

Assessment of Olfaction in Patients After Total Laryngectomy

Thesis

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Abstract

After a total laryngectomy the upper and lower airways are disconnected resulting in a wide range of adverse effects, e.g. deterioration of nasal functions in breathing, loss or decrease of normal sense of smell.

The overall aims of this thesis were:

- 1) To assess the olfaction in laryngectomized patients.
- 2) To evaluate the long-term olfaction state of these patients after the operation.

The study population consisted of 32 laryngectomized patients. Olfaction acuity was examined with the Scandinavian Odor Identification Test (SOIT). The patients were categorized as non-smellers (anosmia) or smellers (normosmia or hyposmia) based on the SOIT results.

It was concluded that:

- 1) Olfactory impairment is common in laryngectomized patients.
- 2) The more the duration after total laryngectomy operation, the more impairment of patient olfaction.

Key words: the Scandinavian Odor Identification Test (SOIT), olfaction, total laryngectomy.

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List of abbreviations

AD	Alzheimer's disease
AMP	Adenosine mono-phosphate
BDI	Beck's Depression Inventory
B-SIT	Brief Smell Identification Test TM
cAMP	cyclic adenosine mono-phosphate
CCCRC	Connecticut Chemosensory Clinical Research Center
CC-SIT	Cross-Cultural Smell Identification Test
CNI	Olfactory nerve
CNV	Trigeminal nerve
CN VII	Facial nerve
CN IX	Glossopharyngeal nerve
CN X	Vagus nerve
CSERP	Chemosensory event-related potential
CSF	cerebrospinal fluid
CT	Computed tomography
EEG	Electroencephalography
ENT	Ear, Nose and Throat
EOG	Electro-olfactogram
fMRI	functional magnetic resonance imaging
GWBS	General Well-Being Schedule
HEOG	Human Electro-Olfactogram
HDF	head-down forward
JSO	Jet Stream Olfactometer
LOT	Lateral olfactory tract
MCSTQ	Multi Clinic Smell Taste Questionnaire

MND	motor neuron disease
MRI	Magnetic resonance imaging
MS	multiple sclerosis
NAIM	Nasal Airway Inducing Maneuver
NE	Norepinephrine
NHIS	National Health Interview Survey
NMDA	N-methyl-D-aspartate
OERP	olfactory event-related potential
OMT	Odor Memory Test
ONL	Olfaction Nerve Layer
OSIT	Odor Stick Identification Test
OSNs	Olfactory sensory neurons
PDE	Phosphodiesterase
PST	Pocket Smell Test TM
QOD	Questionnaire for Olfactory Dysfunction
QOL	Quality Of Life
Q-SIT	Quick Smell Identification Test TM
SF-36	Short Form -36 Health Survey
SIT	Smell Identification Test
SMT	Sniff Magnitude Test
SND	Sino-nasal disease
SOIT	Scandinavian Odor Identification Test
STT	Smell Threshold Test TM
UPSIT	University of Pennsylvania Smell Identification Test
URTI	Upper respiratory tract infection

Introduction

The nose is our most important environmental sensor. Very low levels of environmental chemicals can be detected and categorized as pleasant, neutral or unpleasant. Especially unpleasant odors or those that are believed harmful can annoy us (**Danuser, 2001**).

Sense of smell provides people with valuable input from the chemical environment around them. When this input is decreased or distorted, disability and decreased quality of life are reported (**Miwa et al., 2001**).

Olfactory disorders have a great impact on human's life as olfaction is essential for both physiological (e.g., food, drink) and security needs. Normal salivary and pancreatic/gastric anticipatory secretions in response to food smells are presumably absent or severely attenuated in the anosmic (patient with absence of smell function). The unpalatability of food when it arrives serves further to decrease food enjoyment (**Toller, 1999; Rombaux et al., 2005**).

So smell disorders have significant consequences for the patient including:

- 1- Impaired quality of life.
- 2- Increased health or safety risks from spoiled foods and dangerous vapors (e.g. leaking natural gas).
- 3- Altered food choices and consumption patterns that can adversely impact health or worsen underlying illnesses (e.g. decreased body weight, impaired immunity, overuse of salt in hypertension or sugar in diabetes mellitus) (**Doty, 2005**).

Aim of work

The aim of this work is to review the anatomy and pathophysiology of olfaction and to assess the olfactory function in patients undergone total laryngectomy.

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Chapter 1

Anatomy of Olfactory Nervous System

The olfactory nervous system is a hierarchically ordered neuronal pathway that consists of three main stations: the olfactory epithelium, olfactory bulb and olfactory cortex (*Fukushima et al., 2002*).

The olfactory epithelium

The olfactory epithelium is situated in the superior aspect of the nasal vault in the cribriform plate medial to the middle turbinate and has a surface area of 1.5 to 2.5 cm² in adults in each nasal fossa (*Rombaux et al., 2005*).

Some areas of the olfactory epithelium are also present in the superior turbinate, the dorsoposterior region of the septum and the anterior and middle parts of the middle turbinate (*Leopold et al., 2000; Lane et al., 2002*).

Ultrastructure of the olfactory epithelium

The human olfactory epithelium is a pseudostratified columnar epithelium that rests on a highly cellular lamina propria that contains the Bowman's glands and extends about 150 um down to the underlying bone or cartilage. It contains four major cell types: ciliated bipolar olfactory receptors, microvillar cells, sustentacular cells and basal cells. All except the basal cells project to the surface (*Meredith, 2001; Jafek et al., 2002*).

The olfactory receptor neurons are a collection of about 6 million bipolar receptor cells whose cell bodies, dendrites and initial axon segments are located within the olfactory neuroepithelium. Each bipolar receptor cell sends up to 50 cilia from its dendritic knob into the overlying mucus, thus enhancing the effective surface area for odorant binding. Each bipolar neuron sends a single axon through the cribriformplate to the olfactory bulb(**Moran et al., 1982**).

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These bipolar neurons are unique in three ways:

- 1- They are directly exposed to the external environment.
- 2- They have a propensity to regenerate from the basal cells.
- 3- They serve both as the receptor cell and the first order neuron (**Hinds et al., 1984; Lewis et al., 1995**).

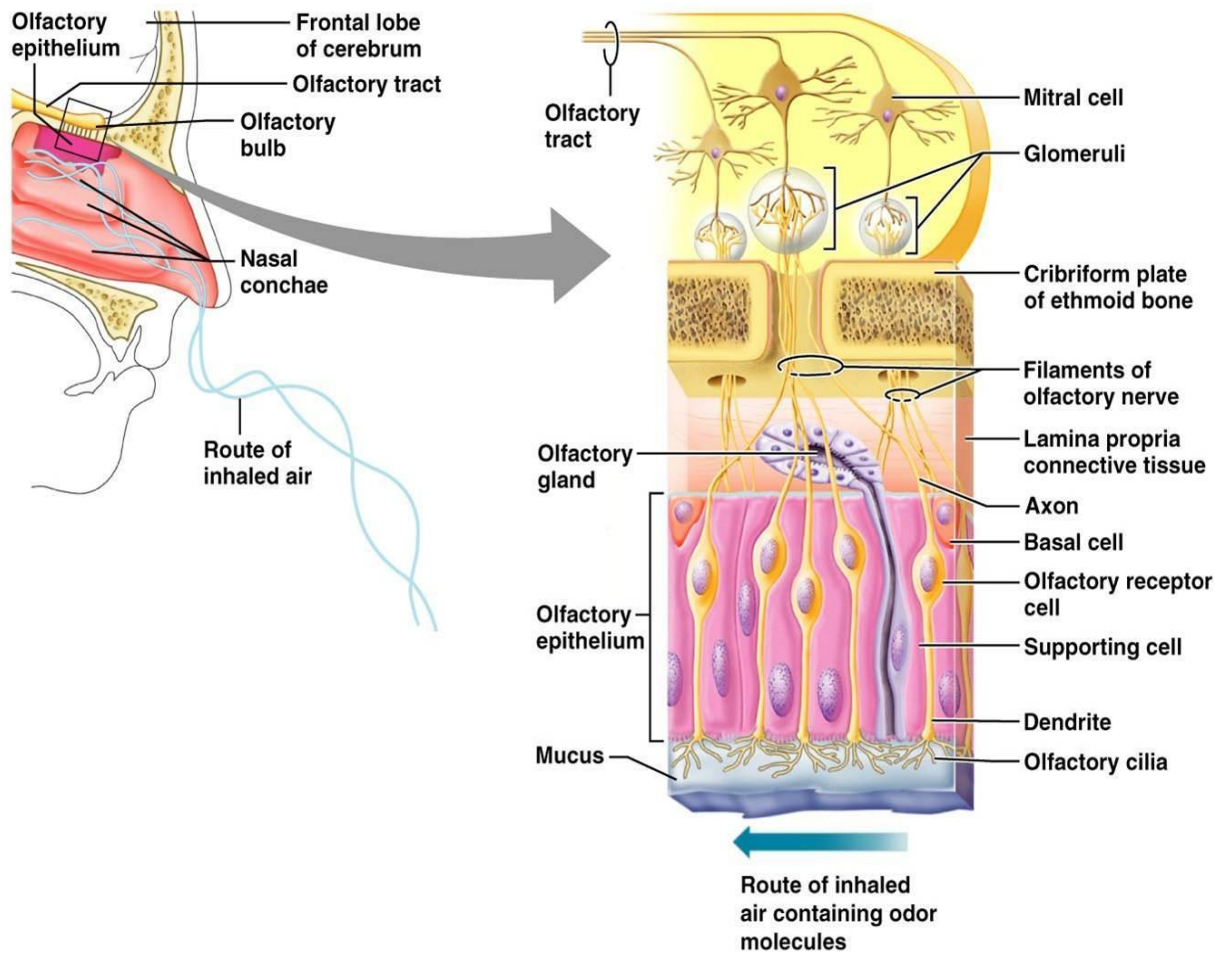


Figure 1: Structure and function of the olfactory epithelium (Jafek et al., 2002)

The olfactory bulbs

The oval olfactory bulbs are comprised of six concentric layers: namely, the glomerular nerve cell layer, the external plexiform layer, the mitral and tufted cell layer, the internal plexiform layer, and the granule cell layer (Figure 2 and 3). The main afferent apical dendrite of the second order neurons (mitral and tufted cells) are influenced not only by olfactory nerve axon terminals but also by interneurons and centrifugal fibers (Shipley and Reyes, 1991).

The mitral cells are the biggest neurons in the bulb, project to the olfactory cortex via the lateral olfactory tract (LOT) (*Kratskin,1995; Moriizumi et al., 1995*).

Thus the LOT is a major central olfactory pathway connecting the olfactory bulb to the olfactory cortex and is made up of myelinated fiberbundles of mitral cells (*Fukushima et al., 2002*).

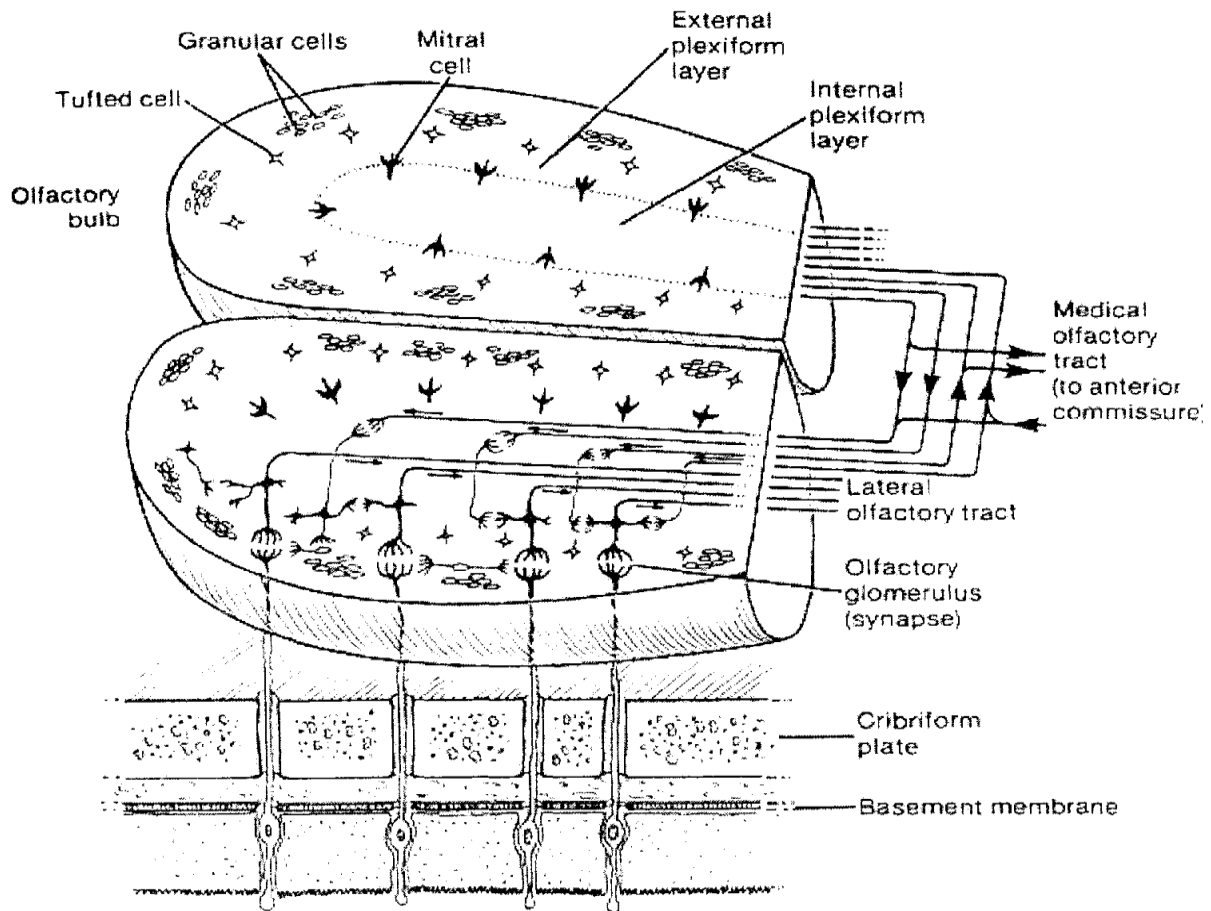


Figure 2: Structure of the olfactory bulbs and their neural connections to each other, the olfactory mucosa, and the brain (*Leopold and Holbrook, 2005*).

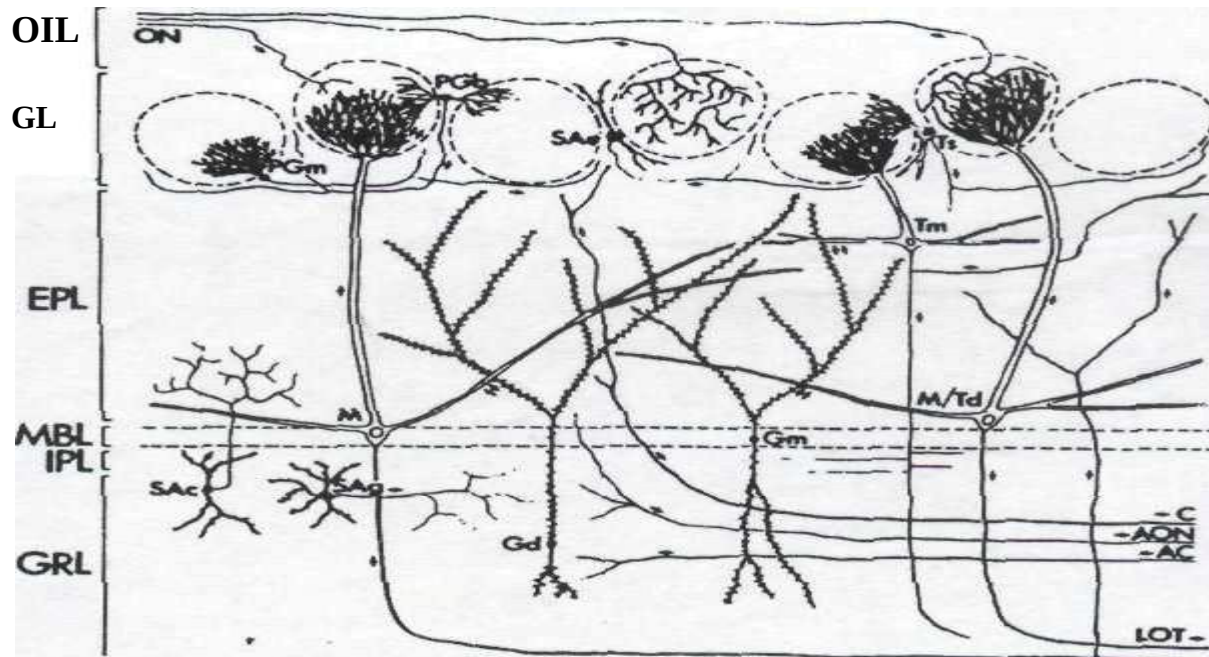


Figure 3: Diagram of main layers and types of olfactory bulb neurons in the mammalian olfactory bulb as based upon Golgi stained material. Main layers are indicated on left as follows: **ONL**, olfactory nerve layer; **GL**, glomerular layer; **EPL**, external plexiform layer; **MBL**, mitral body layer; **IPL**, internal plexiform layer; and **GRL**, granule cell layer. **ON**, olfactory nerves; **PGb**, periglomerular cells with biglomerular dendrites; **PGm**, periglomerular cell with monoglomerular dendrites; **SAe**, short-axon cell with extraglomerular dendrites; **M**, mitral cell; **M/Td**, displaced mitral cell or deep tufted cell; **Tm**, middle tufted cell; **Ts**, superficial tufted cell; **Gm**, granule cell with cell body in mitral body layer; **Gd**, granule cell with cell body in deep layers; **SAc**, short-axon cell of Cajal; **SAg**, short-axon cell of Golgi; **c**, centrifugal fibers; **AON**, fibers from anterior olfactory nucleus; **AC**, fibers from anterior commissure; **LOT**, lateral olfactory tract (Shepherd, 1972).