OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

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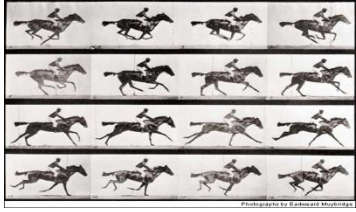
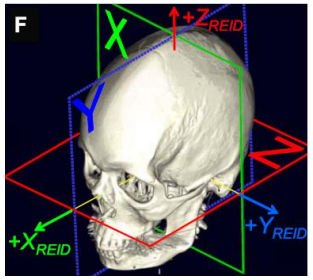
Boston, MA

Wilmington, Delaware and Philadelphia, Pennsylvania, USA

Goal



- Create a 3-D model of the vestibular system to allow visualization of multiple phenomenon.
- Slow motion- simultanous ,rapidy sequential events
- Based on human membranous labyrinth
- Based on known human canal geometry

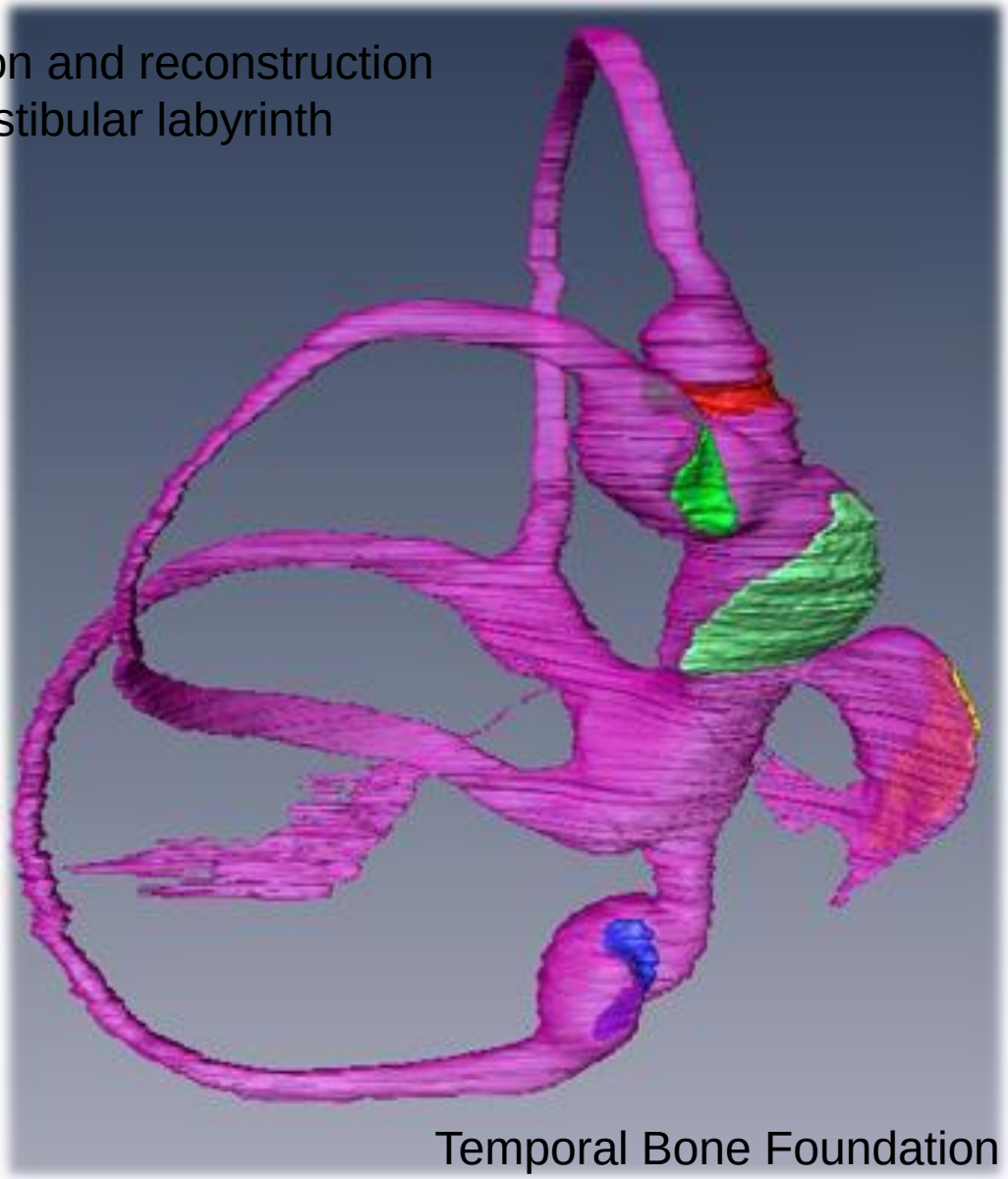


DellaSantina et. al.,*JARO* 6: 191-206, 2005

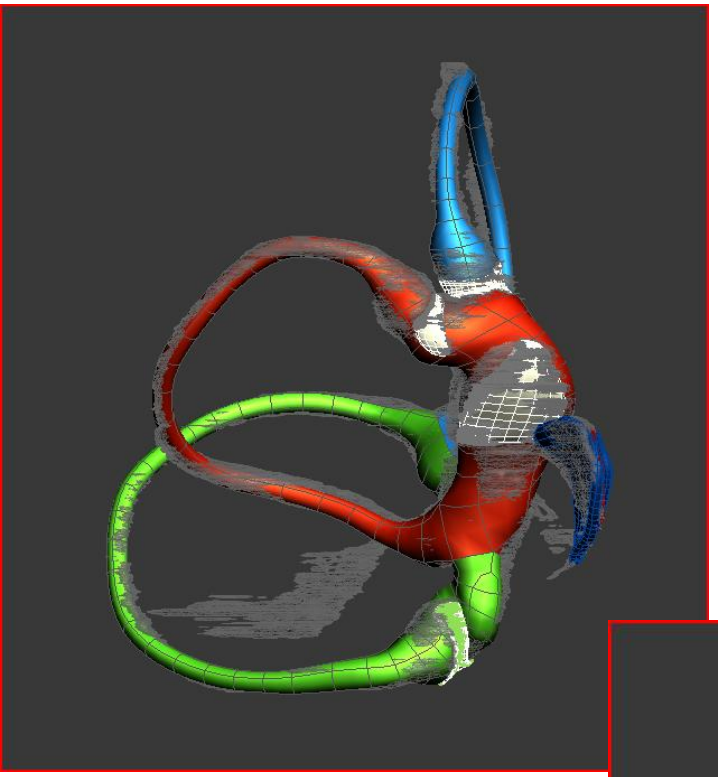
- Easy to use
- Examine currently accepted hypothesis of disease and treatment

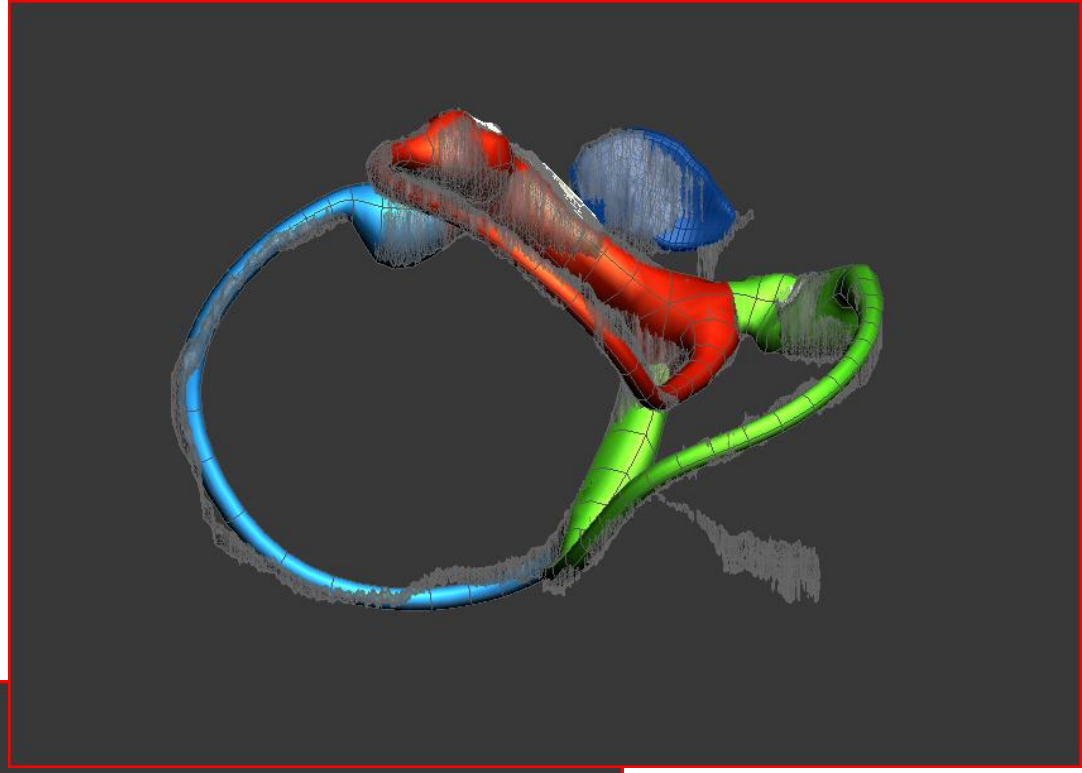
Preliminary Results

100µ segmentation and reconstruction
of human vestibular labyrinth

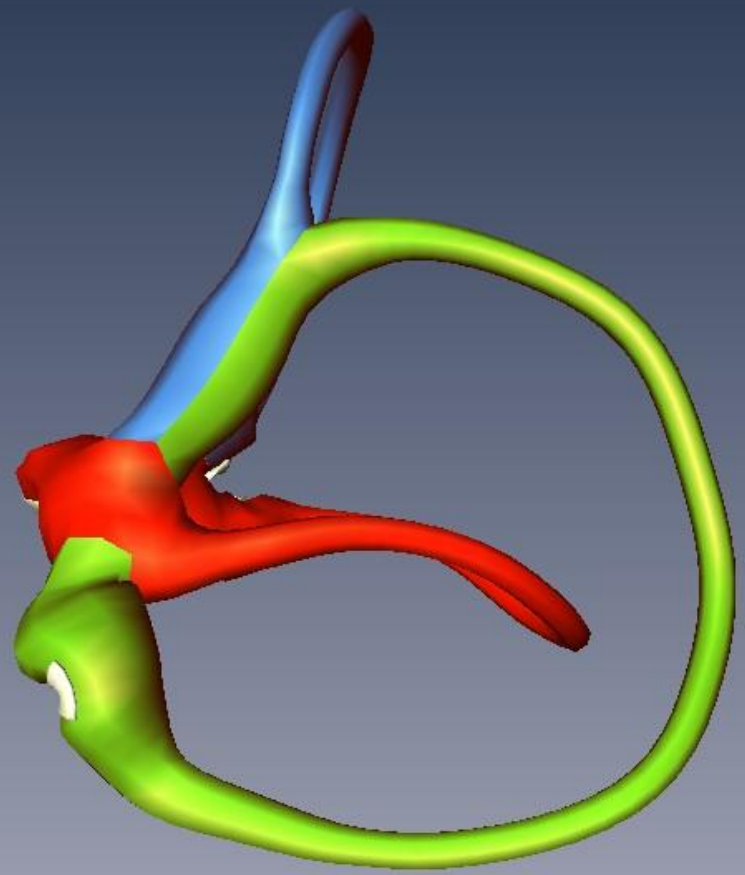


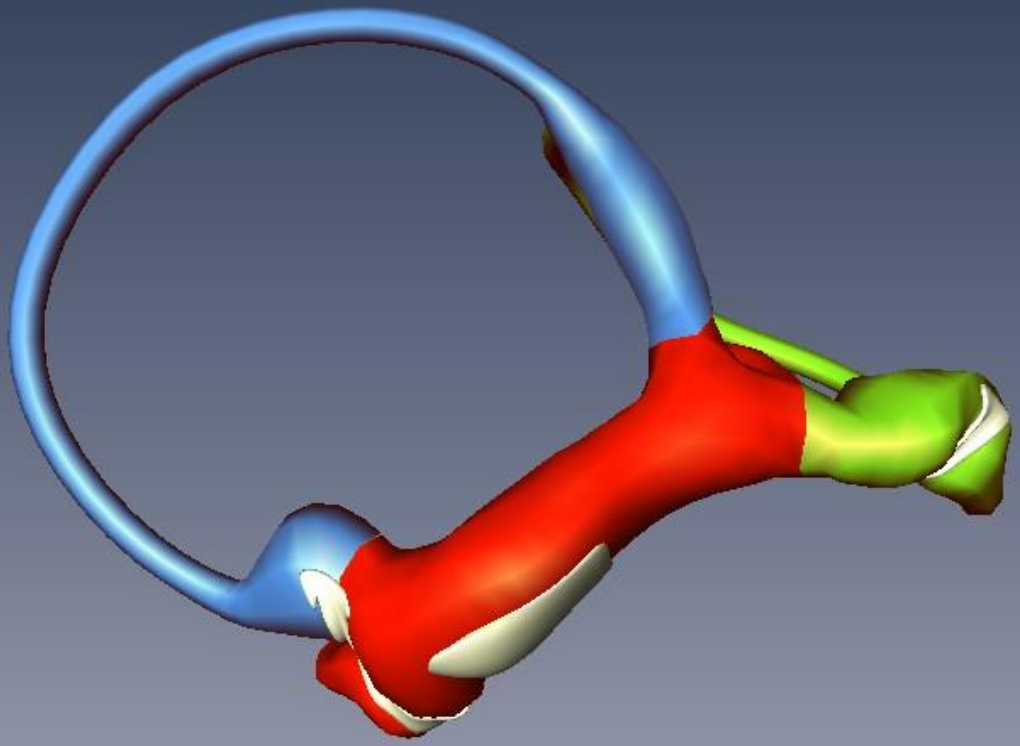
Temporal Bone Foundation
Boston, MA

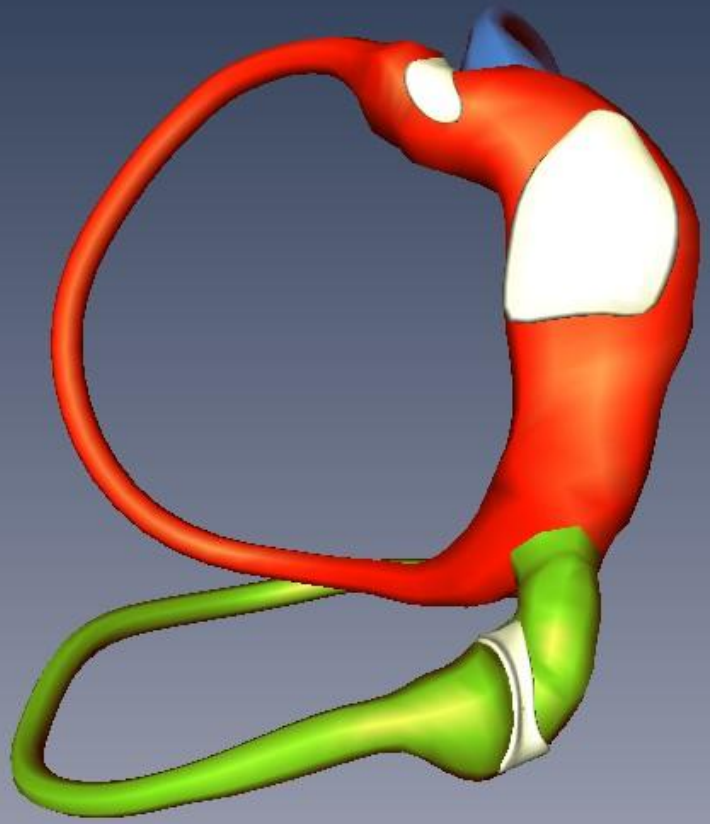




Smoothing and contour averaging using 3DSMax Software (Autodesk Inc. San Rafael,CA).

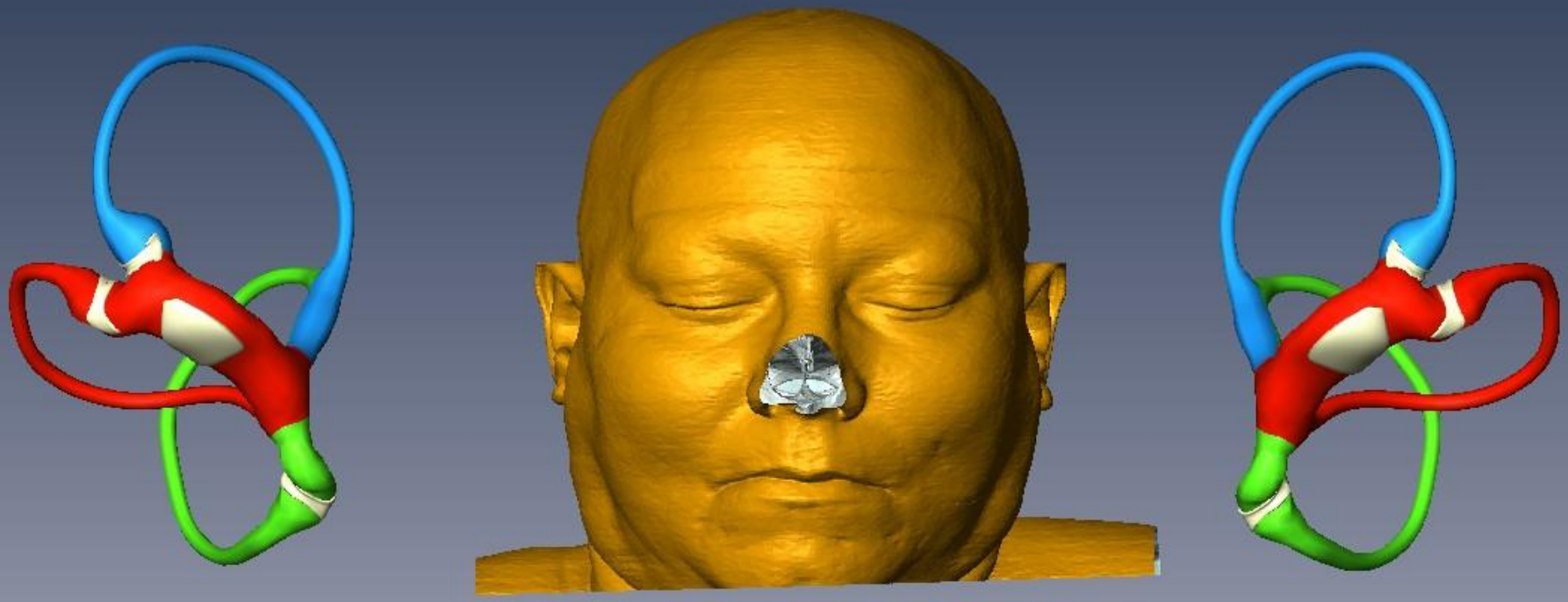




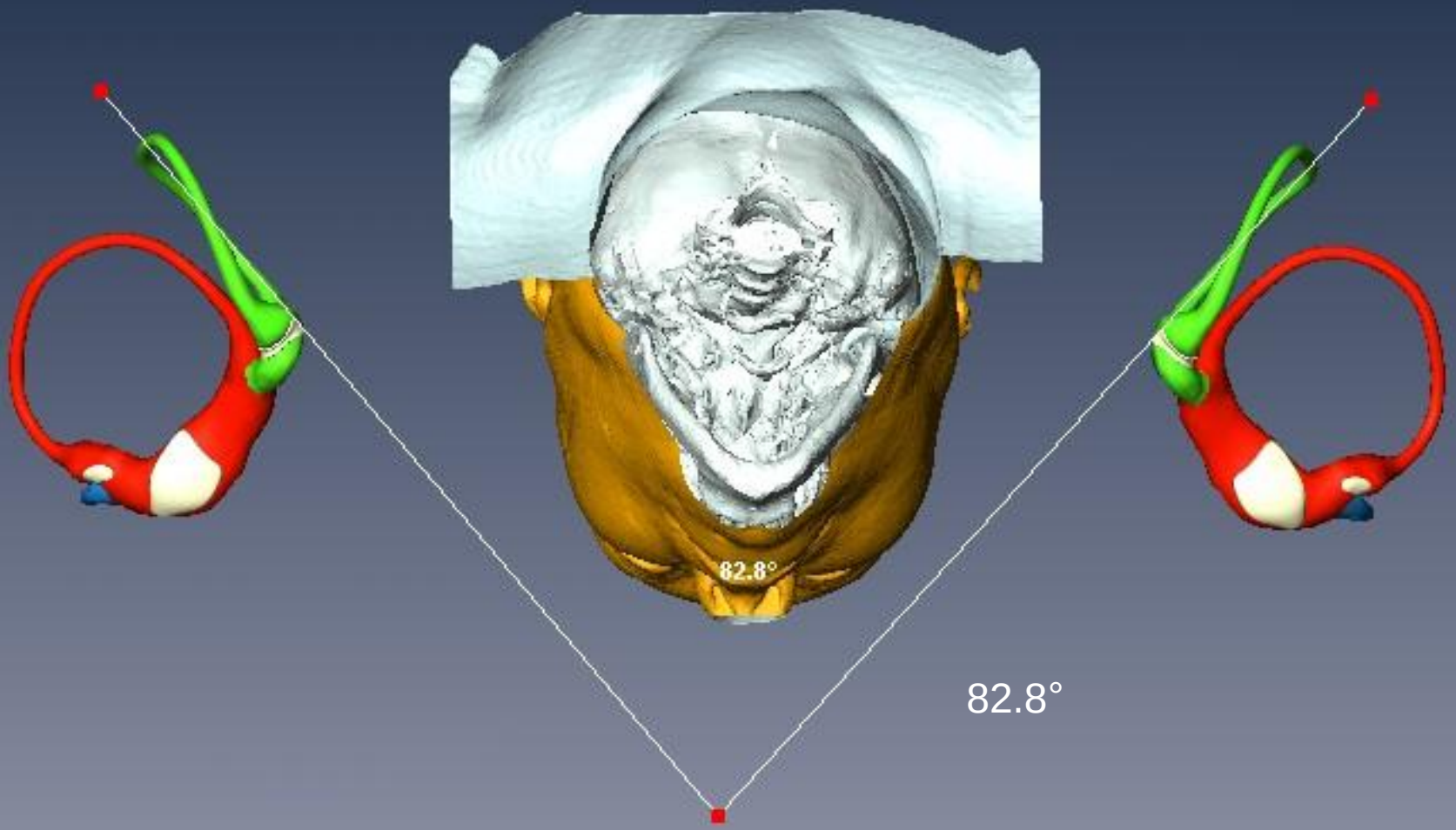


Labyrinth placed in 3D network with MRI based skull anatomy;
Amira 6.5 (Mercury Computer Systems, Chelmsford, MA, USA)

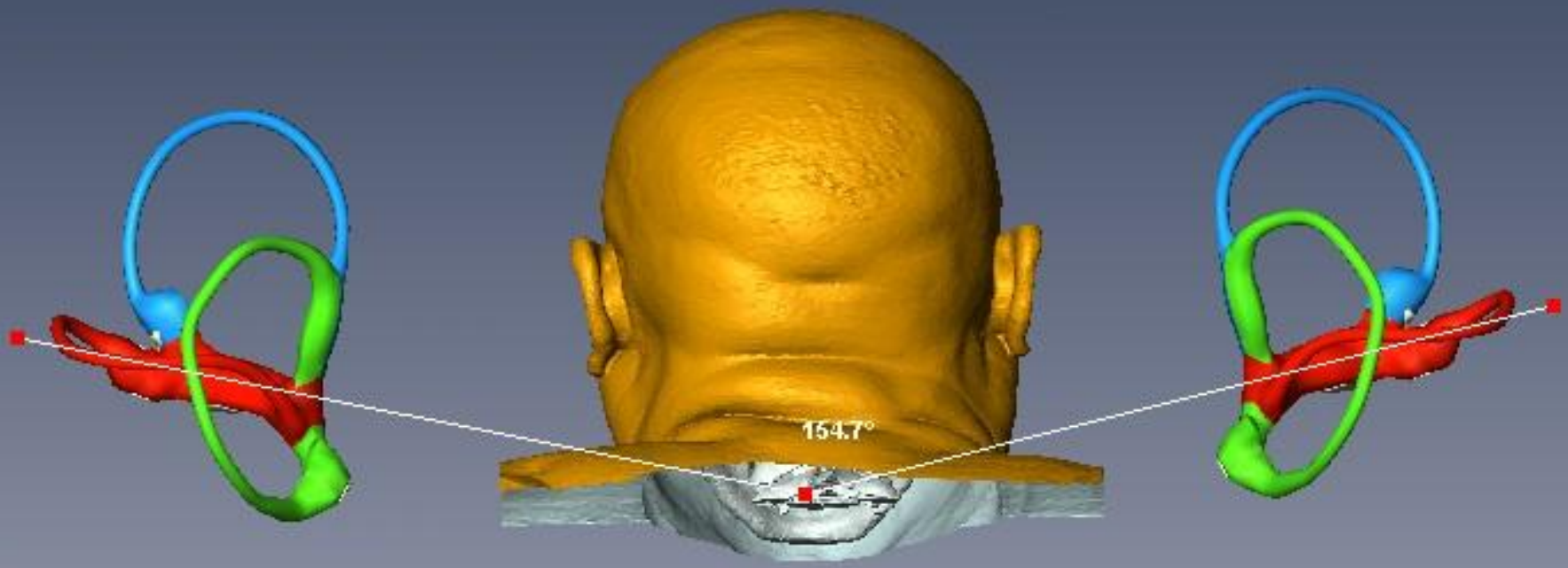
Labyrinth cloned / positioned relative to skull



Skin surface applied

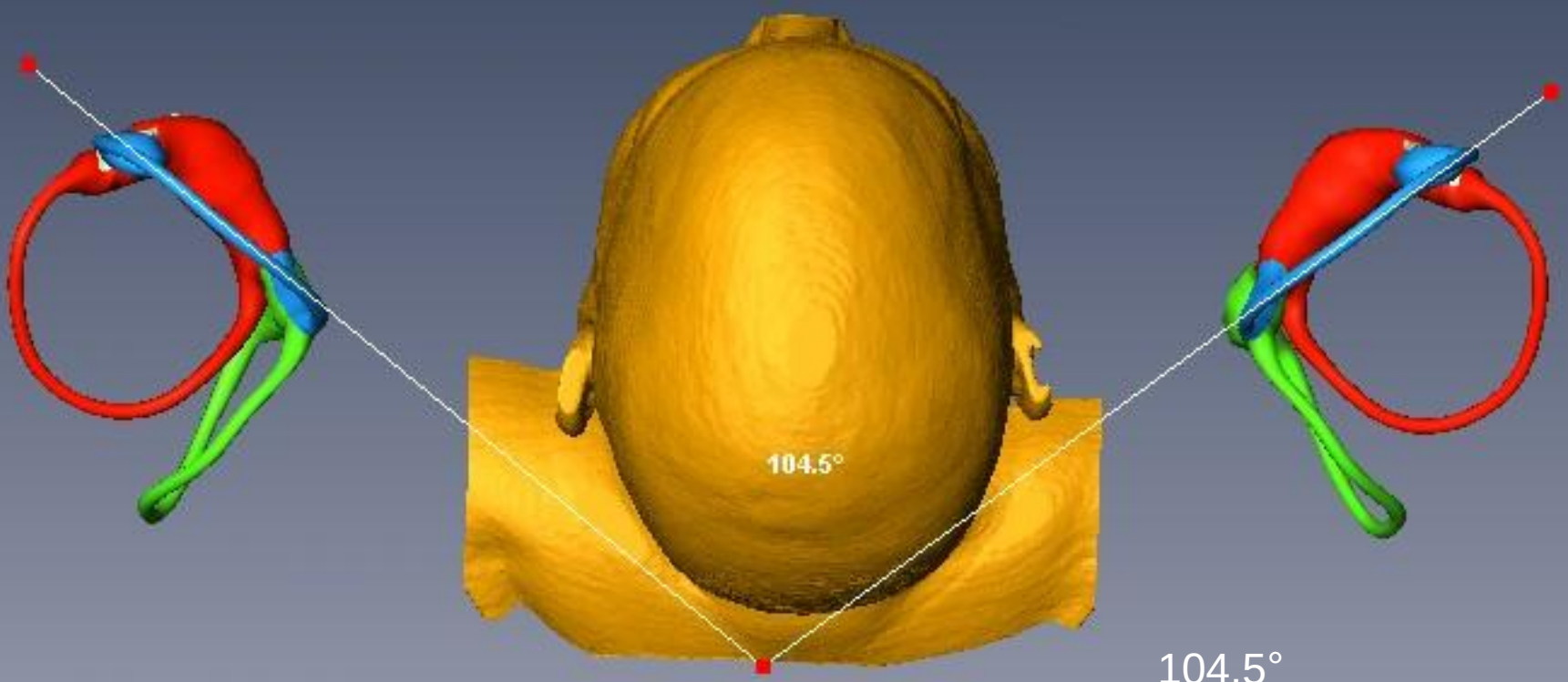


Inter-canal angle alignment



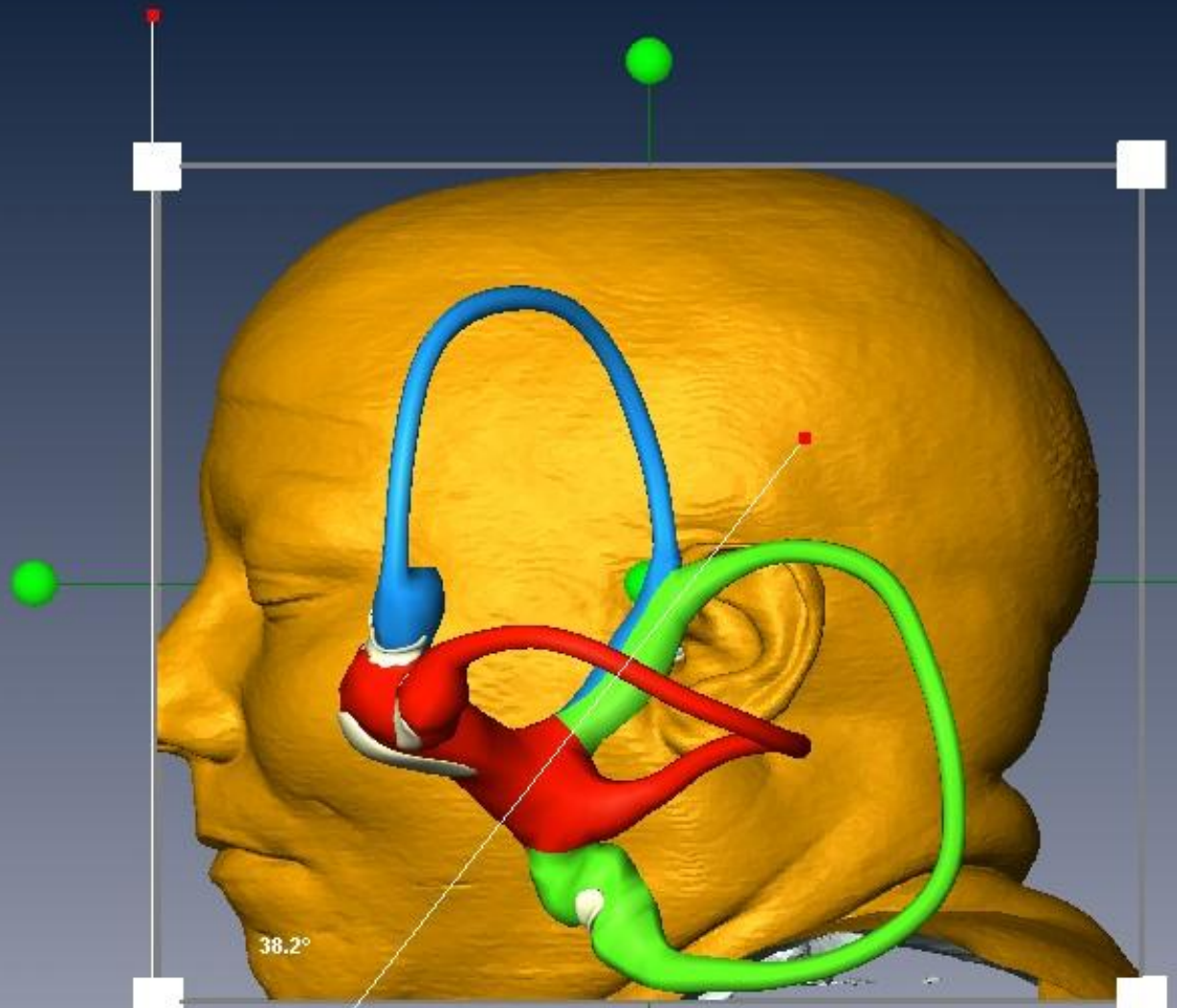
154.7°

Inter-canal angle alignment

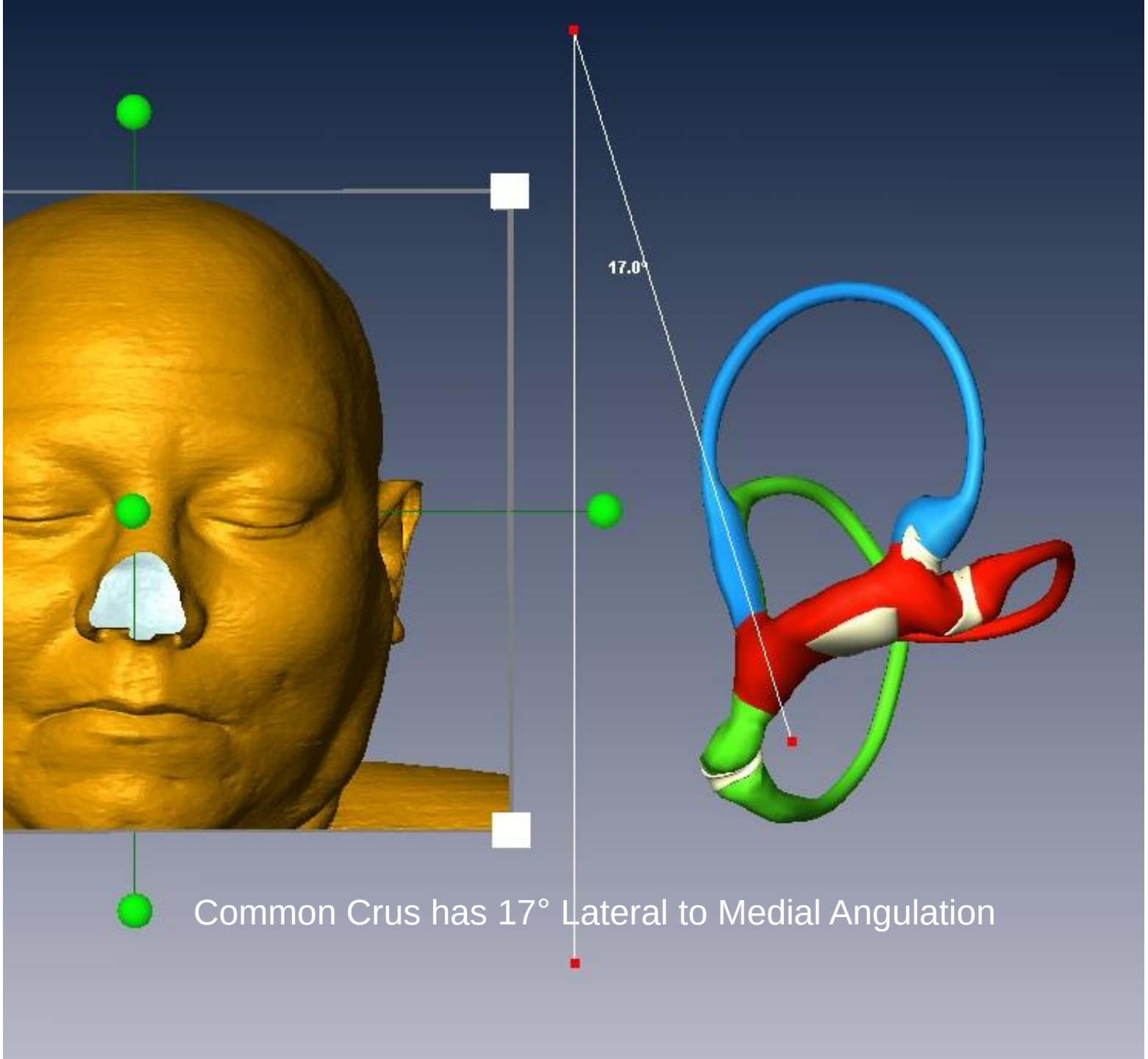


104.5°

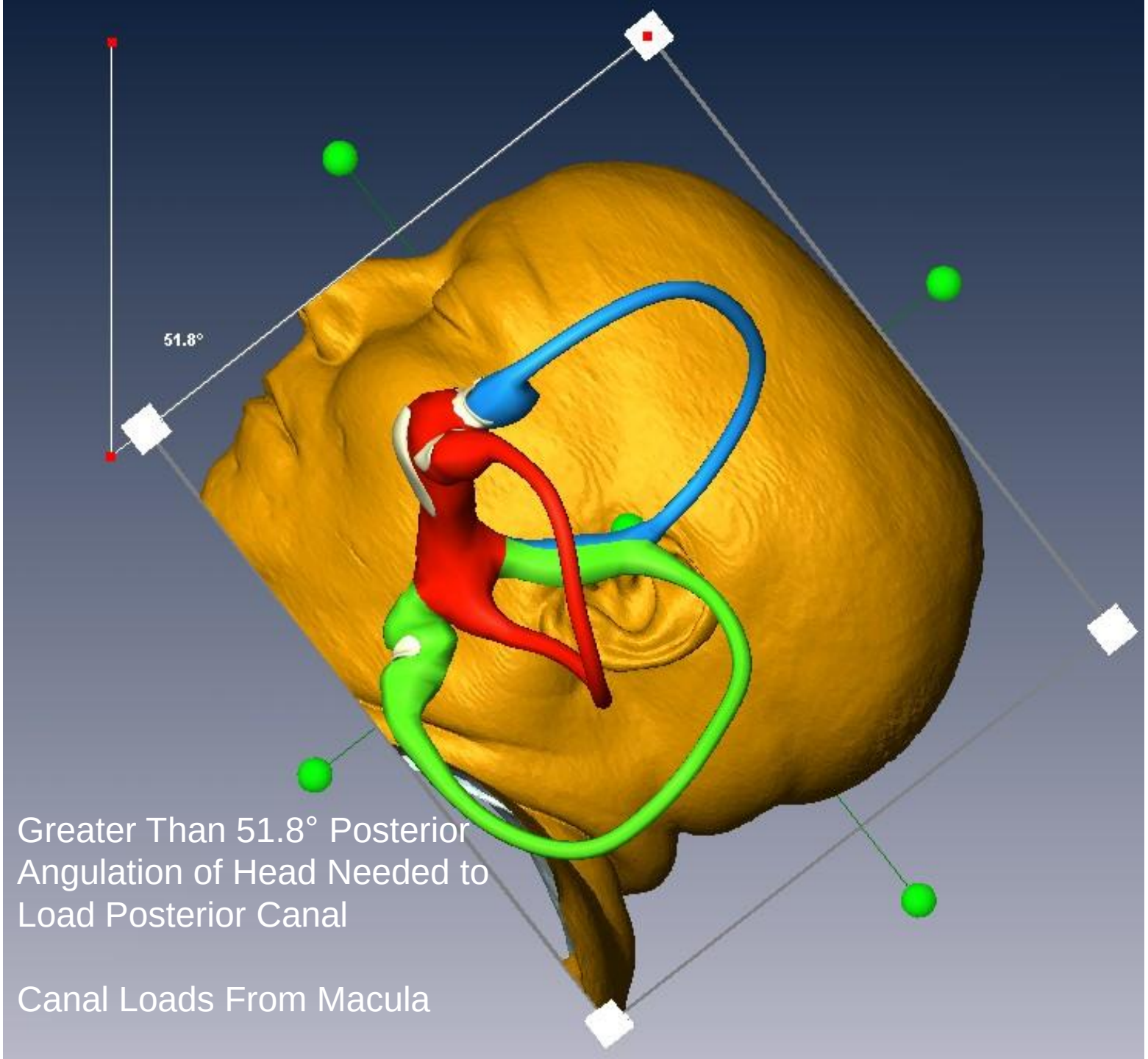
Inter-canal angle alignment



Common Crus has 38° Posterior Angulation

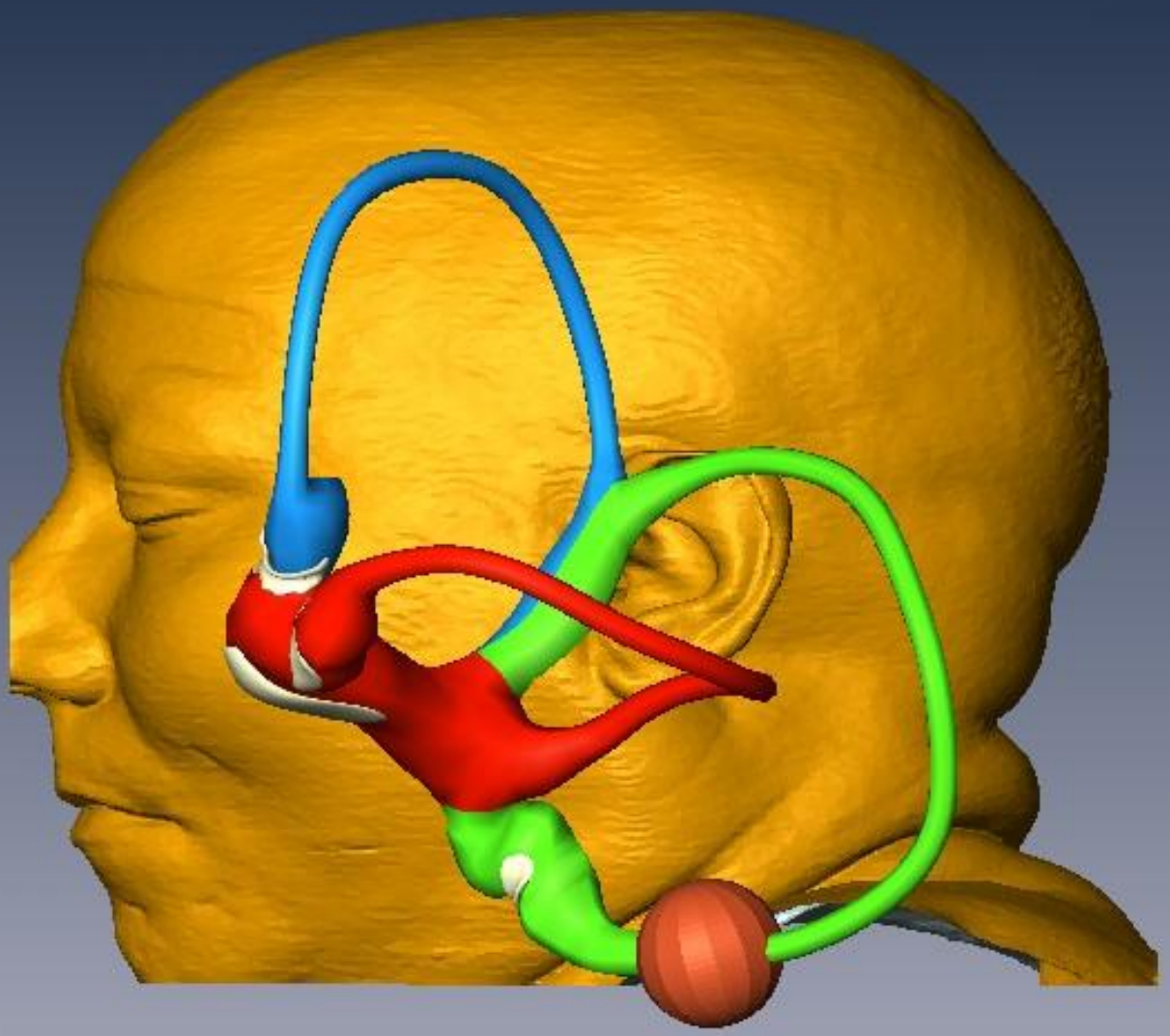


Common Crus has 17° Lateral to Medial Angulation



Greater Than 51.8° Posterior Angulation of Head Needed to Load Posterior Canal

Canal Loads From Macula

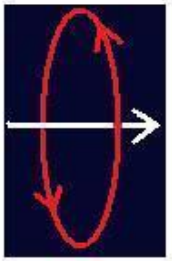


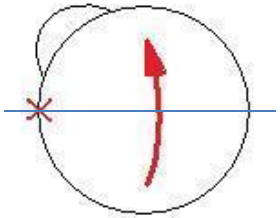
Loaded Posterior Canal
Lower non-Ampulated End of Horizontal Canal
Promotes Canal Emptying

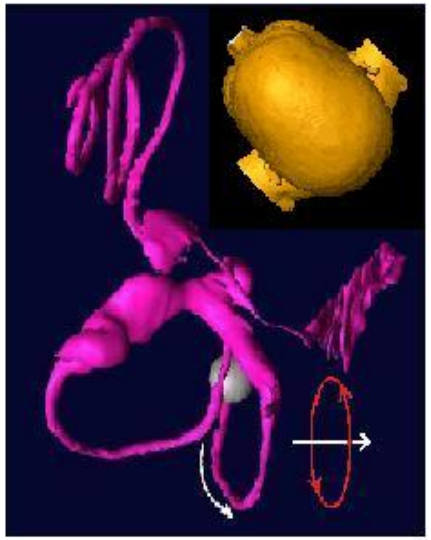
TEIXIDO

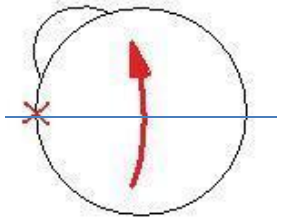
Left Posterior Canalithiasis

1. **Direction of the slow phase is the direction of otolith movement.**
2. **The axis of rotation of the canal determines the axis of rotation of the eye.**



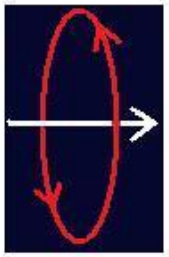


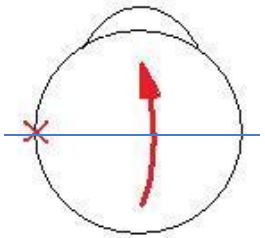


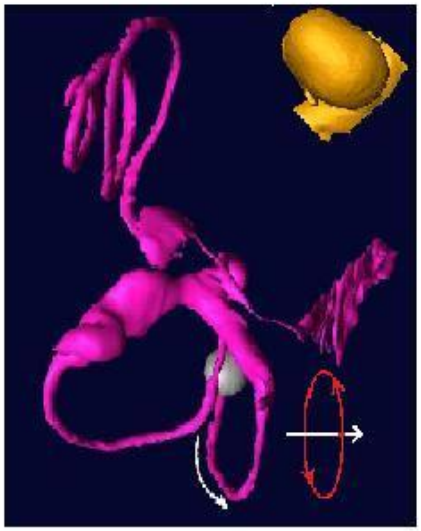


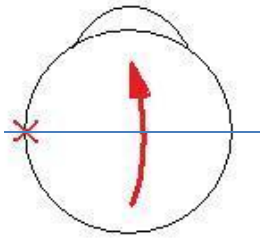
3. **Slow phase is downward and apogeotropic rotary.**
4. **Fast phase is upward and geotropic rotary.**

Left Posterior Canalithiasis Rightward Gaze



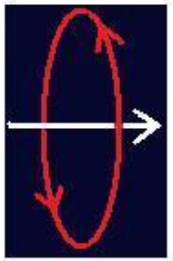


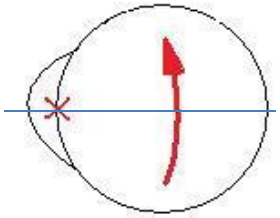


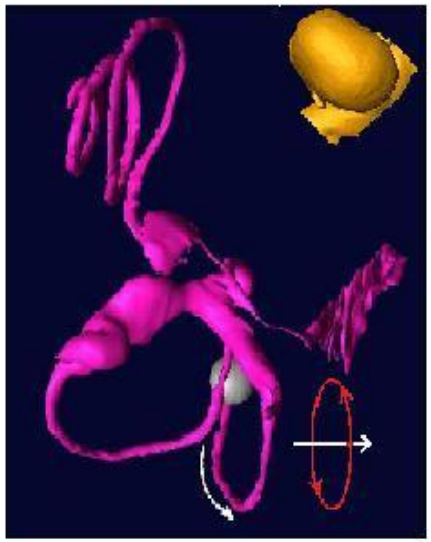


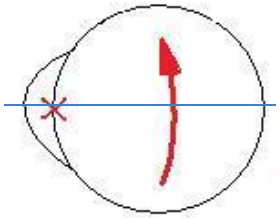
Right gaze during left posterior canal stimulation results in pure downbeat slow phase and upbeat nystagmus.

Left Posterior Canalithiasis
Leftward Gaze









Left gaze during left posterior canal stimulation results in pure torsional apogeotropic slow phase and geotropic nystagmus

Left Posterior Canalithiasis

OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

Diagnostic Considerations:

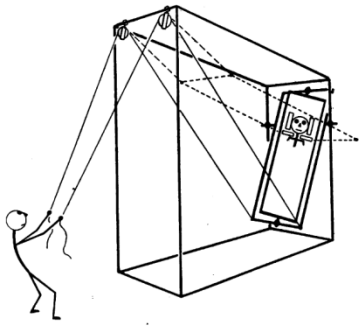
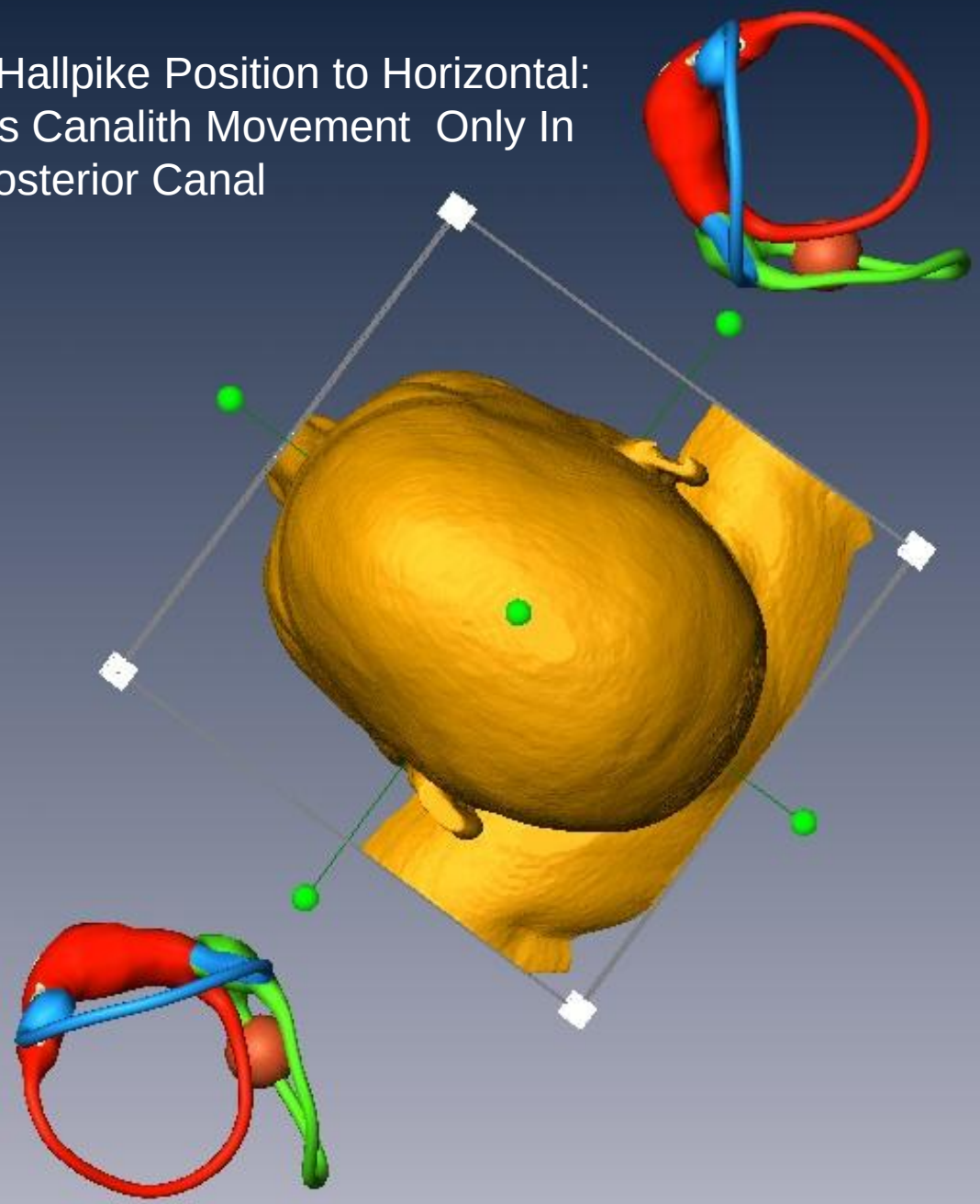


FIG. 7.

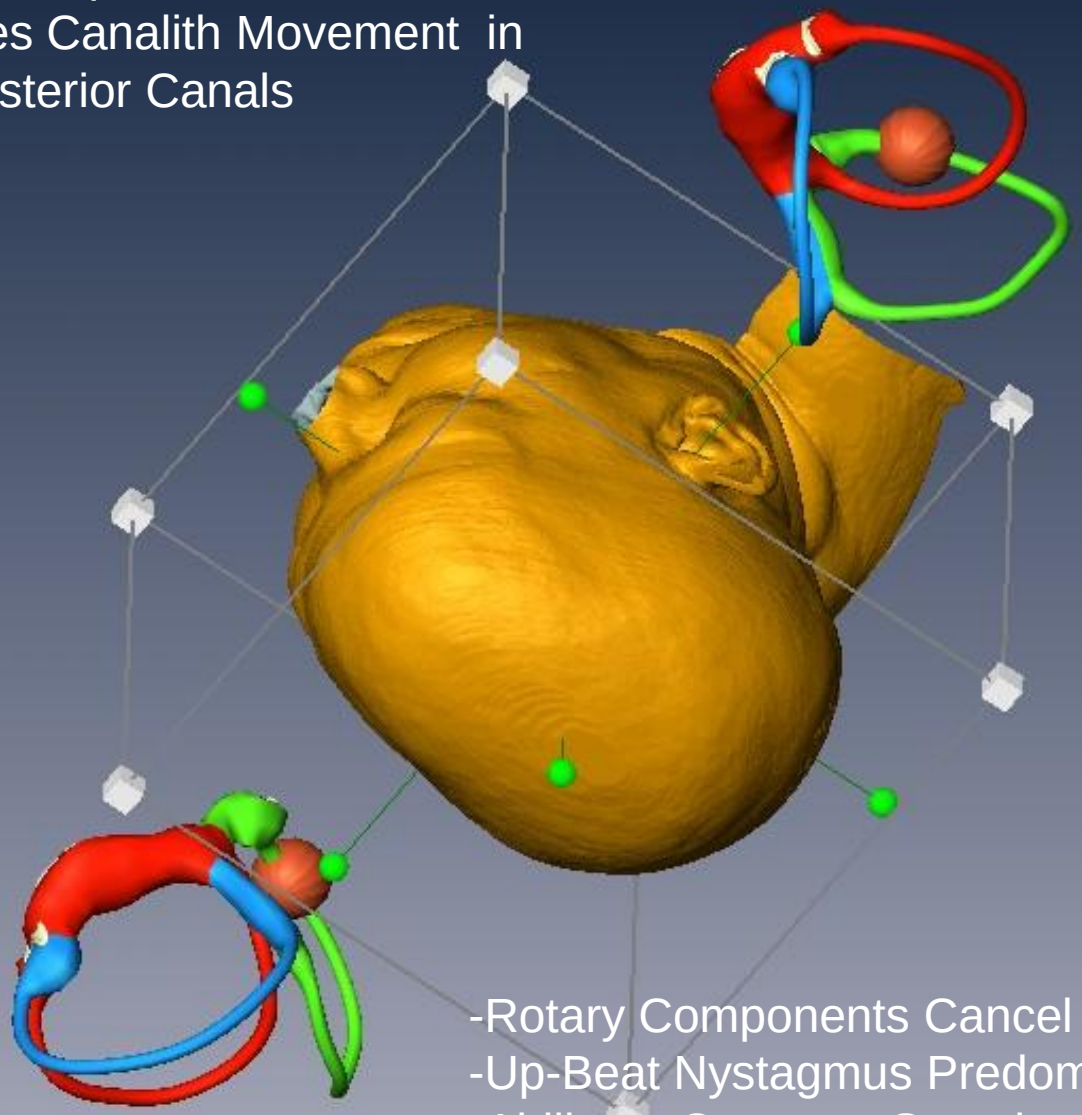
By means of apparatus shown in Fig. 7 it is possible to move the patient *en masse* into the critical position,

Dix, M.R.; Hallpike, C.S.: The pathology, symptomatology and diagnosis of certain common disorders of the vestibular system. Proc. R. Soc. Med. *45:* 341–354 (1952).

Left Dix-Hallpike Position to Horizontal: Promotes Canalith Movement Only In Lower Posterior Canal



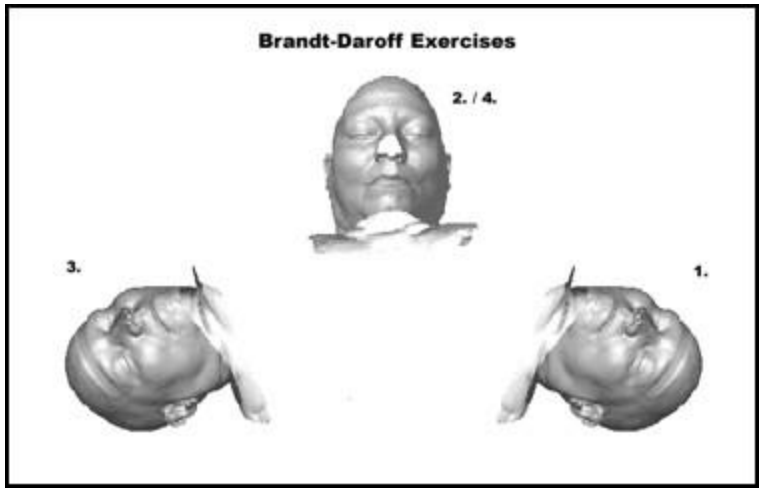
Left Dix-Hallpike Position to Below Horizontal:
Promotes Canalith Movement in
Both Posterior Canals



-Rotary Components Cancel
-Up-Beat Nystagmus Predominates
-Ability to Compare Severity Confounded-
-Superior Canalithiasis in Either Ear May
Confuse Eye Movements

OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

Treatment:
Brandt-Daroff Exercises



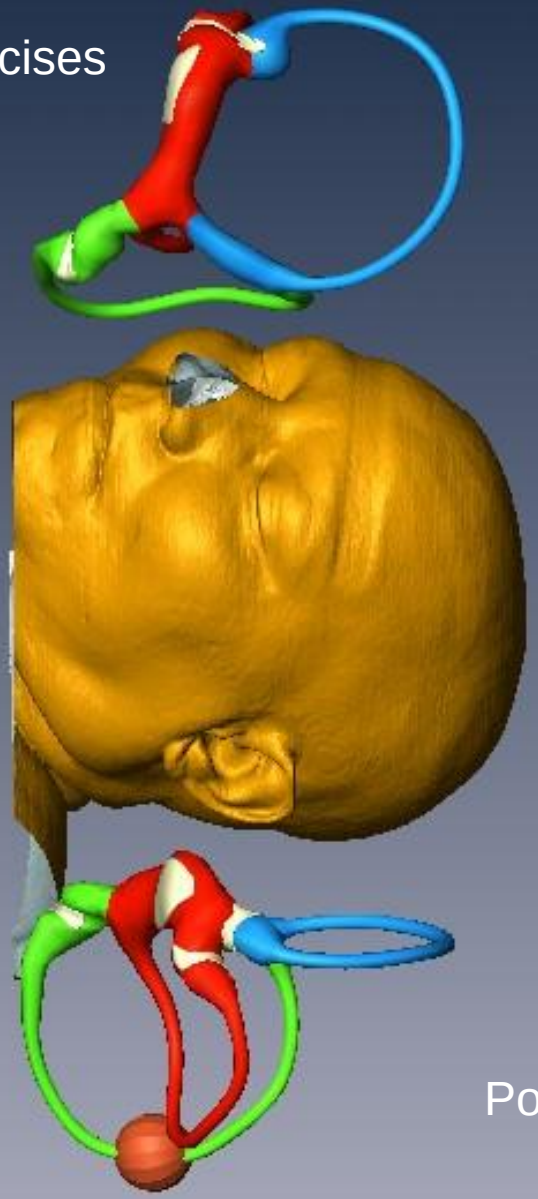
Brandt-Daroff Exercises

Membranous labyrinth from EPL Viewer- http://tbregistry.org/3D_Viewer.htm

Brandt-Daroff Exercises

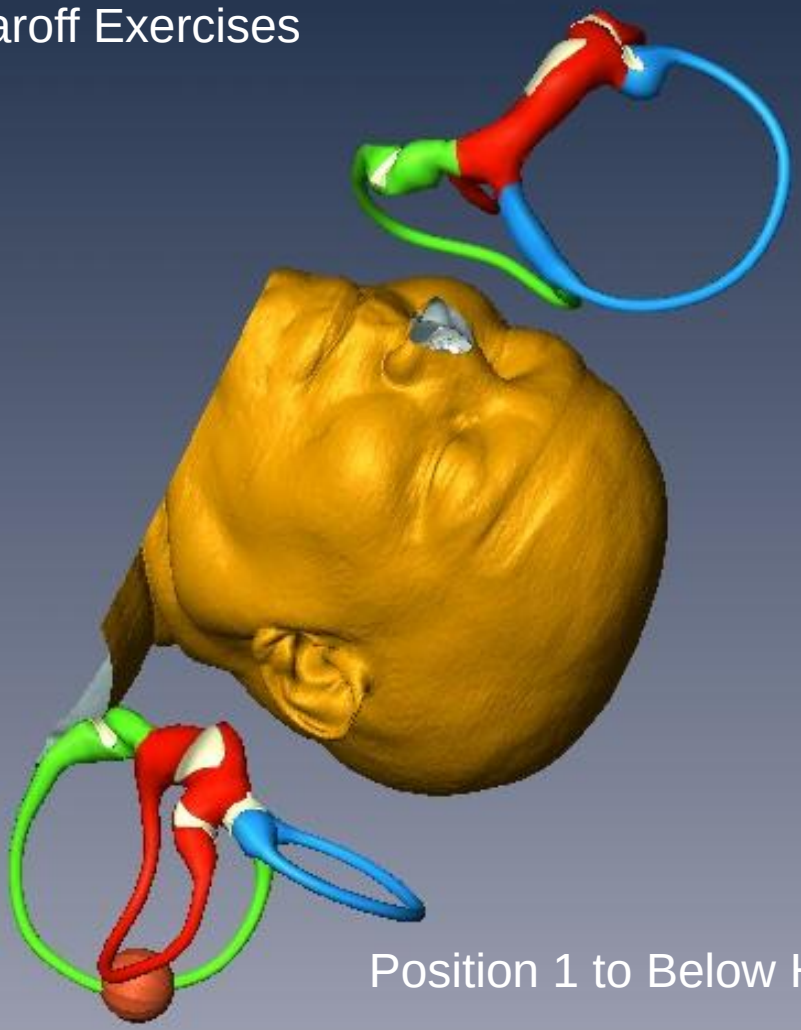
Neutral Position: Left Posterior Canal Canalithiasis

Brandt-Daroff Exercises



Position 1

Brandt-Daroff Exercises

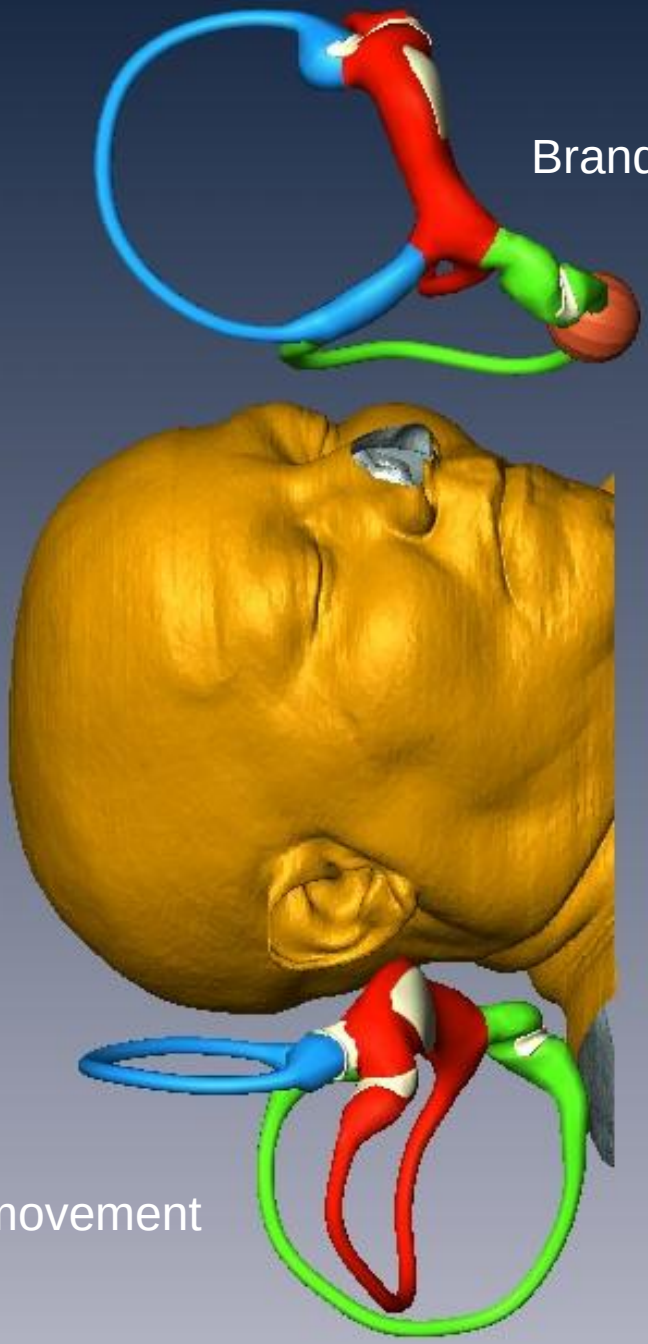


Position 1 to Below Horizontal

Brandt-Daroff Exercises

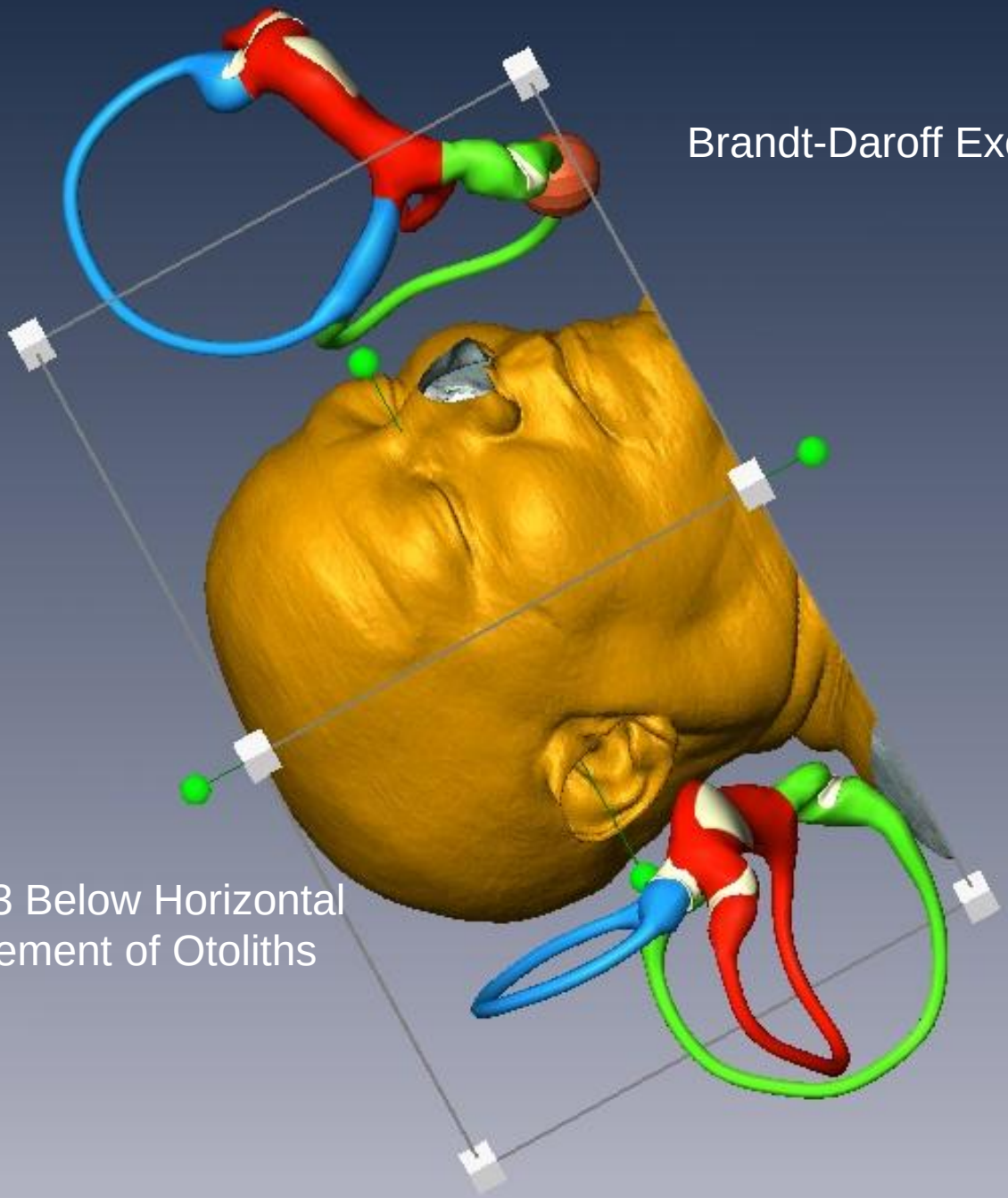
Position 2 - Neutral

Brandt-Daroff Exercises



Position 3 – No movement

Brandt-Daroff Exercises



Position 3 Below Horizontal
Displacement of Otoliths

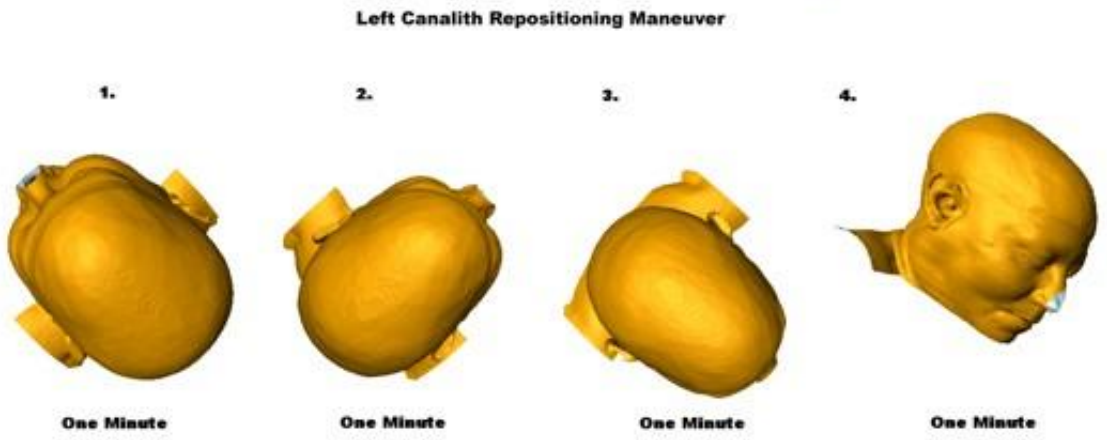
Brandt-Daroff Exercises

- Head hanging below horizontal enhances treatment of posterior canal disease

OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

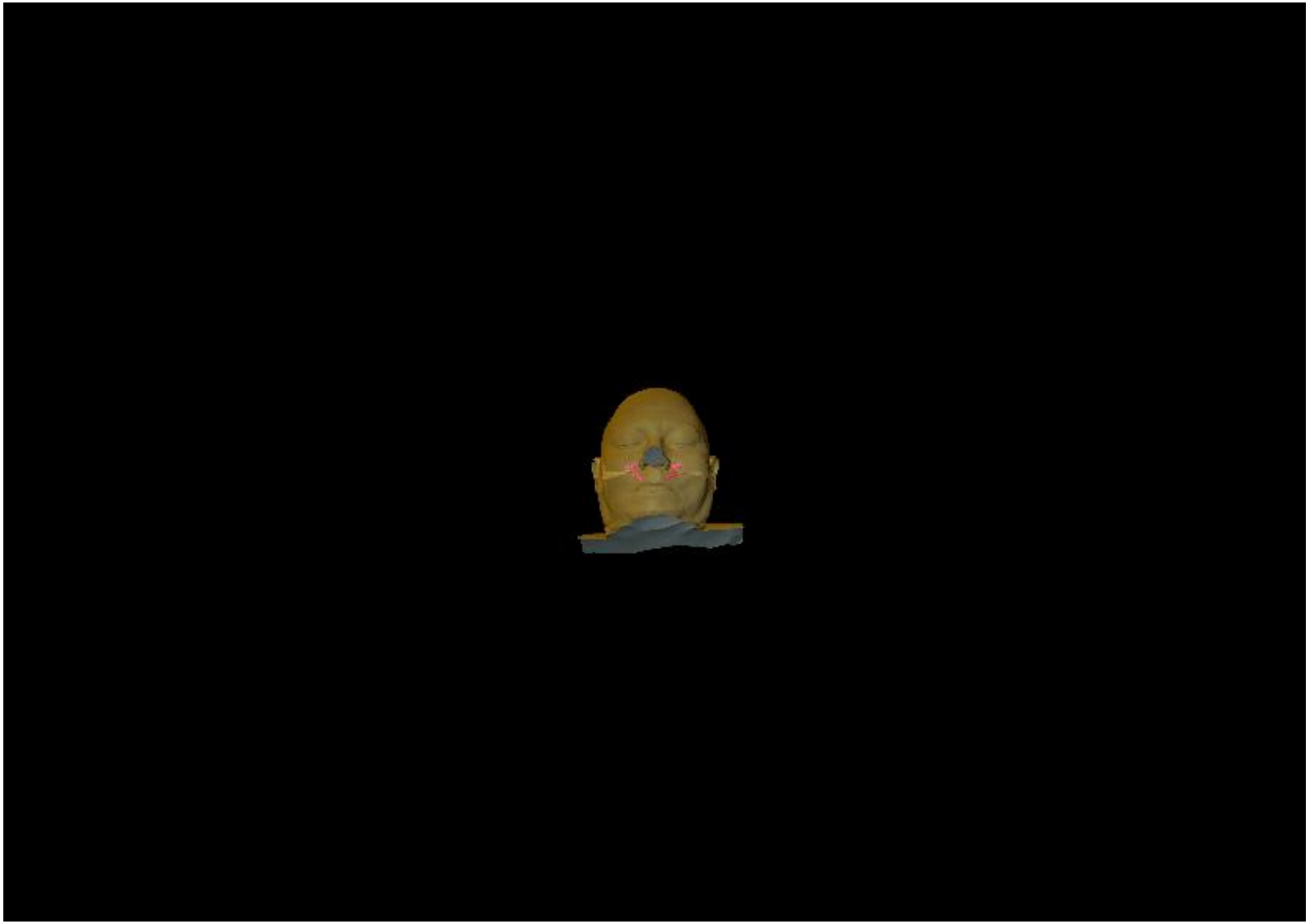
Treatment:
Canalith Repositioning

EPLEY, J.M. 1992. The canalith repositioning procedure: for treatment of benign paroxysmal positional vertigo. Otolaryngol. Head Neck Surg. **107: 399–404.**



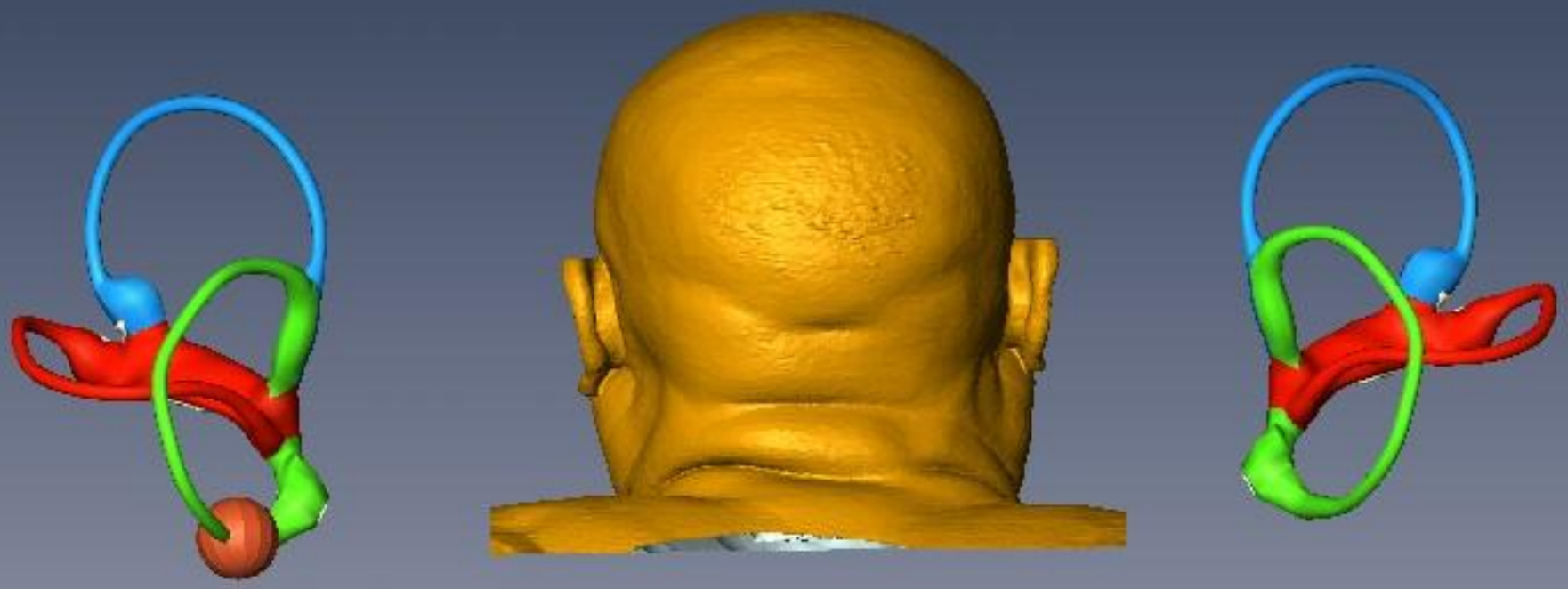
CRP-Left Posterior Canalithiasis

Canalith Repositioning Procedure



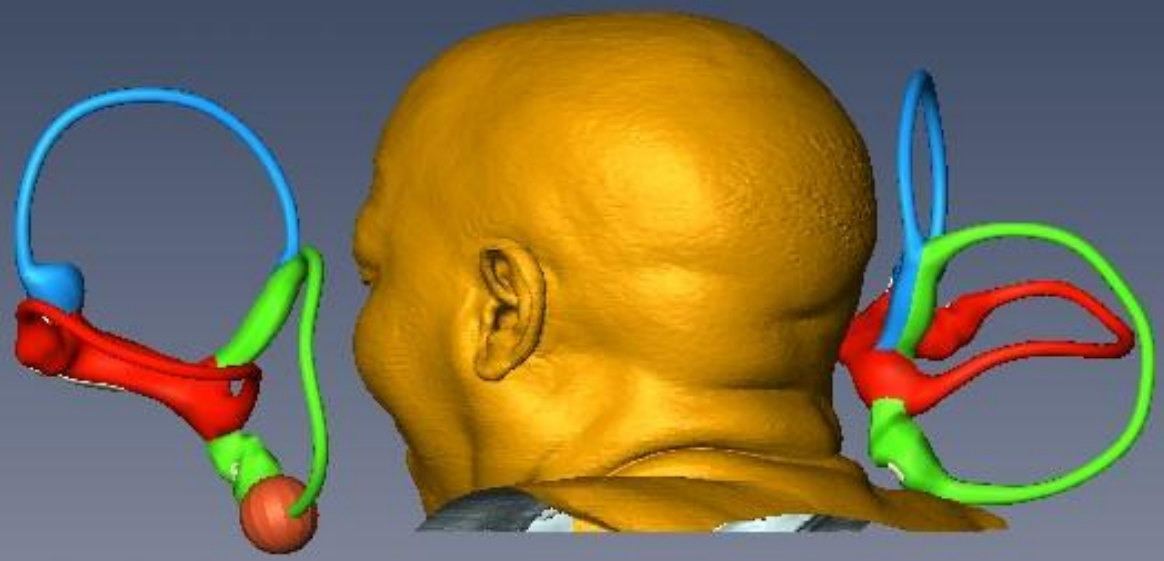
Membranous labyrinth from EPL Viewer- http://tbregistry.org/3D_Viewer.htm

Canalith Repositioning



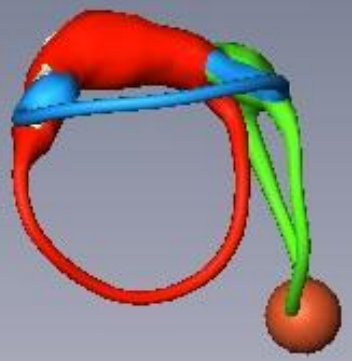
Left Posterior Canalithiasis Neutral Position

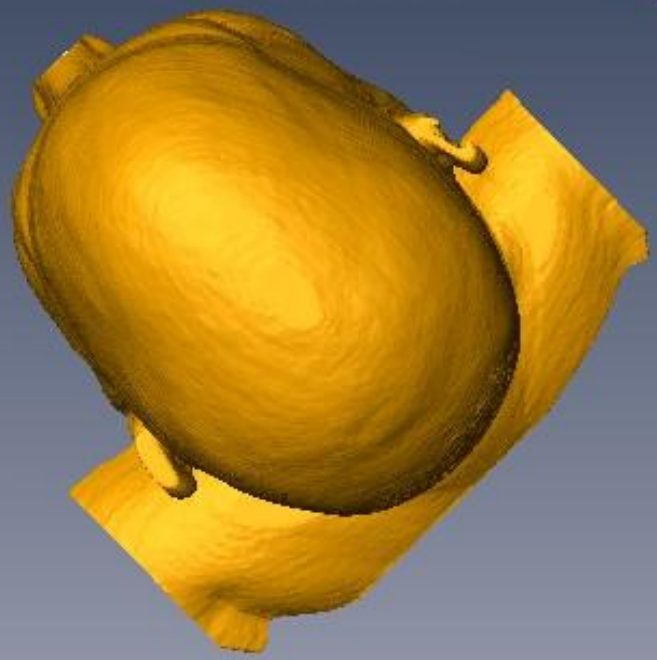
Canalith Repositioning

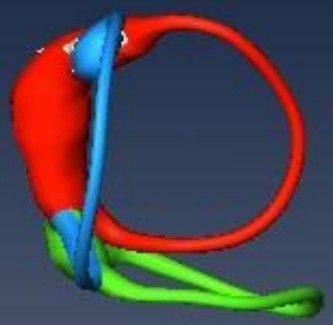


Preparation for Position 1

Canalith Repositioning

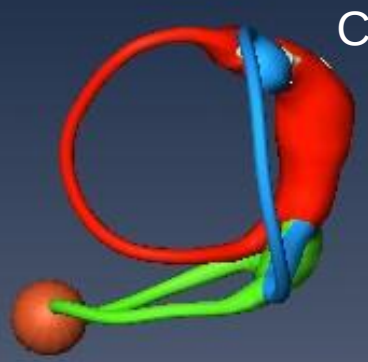


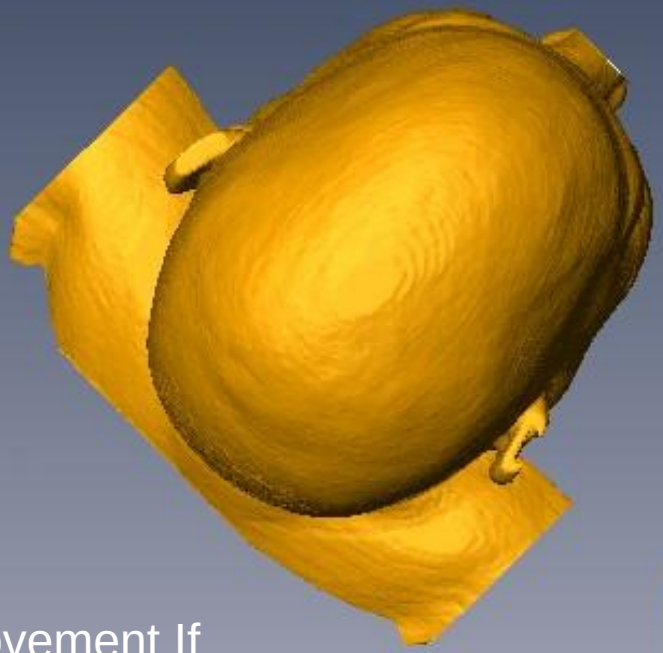


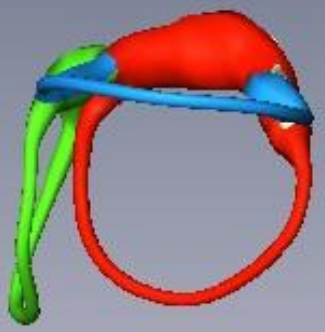


Position 1 to Horizontal

Canalith Repositioning

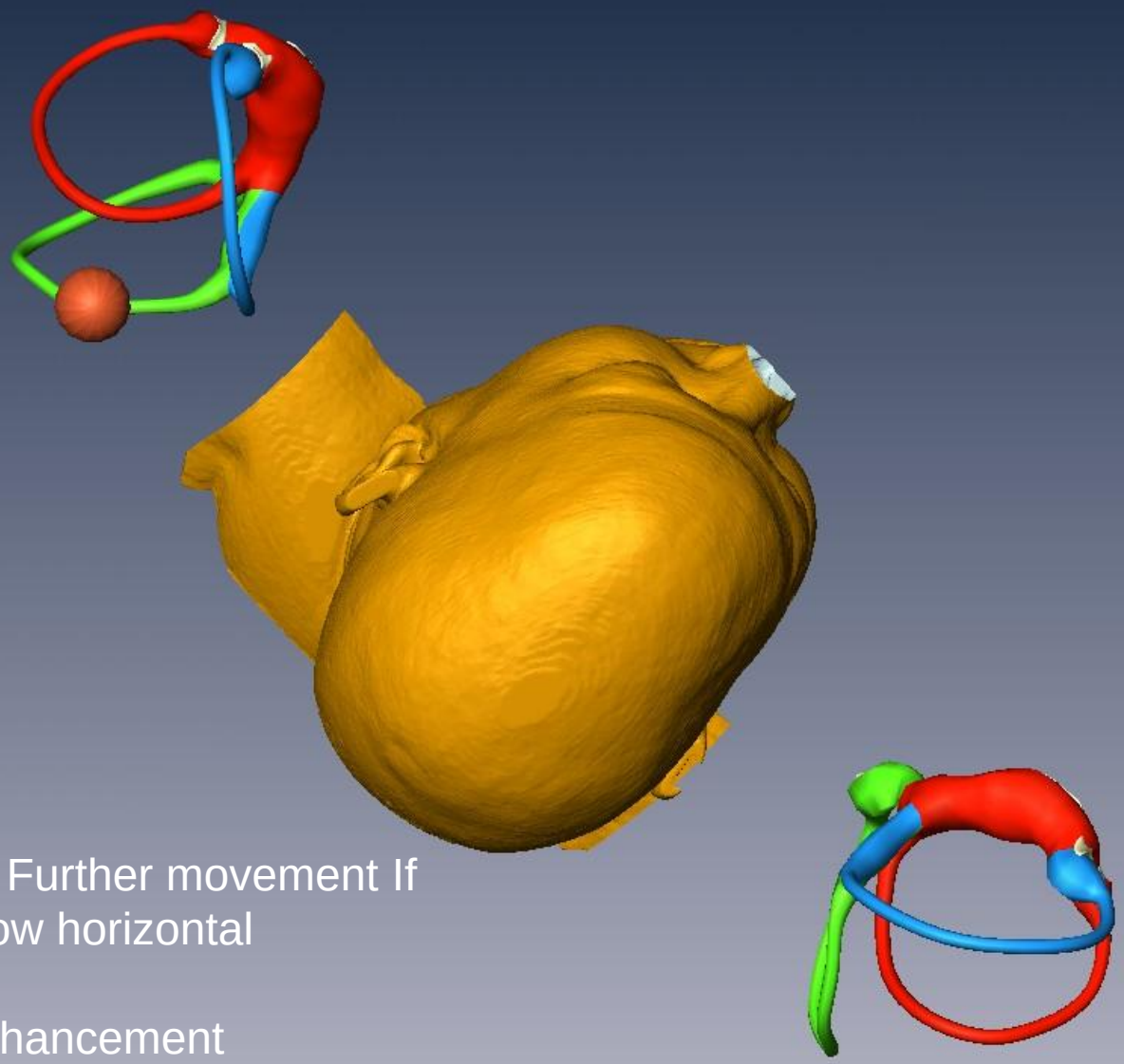






Position 2 – No Movement If Head horizontal

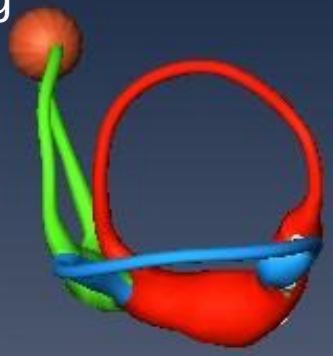
Optional

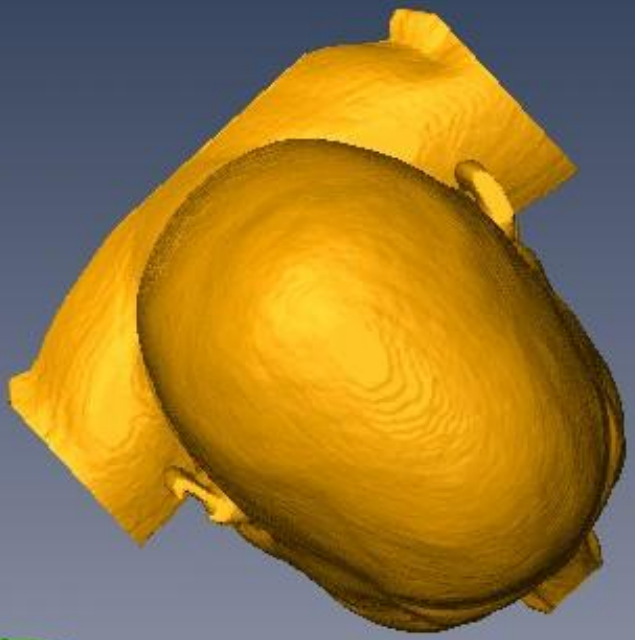


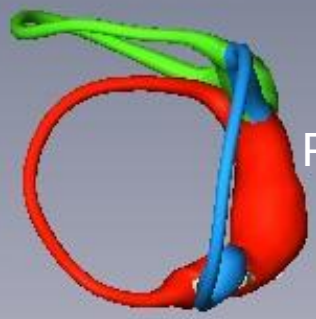
Position 2 – Further movement If Below horizontal

enhancement

Canalith Repositioning

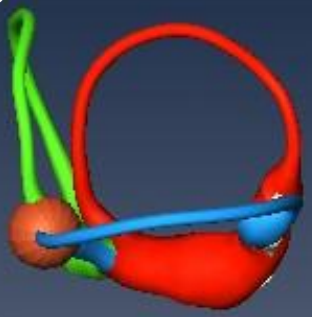


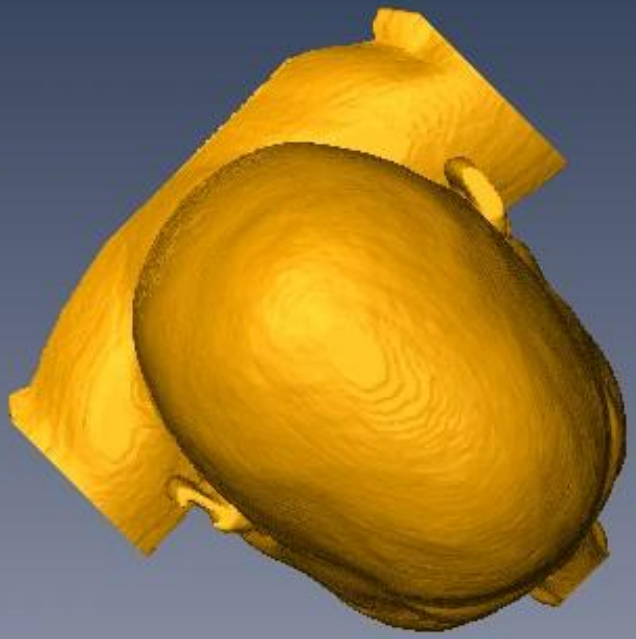


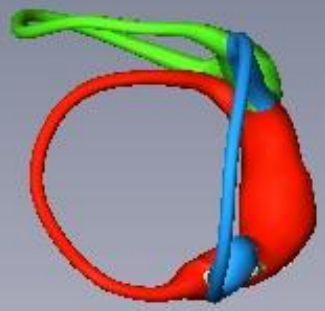


Position 3 – Otoliths Advance to Common Crus

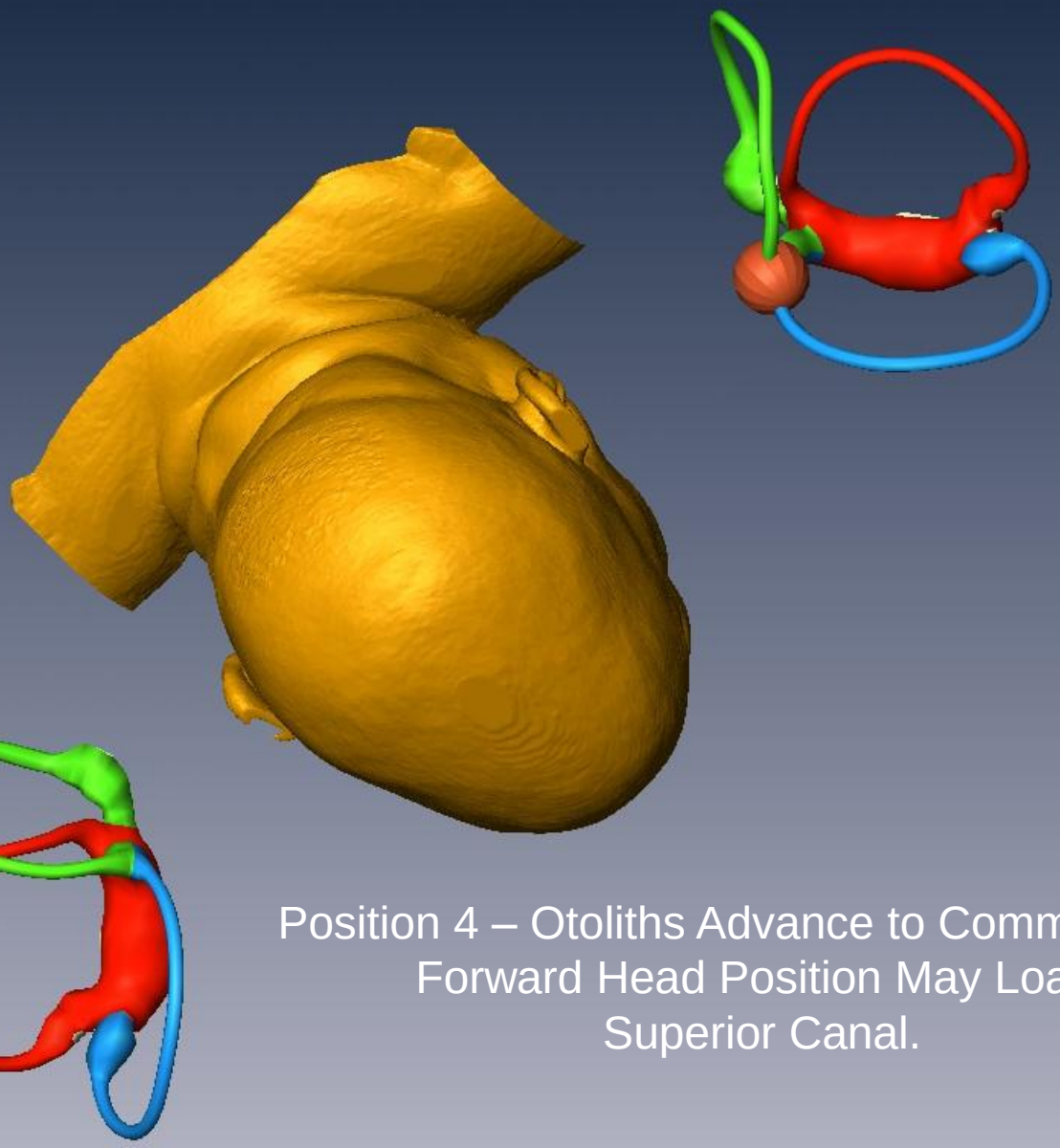
Canalith Repositioning





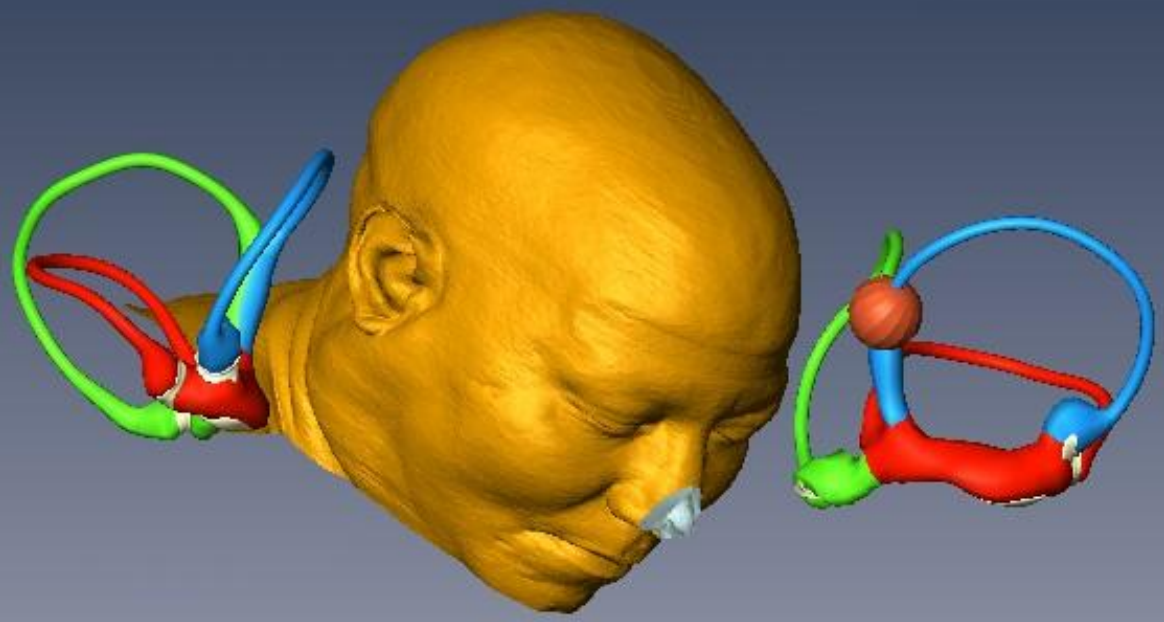


Position 4 – Otoliths Advance to Common Crus
Forward Head Position May Load
Superior Canal



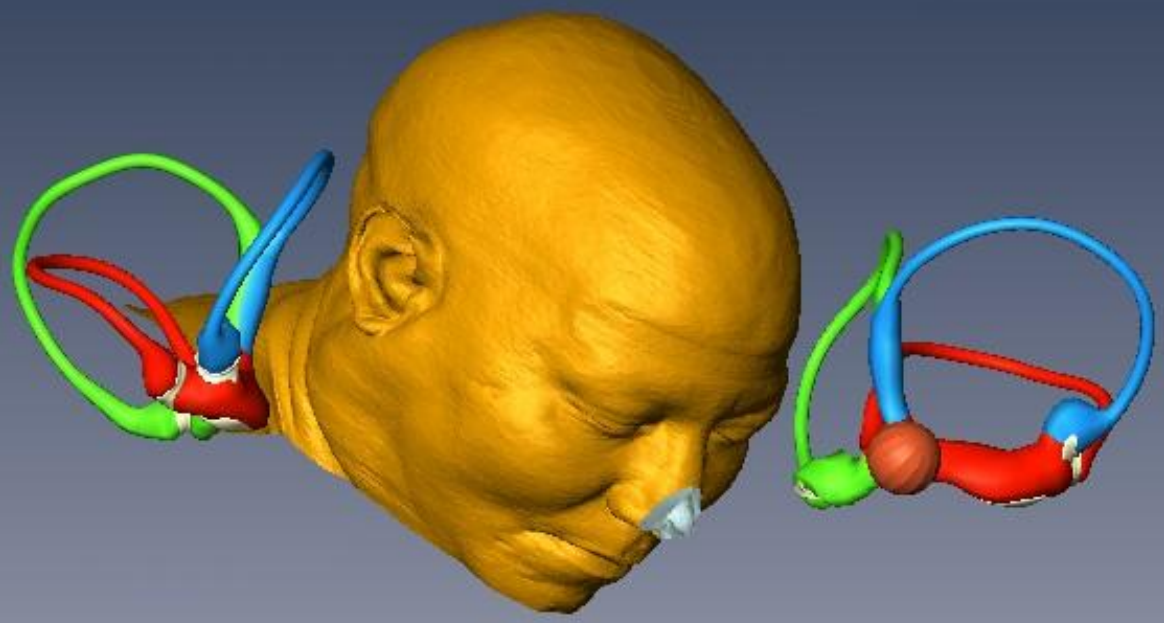
Position 4 – Otoliths Advance to Common Crus
Forward Head Position May Load
Superior Canal.

Canalith Repositioning



Position 5 – Otoliths Advance to Utricle

Canalith Repositioning



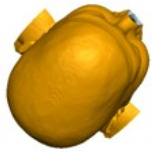
Position 5 – Otoliths Advance to Utricle
Forward Head Position Brings Common Crus Upright
But May Risk Loading Superior Canal

Canalith Repositioning

Repositioning Complete

Canalith Repositioning Observations:

- Hanging head below horizontal is not essential for success but is an enhancement

-Position 2  is optional

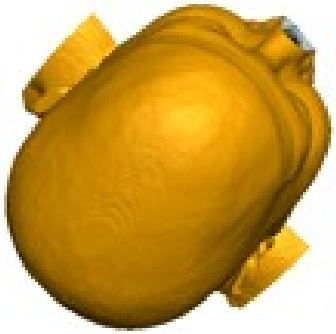
-Forward head tilt in position 3 may risk loading superior canal

-Excessive time in position 3 may increase risk of loading superior canal

-Upright position in position 4 may decrease risk of superior canal loading

Canalith Repositioning Recommended Treatment:

1- Head Hanging



2- Head Hanging (Optional)

3- Avoid Forward Head Tilt/Excess Time

4- Head Upright Wait 1 Minute To Retest

OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

Treatment:

Liberatory Maneuver

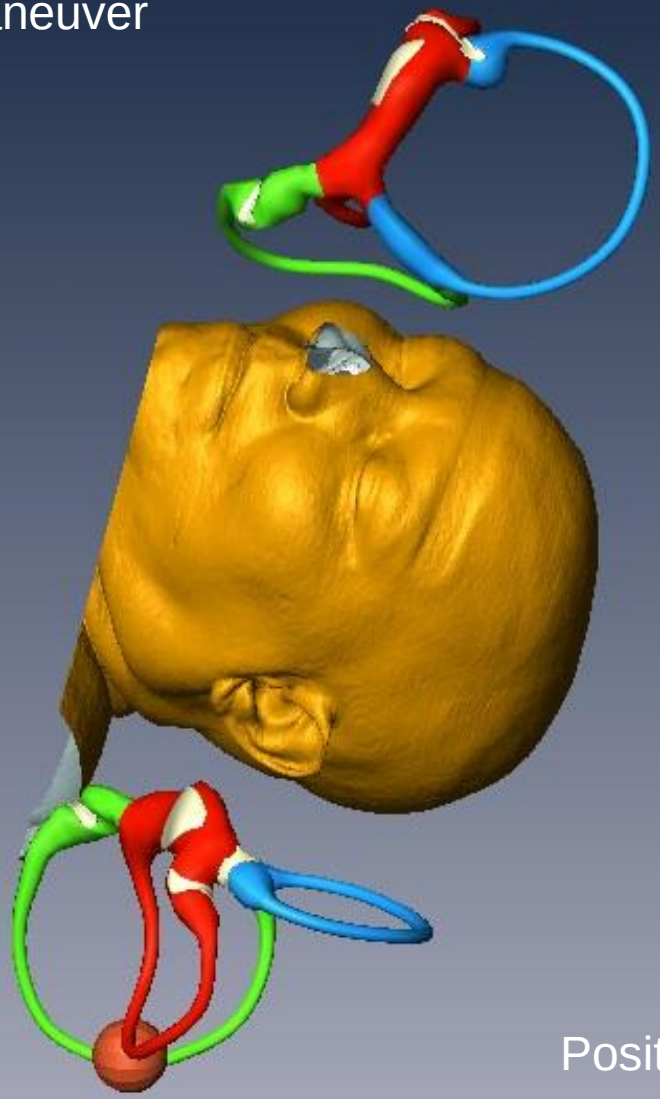
Curing the BPPV with a Liberatory Maneuver

Adv. Oto-Rhino-Laryng., vol. 42, pp. 290–293 (Karger, Basel 1988)

Liberatory Maneuver of Semont

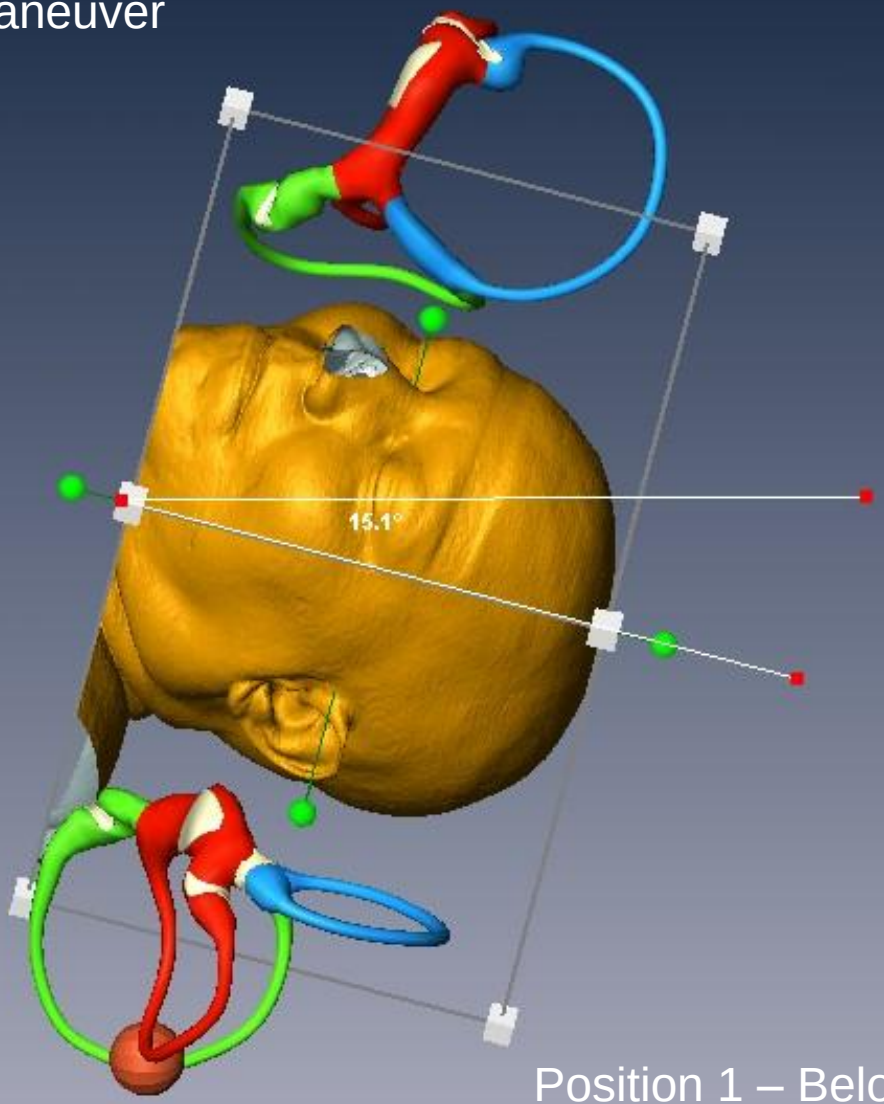
Membranous labyrinth from EPL Viewer- http://tbregistry.org/3D_Viewer.htm

Liberatory Maneuver



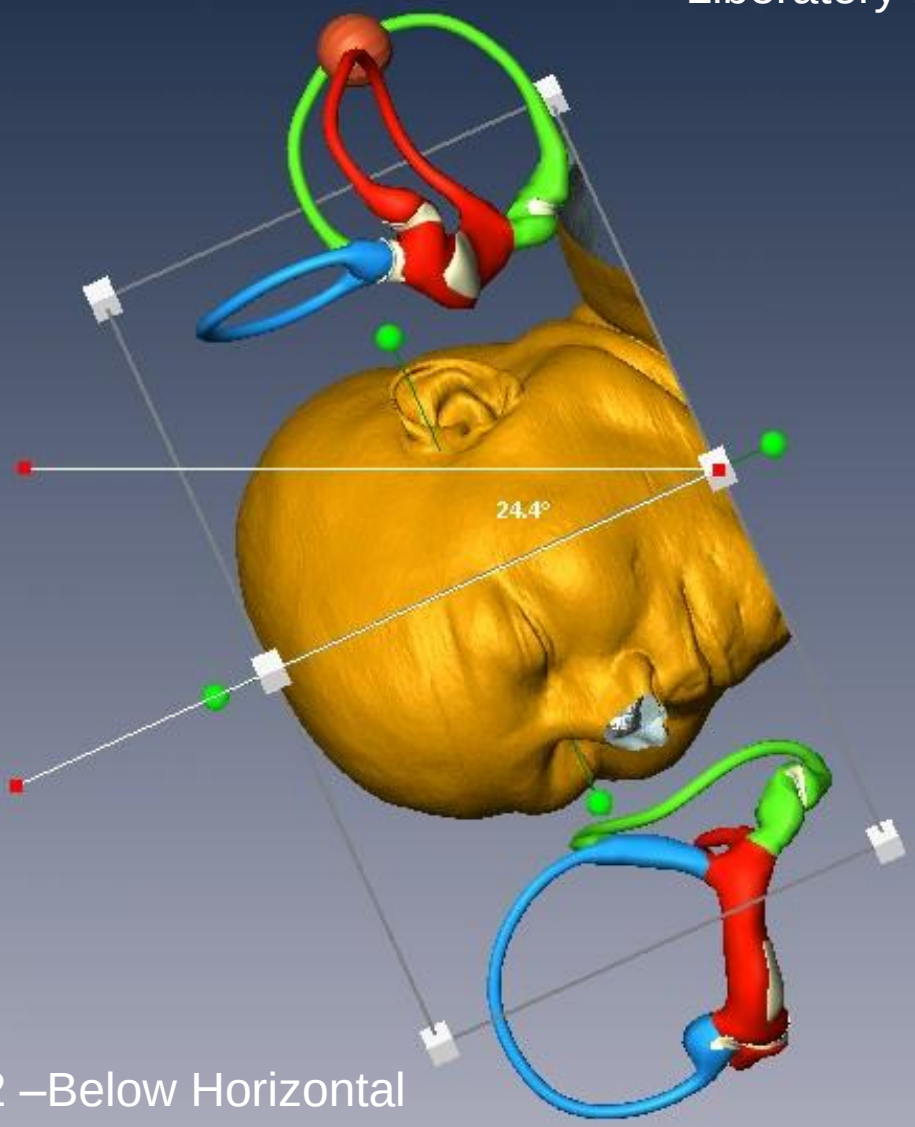
Position 1

Liberatory Maneuver



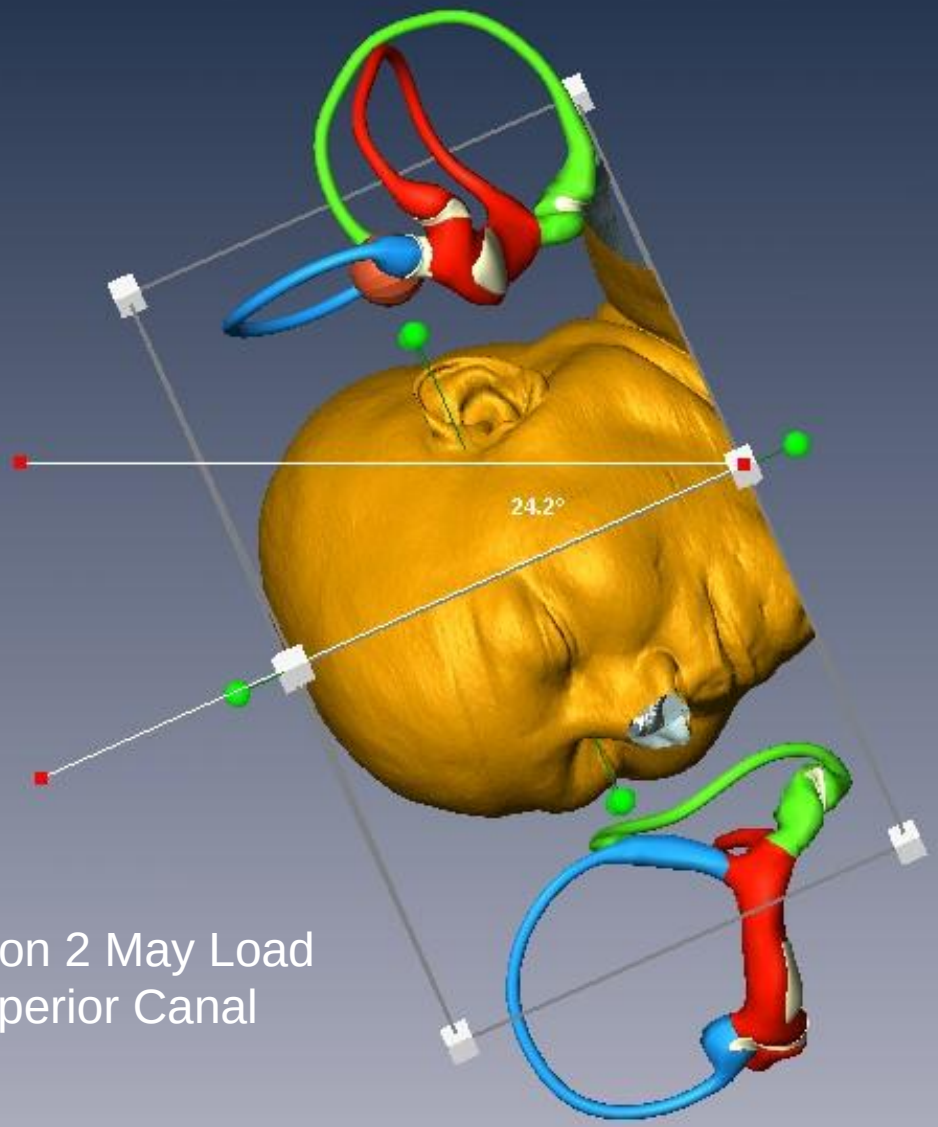
Position 1 – Below Horizontal

Liberatory Maneuver



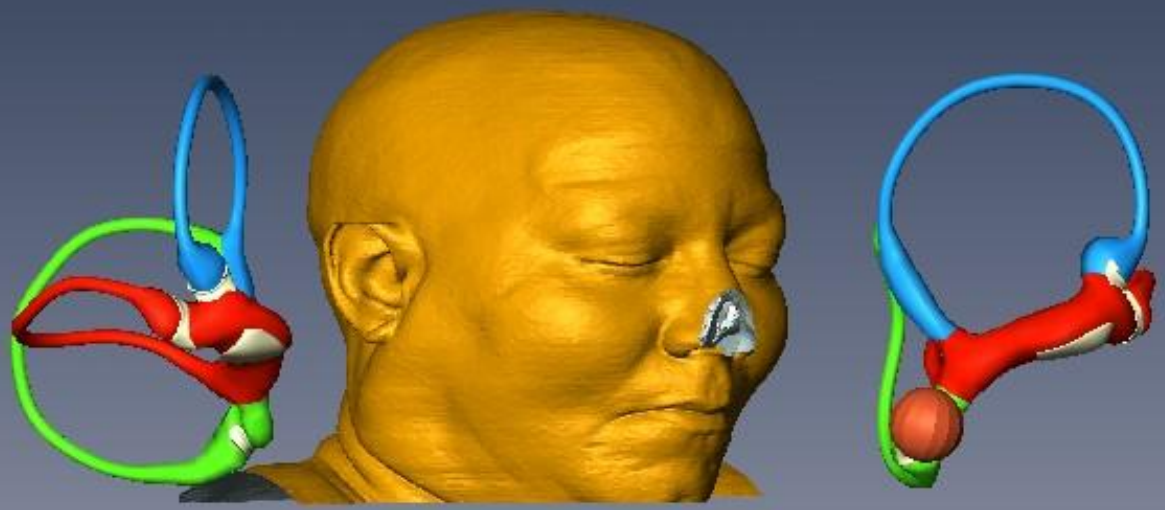
Position 2 –Below Horizontal
Greater Than 40° Total Angle Below Horizontal in Positions 1 and 2 To Insure Progression Of Otolith Mass

Liberatory Maneuver



Position 2 May Load
Superior Canal

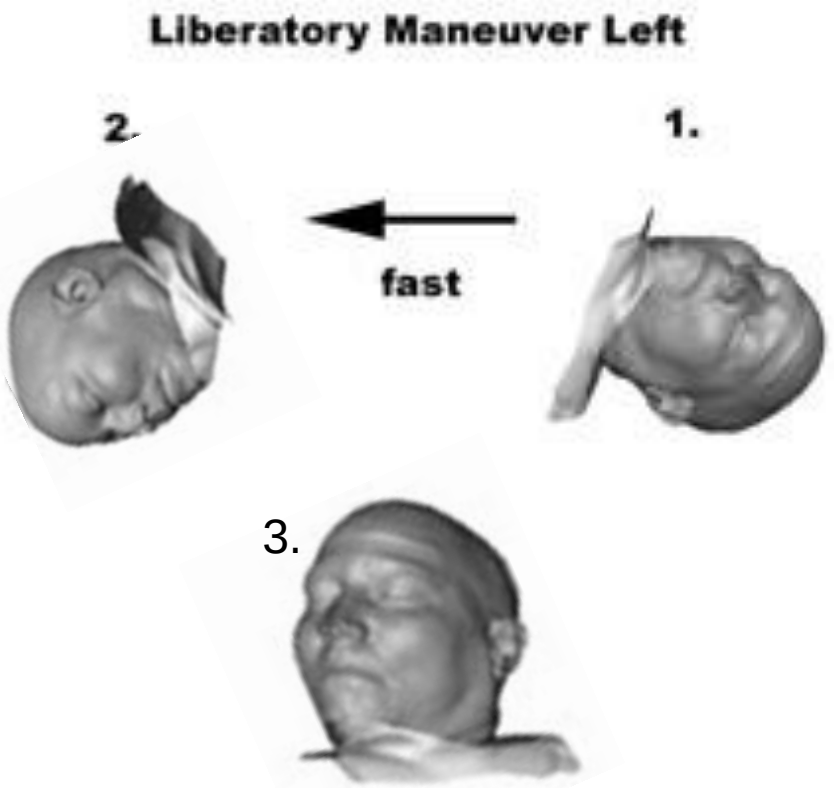
Liberatory Maneuver



Position 3

Treatment:
Liberatory Maneuver

Not Too Long



Combined Angles
Below Horizontal
> 40°

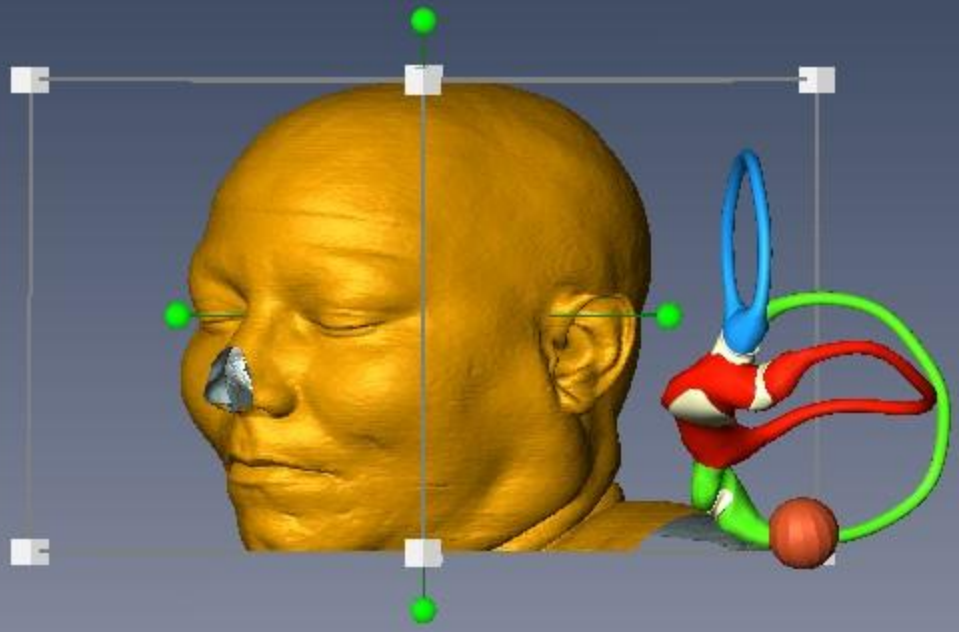
Head Upright

OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

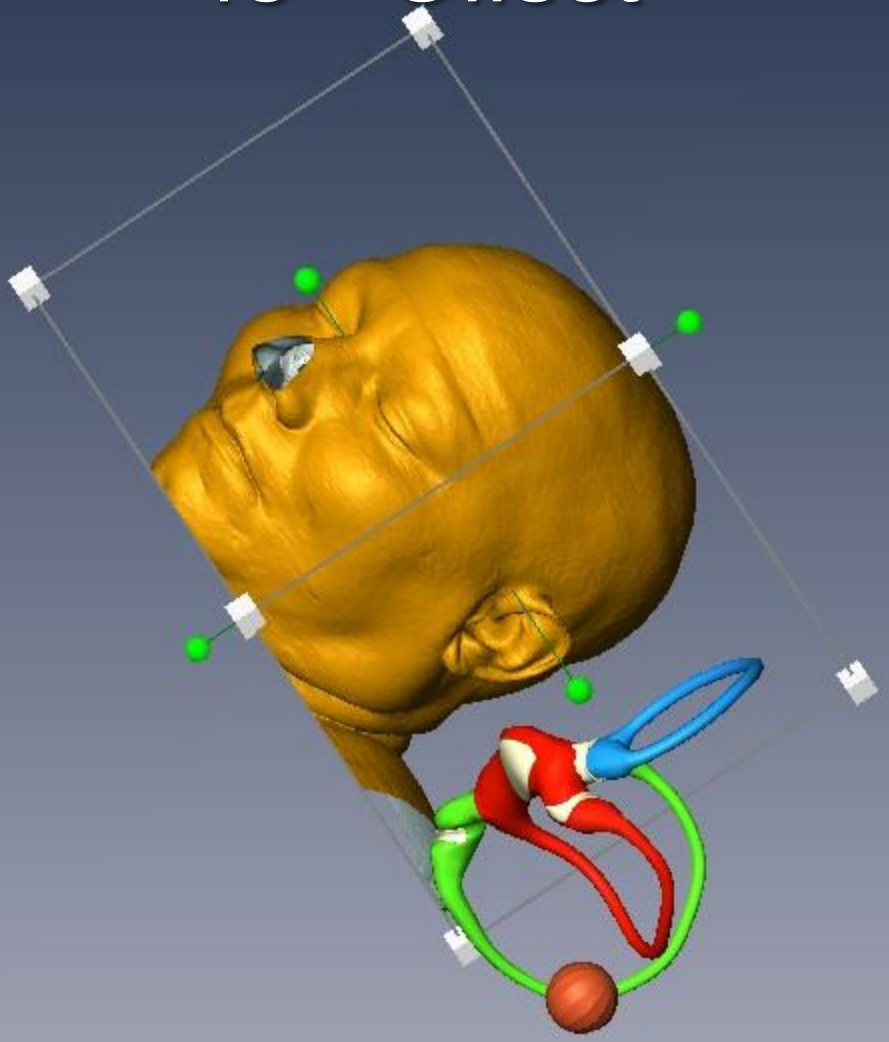
Treatment:
360° Toes Over Head Rotation

Lempert T, et al. Three hundred sixty degree rotation of the posterior semicircular canal for treatment of benign positional vertigo: a placebo-controlled trial. Neurology 1997;49:729-33.

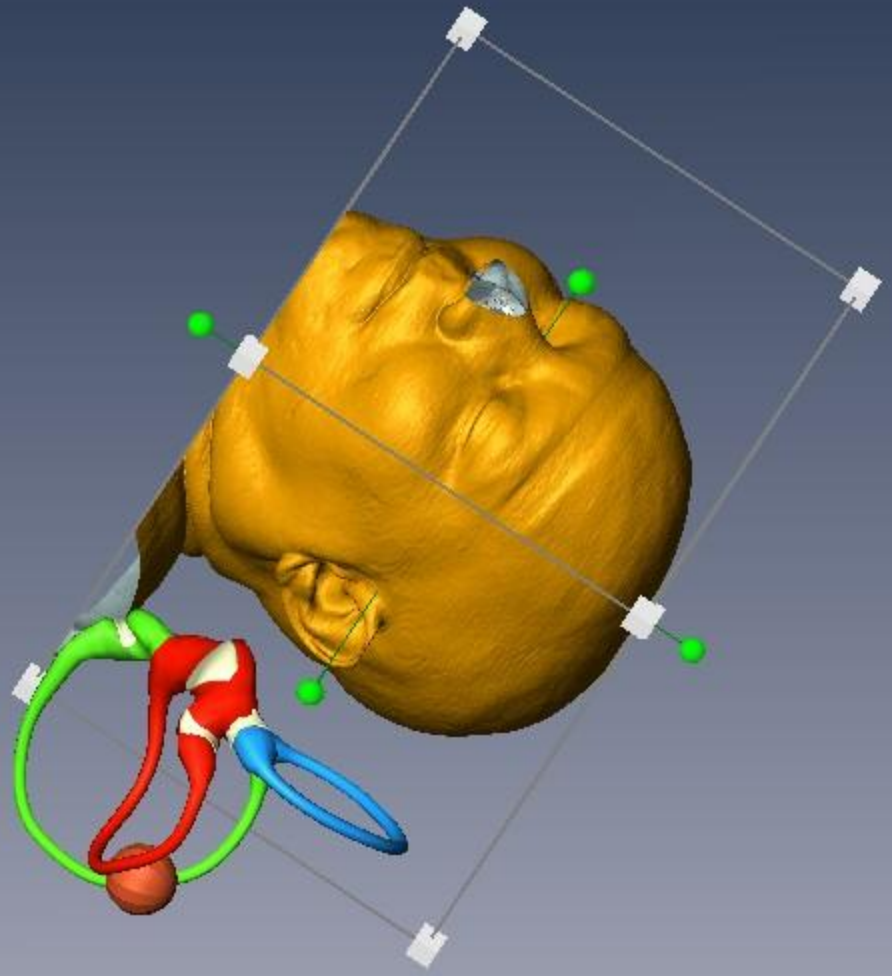
360° Toes Over Head Rotation 45° Offset



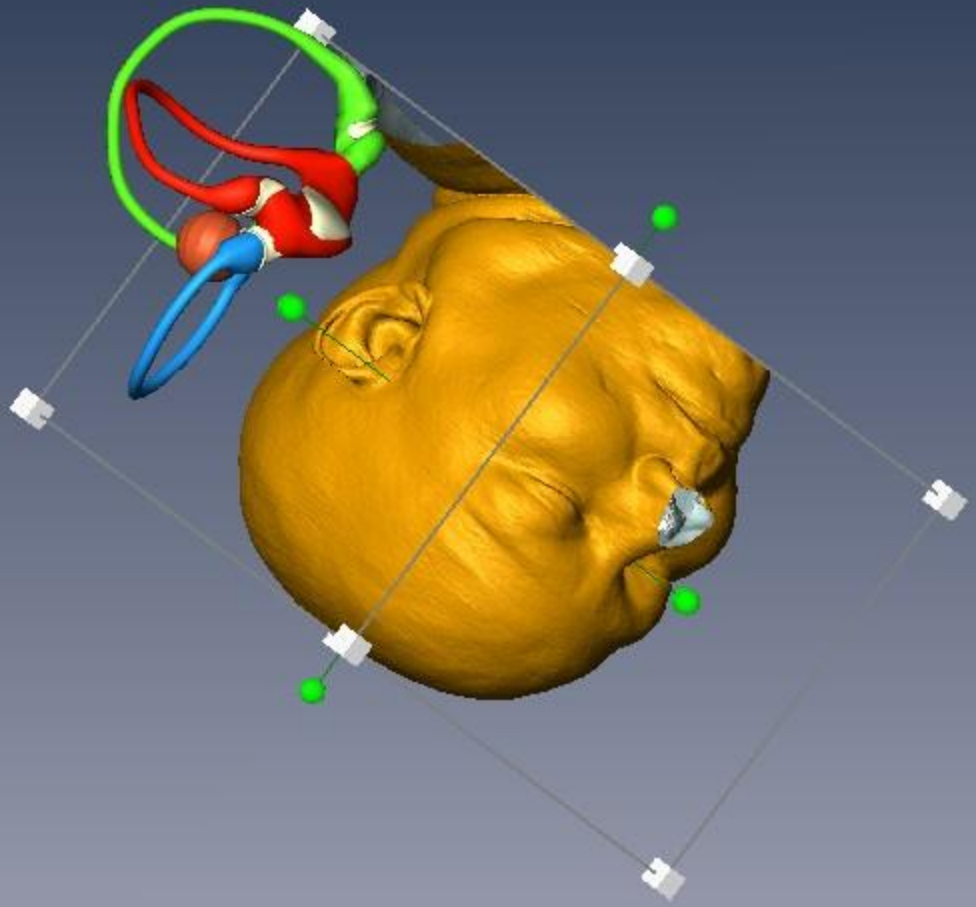
360° Toes Over Head Rotation
45° Offset



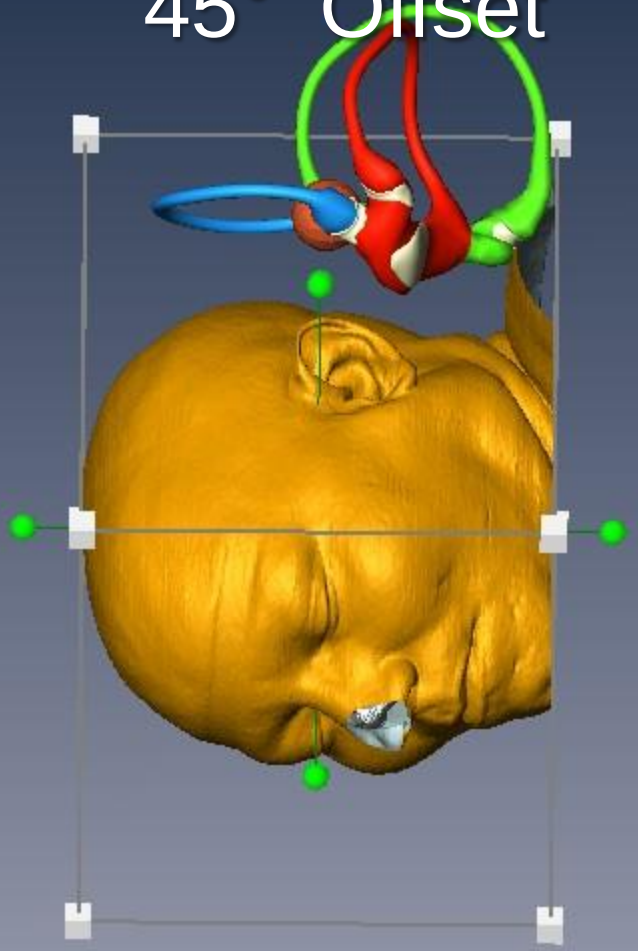
360° Toes Over Head Rotation
45° Offset



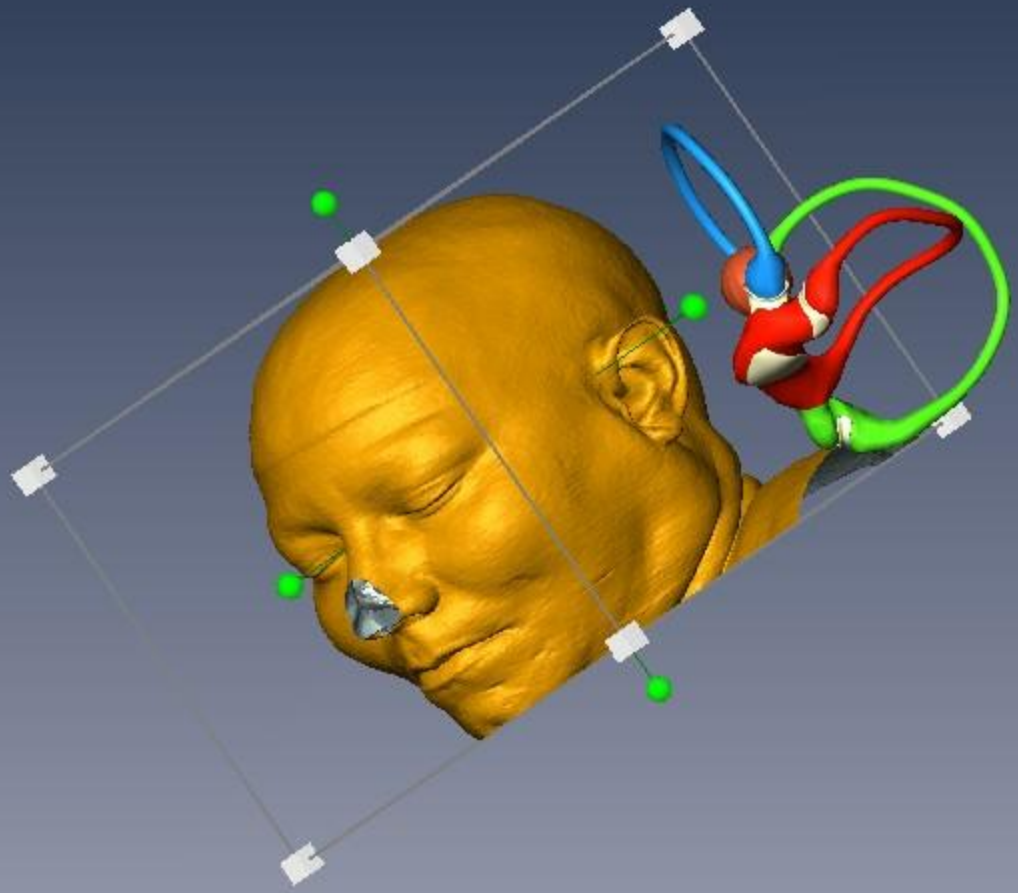
360° Toes Over Head Rotation
45° Offset



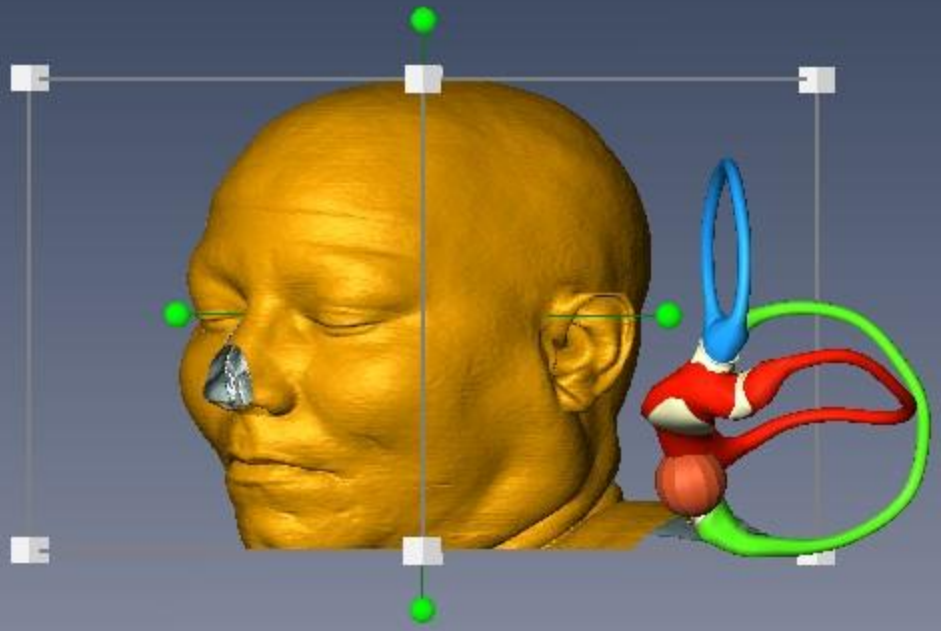
360° Toes Over Head Rotation
45° Offset



360° Toes Over Head Rotation
45° Offset



360° Toes Over Head Rotation
45° Offset



Treatment Recommendation: 360° Toes Over Head Rotation

- Slower rotation velocities may carry greater risk of Superior canal conversion
- 360° Coronal plane rotation may eliminate risk of Superior canal conversion

Thanks

Delaware Biotechnology Institute:
- Kanik Sem
- Karl V. Steiner
- Patrick Coller
- Robert Forstrom
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- Doug O'Neal
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- Brian Little

Temporal Bone Foundation:
- Rindy Northrop

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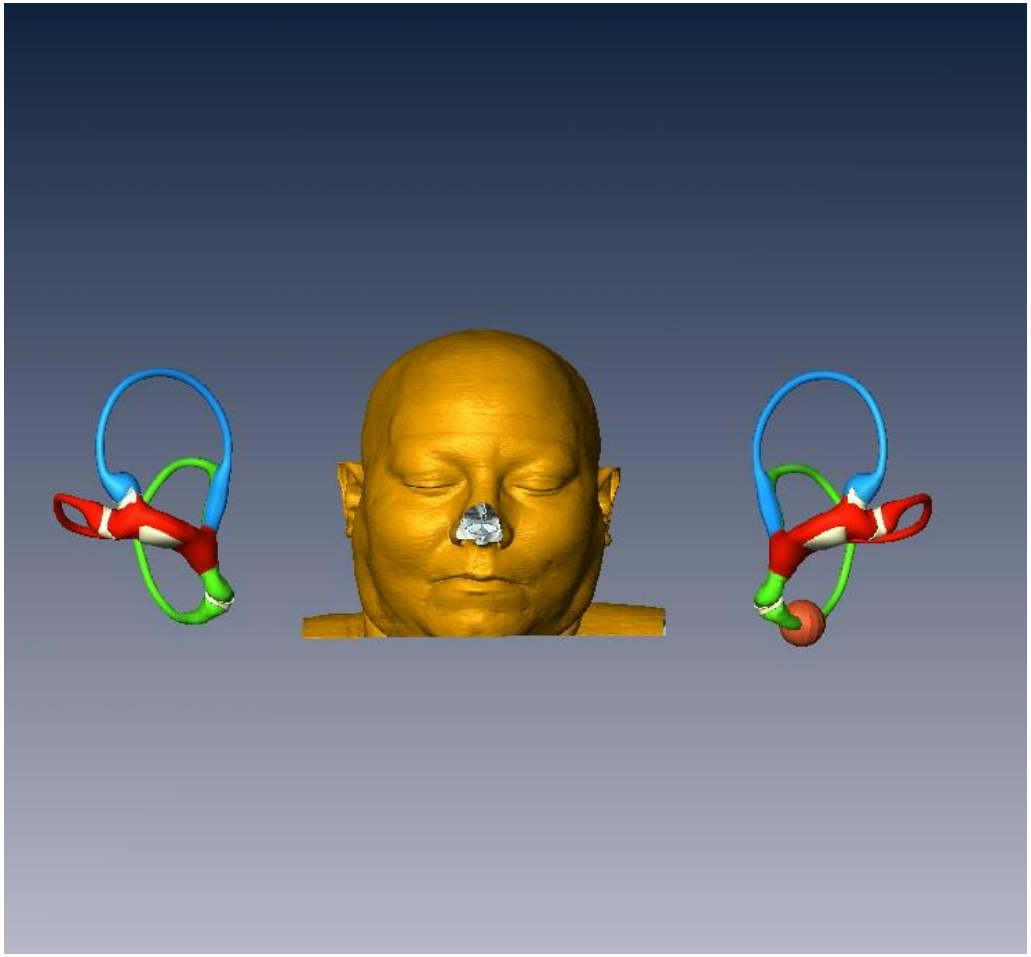
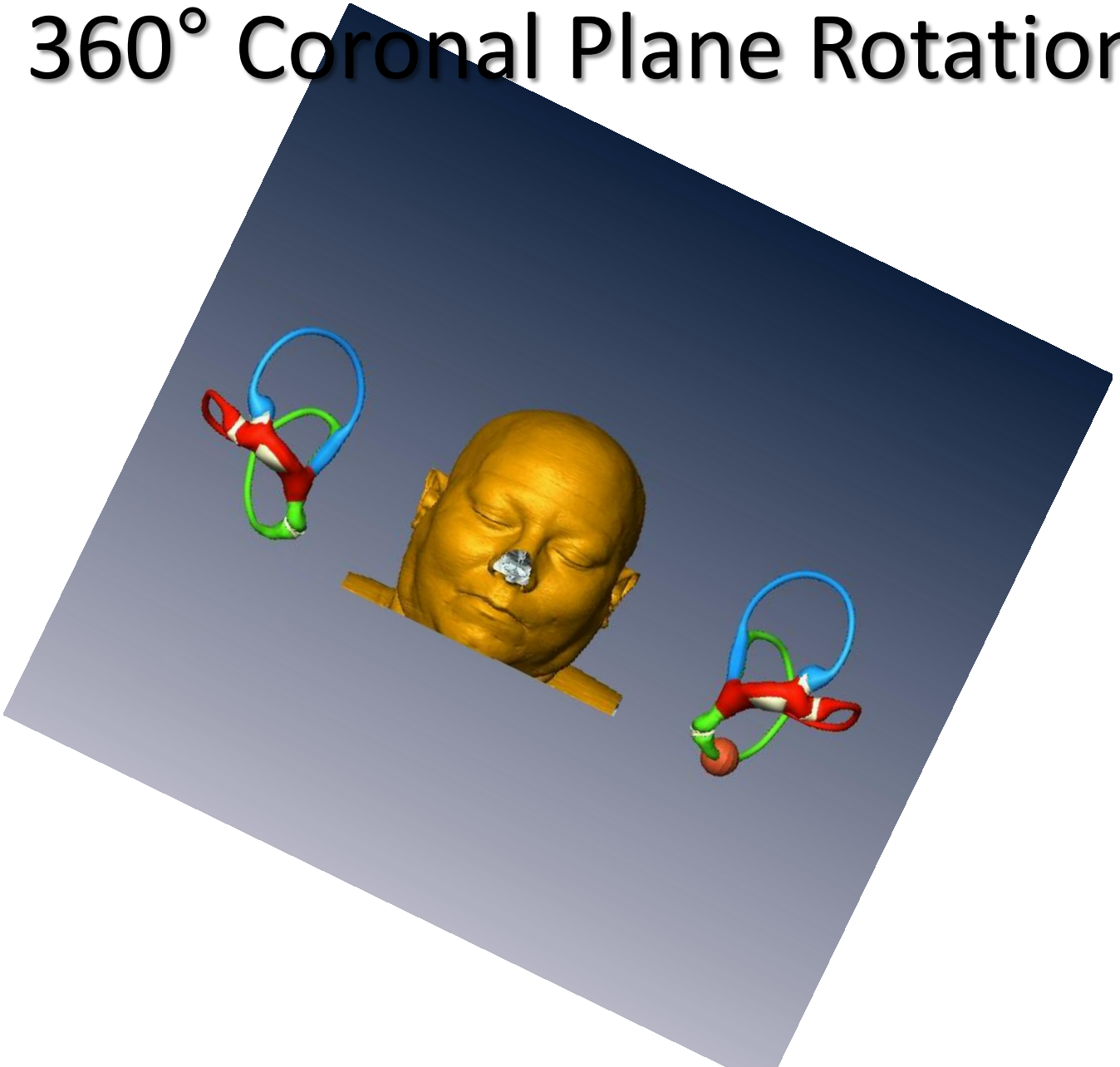
To download movies Google: Teixido BPPV

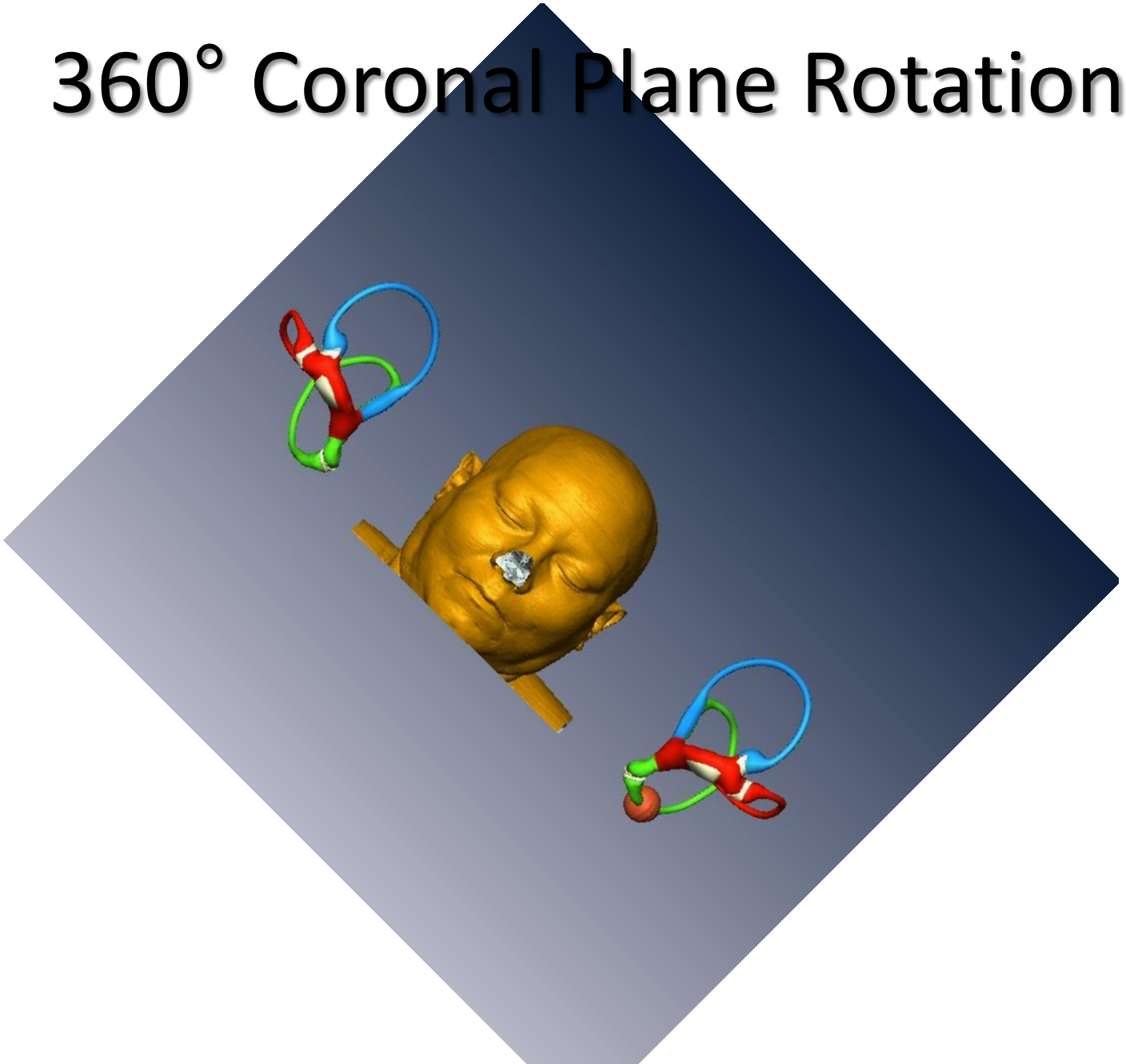
360° Coronal Plane Rotation



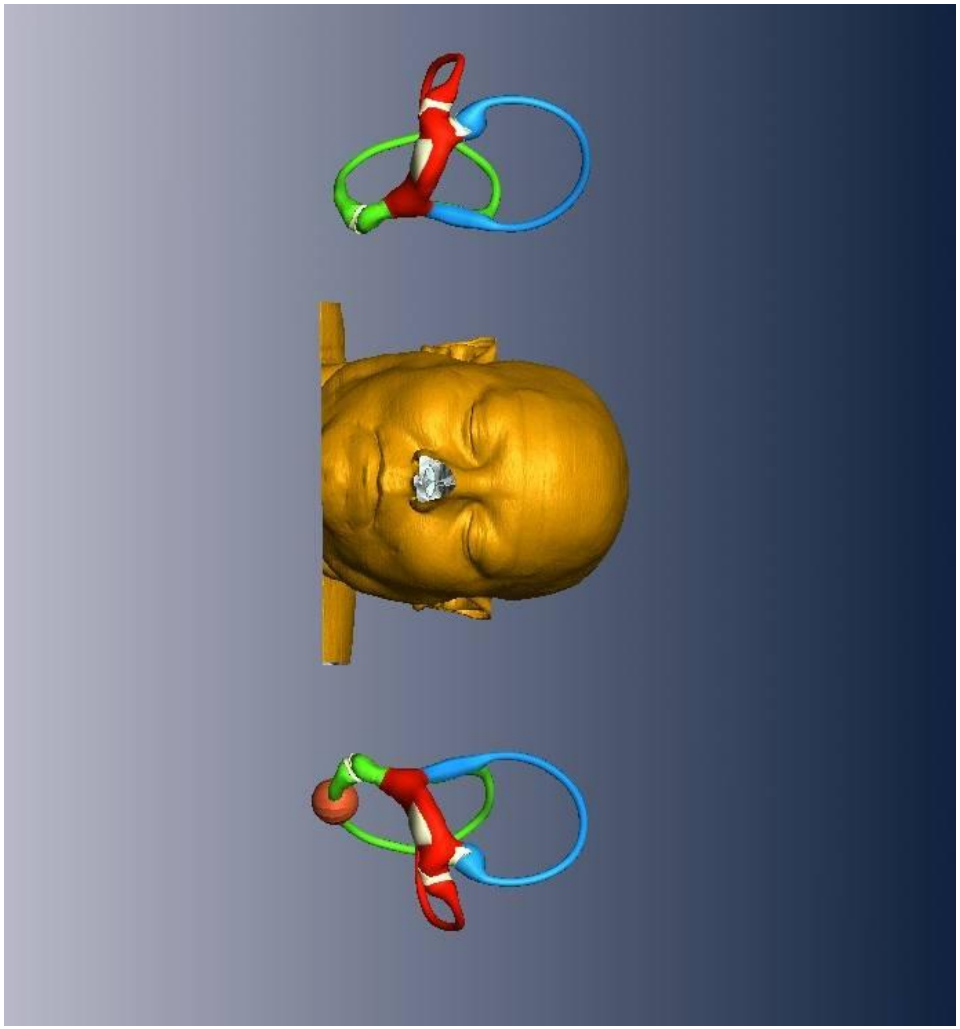
360° Coronal Plane Rotation



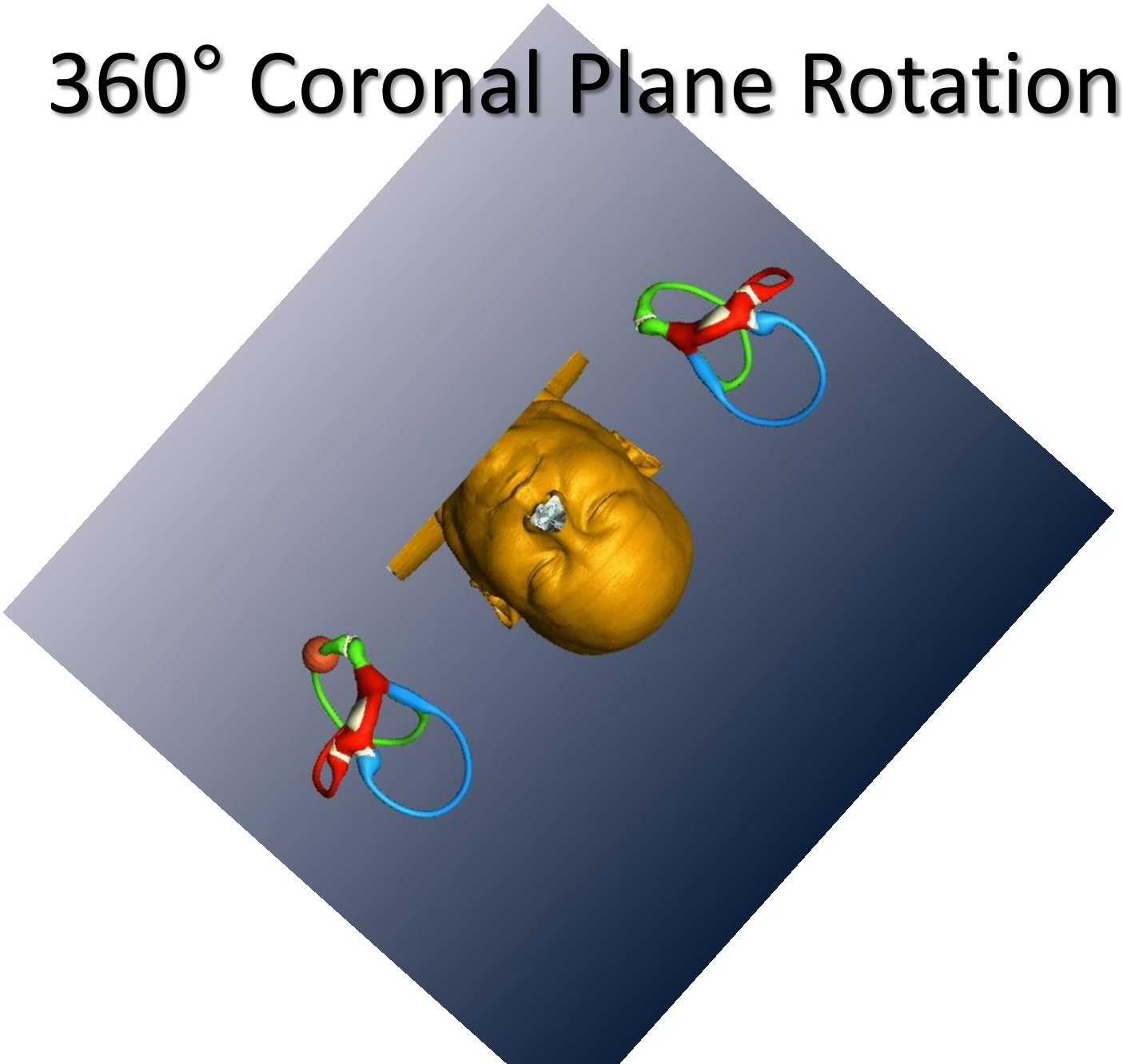
360° Coronal Plane Rotation



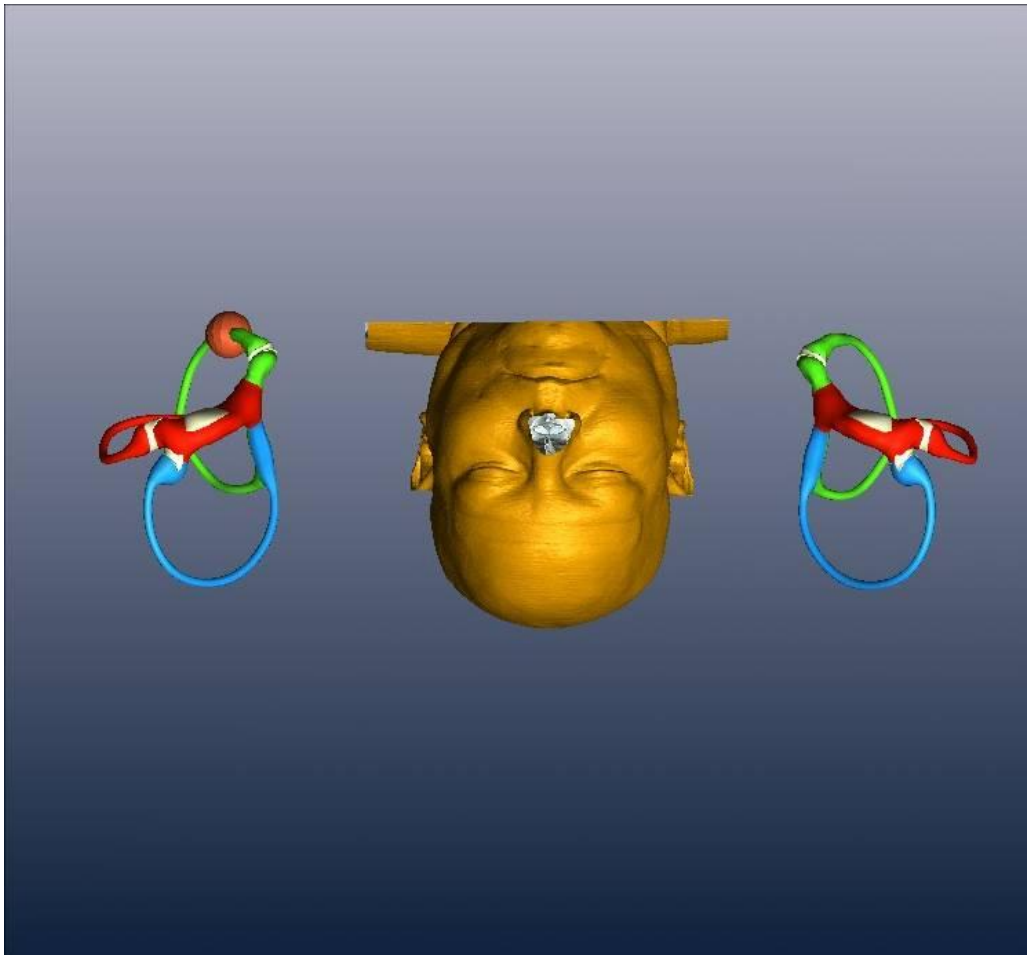
360° Coronal Plane Rotation



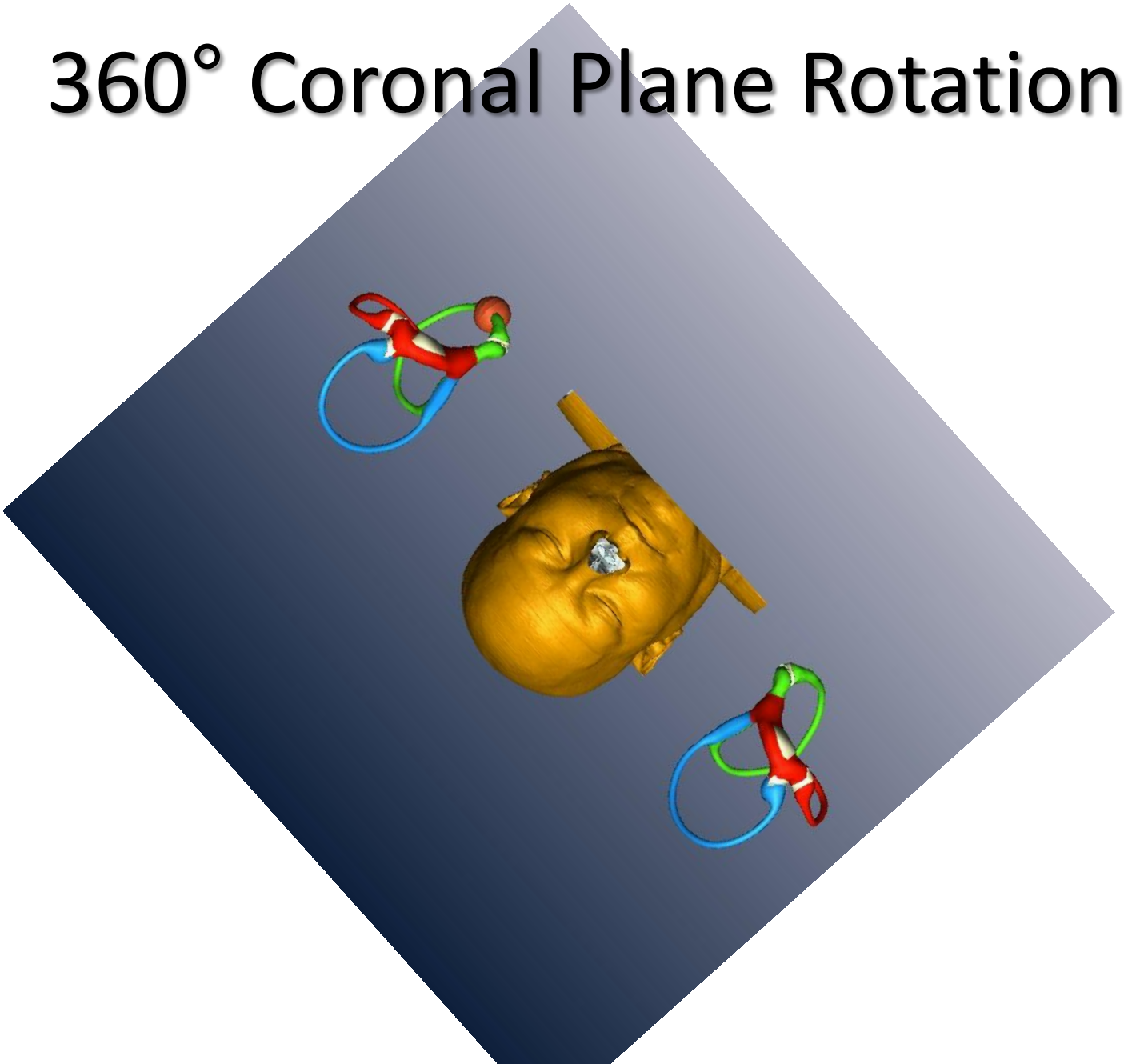
360° Coronal Plane Rotation



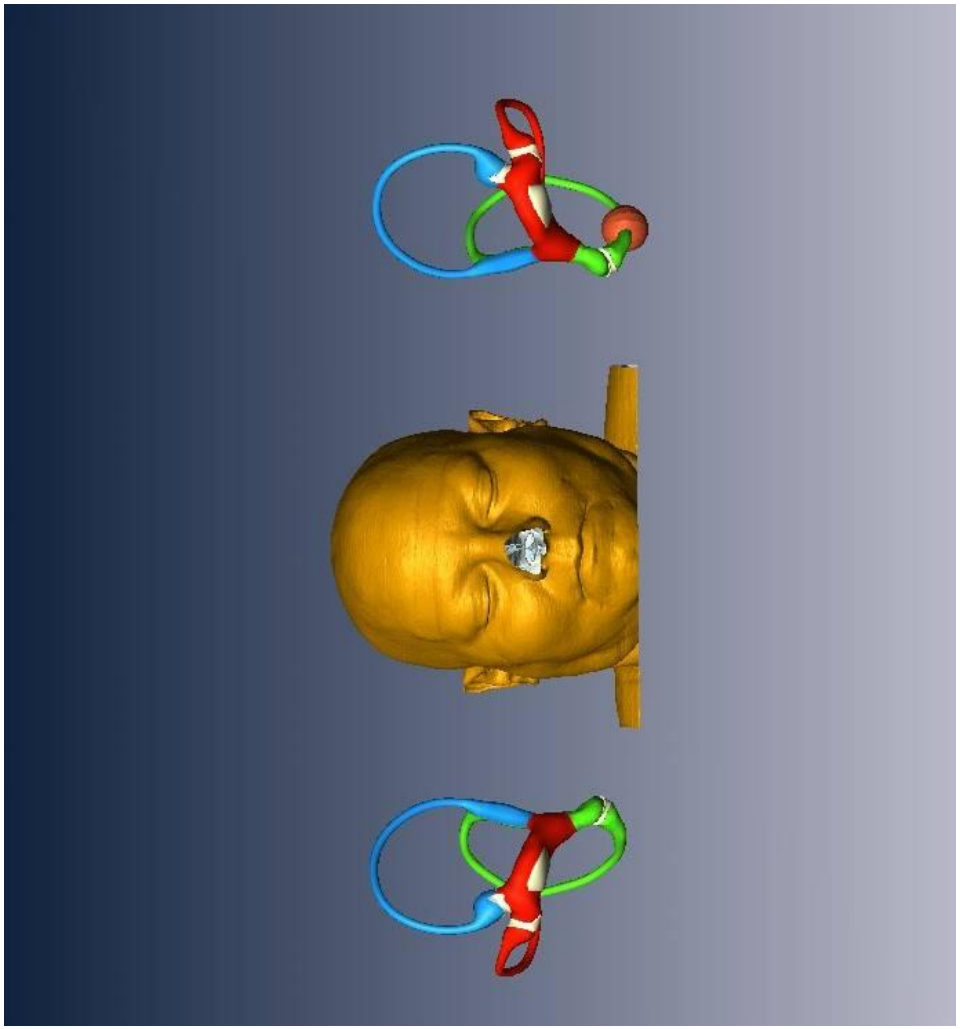
360° Coronal Plane Rotation



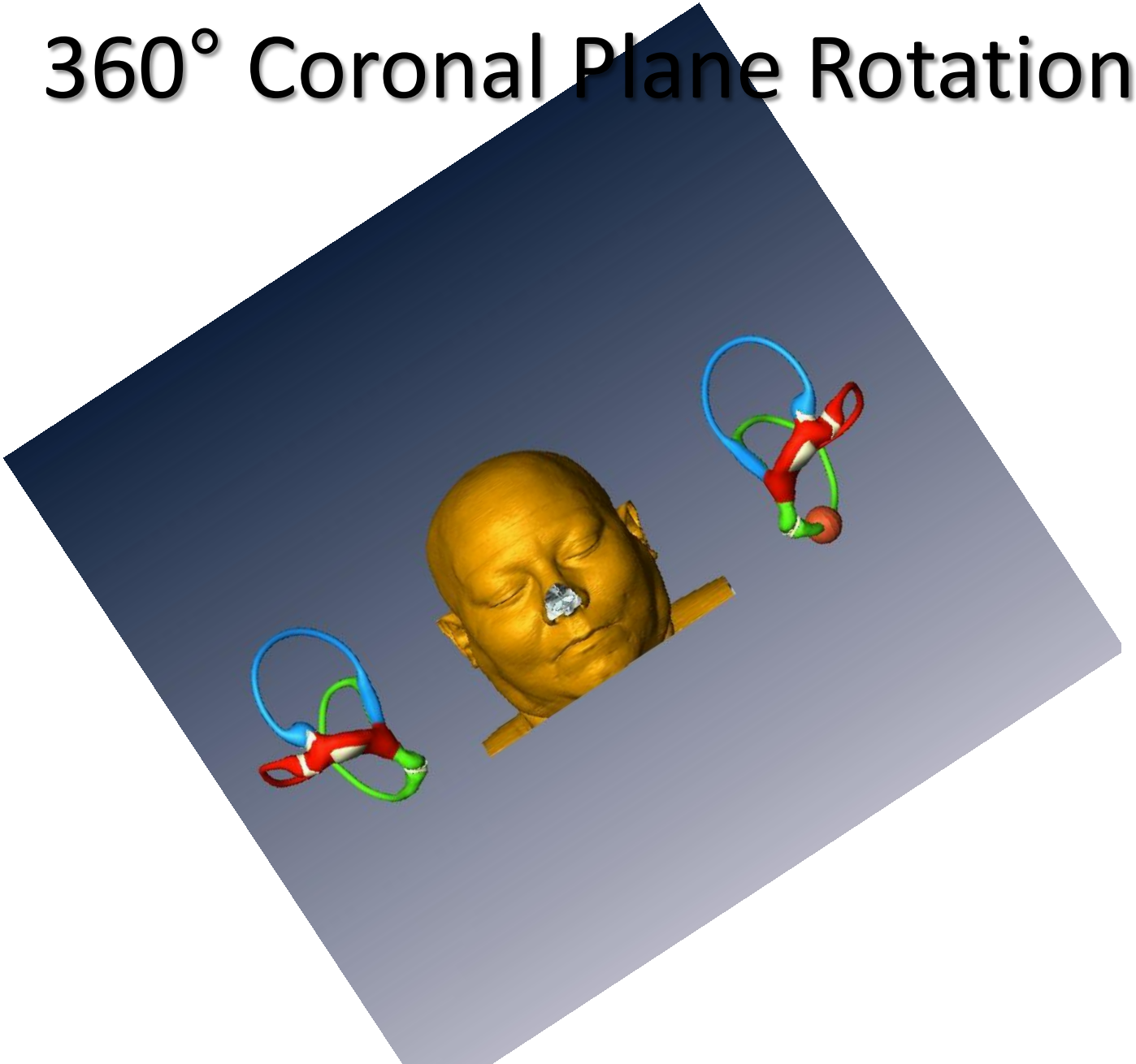
360° Coronal Plane Rotation



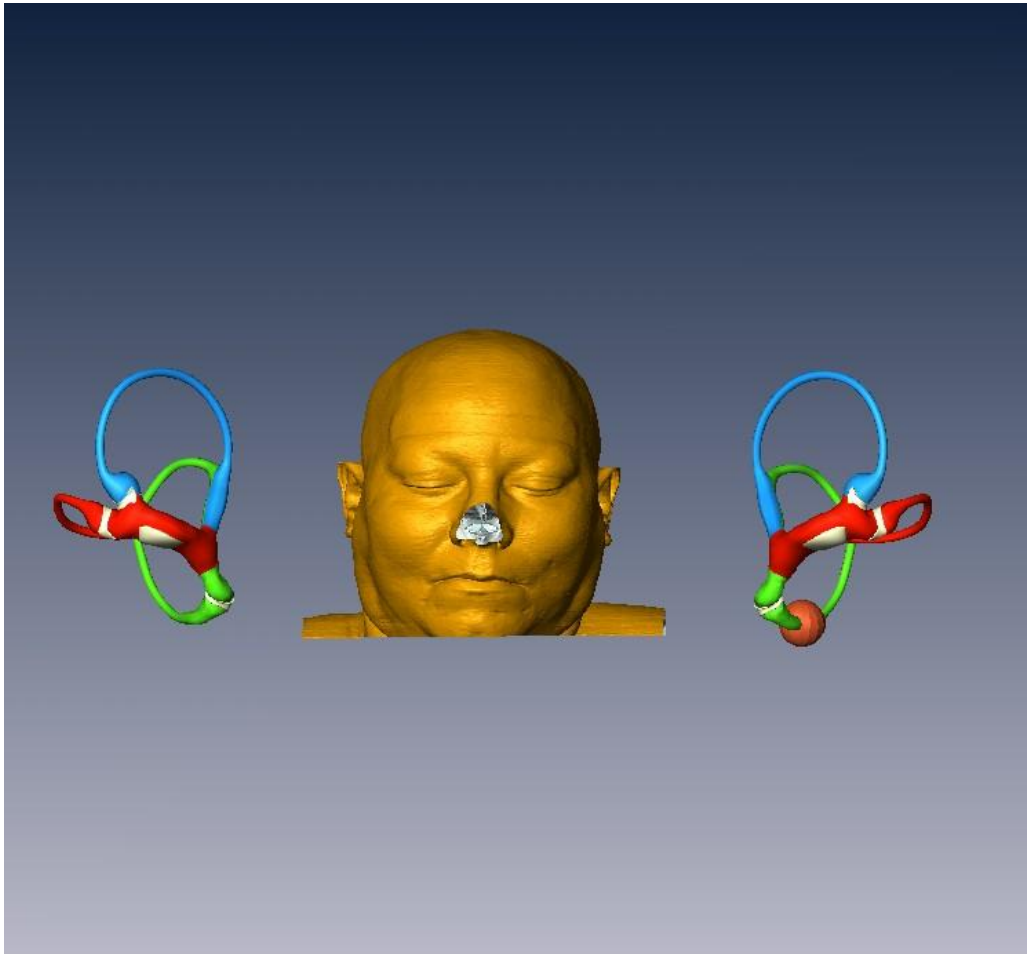
360° Coronal Plane Rotation



360° Coronal Plane Rotation



360° Coronal Plane Rotation

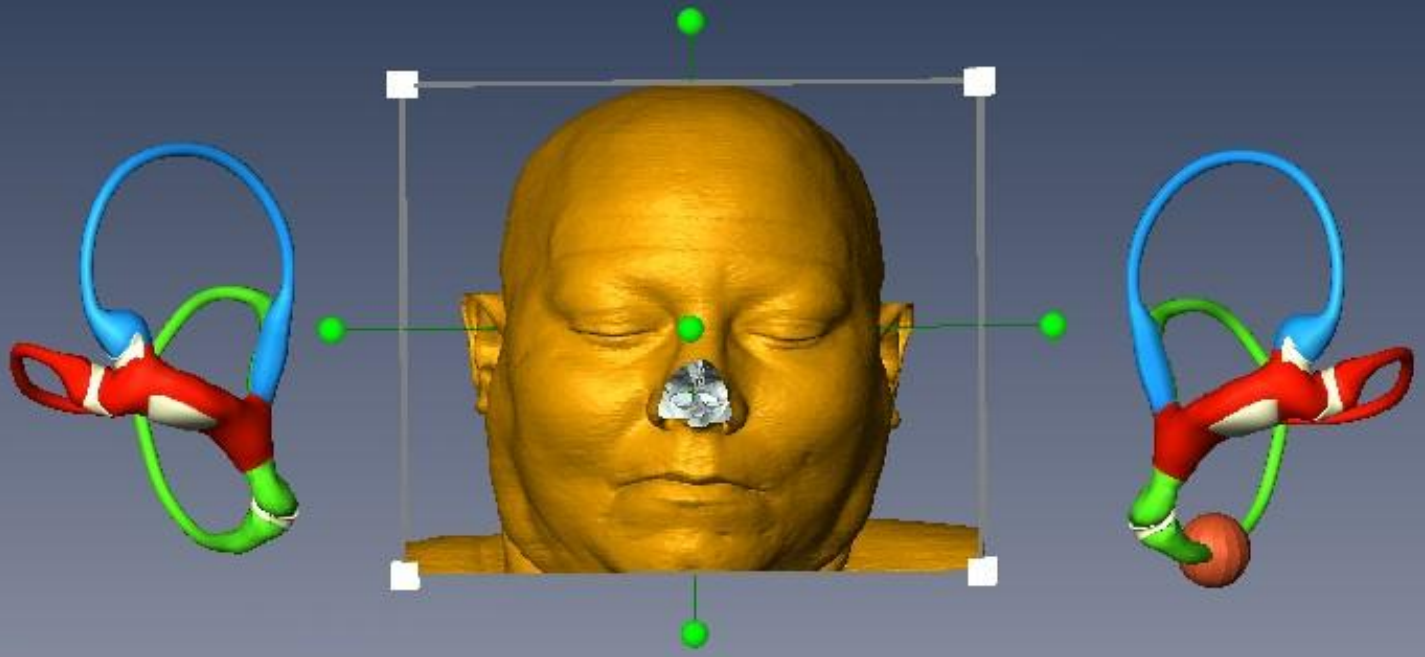


360° Coronal Plane Rotation

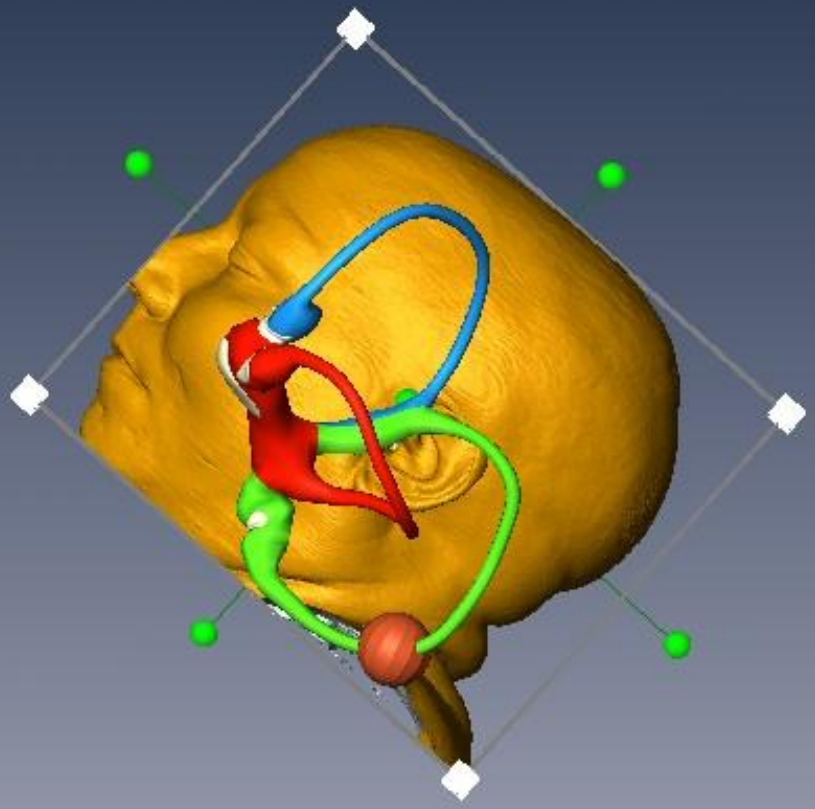
-Eliminates risk of canal conversion

-May treat all 3 canals simultaneously

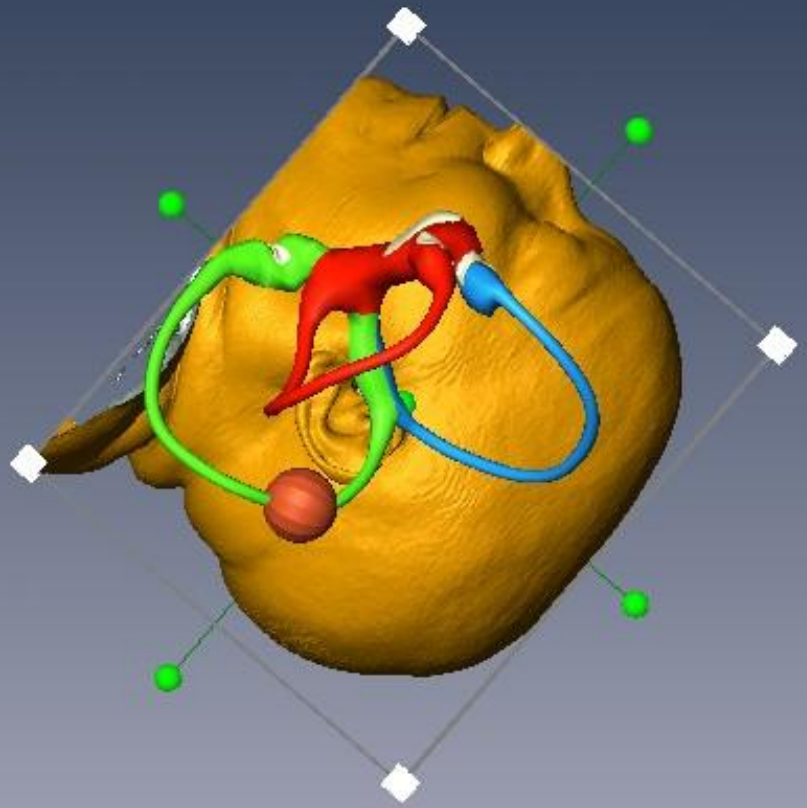
360° Toes Over Head Rotation



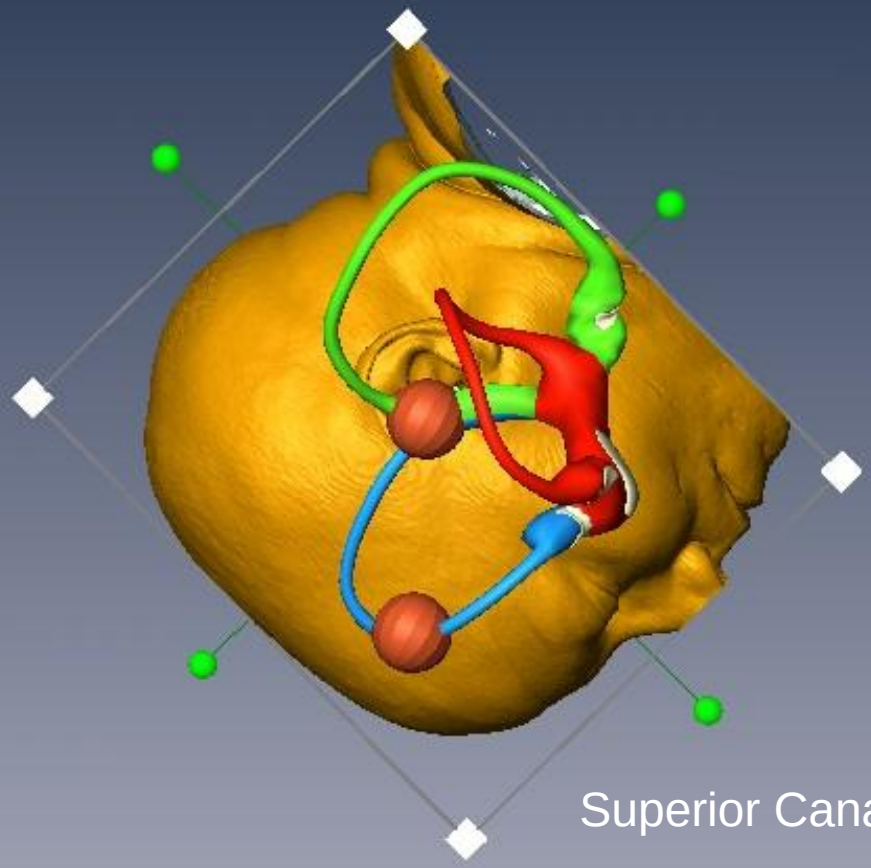
360° Toes Over Head Rotation



360° Toes Over Head Rotation

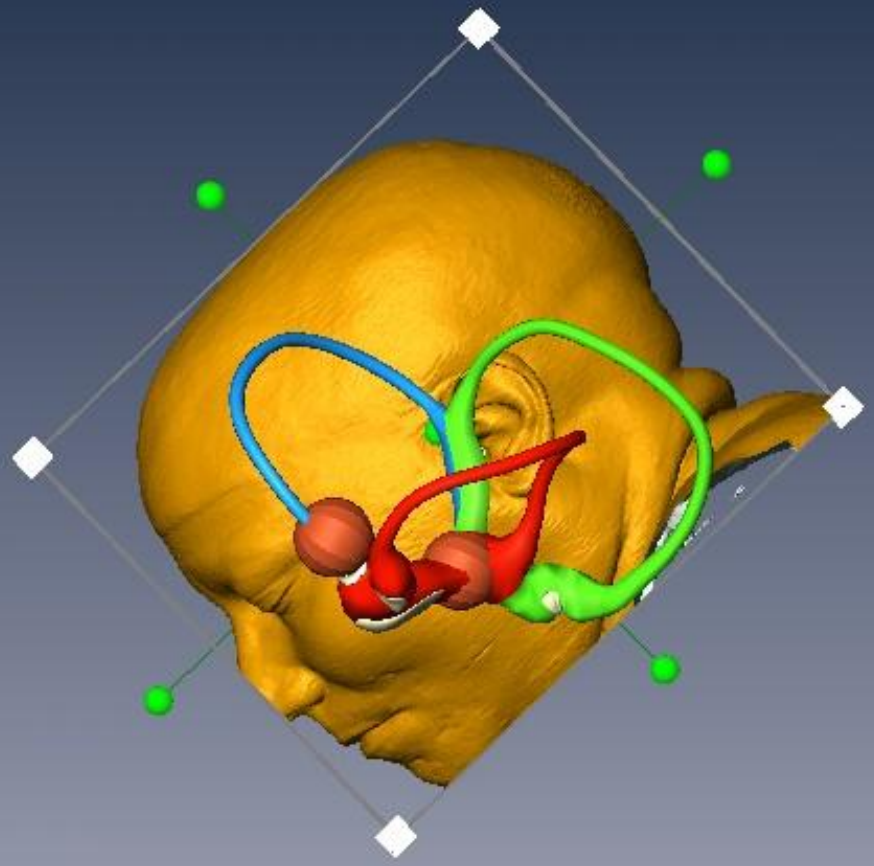


360° Toes Over Head Rotation



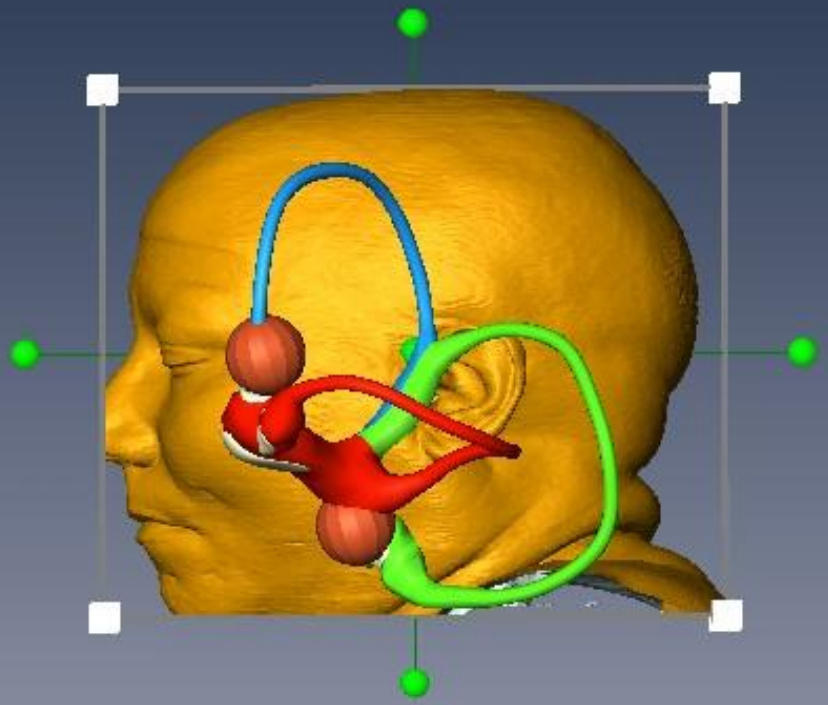
Superior Canal Conversion

360° Toes Over Head Rotation



Superior Canal Conversion

360° Toes Over Head Rotation

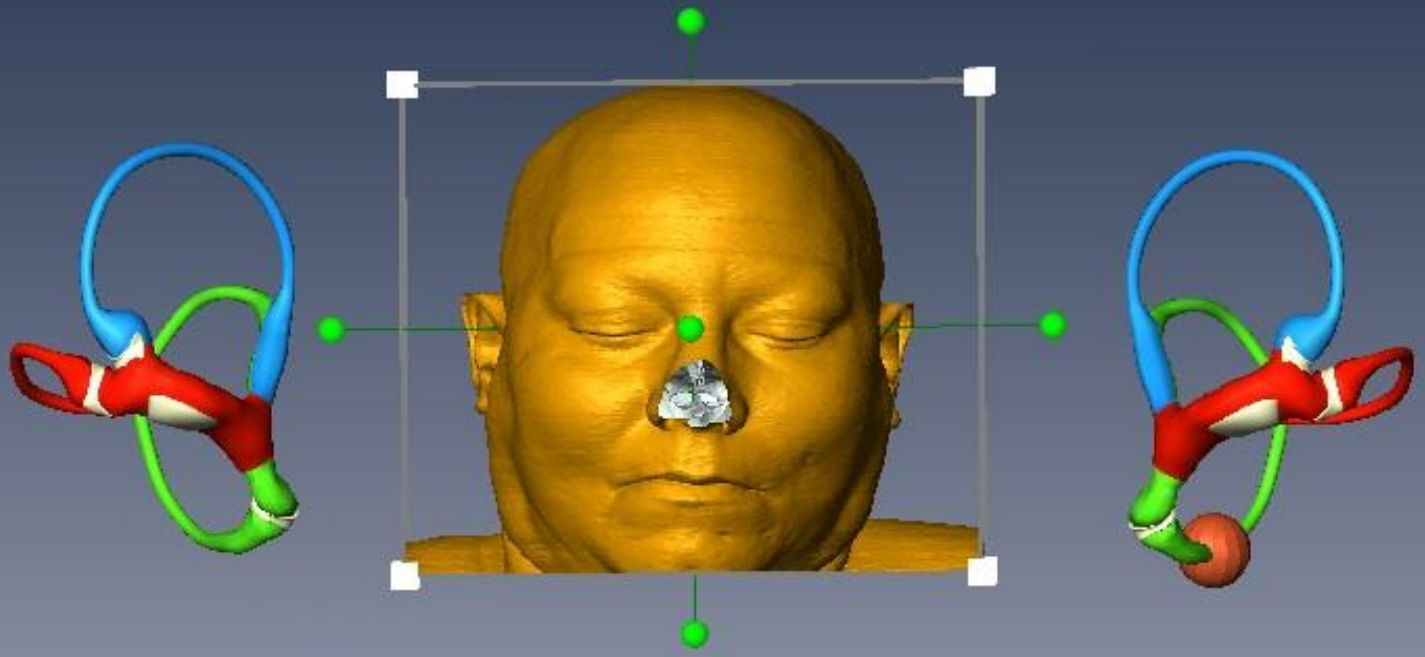


Superior Canal Conversion

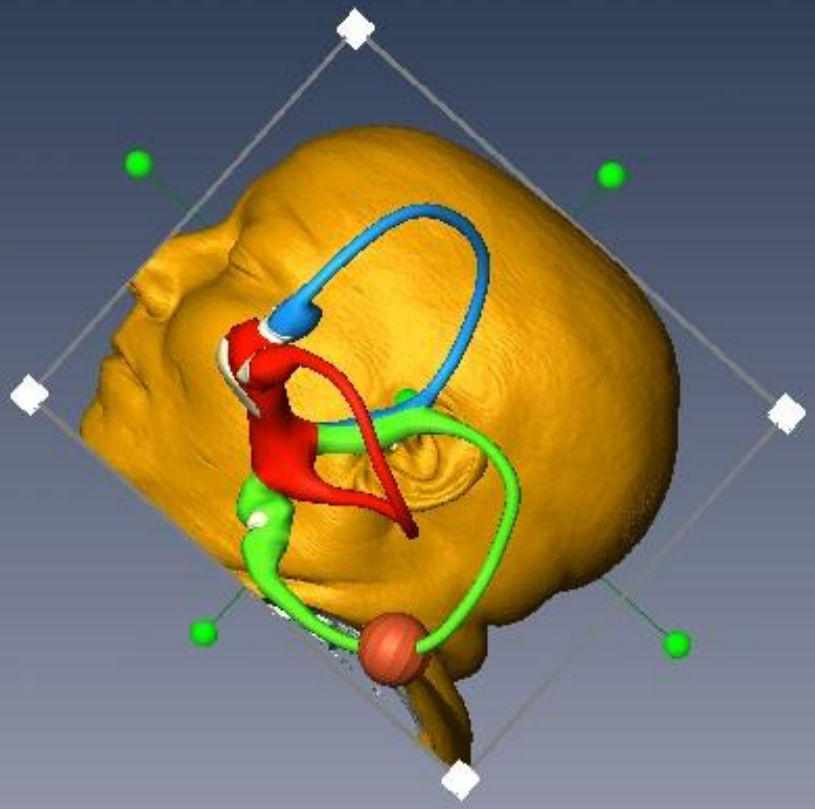
Treatment Recommendation: 360° Toes Over Head Rotation

- Slower rotation velocities may carry greater risk of Superior canal conversion
- 360° Coronal plane rotation may eliminate risk of Superior canal conversion

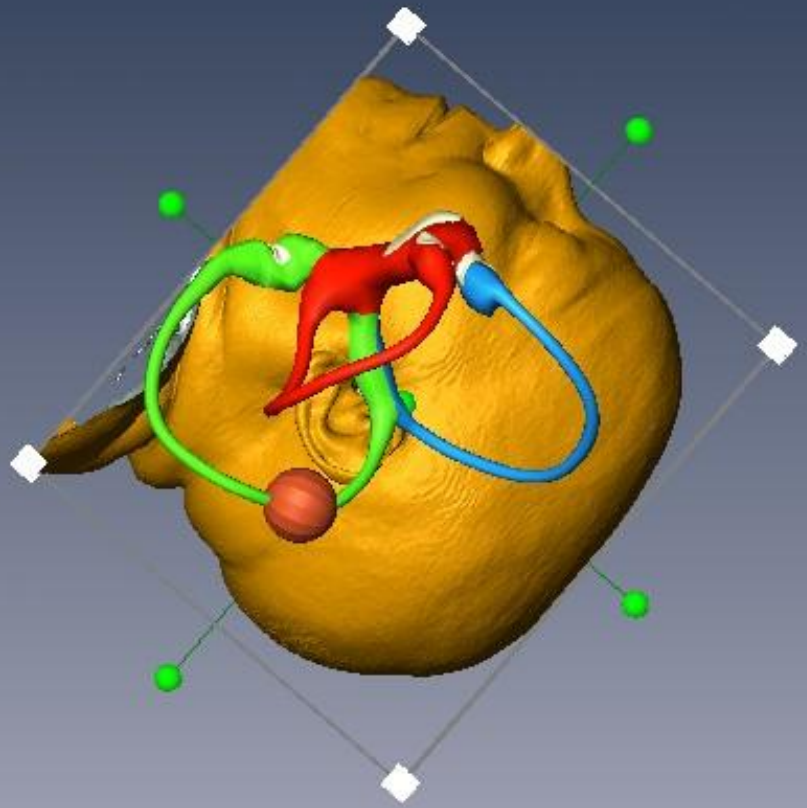
360° Toes Over Head Rotation



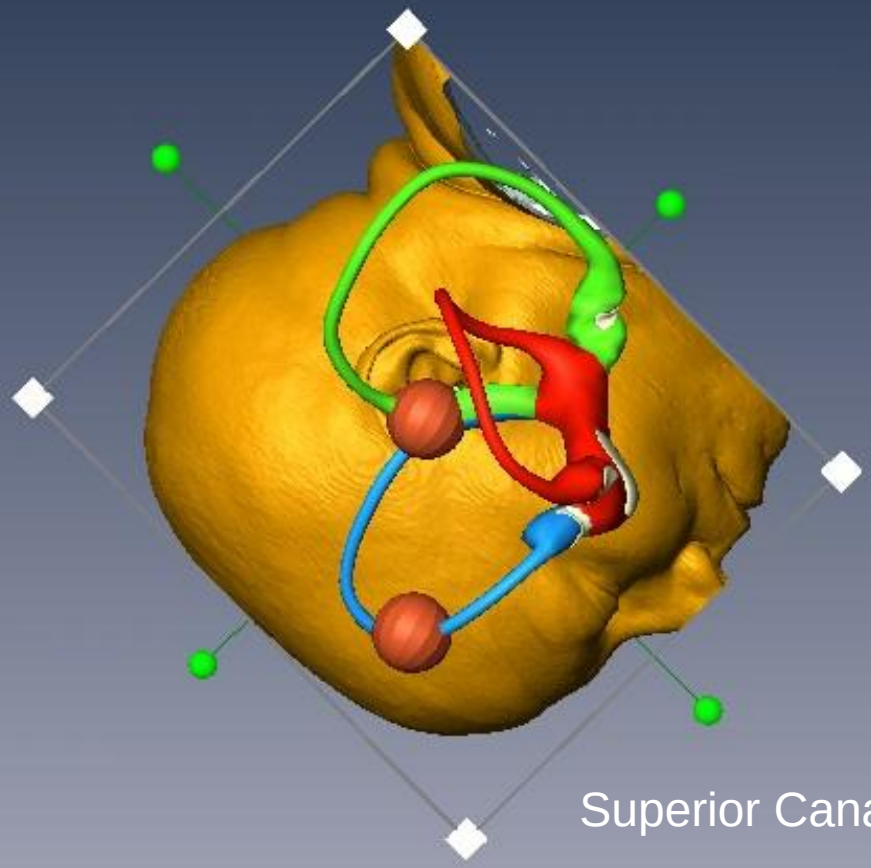
360° Toes Over Head Rotation



360° Toes Over Head Rotation

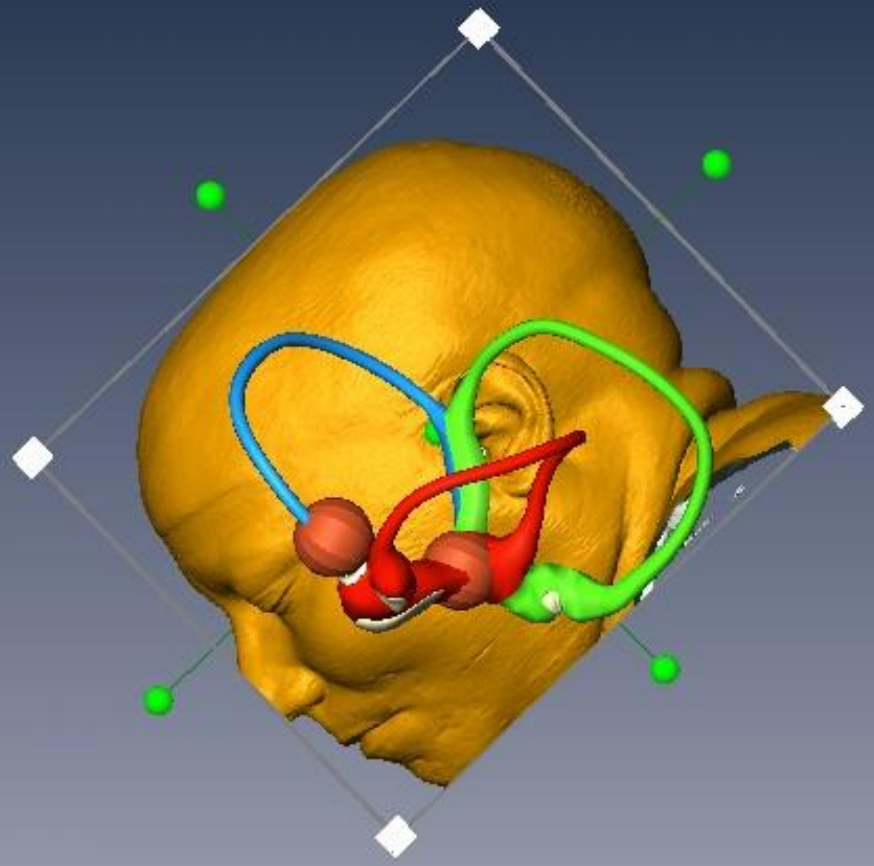


360° Toes Over Head Rotation



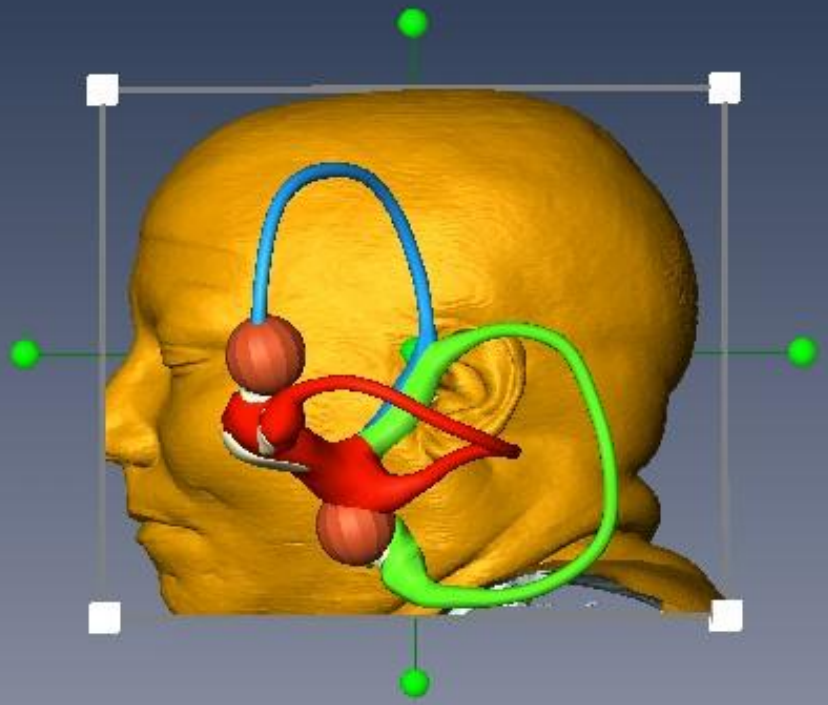
Superior Canal Conversion

360° Toes Over Head Rotation

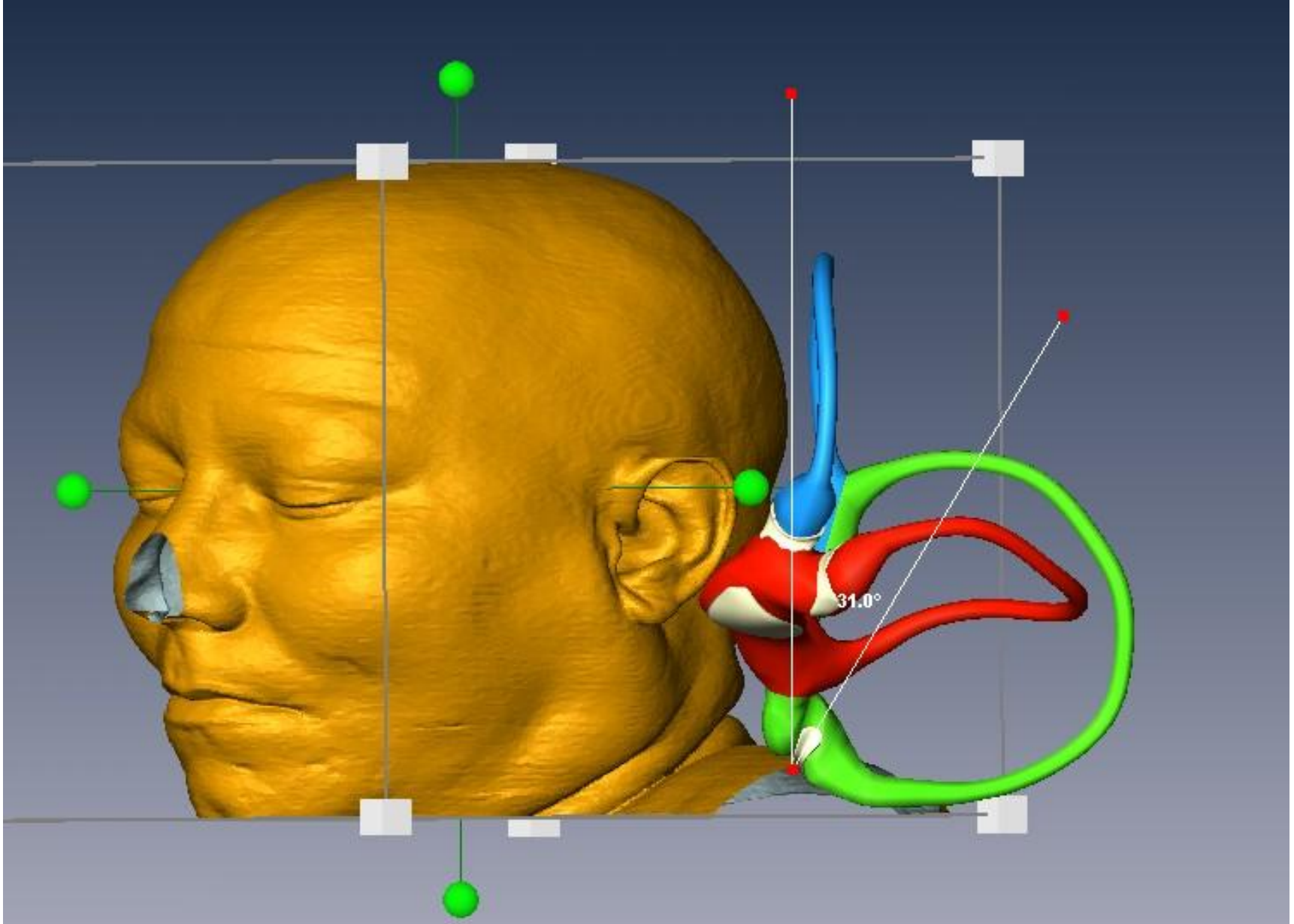


Superior Canal Conversion

360° Toes Over Head Rotation

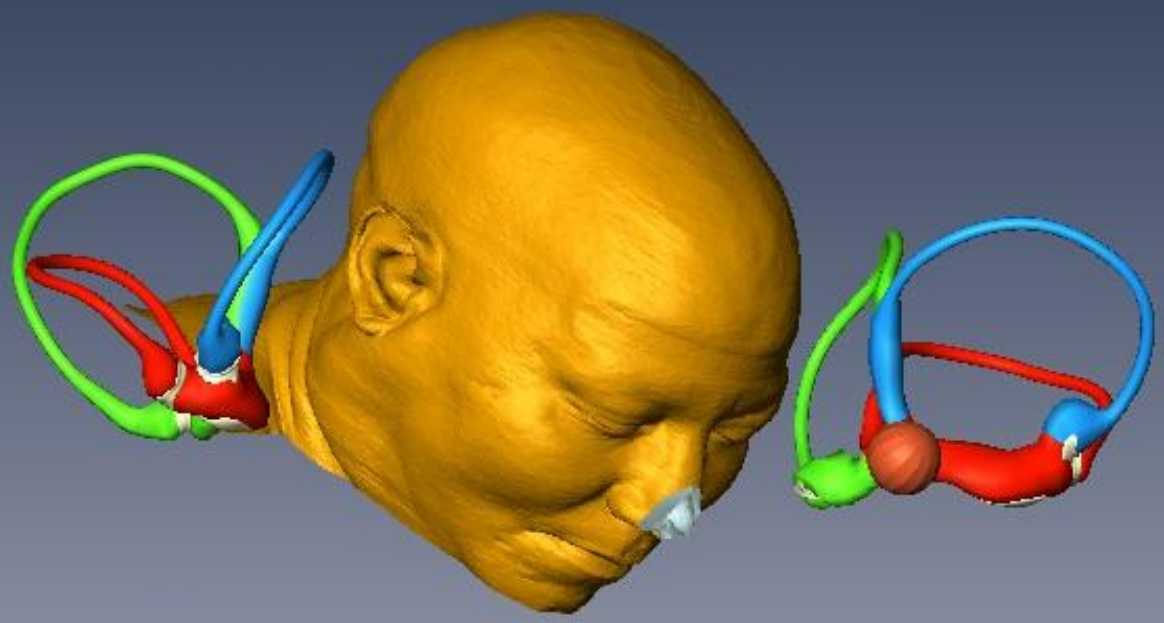


Superior Canal Conversion



Posterior Canal Crista has 31° Posterior Angulation

Liberatory Maneuver



Head Upright Rather Than Forward To Insure Against Conversion to Superior Canal