Diagnosis of malocclusions. X-ray diagnosis. Cephalometrics

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Radiographs - Orthodontic records

Role of orthodontic records

• Diagnosis and treatment planning
• Acting as an aide-memoire
• Providing a legal document of treatment
• Providing proof to commissioning bodies that treatment was justified and conducted to a good standard
• Audit, teaching and research
Classification of X-rays

• Intraoral X-rays
  – Routine use in dentistry (cariology, endodontics)

• Extraoral X-rays
  – Important in the orthodontic diagnosis
Intraoral X-rays

- Periapical x-rays
- Bitewing x-rays
- Local x-rays
Extraoral X-rays

- Panoramic tomogram-Orthopantomogram
- Antero-posterior cephalometric x-ray
- Handwrist and mesocarpal x-rays
- Cephalogram, lateral cephalometric x-rays
Dental panoramic tomogram

- To identify general and dental pathology
- To assess dental development
- To localize unerupted teeth (!)
- To assess root length during diagnosis and treatment planning

*Before* treatment and *near the end of treatment* to assess the root length & root parallelism

**Limitation:** anterior maxillary region is not clearly visible ➞ upper anterior occlusal view
Orthopantomogram

- The main beam is always perpendicular to the dental arch
- The tube and the cassette are moving around the head controversially
PA x-ray

This technique is similar to the those of the lateral cephalometric X-ray, but the head is turned with 90°

- *Rarely* used in orthodontics, mostly to examine the asymmetry

- Fractures, tumors may also be seen
Hand-wrist radiographs

• To determine skeletal age by assessment of pattern of ossification of bones within the hand
• Limited benefit of this technique
• It has been abandoned by number of clinicians
Handwrist x-rays...

The radiographs are used in an attempt to identify ossification of the phalanxes and so assisting in the assessments of the pubertal growth spurt.
Cephalometric radiography

- Standardised and reproducible method of taking radiographs of the facial skeleton and cranial vault.
- Two cephalometric views:
  - *Lateral* cephalometric view – the most commonly used
  - *Posterio-anterior* cephalometric view – used for the assessment of skeletal asymmetry
Rules of taking cephalommetric X-rays

- The distance between the head’s median-sagittal plane and the focus of the x-ray is 1.5m
- The main beam perpendicular to the head’s median-sagittal plane
- The main beam pass through the two auditory meatus parallel to the head median sagittal plane /15-18 cm/
Rules of taking cephalometric x-rays

- The Frankfurt horizontal plane is horizontal
- Central occlusion
- Lips and soft tissues have to be in natural position
Use of lateral cephalometric

• Diagnosis and treatment planning
• Monitoring growth (serial radiographs)
• Monitoring treatment changes (serial radiographs)
• Monitoring stability following orthognatic surgery
• Assisting in the localisation of unerupted teeth
• Estimation of skeletal age by assessing development of the cervical vertebra
• Audit, documentation, research and teaching
An example for the usage

Before treatment

After treatment
Lateral cephalometric analysis

Cephalometry should not be substitute for a detailed clinical examination. Occasionally the results of cephalometric analysis contradict clinical findings. *In doubt*, greater creditibility should be given to the results of clinical examination.
Cephalometric estimations and relations

• Maxilla and the skull
• Mandibule and the skull
• Maxilla and the mandibule
• Upper teeth and the maxilla
• Lower teeth and the mandibule
• Upper and the lower teeth
The sequence of the estimation

- Visual control of the whole X-ray
- Superimposing the important landmarks
- Signs of the anatomical points and lines
- Measurement of the angles
- Linear measurements
Lateral cephalometric analysis
Lateral cephalometric analysis
Natural anatomical points

- Nasion - N
- Orbitale - O
- Anterior nasal spine - Spa
- Posterior nasal spine - Spp
- Pogonion - Pog
- Gnathion - Gn
- Menton - M
- Gonion - Go
Arteficial anatomical points

• Subspinale - A
• Supramentale - B
• Sella - S
• Porion - P
Groups for cephalometric analysis

- Hard tissue points
- Cephalometric planes
- Angles describing skeletal relationships
- Distances and angles describing dental relationships
- Soft tissue points and planes
Hard tissue points - definitions and locations
<table>
<thead>
<tr>
<th>Abbreviations</th>
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<tbody>
<tr>
<td>G</td>
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<tr>
<td>N</td>
</tr>
<tr>
<td>Po</td>
</tr>
<tr>
<td>Or</td>
</tr>
<tr>
<td>PNS</td>
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<tr>
<td>ANS</td>
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<tr>
<td>Go</td>
</tr>
<tr>
<td>Pog</td>
</tr>
<tr>
<td>Gn</td>
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<tr>
<td>Me</td>
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</table>
Hard tissue points

Sella (S): located in the centre of the sella turcica. Locating the point before tracing the shadow of the anterior and posterior clinoid processes and floor of the fossa is probably more accurate than locating the point after tracing the structure.
Hard tissue points
Nasion (N):
it is located at the most inferior, anterior point on the frontal bone adjacent to frontonasal suture. Again, point location should precede tracing of the bony outlines.
Hard tissue points

Orbitale (O):

is located on the lowest point on the outline of the bony orbit. Usually both right and left orbital outlines are visible. Orbitale is then located at the bisection of the two orbit outlines. Orbitale may be difficult to locate in some subjects.
Hard tissue points
Porion (Po): located at the most superior point on the shadow of ear rod at the superior border of external auditory meatus. (The correct location of porion is thus directly dependent on the placement of the ear rods at the time x-ray film exposure.)
Hard tissue points

Point A (A) :

is located at the most posterior part of the anterior shadow of the maxilla, usually near the apex of the central incisor root.
Hard tissue points

Spina nasalis *anterior*: the tip of the bony anterior nasal spina at the inferior margin of the piriform aperture in the midsagittal plane

*posterior*: the most posterior point of the bony hard palate in the midsagittal plane
Hard tissue points

Point B (B): is located at the most posterior point on the shadow of the anterior border of the mandible, usually near the apex of the central incisor root.
Hard tissue points
Pogonion (Pog): is located at the most anterior point on the shadow of the chin.
Hard tissue points

Gnation (Gn): is located at a point on the shadow of the chin midway between pogonion and menton.
Hard tissue points

Menton (Me): is located at the most inferior point on the shadow of the chin.
Hard tissue points

Articulare (Ar):
is the point of intersection of the inferior border of the cranial base and averaged posterior surface of the mandibular condyles.
Hard tissue points

Gonion (Go):
is the midpoint of the angle of the mandible found by bisecting the angle formed by the mandibular and ramus planes.
Cephalometric planes
Evaluation of the cephalometric X-ray planes

- Sagittal dimension
- Vertical dimension
Cephalometric planes

- S-N plane
- Frankfort horizontal plane
- Facial plane
- Ramus plane
- Mandibular plane
- Po
- Or
- Ar
- Me
- Pog
Cephalometric planes
Sella-nasion plane (S-N): easily located and has been used for superimposition of tracings from two or more sequentially exposed cephalograms
Cephalometric planes

Frankfort horizontal plane (Po-Or):
formed by line passing through points porion and orbitale
Cephalometric planes

Functional occlusal plane: occlusal surfaces of the maxillary and mandibular 1st permanent molars and 1st and second praemolars.
Cephalometric planes
Mandibular plane (Go-Me):
drawn between menton and Gonion (a point tangent to the posterior portion of the lower border of the mandible just as it turns upward to the posterior border of the ramus)
Cephalometric planes

Facial plane (N-Pog):
formed by passing a line through the nasion and pogonion points
Cephalometric planes
Ramus plane (condylus – angulus)
Measurement of the angles

Relations

• The position of the maxilla and the mandible correlates to the skull in *sagittal* and *vertical* planes

• The relation and position of the incisors
Angles describing skeletal relationships

SNA angle: relates the anterio-posterior position of the maxillary apical base to a line passing through the anterior cranial base.
Angles describing skeletal relationships

SNB angle:

relates the anterio-posteror position of the mandibular apical base to a line passing through the anterior cranial base.
Angles describing skeletal relationships

**ANB angle (SNA-SNB)**:
relates the anterio-posterior position of the maxilla to the anterio-posterior position of the mandible
Angles describing skeletal relationships

Facial angle (N-Pog:FH): relates the anterio-posterior position of the chin to the Frankfort horizontal plane
Angles describing skeletal relationships
SN-Pog angle: relates the anterio-posterior position of the chin to the line passing through the anterior cranial base.
Angles describing skeletal relationships

Mandibular plane-Frankfort horizontal plane angle: (FMA or MP-FH): relates the cant of the mandibular plane to the Frankfort horizontal plane
Angles describing skeletal relationships
Mandibular plane-S-N plane angle (MP-SN): relates the cant of the mandibular plane to a line passing through the anterior cranial base
Angles describing skeletal relationships
The maxilla and the mandible position correlate to the scap in the vertical plane ($B_1, B_2, P, O$)

- $B_1$: SN-GoM (32°)
- $B_2$: FH-GoM (25°)
- $P$: SN - Spa-Spp (12°)
- $O$: SN-occlusal plane (15°)
Angles describing skeletal relationships

The position of the maxilla and the mandibula correlate to the skull in the sagittal plane ($B_3$, $AB$), mandible angle ($Go$)

- $B_3$: Spa-Spp-GoM (20°)
- $AB$: Spa-Spp-AB (90°)
- $Go$: 123°
Facial heights:

- anterior (upper, lower, total)
- posterior

### Vertical proportions

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
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<tbody>
<tr>
<td>Upper/Total</td>
<td>0.44</td>
<td>0.48</td>
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<tr>
<td>Lower/Total</td>
<td>0.56</td>
<td>0.54</td>
</tr>
<tr>
<td>Post./Total</td>
<td>0.67</td>
<td>0.67</td>
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Angles and distances describing dental relationships
The relation and position of the incisors
Angles and distances describing dental relationships
The relation and position of the incisors

Inclination of incisors

ii: 135°
Linear measurements

Overjet, overbite
Average values

Facial angles
- SNA: 82°
- SNB: 80° (79°)
- ANB: 2° (3°)
- FH-NPog: 87.5°

Basis angles
- B₁ (ML-NSL): 32°
- B₂ (Fr-ML): 25°
- B₃ (ML-NL): 23.5° (20°)
- SN-MP: 12°
- SN-Occlusal plane: 15°
- Go szög: 123°

Inclination of incisors
- α: 110°
- β: 90° (92°)
- ii: 130° (135°)
## Cephalometric Norms for 12-Year-Old Males

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
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<tr>
<td><strong>Skeletal Antemposterior</strong></td>
<td></td>
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<tr>
<td>SNA°</td>
<td>82</td>
<td>3.7</td>
<td>76</td>
<td>90</td>
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<td>SNB°</td>
<td>80</td>
<td>3.7</td>
<td>73</td>
<td>86</td>
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<td>ANB°</td>
<td>2</td>
<td>2.4</td>
<td>-2</td>
<td>6</td>
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<td>SN-N: Pog°</td>
<td>81</td>
<td>4.2</td>
<td>72</td>
<td>88</td>
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<tr>
<td>HH:N-Pog°</td>
<td>86</td>
<td>4.5</td>
<td>79</td>
<td>94</td>
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<tr>
<td><strong>Skeletal Vertical</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>N-Me mm</td>
<td>122</td>
<td>6.0</td>
<td>113</td>
<td>135</td>
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<tr>
<td>S:Go mm</td>
<td>90</td>
<td>6.8</td>
<td>80</td>
<td>102</td>
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<td>S:Go/N:Me%</td>
<td>74</td>
<td>6.5</td>
<td>61</td>
<td>87</td>
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<td>MP:SN°</td>
<td>28</td>
<td>7.2</td>
<td>13</td>
<td>43</td>
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<td>MP:FH°</td>
<td>23</td>
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<td>42</td>
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<tr>
<td><strong>Dental Angular</strong></td>
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<tr>
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<td>115</td>
<td>152</td>
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<td>L:SN°</td>
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<td>89</td>
<td>115</td>
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<td>T:FH°</td>
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<td>48</td>
<td>85</td>
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<tr>
<td>T:MP°</td>
<td>96</td>
<td>9.2</td>
<td>78</td>
<td>108</td>
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<tr>
<td><strong>Dental Linear</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>L:A-Pog mm</td>
<td>4</td>
<td>1.9</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>T:NB mm</td>
<td>4</td>
<td>2.5</td>
<td>-1</td>
<td>9</td>
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SD, Standard deviation.
## Cephalometric Standards for 14-Year-Old Females

<table>
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<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
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<td><strong>Skeletal Anteroposterior</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SNAº</td>
<td>80</td>
<td>3.8</td>
<td>74</td>
<td>90</td>
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<tr>
<td>SNBº</td>
<td>77</td>
<td>3.3</td>
<td>71</td>
<td>84</td>
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<tr>
<td>ANBº</td>
<td>3</td>
<td>2.1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>SN:Pogº</td>
<td>77</td>
<td>3.3</td>
<td>72</td>
<td>84</td>
</tr>
<tr>
<td>FH:N-Pogº</td>
<td>84</td>
<td>2.5</td>
<td>79</td>
<td>89</td>
</tr>
<tr>
<td><strong>Skeletal Vertical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N:Me mm</td>
<td>107</td>
<td>5.0</td>
<td>96</td>
<td>116</td>
</tr>
<tr>
<td>S:Go mm</td>
<td>72</td>
<td>3.7</td>
<td>61</td>
<td>78</td>
</tr>
<tr>
<td>S:Go/N:Me%</td>
<td>68</td>
<td>3.5</td>
<td>63</td>
<td>75</td>
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<tr>
<td>MP:SNº</td>
<td>34</td>
<td>4.2</td>
<td>24</td>
<td>39</td>
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<td>MP:FHº</td>
<td>28</td>
<td>4.9</td>
<td>19</td>
<td>35</td>
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<tr>
<td><strong>Dental Angular</strong></td>
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<td></td>
</tr>
<tr>
<td>L: Tº</td>
<td>129</td>
<td>9.0</td>
<td>111</td>
<td>142</td>
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<td>L:SNº</td>
<td>102</td>
<td>5.4</td>
<td>96</td>
<td>110</td>
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<tr>
<td>T: FHº</td>
<td>58</td>
<td>6.5</td>
<td>46</td>
<td>65</td>
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<tr>
<td>T: MPº</td>
<td>95</td>
<td>5.5</td>
<td>86</td>
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<tr>
<td><strong>Dental Linear</strong></td>
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</tr>
<tr>
<td>L: A-Pog mm</td>
<td>6</td>
<td>1.7</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>T: NB mm</td>
<td>4</td>
<td>2.0</td>
<td>2</td>
<td>8</td>
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</tbody>
</table>


SD, Standard deviation.
Normal (Eastman) values for Caucasians unless stated otherwise*.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Normal (SD)</th>
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<tbody>
<tr>
<td>SNA</td>
<td>$81^\circ (3^\circ)$</td>
</tr>
<tr>
<td>SNB</td>
<td>$78^\circ (3^\circ)$</td>
</tr>
<tr>
<td>ANB</td>
<td>$3^\circ (2^\circ)$</td>
</tr>
<tr>
<td>MMPA</td>
<td>$27^\circ (4^\circ)$</td>
</tr>
<tr>
<td>LAFH%</td>
<td>$55% (2%)$</td>
</tr>
<tr>
<td>U1–Maxillary plane</td>
<td></td>
</tr>
<tr>
<td>Caucasians</td>
<td>$109^\circ (6^\circ)$</td>
</tr>
<tr>
<td>African Caribbeans</td>
<td>$118^\circ$</td>
</tr>
<tr>
<td>Chinese</td>
<td>$113^\circ$</td>
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<tr>
<td>L1–Maxillary plane</td>
<td></td>
</tr>
<tr>
<td>Interincisal angle</td>
<td>$135^\circ (10^\circ)$</td>
</tr>
</tbody>
</table>
Soft tissue profile points: glabella (G'), pronasale (Pn), labrale superius (Ls), labrale inferius (Li), and pogonion (Pog').
Soft tissue analysis of maxillary and mandibular prominence
Soft tissue points
Soft tissue glabella (G’)
The most prominent point in the midsagittal plane of the forehead
Soft tissue points
 Pronasale (Pr):
 the most prominent point on the tip of nose
Soft tissue points
Labrare superius (Ls):
the median point in the upper margin of the upper membranous lip
Soft tissue points
Labrare inferius (Li):
the median point in the lower margin of the lower membranous lip
Soft tissue points

Soft tissue pogonion (Pog’): the most prominent point on the soft tissue contour of the chin
• Nasolabial angle

Ricketts E (Esthetic)-line

Normal: 102.8°
Acute: <90° (IV)
Obtuse: >90 ° (II, III)

The tip of the nose and chin points
Straight, retrusive (II), protrusive
Con Beam Computer Tomography (CBCT)

Three dimensional hard and soft tissue scans

- To examine facial morphology, monitor growth and treatment progress

CBCT may be increasingly used in the future for the assessment of impacted teeth, skeletal discrepancies and the mandibular condyles.
Thank you for your attention!