Resonance Disorders & Velopharyngeal Dysfunctions
Anatomy, Physiology, and Current Imaging Research

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Overview

Anatomy of velopharyngeal structures
Physiology of velopharyngeal closure
Current research findings from MRI studies
Lateral-view X-ray of Normal Adult
Lateral-view X-ray of a Child
Anterior Tubercle

Hard Palate
Velopharyngeal Muscles

- Levator Veli Palatini
- Musculus Uvulae
- Palatoglossus
- Palatopharyngeus
- Superior Pharyngeal Constrictor
- Salpingopharyngeus
- Tensor Veli Palatini
Velopharyngeal Muscles

- Levator veli palatini muscle
  - *Forms sling through midline of velum*
  - *Elevates and retracts velum*

- Musculus Uvulae
  - *Intrinsic velar muscle*
  - *Adds stiffness to velum and assists in velar extension*
A. Levator veli palatini
B. Tensor veli palatini
C. Palatopharyngeus
D. Hamulus
E. Musculus uvulae
Levator Veli Palatini Muscle
Inserting into the Velum
Dorsal view of nasal surface of velum

LVP

MU
Anatomy
Oblique Coronal MRI
Normal Adult
Velopharyngeal Muscles

• Palatoglossus muscle
  – Antagonist to levator
  – Depresses velum
  – Contained within the anterior faucial pillar

• Palatopharyngeus
  – Horizontal fibers: sphincter action of lateral and posterior pharyngeal walls pulling them medially
  – Vertical fibers: lowering the velum; elevation of larynx
Velopharyngeal Muscles

- Superior pharyngeal constrictor
  - Medial displacement of lateral pharyngeal walls
Passavant’s Ridge
Normal Anatomy

Levator Veli Palatini

From Ruding (1964)
Physiology

Nasal sounds: velum is maintained in lowered position (palatoglossus/palatopharyngeus muscles)

Oral sounds: velum must elevate and close off nasal cavity from oral cavity below:
  • Posterior and superior movement of velum
  • Anterio-medial movement of pharyngeal walls
  • Complete contact of velum against posterior pharyngeal wall
Physiology

- Several closure patterns
- May use Passavant’s ridge or adenoid pad to create velopharyngeal closure
Velopharyngeal Closure

*There are numerous types of closure patterns*
3D Computer Reconstruction of the Velopharyngeal Mechanism

Jamie L. Perry & David P. Kuehn
Department of Speech and Hearing Science

Beckman Institute
Imaging Technology Group
University of Illinois, Champaign-Urbana
Unoperated Cleft Palate
Magnetic Resonance Imaging (MRI)

Disadvantages of dissection:
• Time consuming
• Cannot be used on living subjects

Disadvantages of x-ray:
• Invasive; uses ionizing radiation
• Cannot visualize underlying muscles

Advantages of MRI:
• Noninvasive; safe to use
• Enables visualization of the velopharyngeal muscles in situ in living subjects
Current Research Using MRI

MRI

- Diagnostic tool
- Understanding variability among individuals
- Pre and Postsurgical Assessments
- Potential surgical planning tool
- Dynamic imaging during speech production
Diagnostic Tool

Axial MRI

Submucous Cleft Palate

*Levator fibers attach to hard palate*
Diagnostic Tool

Axial MRI

Submucous Cleft Palate

*Levator fibers cross the midline*
Variability in Levator Muscle Among Individuals

Adult population with normal anatomy
- Ettema et al. (2002)
- Might suggest an **acceptable range of muscle variation**

Adult cleft palate population
- Ha et al. (2007)

Infant cleft palate population
- Kuehn et al. (2004)
- Perry (2007)
Variability Among Individuals

Comparisons Between Control Subjects (normal anatomy) and Subjects with Cleft Palate
Pre and Postsurgical Assessments

Levator Muscle Measures

Subject 3: Presurgical

Subject 3: Postsurgical
Pre and Postsurgical Assessments

Velopharyngeal Port Measures
Pre and Postsurgical Assessments
Surgical Planning Tool
Dynamic Imaging

Subject saying: “Me, Me, Me, Sam, Sam, Sam”

12.5 frames per second

Spiral
128x128
24 cm FOV
TR 20 ms
TE 1.5 ms

(Real time; Simultaneous frames movie)
Sutton (UIUC, Bioengineering)

Sutton & Kuehn (2007)
References:


Laboratories:

- Illinois State University, Speech Science Laboratory
- University of Illinois, biomedical imaging center
- Beckman Institute visualization, imaging, and media laboratory