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

Michael T. Teixido M.D.
Assistant Professor - Otolaryngology

AAO-HNS Annual Meeting - September 2010
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- simultaneous, rapidly sequential events
• Based on human membranous labyrinth
• Based on known human canal geometry
• Easy to use
• Examine currently accepted hypothesis of disease and treatment

Preliminary Results

DellaSantina et. al., JARO 6: 191-206, 2005
100µ segmentation and reconstruction of human vestibular labyrinth
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

82.8°
Inter-canal angle alignment

154.7°
Inter-canal angle alignment

104.5°
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
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:

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
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

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

Liberatory Maneuver Left

1. Combined Angles Below Horizontal > 40°
2. Not Too Long
3. Head Upright
OBSERVATIONS ON POSTERIOR CANAL BENIGN POSITIONAL VERTIGO USING A 3-D MODEL

Treatment:
360° Toes Over Head Rotation

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
  Brian Kung
  Peter Seymour
  Omar Sabra
  Doug O’Neal
  Praveen Thiagarajan
  Sabbir Khan

Christiana Care Health Systems:
  Brian Little

Temporal Bone Foundation:
  Rindy Northrop

This project was supported by NIH Grant Number 2 P20 RR016472-04 under the INBRE Program of the National Center for Research Resources.

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