo (˚) | The angle formed from a line connecting porion to orbitale and a line connecting nasion to pogonion |
| Holdaway Ratio (L1-NB:Pg-NB) (%) | The ratio of the linear distance from the lower incisor to the NB line to the linear distance of pogonion to the NB line |
| Holdaway Angle (NB to H-line) (°) | The angle formed by the H-line to NB line |

**Supplementary Table 2.** Intra-examiner repeatability of the measurements.

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| --- | --- | --- | --- | --- | --- |
| **Measurements** | **Mean** | **SD** | **SE** | **p-value** | **ICC** |
| SNA | -0.28 | 0.75 | 0.24 | 0.269 | 0.97 |
| SN-Palatal Plane | -0.21 | 0.66 | 0.21 | 0.343 | 0.97 |
| Occlusal Plane to SN | -0.30 | 0.96 | 0.30 | 0.348 | 0.98 |
| A-N Perpendicular (mm) | -0.17 | 0.58 | 0.18 | 0.381 | 0.98 |
| SNB | -0.14 | 0.85 | 0.27 | 0.613 | 0.97 |
| SNPg | -0.39 | 1.06 | 0.34 | 0.275 | 0.95 |
| FMA (MP-FH) | 0.08 | 0.96 | 0.30 | 0.798 | 0.99 |
| SN - MP | 0.31 | 1.52 | 0.48 | 0.534 | 0.97 |
| Mandibular Plane to Occlusal Plane | 0.66 | 0.88 | 0.28 | 0.041 | 0.97 |
| B-N Perpendicular (mm) | -0.03 | 0.95 | 0.30 | 0.922 | 0.99 |
| Pog-N Perpendicular (mm) | -0.59 | 1.25 | 0.40 | 0.170 | 0.98 |
| Y-Axis (SGn-SN) | 0.24 | 0.66 | 0.21 | 0.277 | 0.98 |
| ANB | -0.15 | 0.24 | 0.08 | 0.081 | 0.99 |
| Palatal-Mandibular Angle (PP-MP) | 0.58 | 0.94 | 0.30 | 0.082 | 0.98 |
| Wits Appraisal (mm) | 0.17 | 0.49 | 0.16 | 0.303 | 0.98 |
| Maxillary length (ANS-PNS) (mm) | 0.19 | 1.60 | 0.51 | 0.717 | 0.89 |
| Mandibular length (Co-Gn) (mm) | -0.43 | 2.33 | 0.74 | 0.574 | 0.97 |
| Ba-S-N | -0.54 | 1.40 | 0.44 | 0.255 | 0.95 |
| U1 - SN | 0.25 | 2.30 | 0.73 | 0.739 | 0.92 |
| U1 - NA | 0.54 | 2.11 | 0.67 | 0.439 | 0.95 |
| U1 - NA (mm) | 0.18 | 0.53 | 0.17 | 0.311 | 0.95 |
| U1 - Palatal Plane | 0.04 | 2.06 | 0.65 | 0.952 | 0.95 |
| U1 Protrusion (U1-APo) (mm) | 0.23 | 0.71 | 0.23 | 0.336 | 0.96 |
| L1 - MP | 0.95 | 1.55 | 0.49 | 0.084 | 0.96 |
| L1 - NB | 1.02 | 1.72 | 0.54 | 0.094 | 0.95 |
| L1 - NB (mm) | -0.05 | 0.59 | 0.19 | 0.794 | 0.96 |
| L1 Protrusion (L1-APo) (mm) | 0.17 | 0.74 | 0.23 | 0.485 | 0.87 |
| Interincisal Angle (U1-L1) | -1.39 | 2.99 | 0.95 | 0.176 | 0.92 |
| Overjet | -0.02 | 0.16 | 0.05 | 0.705 | 0.99 |
| Overbite | -0.67 | 0.69 | 0.22 | 0.013 | 0.88 |
| Upper Lip to E-Plane (mm) | 0.13 | 1.23 | 0.39 | 0.746 | 0.89 |
| Lower Lip to E-Plane (mm) | 0.24 | 1.06 | 0.33 | 0.491 | 0.92 |
| ILG (HP) (mm) | 0.35 | 0.39 | 0.12 | 0.019 | 0.97 |
| Nasolabial Angle (Col-Sn-UL) | 3.09 | 3.63 | 1.15 | 0.025 | 0.85 |
| H-Angle (Pg'UL-Pg'Na') | 0.24 | 1.89 | 0.63 | 0.709 | 0.93 |
| UFH (G'-Sn') (mm) | 1.36 | 6.89 | 2.18 | 0.548 | 0.35 |
| LFH (Sn'-Me') (mm) | -0.32 | 1.26 | 0.40 | 0.444 | 0.94 |
| Upper Face Height (N-ANS) (mm) | -0.06 | 0.64 | 0.20 | 0.774 | 0.99 |
| Lower Face Height (ANS-Me) (mm) | -0.41 | 1.03 | 0.33 | 0.240 | 0.92 |
| UFH (N-ANS/(N-ANS+ANS-Me)) (%) | 0.15 | 0.36 | 0.11 | 0.224 | 0.99 |
| LFH (ANS-Me/(N-ANS+ANS-Me)) (%) | -0.15 | 0.36 | 0.11 | 0.224 | 0.99 |
| Posterior Face Height (Ar-Go) (mm) | 0.84 | 2.36 | 0.75 | 0.290 | 0.94 |
| PFH:AFH (Co-Go : N-Me) (%) | 0.00 | 1.46 | 0.46 | 1.000 | 0.95 |
| Convexity (NA-APo) | 0.19 | 0.89 | 0.28 | 0.518 | 0.99 |
| Facial Angle (FH-NPo) | -0.28 | 0.65 | 0.20 | 0.204 | 0.98 |
| Holdaway Ratio (L1-NB:Pg-NB) (%) | -11.09 | 35.29 | 11.16 | 0.346 | 0.00 |
| Holdaway Angle (NB to H-line) | 0.20 | 1.79 | 0.56 | 0.731 | 0.94 |

Supplementary Table 3. The descriptive statistics of the cephalometric measurements at T1, T2, and T3, including mean, standard deviation, and minimum/maximum values.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **T1** | | | | **T2** | | | | **T3** | | | |
| **Measurements** | **Mean** | **SD** | **Min** | **Max** | **Mean** | **SD** | **Min** | **Max** | **Mean** | **SD** | **Min** | **Max** |
| SNA | 79.58 | 3.12 | 70.50 | 87.20 | 80.01 | 3.36 | 71.70 | 89.50 | 80.10 | 3.27 | 71.60 | 88.40 |
| SN-Palatal Plane | 8.58 | 2.89 | -2.30 | 14.20 | 8.46 | 3.03 | -0.70 | 16.30 | 8.44 | 3.10 | -0.30 | 16.20 |
| Occlusal Plane to SN | 19.41 | 3.65 | 10.60 | 29.40 | 18.13 | 4.14 | 7.10 | 27.20 | 16.97 | 4.22 | 4.70 | 25.50 |
| A-N Perpendicular (mm) | -2.06 | 3.44 | -12.70 | 8.90 | -1.69 | 3.26 | -12.40 | 5.70 | -1.64 | 3.66 | -15.50 | 6.70 |
| SNB | 76.45 | 3.09 | 67.90 | 85.10 | 77.34 | 3.24 | 69.80 | 88.00 | 77.76 | 3.41 | 69.60 | 87.40 |
| SNPg | 77.12 | 3.19 | 68.80 | 85.20 | 78.15 | 3.36 | 70.50 | 87.60 | 78.85 | 3.53 | 70.90 | 87.40 |
| FMA (MP-FH) | 28.34 | 4.40 | 18.40 | 39.90 | 27.49 | 4.39 | 16.90 | 38.40 | 26.88 | 4.81 | 14.40 | 41.00 |
| SN - MP | 34.22 | 4.47 | 23.00 | 46.50 | 33.43 | 4.72 | 21.30 | 47.00 | 32.65 | 5.10 | 19.20 | 46.90 |
| Mandibular Plane to Occlusal Plane | 15.81 | 2.99 | 8.90 | 23.00 | 16.24 | 3.11 | 8.60 | 23.70 | 16.70 | 3.68 | 7.30 | 26.20 |
| B-N Perpendicular (mm) | -8.38 | 5.39 | -23.70 | 5.20 | -7.18 | 5.16 | -24.90 | 5.80 | -6.71 | 5.97 | -28.10 | 8.40 |
| Pog-N Perpendicular (mm) | -8.30 | 6.06 | -24.20 | 5.60 | -6.65 | 5.95 | -26.60 | 8.10 | -5.54 | 6.79 | -29.00 | 10.20 |
| Y-Axis (SGn-SN) | 68.19 | 3.11 | 58.90 | 76.20 | 67.95 | 3.28 | 57.40 | 76.00 | 67.85 | 3.48 | 58.40 | 76.30 |
| ANB | 3.13 | 1.94 | -2.80 | 7.60 | 2.68 | 1.94 | -2.60 | 7.50 | 2.33 | 2.12 | -3.00 | 8.00 |
| Palatal-Mandibular Angle (PP-MP) | 26.65 | 4.31 | 13.10 | 37.70 | 25.92 | 4.50 | 13.80 | 40.30 | 25.23 | 4.88 | 12.90 | 39.70 |
| Wits Appraisal (mm) | -0.74 | 2.36 | -7.30 | 4.40 | -0.93 | 2.49 | -8.80 | 5.90 | -0.81 | 2.92 | -8.70 | 5.10 |
| Maxillary length (ANS-PNS) (mm) | 48.79 | 3.15 | 41.70 | 57.50 | 50.53 | 3.35 | 42.80 | 59.90 | 52.22 | 3.61 | 39.20 | 61.20 |
| Mandibular length (Co-Gn) (mm) | 110.43 | 6.09 | 95.50 | 135.60 | 115.68 | 6.58 | 101.40 | 133.60 | 120.71 | 6.75 | 103.50 | 138.90 |
| Ba-S-N | 129.71 | 4.15 | 120.90 | 141.70 | 129.74 | 4.19 | 120.70 | 141.40 | 129.89 | 4.51 | 118.90 | 141.10 |
| U1 - SN | 103.17 | 6.23 | 84.80 | 120.80 | 103.32 | 6.49 | 88.50 | 124.30 | 103.25 | 6.91 | 85.30 | 123.20 |
| U1 - NA | 23.59 | 5.67 | 7.70 | 42.70 | 23.31 | 6.16 | 8.50 | 39.10 | 23.15 | 6.53 | 4.70 | 38.10 |
| U1 - NA (mm) | 4.16 | 1.95 | -1.00 | 11.60 | 4.61 | 2.34 | -1.60 | 11.40 | 5.01 | 2.54 | -2.50 | 12.00 |
| U1 - Palatal Plane | 111.75 | 5.80 | 95.70 | 128.60 | 111.77 | 5.96 | 97.70 | 129.60 | 111.69 | 6.12 | 97.00 | 129.20 |
| U1 Protrusion (U1-APo) (mm) | 6.03 | 1.81 | 1.90 | 10.30 | 6.10 | 2.10 | 1.10 | 11.90 | 6.05 | 2.27 | -0.10 | 11.90 |
| L1 - MP | 90.54 | 5.98 | 75.10 | 106.80 | 90.63 | 6.21 | 73.30 | 106.90 | 90.42 | 6.45 | 74.10 | 111.10 |
| L1 - NB | 23.63 | 5.61 | 6.20 | 36.10 | 23.80 | 5.96 | 7.60 | 37.70 | 23.41 | 5.88 | 8.30 | 40.20 |
| L1 - NB (mm) | 4.36 | 1.79 | -0.60 | 8.80 | 4.40 | 1.96 | -0.80 | 9.70 | 4.52 | 2.08 | -0.80 | 9.70 |
| L1 Protrusion (L1-APo) (mm) | 2.02 | 1.85 | -2.20 | 6.90 | 2.14 | 1.91 | -2.60 | 8.00 | 2.19 | 2.02 | -2.50 | 8.50 |
| Interincisal Angle (U1-L1) | 129.65 | 8.10 | 107.00 | 149.60 | 130.21 | 8.91 | 109.80 | 158.70 | 131.10 | 9.15 | 108.10 | 154.20 |
| Overjet | 4.11 | 1.53 | -3.30 | 8.10 | 4.11 | 1.35 | 0.80 | 8.70 | 4.00 | 1.30 | 1.10 | 9.00 |
| Overbite | 1.58 | 1.99 | -6.20 | 5.50 | 2.12 | 1.73 | -2.40 | 5.70 | 1.97 | 1.85 | -6.20 | 5.60 |
| Upper Lip to E-Plane (mm) | -2.47 | 2.18 | -8.60 | 3.40 | -3.15 | 2.19 | -9.30 | 1.70 | -4.11 | 2.33 | -10.30 | 3.80 |
| Lower Lip to E-Plane (mm) | -0.30 | 2.20 | -5.10 | 4.20 | -0.83 | 2.57 | -6.50 | 5.50 | -1.54 | 2.44 | -7.80 | 4.80 |
| ILG (HP) (mm) | 2.87 | 2.84 | 0.50 | 13.90 | 2.78 | 2.72 | 0.40 | 13.60 | 2.37 | 2.35 | 0.50 | 11.80 |
| Nasolabial Angle (Col-Sn-UL) | 115.28 | 9.64 | 83.90 | 141.20 | 115.43 | 8.42 | 85.80 | 133.80 | 113.15 | 8.68 | 87.30 | 130.90 |
| H-Angle (Pg'UL-Pg'Na') | 14.96 | 4.13 | 4.60 | 28.20 | 14.81 | 4.03 | 0.90 | 22.20 | 13.98 | 4.14 | 3.80 | 25.40 |
| UFH (G'-Sn') (mm) | 68.05 | 6.38 | 53.40 | 91.10 | 70.94 | 6.37 | 55.40 | 93.80 | 72.64 | 6.02 | 57.20 | 87.60 |
| LFH (Sn'-Me') (mm) | 66.22 | 4.38 | 54.70 | 76.40 | 69.10 | 5.18 | 56.10 | 83.20 | 71.00 | 4.86 | 59.00 | 83.60 |
| Upper Face Height (N-ANS) (mm) | 49.92 | 3.38 | 41.70 | 61.30 | 52.28 | 3.49 | 43.30 | 63.40 | 53.92 | 3.40 | 43.80 | 66.80 |
| Lower Face Height (ANS-Me) (mm) | 61.18 | 4.03 | 52.00 | 71.40 | 63.22 | 4.43 | 53.10 | 77.40 | 65.63 | 4.90 | 51.70 | 78.10 |
| UFH (N-ANS/(N-ANS+ANS-Me)) (%) | 44.94 | 1.89 | 38.70 | 49.90 | 45.27 | 1.86 | 39.10 | 49.20 | 45.15 | 1.99 | 39.70 | 50.50 |
| LFH (ANS-Me/(N-ANS+ANS-Me)) (%) | 55.06 | 1.89 | 50.10 | 61.30 | 54.73 | 1.86 | 50.80 | 60.90 | 54.88 | 1.95 | 49.90 | 60.30 |
| Posterior Face Height (Ar-Go) (mm) | 40.73 | 3.69 | 32.40 | 54.80 | 43.34 | 4.00 | 33.70 | 54.20 | 45.91 | 4.17 | 36.40 | 56.20 |
| PFH:AFH (Co-Go : N-Me) (%) | 51.91 | 3.37 | 44.10 | 61.40 | 52.47 | 3.57 | 43.60 | 61.90 | 53.41 | 3.93 | 43.80 | 64.90 |
| Convexity (NA-APo) | 5.23 | 4.93 | -11.40 | 16.80 | 3.95 | 5.06 | -10.30 | 18.20 | 2.63 | 5.41 | -11.50 | 17.00 |
| Facial Angle (FH-NPo) | 85.42 | 3.31 | 77.20 | 93.30 | 86.50 | 3.12 | 76.90 | 94.50 | 87.20 | 3.40 | 75.90 | 95.30 |
| Holdaway Ratio (L1-NB:Pg-NB) (%) | -1.95 | 33.54 | -212.90 | 253.80 | -0.17 | 22.84 | -286.60 | 32.00 | 2.47 | 31.63 | -129.60 | 314.10 |
| Holdaway Angle (NB to H-line) | 11.57 | 4.50 | -0.10 | 24.40 | 11.10 | 4.47 | -1.80 | 19.20 | 9.78 | 4.60 | -1.00 | 21.50 |