

Crown Coordinate System

Preface

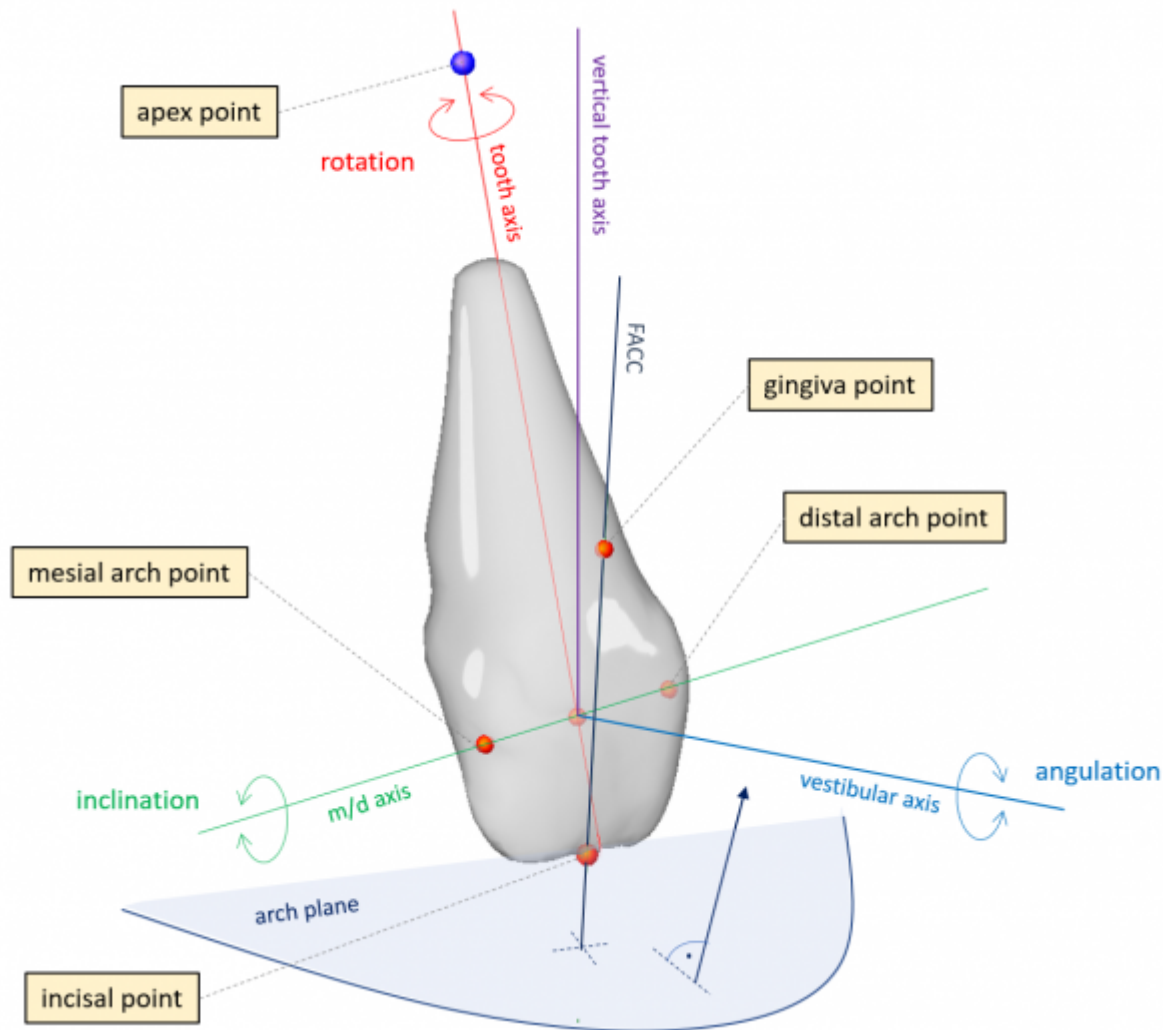
The verbal description of tooth movements has always been based on the anatomical conditions of tooth anchoring in the jaw. Different reference systems are used for individual movement components. For example, rotations are understood as rotations around the root axis, while inclination and angulation refer to the alignment of the clinical crown axis (FACC) in relation to the occlusal plane of the jaw. The situation is similar for the displacement components: here, occlusal movements are interpreted along the root axis while transversal movement components are understood in the mesial-distal direction or perpendicular to it.

The digital planning of tooth movements requires to formulate the anatomically non-orthogonal tooth coordinate system in a mathematically consistent manner in order to be able to clearly describe tooth positions and their changes numerically.

The mathematically consistent modeling of tooth movements used in all OnyxCeph³™ modules is described below.

Crown coordinates

The definitions for points, axes and movements are based on the terms traditionally used for this purpose in dentistry. For anatomical reasons, this is a non-Cartesian (oblique-angled) coordinate system.



The axes of the crown coordinate system are

- Rotation axis (tooth axis)
- Inclination axis (m/d axis)
- Angulation axis (vestibular axis)

defined by crown landmarks

- mesial arch point
- distal arch point
- apex point

Translations and rotations are applied along resp. around these coordinate system axes.

Rotation

Rotation around the "tooth axis" [m/d mid point ↔ apex point]

Increasing rotation means the labial landmark is moved/tilt in mesial direction

Inclination

Rotation around the "m/d-axis" [mesial arch point ↔ distal arch point]

Increasing inclination means that the incisal landmark is moved/tilt in buccal direction and the apex landmark is moved/tilt in the opposite direction.

Note: The measurement of inclination is always performed with reference to an arch plane that is aligned with the midpoint and endpoints of the arch curve and whose position and alignment can be adjusted by the user to the skeletal conditions in the jaw.

Angulation

Rotation around the vestibular axis [perpendicular to m/d-axis and tooth axis]

Increasing angulation means the incisal landmark is moved/tilt in mesial direction and the apex landmark is moved/tilt in the opposite direction.

Note: The measurement of angulation is always performed with reference to an arch plane that is aligned with the midpoint and endpoints of the arch curve and whose position and alignment can be adjusted by the user to the skeletal conditions in the jaw.

Tooth Displacements

- Displacements along root axis are measured positive in apical direction
- Displacements along m/d axis are measured positive in mesial direction
- Displacements along vestibular axis are measured positive in vestibular direction

Measurements and Reference Planes

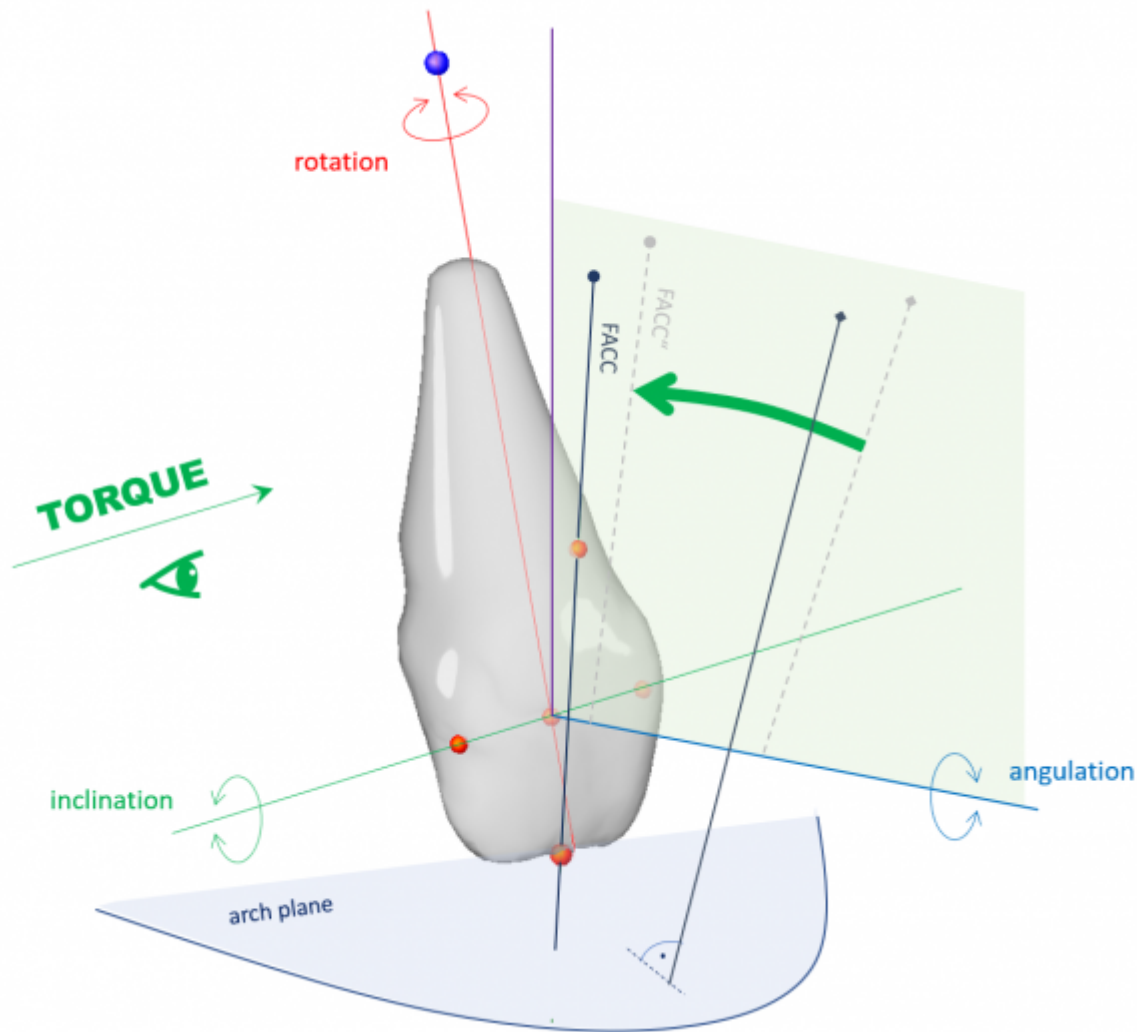
Crown translations [+/-] are measured in mm as displacements along the corresponding crown coordinate axes.

Crown rotation [+/-] is measured in ° as rotation angle around the tooth axis.

Crown Inclination (absolute value) is measured in ° as angle between the surface normal of the jaw reference plane¹ and the projection of the clinical crown axis² into the mid m/d crown plane.

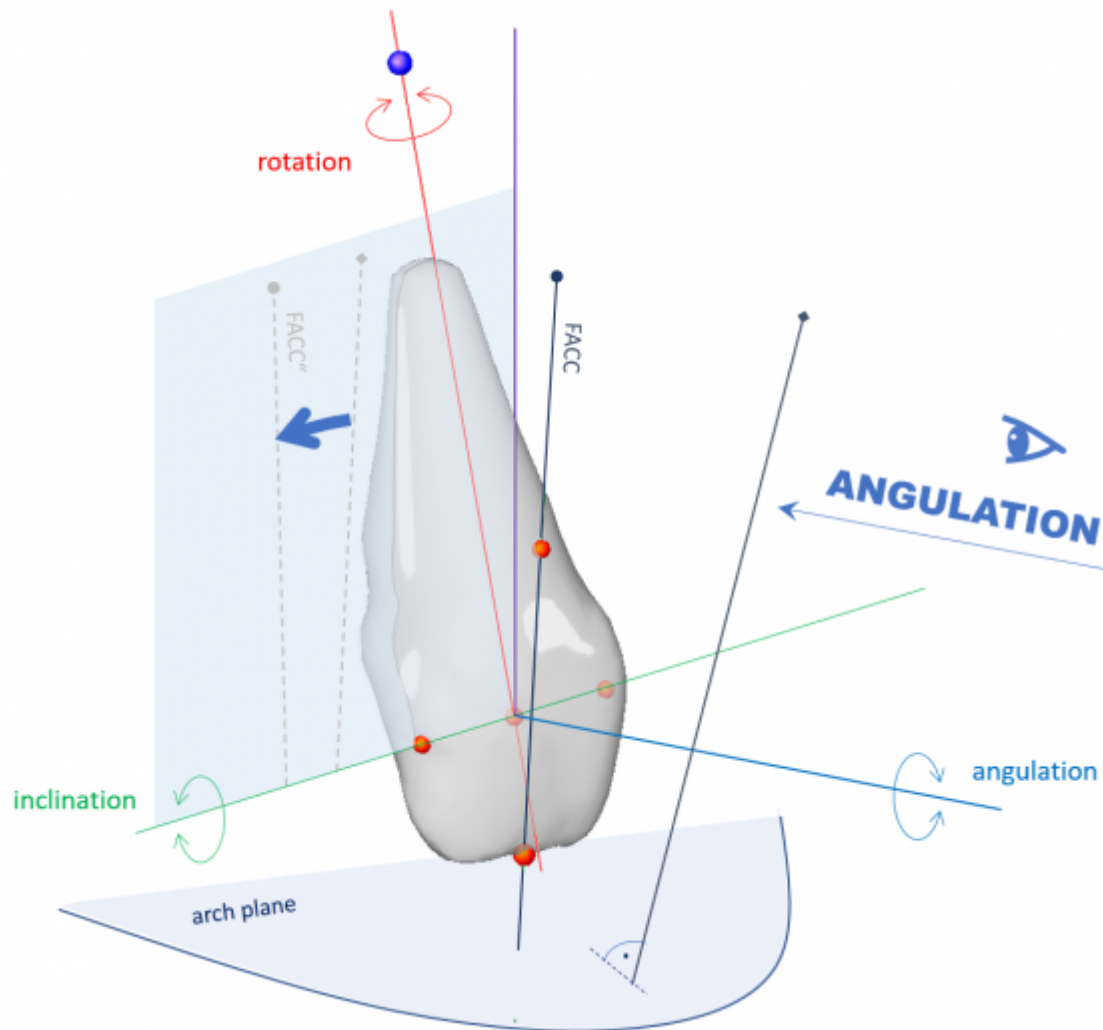
Thus, inclination is defined by individual crown shape and crown alignment related to the dental arch.

Inclination increments [+/-] are measured as difference between two absolute inclination values.



Crown Angulation (absolute value) is measured in ° as angle between the surface normal of the jaw reference plane¹ and the projection of the clinical crown axis² into the m/d crown plane.

Thus, angulation is defined by individual crown shape and crown alignment related to the dental arch. Angulation increments [+/-] are measured as difference between two absolute angulation values.



¹ The reference plane (dental arch plane) is defined by the mid position of the frontal incisors mesial arch points and both of the distal arch points of the most rear molars. When interpreting displayed measured values, it is important to consider the orientation of the reference plane used to calculate these values.

² The Facial Axis Clinical Crown (FACC) is defined along the line between incisal point [resp. mid cusp point position on molars] and gingiva point.

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