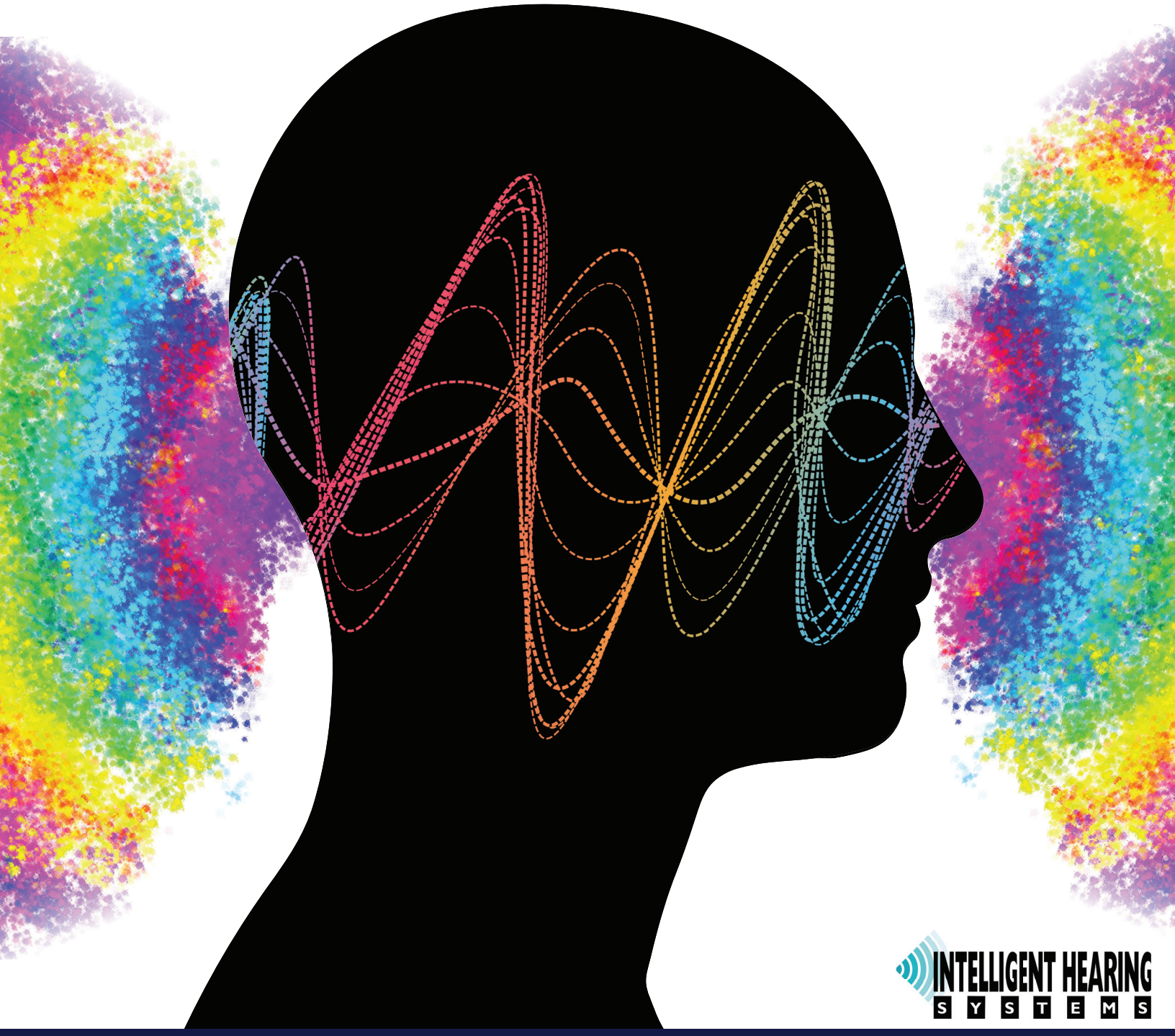
# Clinical Audiology Concepts with SmartVS

First Edition



INTELLIGENT HEARING SYSTEMS

David K. Brown

# Clinical Audiology Concepts with SmartVS

First Edition

David K. Brown, PhD

Editor

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# Preface

This is the first edition of Clinical Audiology Concepts with SmartVS, which is a companion to the Smart Virtual Simulator (SmartVS) software package. The background knowledge of audiology is presented in this book to facilitate the learning of practical and clinical concepts that can be practiced using the SmartVS software. This companion text book is organized into three sections in the typical order that a clinician would perform the various evaluations on a patient: Part 1 covers the **fundamentals of hearing science** including the **properties of sound and speech acoustics and the anatomy and physiology of the auditory system**. In Part 2, we discuss **otoscopy**, to assess the external auditory structures, **tympanometry**, to assess tympanic membrane and middle ear compliance, acoustic reflex (measured during tympanometry), to assess the middle ear, **audiometry** to assess hearing sensitivity to pure tones and speech using behavioral techniques, **otoacoustic emissions** to assess cochlear function, and **auditory evoked potentials** (AEP), to assess retrocochlear function from the auditory 8th nerve to cortical regions. All of these concepts can be demonstrated using the SmartVS software. Part 3 describes the **management of hearing problems** including a variety of hearing disorders, hearing aids and auditory implants and **helping those with hearing loss**. Additionally, each chapter has exercises that will engage the reader and provide them with hands-on experience with many concepts for each of these tests.

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*To my students, thank you for pushing me to develop new ways to teach the basics of Audiology.*

*Thanks to my colleagues and friends for helping me further my understanding of the use of simulation in Audiology education.*

– David K. Brown

# Chapter 4

# Otoscopy

## Chapter Objectives:

You should be able to:

1. Define otoscopy and identify the different parts of an otoscope.
2. Identify different types of otoscopes and describe the differences between them.
3. Describe how to conduct palpation of the external ear and identify the landmarks of the pinna.
4. Describe how to conduct otoscopy, including preparation, choosing specula size and inserting the specula.
5. Identify the landmarks of the tympanic membrane and their locations on the tympanic membrane.
6. Define a variety of pathologies visualized during otoscopy and how to identify them.
7. Describe how to document otoscopy results and identify patients that should be referred for further diagnostic testing.

**The following interactive icons may appear in this chapter**

Download a fillable PDF form for a chapter exercise

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# What is Otoscopy?

Otoscopy is a clinical examination used by audiologists and other healthcare professionals to inspect structures of the outer ear, including the external auditory canal, tympanic membrane (TM), and auricle. The purpose of otoscopy is to evaluate the condition of these structures and to check for any signs of ear pathology or abnormality that could impact hearing thresholds and overall hearing health. Due to the inability to visualize inside the ear canal, a tool called an otoscope is used to provide magnification and illumination of the external ear canal and tympanic membrane. Audiologists conduct otoscopy on patients of all ages and at every standard audiology appointment to reduce complications during audiometric testing and ensure the correct treatment plan is given. An audiologist's understanding of otoscopy and their correct technique will ensure that an accurate hearing diagnosis is given, leading to overall good patient care.

# Parts of an Otoscope

While there are several types of otoscopes, the parts of an otoscope tend to stay the same. As shown in Figure 4-1, an otoscope consists of three primary parts: the cone, the head, and the handle. The otoscope's cone projects off the otoscope head and is sized to perfectly fit a speculum. The speculum is the detachable component of the otoscope, which comes in different sizes, that when attached, aids in focusing light into the ear canal. Combined, these two parts of an otoscope are placed into the external auditory canal.

The head of the otoscope contains the light source and magnifying lens. The light source provides illumination through a bulb, although the type of bulb can be one of several including incandescent, halogen, xenon, and LED lights (Bankaitis, 2011). Most otoscopes utilize a halogen or xenon bulb which allows for a brighter and stronger light compared to incandescent bulbs. The low-level magnifying lens, typically a 3X or 4X, provides magnification of the tympanic membrane for better visualization.

The otoscope's handle contains the power switch and battery. The power switch on a standard full-sized otoscope allows for control over the light's intensity through a rotating power switch. Located within the handle of the otoscope is the battery or power source. Full-size otoscopes will be powered by either a wall mount or a rechargeable battery. Most use rechargeable batteries rather than disposable alkaline batteries (Bankaitis, 2011). However older full sized and pocket otoscopes may use alkaline batteries that need to be replaced regularly. Located at the base of the handle is the cap, allowing for access inside the battery handle to replace disposable batteries.

**Figure 4-1.** Full Sized Otoscope with Labeled Parts

# Types of Otoscopes

## *Pocket Otoscopes*

Pocket otoscopes, as shown in Figure 4-2A, were originally designed to be carried in the pocket of a lab coat, in turn, they are much smaller and lighter compared to traditional full-sized and video otoscopes (Bankaitis, 2011). Due to their small size and lower cost, pocket otoscopes commonly utilize disposable batteries to power the light source. Additionally, these otoscopes do not permit control over light intensity, with only a simple on and off switch. While pocket otoscopes are inexpensive, they have fewer additional functions compared to full sized otoscopes and video otoscopes due to simple technology and non-interchangeable heads and handles**.** The small size of pocket otoscopes allows for easy transportation but are not commonly used by audiologists in clinics due to their lack of advanced features.

## *Full Sized Otoscopes*

Full sized otoscopes are commonly used by audiologists due to the flexibility they provide. Unlike pocket otoscopes, full sized otoscopes (see Figure 4-2B) are larger, heavier, and the head and handle are interchangeable (Bankaitis, 2011). The head and the handle of a full-sized otoscope tend to be more advanced compared to pocket otoscopes and can be purchased individually as the head and handle are interchangeable. Interchangeable parts allow for easier repairs and more accommodations to be made to the otoscope, including access to recent technology without having to purchase a new otoscope. Additionally, most full-sized otoscopes utilize a

rechargeable battery, allowing for the otoscope to be plugged into a charging base instead of consistently replacing disposable batteries.

**Figure 4-2. Otoscopes**. A. Traditional full-sized handheld otoscope. B. Traditional Pocket Otoscope. C. Video Otoscope

## *Video Otoscopes*

The last type of otoscope is the video otoscope (Figure 4-2C). A video otoscope allows the user to connect the otoscope to a monitor to display the image from the otoscope onto a screen. A video otoscope works through a cable that attaches to the head of the otoscope and connects to a monitor allowing for the otoscope visual to be transported to a larger screen. This allows the clinician to show the patient their ear canal and point out any abnormalities or conditions such as an osteoma. When using the video otoscope, you may also be able to see the patient's TM moving.

**VIDEO: TM MOVEMENT**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/TM_MOVEMENT.MP4

Video otoscopes are the most expensive otoscopes on the market; however, they do offer advantages for audiologists. The monitor visual allows for a larger image of the ear canal and tympanic membrane and can also be used to take pictures or videos that can be added to the patients file. This can be beneficial to both patients and other health care professionals, as a visual of the tympanic membrane can help explain suspected pathologies.

# How to Perform Otoscopy

## *Preparation*

Before conducting an otoscopic examination, all materials should be gathered, such as the otoscope and speculums. The examiner's hands should be disinfected, along with the area where the otoscopy examination is going to be completed. After disinfecting the area, the patient should be seated in a comfortable chair that allows both sides of the head to be examined. Case history questions should be asked prior to starting otoscopy to determine any red flags that need to be inspected. Lastly, always give a clear description of the procedure before conducting otoscopy, this allows the patient to feel comfortable and reduces any patient confusion.

## *Palpation*

Before visualization of the tympanic membrane, the external ears should first be visualized. With the patient seated, the examiner should visualize the pinna and mastoid for any surgical scars, masses, or any other malformations. The landmarks of the pinna should be inspected to ensure proper formation of the pinna and to aid in identification of malformations (see Figure 4-3 for tympanic membrane landmarks). Any abnormalities should be noted. After inspection, the mastoid and pinna should be palpated. When palpating the ear, watch for any indications from the patient that they are in pain or discomfort. Discomfort during palpation could be a sign of a pathology, such as an infection of the middle ear space. If there is pain or discomfort during palpation, a referral to an ENT or a primary care physician may be needed for further diagnostic testing.

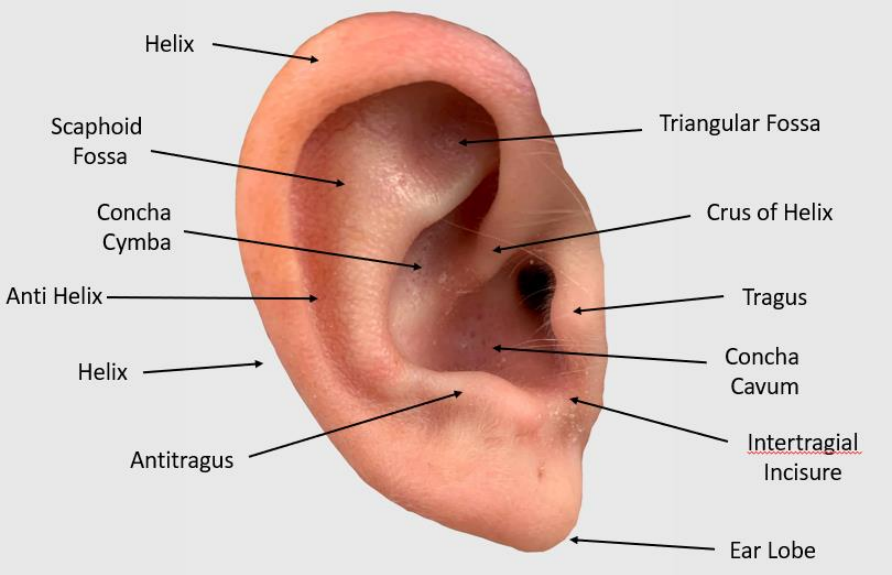


**Figure 4-3.** Pinna with Labeled Landmarks.

**EXERCISE 1: PALPATION OF THE OUTER EAR**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_1.PDF

## *Choosing the Specula Size*

The largest speculum that fits comfortably in the ear canal should be chosen when performing otoscopy. The largest specula will allow for the largest beam of light and give the largest view of the tympanic membrane. When using a smaller speculum, repositioning may be required to get a full view of all four quadrants of the tympanic membrane. Typically, a 4-5 mm speculum is used for adults, however, children have narrower ear canals, and a smaller 3-4 mm speculum may be more appropriate. For otoscopy in infants, a 2.5-3 mm speculum is most commonly used. A general rule is to always start with the largest size and then decrease the speculum size if the patient experiences any discomfort. Once the speculum size is chosen, twist the speculum onto the otoscope cone in a clockwise direction and ensure it is secured.

**EXERCISE 2: CHOOSING THE SPECULA**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_2.PDF

## *Holding an Otoscope*

There are two main methods to hold an otoscope: the pencil grip and the pistol grip. When using the pencil grip technique, the otoscope is held like a pencil with the otoscope handle positioned upwards between the thumb and index finger. The ring and pinky fingers will then be used to brace by placing them against the patient's temple (see Figure 4-4A). When using the pistol grip technique, the otoscope is held in the palm of the hand with the back of the index finger used to brace by placing it against the patient's cheek (see Figure 4-4B). Both techniques can be used, however it is recommended that the otoscope be held in the right hand when evaluating the patient's right ear and the left hand when assessing the patient's left ear (Falkson & Tadi, 2021).

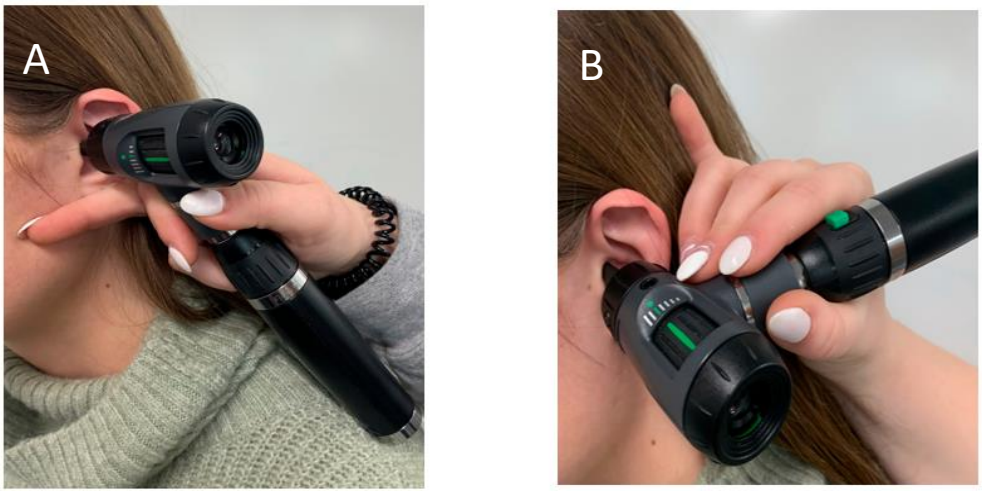


**Figure 4-4**. Methods of holding an otoscope to visualize the ear canal and tympanic membrane. Both methods: A. Pistol Grip Method and B. Pencil Grip Method. Both methods utilize bracing techniques to provide protection to the patient.

## *Bracing*

While the pencil and pistol techniques are recommended to be used during otoscopy, any technique to method is acceptable if adequate bracing is occurring. Bracing is the technique where the fingers or portion of the hand are placed against the patient's cheek or side of the head to prevent head movement from injuring the patient. Bracing is completed to limit movement and ensure the patient safety. Without adequate bracing, the patient could move their head while the speculum is in their canal potentially resulting in pain and abrasions of the ear canal wall or tympanic membrane.

## *Inserting the Speculum*

Once the patient is in position and the clinician is holding the otoscope and bracing, the speculum can then be inserted into the external ear canal. Before inserting the speculum, the clinician must

straighten the ear canal providing a clear line of sight for visualization of the tympanic membrane. In adults, the free hand of the examiner should be used to grasp the patient's auricle and gently pull up and back to straighten the ear canal. For children less than three years of age, the ear canal is straightened by pulling the pinna down and back. While inserting the specula, the ear canal should be visualized and any abnormalities such as excessive or occluding cerumen, infections, foreign bodies or abnormalities should be noted. Once the speculum is inserted, look into the otoscope lens, and begin visualizing the tympanic membrane. The speculum may need to be repositioned to get a full view of all four quadrants of the tympanic membrane. This can be done by angling the speculum slightly downward for better visualization in adults, while for children under the age of three a slight upward angle may provide better visualization.

**VIDEO: INSERTION OF THE SPECULUM**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EAR_CANAL_INSERTION.MP4

**EXERCISE 3: HOLDING AN OTOSCOPE**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_3.PDF

# Visualization of the Tympanic Membrane

During visualization of the tympanic membrane, the provider should evaluate the overall health of the tympanic membrane and observe factors such as color, presence of perforations, and a bulging appearance (Mankowski & Raggio, 2021). A healthy tympanic membrane appears to be a translucent grey or pink color, with a slightly concaved appearance. Observations such as an abnormal color, or a bulging appearance should be considered when deciding when to refer to an ENT. During the examination, all four quadrants of the tympanic membrane, the anterosuperior, anteroinferior, posteroinferior and posterosuperior should be visualized as shown in Figure 4-5. These quadrants are formed by an imaginary line drawn vertically along the manubrium of the malleus and a line passing perpendicularly through the umbo.

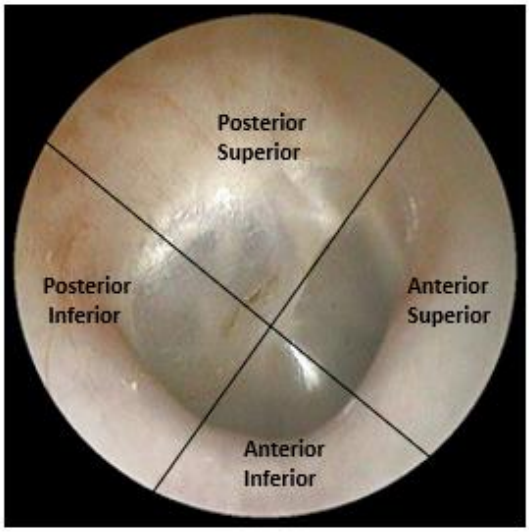


**Figure 4-5.** Tympanic Membrane with Labeled Quadrants.

Visualization of all four quadrants of the tympanic membrane is ensured through identification of the tympanic membrane landmarks. Additionally, visualization of these landmarks aids in identification of pathologies. No visualization or abnormal visualization of landmarks can be indicative of certain pathologies. As shown in Figure 4-6, the landmarks of the tympanic membrane include the umbo, the manubrium of the malleus, the short process of the malleus, the light reflex or cone of light, the pars tensa and the pars flaccida.

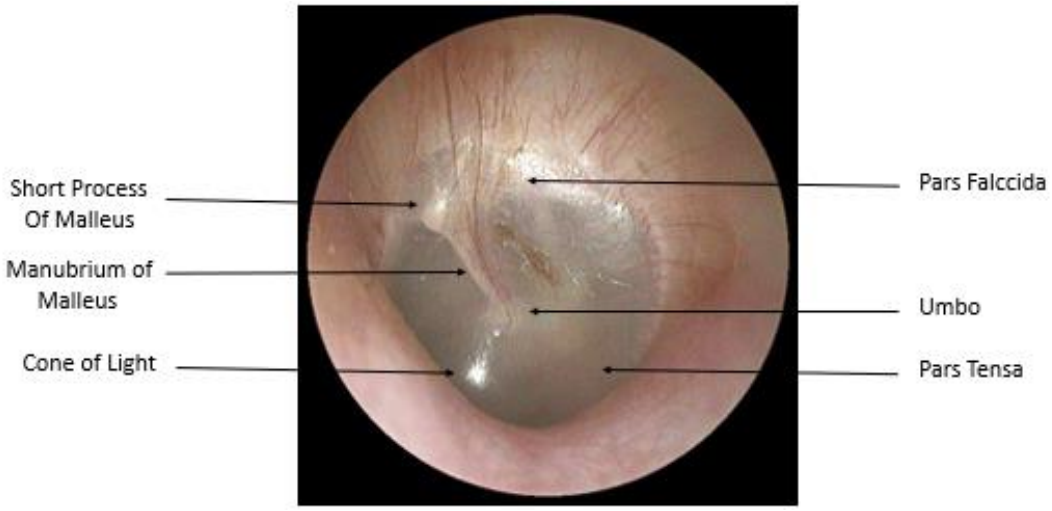


**Figure 4-6.** . Right Tympanic Membrane with Labeled Landmarks

The manubrium, or the handle of the malleus, is the largest landmark of the tympanic membrane. This landmark aids in determining right and left ears as the manubrium always points towards the face of the patient. For example, in the right ear (Figure 4-6), the malleus will be pointing towards the right side. Additionally, the cone of light also aids in identification

of the right or left ear. The cone of light is the light reflected off the tympanic membrane from the otoscope. This light usually reflects in a triangular shape located below the umbo. The positioning of this light changes based on the ear being evaluated, the cone of light is located at the 5 o'clock position or more towards the right side in the right ear, while in the left ear the cone of light is reflected in the 7 o'clock position or more towards the left. When the cone of light is diminished or absent, this could be indicative of a pathology changing the slightly concaved structure of the tympanic membrane. For example, acute otitis media can create bulging of the tympanic membrane while pathologies such as eustachian tube dysfunction can cause retraction of the TM, both resulting in an absence or reduction of the cone of light. The other landmarks of the tympanic membrane also aid in determination of pathologies and ensuring all portions of the tympanic membrane are visualized. The umbo, the point where the malleus connects to the tympanic membrane, is what pulls the tympanic membrane back and forms the tympanic membrane's slight concaved appearance. The umbo is located in the pars tensa, the thicker and tauter portion of the tympanic membrane. Located above the pars tensa, situated above the short process of the malleus, is the pars flaccida. The pars flaccida is the more flaccid or moveable portion and makes up a small area of the upper tympanic membrane.

**EXERCISE 4: IDENTIFICATION OF TYMPANIC MEMBRANE LANDMARKS**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_4.PDF

# Abnormalities of the Tympanic Membrane

When visualizing the tympanic membrane, any discoloration, obstruction, or unidentifiable landmarks are a red flag for a pathology. There are numerous pathologies that can be observed through otoscopy. An audiologist's role is not to diagnose patients with ear pathologies but being aware of all pathologies aids in making correct referrals and developing the best care plan for the patient. Below are common abnormalities that can be seen during an otoscopic examination, along with the recommendations that should be given to the patient. A general rule to follow when conducting otoscopy is to refer patients to an ENT or their primary care physician whenever there is identification of an abnormality in the ear canal, pinna, or of the tympanic membrane.

**EXERCISE 5: IDENTIFYING ABNORMAL TYMPANIC MEMBRANES**
HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_5.PDF

# How to Document Otoscopy Findings

When documenting otoscopy results, it's important to always document what was seen in both ears. If otoscopy resulted in normal findings a simple statement such as "clear ear canals, and healthy tympanic membrane was visualized bilaterally" can be given. If any abnormality is found a detailed statement about the appearance, and location of the abnormality should be given. For a reference point for other health care professionals, the location of the pathology should be given by utilizing the tympanic membrane quadrants when describing location. For example, when visualizing a tympanic membrane perforation, a statement such as "upon visualization of the right tympanic membrane, the tympanic membrane was red and appeared irritated and a small perforation was identified in the upper portion of the anteroinferior quadrant." When documenting otoscopy results, be as concise as you can, while describing the location and appearance of any abnormalities identified.

**EXERCISE 6: DOCUMENTING OTOSCOPY**

HTTPS://SMARTVS.IHSYS.INFO/BOOK/CHAPTER_4/EXERCIZE_4_6.PDF

**Table 4-1** Abnormal Tympanic Membrane Visualizations.

| ABNORMALITY | VISUALIZATION OF ABNORMALITY | DESCRIPTION OF ABNORMALITY | WHAT SHOULD AN AUDIOLOGIST DO? |
|---|---|---|---|
| **Acute Otitis Media** | Opaque and red TM with bulging appearance. | Infection of the fluid in the ME and inflammation of the ME space. | Refer to an ENT or patients primary care physician. |
| **Otitis Media with Effusion** | Retraction of TM with appearance of slight opaqueness. Fluid is serous and has a clear color. | Fluid in the ME space, with no inflammation of the membrane or middle ear space. | Refer to an ENT or patients primary care physician. |
| **Cerumen Impaction** | No visualization of TM. Cerumen covers all quadrants of TM. | Cerumen impaction will result in conductive hearing loss. | Remove cerumen or refer to ENT or physician for cerumen removal. |
| **Excessive Cerumen** | Partial visualization of the TM. All four quadrants of the membrane are not fully covered. | Could result in aural fullness, but no impact to hearing thresholds. | Remove cerumen or refer to physician for cerumen removal. Audiometric evaluation can still be completed. |
| **Foreign Body** | Object visualized in ear canal. Common foreign bodies include beads, insects, or hearing aid domes. | Can result in discomfort or pain of the ear canal. | Remove foreign body or refer to ENT or physician for removal. |
| **Pressure Equalization Tubes** | A tiny plastic or metal cylinder, commonly placed in the TM's anteroinferior quadrant. | Purposely placed tube that allows for ventilation of the ME. | Audiometric evaluation can be completed as usual. |
| **Tympanic Membrane Perforation** | A hole in the TM where the middle ear space is now visualized. | A rupture in the TM creating a hole. It can cause conductive hearing loss, tinnitus, pain or discomfort. | Refer to an ENT for further treatment. |
| **Tympanosclerosis** | White and rough appearance in locations on the TM with loss of transparency. Can be in multiple locations. | Scarring of the TM resulting from damage or surgery. In serious cases it can result in conductive hearing loss. | Audiometric evaluation can be completed as usual. |
| **Cholesteatoma** | Abnormal growth or polyp sprouting from the ME space or mastoid bone. Commonly seen in the posterosuperior quadrant. | Abnormal growth of squamous epithelium. It can cause hearing loss, otorrhea, pain, and dizziness. | Immediate referral to an ENT for further diagnostic and treatment. |

# Summary

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