

**“...At the
Airport”
Nervous System- Case 2**

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Learning Objectives:

This PBL Package targets the following objectives:

- Correlate the anatomical structures (inner ear, and vestibulocochlear nerve) with their functions in hearing and body balance mechanisms.
- Discuss the significance of the cerebellopontine angle area and anatomical structure related to it.
- Understand the anatomy and function of the vestibulocochlear, trigeminal, and facial nerves.
- Use basic sciences to interpret symptoms, signs and investigation results of a patient presenting with acoustic neuroma.
- Briefly outline a management plan and manage options.
- Discuss the impact of disease on patient, family and work.

Discussion Questions:

- Are there any difficult words you do not understand?
- List the key information about Mohammad.
- Identify Mohammad's presenting problems.
- For each problem, generate a list of possible causes (hypotheses).
- What further information would you like to know from history to refine your hypotheses?

New Terms/Difficult words

- Cargo:
- Airport navigator:

Problems/Hypotheses

Numbness on the right side of his face:

- Problem with sensory receptors in the skin.
- Problem with the sensory nerve.
- Problem with the nuclei of sensory nerve.
- Problem in the higher centres in the cortex.

Facilitation Questions

Balance: Structures/functions needed

- *Normal proprioceptors.*
- *Healthy peripheral nerve.*
- *Normal dorsal column (spinal cord).*
- *Normal cerebellum*
- *Normal vestibular system (ear): semicircular canals, vestibular receptor cells, vestibular hair cells.*
- *Normal vestibular neurons*
- *Normal vestibular nuclei*
- *Normal vestibulospinal tract*
- *No postural drop of blood pressure.*
Normal blood flow to the brain.

Please Read The History

History

Past History

He did not have history of fever, ear discharge, pain or runny nose. He is always fit and never hospitalized and his regular checkups are always normal.

Smoking and Alcohol

Nil

Medications and Allergy

Nil

Family history

His parents died at the age of 85 and 81 after a short illness. He has 6 sisters and brothers all are fine.

Social History

He is married and has three children. He has been working in King Khalid Airport for over 12 years. He is always fit and healthy. He likes his work. He has not visited his family in India for the last 14 months.

New Terms

(Tutor: encourage students to use their medical dictionary to find out more about these words)

- Earwax:
- Hearing:
- frequency:

Problems/Hypotheses

Decreased hearing-right ear:

- Earwax 0.
- Middle ear problem e.g, otitis media - 0
- Perforated drum 0
- Problems with the inner ear +/++ (but can not explain other problems).
- Problems with the 8th cranial nerve ++/+++.
- Problems with the centre +

Ringng noises-right ear:

- Problems in the inner ear +/++
- Problems in the 8th cranial nerve ++/+++
- Intracranial vascular problem (e.g. aneurysm, vascular malformation) ?

Problems/Hypotheses

Anxiety/worried:

- He might lose his job ++.
- He might have a serious disease.?
- Unable to cope with his work with this illness. +/++
- Do errors or mistakes ++.
- Worried about financial/family issues ++.

Numbness-right side of the face

- Problem with sensory receptors in the skin 0/+.
- Problem with the sensory nerve 0/+.
- Problem with the nuclei of sensory nerve +/+++.
- Problem in the higher centres in the cortex +.

Facilitation Questions?

**Which cranial nerve do you think are involved here?
8th and 5th cranial nerves**

Tutor: Encourage students to create a diagram showing the anatomy of these two nerves and their pathways. Students might find these questions difficult to answer, they might use resources available and could consider some of them as part of their learning issues.

What are the function and the anatomy of these two cranial nerves?

What are the impacts of this illness on Mohammad?

- Stress/worries about committing mistakes in his work.
- He might lose his job.
- Financial/family issues.
- Not sure of the cause of his illness.
- Being foreigner and possibly little support from friends.
- Uncertainty/ unable to make a decision.

Tutor: Students might find these questions difficult to answer, they might use resources available and could consider some of them as part of their learning issues.

Clinical Examination

CNS Examination

Gait is normal.

Cranial nerves number: 1 (olfactory nerve), 2 (optic nerve), 3 (oculomotor nerve), 4 (trochlear nerve), and 6 (abducens nerve) are all normal

The 5th cranial nerve (trigeminal nerve): loss corneal reflex on the right side and loss of sensations on the skin over the right maxilla, normal on the left side.

The 7th cranial nerve (facial nerve): weakness on the right side of the face, normal on the left side.

The 8th cranial nerve (vestibulocochlear nerve): evidence of sensory neural hearing loss on the right ear, normal on the left ear.

Other cranial nerves: 9 (glossopharyngeal nerve), 10 (vagus nerve), 11 (accessory nerve), and 12 (hypoglossal nerve) are all normal

The motor and sensory testing are normal on both sides

Coordination tests are normal (excluding cerebellar problem)

Cardiovascular and Respiratory Examinations

Normal

Problems

Problems as per history:

- Loss of hearing- right ear.
- Ringing noises- right ear.
- Surroundings are rotating (vertigo).
- Anxiety and worried.
- Numbness on the right side of the face (5th cranial nerve).

Problems as per examination:

- Anxious and thoughtful.
- 5th, and 7th right side cranial nerve problems.
- 8th cranial nerve: Sensory neural hearing loss- right side.
- No evidence of postural drop of blood pressure.
- Normal middle ear and membranes.
- No evidence of cerebeller problem.
- No evidence of heart problem (e.g., arrhythmias).

Learning Issues

Tutorial Two

Discussion Questions

Nobel Laureates

Do you know a Nobel prize winner whose work has helped in understanding a physiological principle related to this case. Discuss how his/her work helped in advancement of our knowledge in this area.

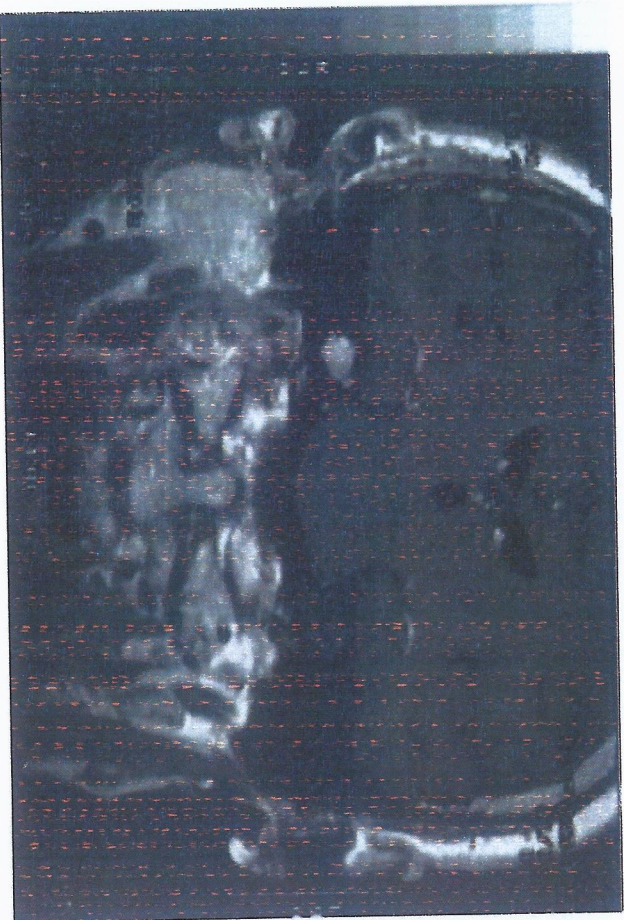
Students may spend 10 minutes discussing this issue. Those interested could submit a written submission to my on my email sazer@ksu.edu.sa

Progress 1

Because Mohammad has unilateral hearing loss, vertigo (spinning, a sense that surroundings are moving), unsteadiness, numbness on the face, and facial weakness, it is most likely that these changes are due to a problem affecting the 8th cranial nerve as well as the 5th and 7th cranial nerves on the right side. Therefore the doctor arranges for an audiometry and MRI scan of the brain. The results of these investigations are shown below.

Progress 1

1. MRI scan of the brain



Report: MRI scan with gadolinium of the brain (coronal) showing an acoustic neuroma on the right side of the brain (the white spot on the left side of the picture).

Source: http://www.dizziness-and-balance.com/disorders/tumors/acoustic_neuroma.htm

Progress 2

Mohammad is referred to a neurosurgeon for further assessment. The neurosurgeon examines Mohammad and reviews his audiometry report and the brain MRI scan. He discusses the diagnosis and management options with Mohammad and his wife. He says, “The clinical examination and investigations show that you have a small tumour on the 8th nerve on the right side. This nerve is responsible for hearing and help in maintaining the body balance. Usually tumours such as yours are benign tumours and the symptoms you are experiencing are due to the pressure of the tumour on the nerves located close to the 8th cranial nerve on the right side such as the nerve that carries sensations from the face (the 5th cranial nerve) and the nerve that carries motor impulses to the muscles of the face (the 7th cranial nerve).”

Our aim is to surgically remove the tumour or stop the tumour from further growth. I would recommend the second approach for your treatment. This is called “Stereotactic Radiation Therapy” where we use radiation delivered from a precise point to maximize the radiation delivered to the tumour mass and at the same time minimize the exposure of normal tissues of nerves from radiation.

Mohammad and his wife ask the neurosurgeon more questions about the Stereotactic Radiation Therapy and then finally Mohammad agrees to undergo this type of treatment.

**Please Read the
Closure**

Learning Objectives:

This PBL Package targets the following objectives:

- Anatomy and physiology of hearing and body balance mechanisms.
- Anatomical structures related to the cerebellopontine angle area.
- Anatomy and function of the vestibulocochlear, trigeminal, and facial nerves.
- Interpretation of symptoms, signs and investigation results of a patient presenting with acoustic neuroma.
- Impact of serious diseases on patient, family and work.

Trigger

Mohammad Kumar, a 55-year-old old Indian technician, works in the cargo section as airport navigator. He presents to a local general practitioner because of progressive decreases in his hearing for the last 5 months. Recently he noticed that he becomes unsteady and feels that the surroundings are rotating. He also has noticed numbness on the right side of his face.

Trigger (Problem)

Mohammad Kumar, a 55-year-old Indian technician, works in the cargo section as airport navigator. He presents to a local general practitioner because of progressive decreases in his hearing for the last 5 months. Recently he noticed that he becomes unsteady and feels that the surroundings are rotating. He also has noticed numbness on the right side of his face.

Problems/Hypotheses

Decreased hearing:

- Earwax.
- Otitis media
- Perforated drum (tympanic membrane)
- Problems with the inner ear.
- Problems with the 8th cranial nerve.
- Problems with the centre

Unsteady/surroundings are rotating

- Problem with the proprioceptors.
- Problem with sensory nerve (proprioception).
- Problem with the dorsal column.
- Problem with the cerebellum.
- Problem with the inner ear.
- Problem with the 8th cranial nerve (viral infection)
- Postural hypotension.
- Decreased blood flow to the brain (e.g., arrhythmias).
- Autonomic dysfunction.

Facilitation Questions

What are the structures and functions do we need to hear?

- External ear.
- Middle ear: a healthy intact tympanic membrane and (malleus, incus, stapes).
- Inner ear: Cochlea, spiral organs of corti
- Auditory nerve
- Hearing Center

Normally we do not feel unsteady or have a sense of rotation of surroundings- What are the structures and functions do we need to feel steady?

Students might need to review what was addressed in previous case.

Further Questions

- Do you remember any history of ear trauma?
- Do you have any fever, discharge or ear pain?
- Do you feel any noise in your ear?
- For how long do you have this sense of rotation?
- Do you feel this sense of rotation when you change your position? I mean from setting to standing for example.
- Did you have any nausea or vomiting?
- Are you on any medication?
- Do you have runny nose or sore throat?
- Have you ever been admitted to hospital?
- Are you diabetic or have any other medical conditions?
- For how long did you feel the numbness on your face?
- Do you have numbness anywhere else?

History

Mohammad first noticed that when he uses his mobile phone he hears better on his left ear. About two months ago he reviewed the company doctor and he recommended ear wash because of excessive earwax. This did not help Mohammad and he noticed no improvement in hearing on the right side. Mohammad cannot remember any history of trauma to his ear or chronic ear problems. A few weeks ago he started to hear ringing noises in his right ear.

About 2-3 months ago he noticed that the surroundings are rotating. He particularly feels the surroundings are tilting when he changes the position of his head. This caused a lot of anxiety and worries because of the nature of his job. It is progressively increasing in frequency, first it occurred about once or twice a day, but for the last a few days it occurs about 6 to 7 times a day.

About 3 weeks ago he noticed numbness of the right side of his face particularly while shaving. He gave no history of numbness or tingling anywhere else.

Discussion Questions

- Are there words that you do not understand?
- Summarize key information that you have obtained from this progress.
- Identify Mohammad's new problems. Provide hypotheses for each problem.
- What further information would you like to know by conducting a clinical examination?

Problems

- Decreased hearing- right ear.
- Ringing noise- right ear.
- Sense of rotation of surroundings.
- Anxiety / worried.
- Numbness- right side of his face.

Problems/Hypotheses

Surroundings are rotating:

- Problem with the proprioceptors - 0.
- Problem with the peripheral nerve -0 .
- Problem with the dorsal column 0/+.
- Problem with the cerebellum ? (but why there are problems in hearing).
- Problem with the inner ear +/-++.
- Problem with the 8th cranial nerve (viral infection) +++
- Decreased blood flow to the brain (e.g, arrhythmia) ?
- Postural hypotension ? +/-0
- Autonomic dysfunction ? +/-0.

Facilitation Questions?

What could possibly cause numbness?

- *Problem in receptors*
- *Problem in transmission along the sensory nerve*
- *Problem with sensory nuclei*
- *Problem with the higher cortical sensory areas.*

Damage to blood supply to the nerve, myelin damage, Na^+/K^+ pump dysfunction, disturbance of normal transmission of impulses etc...

What are the mechanisms by which we hear?

What are the mechanisms by which the body maintain its balance?

Do you know a Nobel prize winner whose work has helped in understanding a physiological principle related to this case. Discuss how his/her work helped in advancement of our knowledge in this area.

Tutor: Students might find these questions difficult to answer, they might use resources available and could consider them as part of their learning issues.

Clinical Examination

Mohammad looks anxious and thoughtful. His vital signs are shown in the table below:

| Vital signs | Mohammad | Normal range |
|------------------|--|--------------------|
| Pulse rate | 82 regular | 60-100/min |
| Blood pressure | 130/80 (sitting) and 120/75 (standing) | 100/60-135/85 mmHg |
| Temperature | 37.1 | 36.6-37.2 °C |
| Respiratory rate | 19 | 12-16/min |

Ear Examination

- Normal external ear
- No ear wax
- Normal healthy tympanic membrane, both sides.

Discussion Questions

- Are there words that you do not understand?
- Summarize key information that you have obtained from clinical examination.
- Use the new knowledge obtained from the clinical examination to refine your hypothesis..
- Work out as a team to identify your “learning issues”.

Refining their Hypotheses

Most likely:

- A problem affecting the 8th cranial nerve on the right side (hearing loss and vertigo).
- A problem affecting two close-by cranial nerves on the right side (5th and 7th cranial nerves).

The exact cause will need further investigations.

Less likely:

- Proprioceptors problem.
- Peripheral nerve problem.
- Cerebeller problem.
- Middle ear problem.
- Autonomic problem (postural hypotension- no significant changes in blood pressure on standing).
- Heart problem (e.g., arrhythmias)

Learning Issues

- Anatomy and functions of the 5th, 7th and 8th cranial nerves.
- What are the anatomical structures responsible for the balance system?
- Mechanisms for maintaining body balance.
- What are the mechanisms responsible for hearing?
- Investigations needed for a patient with a hearing loss.
- Impact of serious diseases on patients and their families.

Discussion Questions

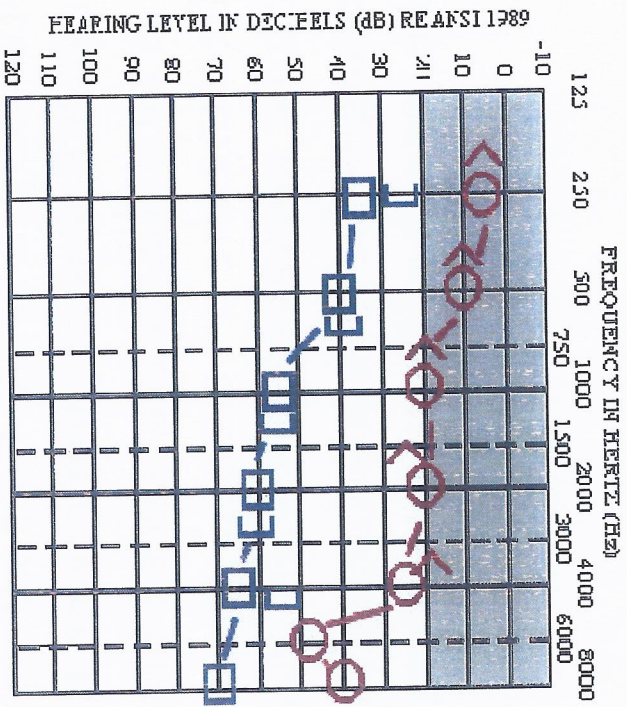
After the students spent about 60 minutes addressing their learning issues. You might spend 10-15 minutes on these questions:

- How would you explain Mohammad's hearing loss, vertigo (spinning), unsteadiness, numbness and weakness of the right side of his face ?
- What investigations would you like to order to help in your diagnosis? Explain how each of the investigations you suggest could help.

**Please Read
Progress 2**

Progress 1

1. Audiometry of the right ear:
- 2.



Report: Right ear: There is evidence of high frequency of sensory neural hearing loss (lower curve). Bone conduction is relatively normal (upper curve). These changes are consistent with the possible diagnosis of acoustic neuroma on the right side.
Left ear: Normal.

Source: http://www.dizziness-and-balance.com/disorders/tumors/acoustic_neuroma.htm

Discussion Questions

- Are there words that you do not understand?
- Summarize key information that you have obtained from this progress.
- What is your final hypothesis?
- Summarise your management goals and your management options.

Discussion Questions

- Are there words that you do not understand?
- Summarize key information that you have obtained from this progress.
- Construct a mechanism summarizing your final hypothesis with regard to the site of the lesion, the mechanisms underlying Mohammad's presenting symptoms. Provide supportive evidence from history, clinical examination and investigation results.

Case Closure

Mohammad successfully undergoes Stereotactic Radiation Therapy and over the next a few days he feels much better. He has no ringing noises in his right ear and he does not feel unsteady as he used to, but his hearing on the right side did not improve. Another audiometry conducted two weeks after the radiation therapy did not show any significant improvement. Over the next couple of weeks, Mohammad returned to his work at King Khalid Airport.