Olfactory Dysfunction and Disorders

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Grand Rounds Presentation
November 26, 2003
Introduction

- Importance of olfaction:
  - Determines the flavor of foods and beverages
  - Early warning system for detection of environmental hazards.

- Prevalence:
  - 2 million Americans
  - At least 1% population under age of 65 and well over 50% over age 65
Anatomy and Physiology

- 3 neural systems
  - CN I: main olfactory system
    - Mediates odor sensation
  - CN V: trigeminal somatosensory system
    - Mediates somatosensory sensation
  - CN 0: nervus terminalis
    - Unknown exact function in humans
Olfactory Epithelium

- Pseudostratified columnar epithelium
- Located in the upper recesses of the nasal chambers
  - Cribriform plate, superior turbinate, superior septum, section of middle turbinate
- Harbors sensory receptors of CN I
Cell Types in Olfactory Epithelium

- Bipolar sensory receptor neurons
  - 6,000,000 cells in adults
  - Olfactory receptors located on the ciliated dendritic ends
  - Axons form 40 bundles as olfactory fila

- Microvillar cells
  - Near the surface of epithelium
  - Exact function unknown
Cell Types

- Supporting cells
  - Insulate receptor cells
  - Regulate mucus composition
  - Deactivate odorants
  - Protect epithelium from foreign agents

- Globose basal cells
- Horizontal basal cells
- Cells lining Bowman’s gland
Olfactory Neuroepithelium
Olfactory Sensory Receptor Neuron
Receptors

- Located on cilia of receptor cells
- 1000 classes - 1% of all expressed genes
- Linked to guanine nucleotide binding protein -> activate adenylate cyclase -> cAMP -> depolarization
- One cell - one type of receptor
Olfactory Bulb

- Located on top of cribriform plate at the base of frontal lobe
- Complex processing center
- Receives receptor cell axons
- Olfactory tract projects to olfactory cortex
  - Frontal lobe, temporal lobe, thalamus, hypothalamus
Classification of Olfactory Disorders

- Anosmia: absence of smell sensation
- Partial anosmia: ability to perceive some, but not all, odorants
- Hyposmia: decreased sensitivity to odorants
- Hyperosmia: abnormally acute smell function
- Dysosmia: distorted smell perception
- Phantosmia: olfactory hallucination
- Olfactory agnosia: inability to recognize an odor
Classification

- Conductive loss
  - Obstruction of nasal passages
  - E.g., chronic nasal inflammation, polyposis

- Sensorineural loss
  - Damage to neuroepithelium
  - E.g., viral infection, airborne toxin

- Central olfactory neural loss
  - CNS damage
  - E.g., tumors, neurodegenerative disorders
Evaluation and Diagnosis

- **History**: most important
  - Olfactory ability prior to the loss
  - Antecedent events (head trauma, URI)
  - Severity
  - Onset (gradual vs. acute)
  - Pattern
  - Other medical conditions
  - Nasal sinus disease and allergy
  - Previous surgery
History (cont)

- Medications
- Smoking history
- Occupational history
- Any complaint of taste loss
Evaluation and Diagnosis

- Physical exam:
  - Nasal endoscopy
  - Neurological exam

- Laboratory tests:
  - Suggested by history and PE only

- Radiographic Imaging:
  - CT: nasal and sinus disease
  - MRI: intracranial causes
Evaluation and Diagnosis

- **University of Pennsylvania Smell Identification Test (UPSIT)**
  - 4 booklets of 10 microencapsulated odors
  - Scratch and sniff format
  - Four responses accompanying each odor
  - Forced choice design
  - Scores are compared to norms (sex- and age-related)
Scores classified into:
- Normal 36-40
- Partial anosmia 20-35
- Total anosmia 8-15
- Probable malingering 0-5

Reliability is very high
Post Upper Respiratory Infection

- Sensorineural loss
- The most frequent cause of smell loss in adults
- More common in middle or older age group
- Woman > man
Post URI

- **History:**
  - follows a viral-like URI, usually more severe than usual
  - Loss is most commonly partial
  - Occasionally with dysosmia or phantosmia
- **PE:** unremarkable
Post URI

- Mechanism: unclear
  - Direct insult to neuroepithelium
    - Greatly reduced number of olfactory receptors
    - Dendrites do not reach surface
    - Lack sensory cilia
    - Replacement of sensory epithelium with respiratory epithelium
  - Ascends to the olfactory tracts or bulbs
Post Viral Olfactory Disorder

- Olfactory cells decreased in number
- Two cilia on olfactory vesicle
Post URI

- Worst case: severe destruction, no regeneration -> anosmia
- Mild case:
  - patchy destruction -> hyposmia
  - Complete regeneration -> normosmia
  - Patchy regeneration or faulty regeneration -> dysosmia
Post URI

- **Treatment:** no effective treatment
- **Prognosis:**
  - Complete recovery in 3 weeks or permanent dysfunction
  - Meaningful recovery is rare
Head injury

- Incidence:
  - 4-7% in early studies
  - Reaching 50% in recent studies

- Generally associated with the severity of the injury
  - Heywood (1990) matched GCS with olfactory test scores
  - Lower GCS score, higher percentage of patients with olfactory impairment
Head Injury

- **Mechanism:**
  - Sinonasal tract alteration
    - Direct injury to olfactory epithelium (mucosal edema, hematoma)
    - Nasal skeleton fracture
    - Post-traumatic rhinosinusitis
    - Potentially treatable
  - Shearing injury
    - Tearing or shearing the axons
    - With naso-orbito-ethmoid region fracture
    - Translational shifts in the brain secondary to coup or contracoup forces
Head Injury

- **Mechanism (con):**
  - Brain contusion or hemorrhage

- **Treatment:**
  - Irreversible most of time
  - Prognosis worsen with time
Post Traumatic Injury

- Olfactory cells decreased in number
- Olfactory receptor is aciliate
Nasal and Sinus Disorders

- Traditionally viewed as conductive loss
- Airflow blockage caused by rhinosinusitis prevent odorant molecules from reaching epithelium
- Surgery or medical treatment alone not effective
- Defining factor may be the severity of the histopathological change
Nasal and Sinus disorder

- Doty and Mishra (2001):
  - Degree of olfactory loss is associated with the severity of nasal sinus disease
  - Improve with systemic steroid and topical steroid
  - No documented relationship between olfactory test scores and intranasal airway access factors
  - Chronic inflammation may be toxic to olfactory mucosa
  - Thin, atrophic epithelium
  - Respiratory epithelium replaces sensory epithelium
Nasal and Sinus Disorder

- Doty and Mishra (2001)
  - Septoplaty and rhinoplasty do not have long-term deleterious effect
  - Improvement of olfactory function postoperatively with sinus surgery (incomplete)
Other Causes of Olfactory Disorders

- Toxin
- Tumor
- Congenital
- Endocrine
- Psychiatric
- Neurodegenerative disorder (Parkinson, Alzheimer disease)
Treatment of Olfactory Disorder

- Conductive loss: relieve obstruction
  - Allergy management
  - Topical cromolyn
  - Topical and systemic corticosteroids
  - Surgical procedure

- Sensorineural loss: no effective treatment
Bibliography