Fundamentals of Video Head Impulse Test: Lesson 2 – Clinical Applications and Interpretation

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Dear all, welcome back to Inventis Academia. Today we are delighted to host the second session in our three part series of the Video Head Impulse test. And it is a true pleasure to welcome again Dr. Vishal Pawar, Specialist neurologist and fellow of the European Board of Neurology who brings with him deep clinical expertise and a unique dedication to vestibular care. The title of today's session is Fundamentals of Video Head Impulse Test.

Lesson number two, Clinical application and Interpretation. This session is I would say, your chance to decode the hit results and take your clinical reasoning one step further. Thank you once again Dr. Pevar for being part of this journey with us. And as always feel free to drop your questions in the dedicated box on the screen and don't forget to complete the post event survey.

Your feedback is truly valuable for me and for Inventis. And now enjoy the webinar and see you later.

Thank you Anna for that kind introduction and good evening everyone from Dubai. Welcome to second webinar series like for video head impulse test. In this mainly we are going to discuss about interpretation. So. So last time during the first webinar I spoke about the types of head impulses.

That is the first one is clinical head impulse and then the VHIT that video had impulse we started you like, you know using uh. It came into use from 2009. So uh. Clinical head impulse uh. Basically uh.

Detection method is visual observation of over sacade. And in video head impulse we use equipment that is infrared video recording with software analysis with different equipments having different technology and the circuits which are detected are over second which happen after the head movement. And in video head impulse test we detect apart from over second we also detect covert sacred which happen during the head movement which can be missed during the clinical head impulse test. So basically clinical head impulse test is qualitative. There is yes or no response that is whether the over second present or absent.

Whether the test is pathological versus it is normal, that's the response. But in case of video head impulse test it is a quantitative test. We can calculate the VOR gain latency, sacade metrics and there are multiple things which we can interpret not only about the peripheral vestibular system but about the central vestibular system because the VOR pathway extends into the central nervous system. And the problem in this, this pathway also can lead to issues with the video head impulse test results. And there is V adaptation which happens from cerebellum.

That also if there is there are cerebellar lesion there are certain you Know abnormalities which are seen in the video head impulse test. So the sensitivity of clinical head impulse test is lower and may miss subtle deficits. And the sensitivity of video head impulse test is higher. It detects partial deficits which cannot be detected by the clinical head impulse test. Then coming to the objectivity.

Clinical head impulse test is subjective examiner dependent. Like in the case of video head impulse test. It is objective and reproducible measurements we can obtain. And the clinical usefulness of clinical head impulse test is it is a quick bedside screening test which can be done in the emergency department in the acute setting. That's the main advantage.

And video head impulse test it it has a diagnostic role, it has monitoring role. Also we can monitor over a period of time and plan the rehabilitation as per the results. Clinical head impulse test is. It's a clinical method and it doesn't need any equipment. But in case of redivide impulse test, elaborate equipment is needed.

And time required for clinical head impulse test is less than a minute. And video ed impulse test varies from equipment to equipment but around it takes five to 10 minutes. In the last webinar we discussed about the importance of this hair cells that is type 1 hair cells versus type 2 hair cells. And type 1 hair cells encode high frequency rapid head movements. And the type 2 hair cells they encode low

frequency slow head movement.

I used one analogy last time. That is high frequencies like something like T20 cricket players where they come play 20 over game and they are rapidly an irregular response and rapid response, they respond differently. And in case of type 2 hair cells it is like a test cricket where there is a, you know, slow response and it is more of a regular response.

So type one hair cells are basically mainly tested by the video head impulse test and type 2 are mainly tested by caloric test. So in case of this video head impulse, as we know that there are covert and over sacades which are absent. In case of like if There is type 2 cell affection and visual conditions it is testable in ambient light. But the caloric testing for example, it requires darkness clinical symptoms. If the type one's hair cells are affected, they are dynamic deficits, osia, poor dynamic gaze.

And type two hair cells when they are affected more of a static deficits like spontaneous nystagmus, dizziness at rest and the common pathologies which cause type 1 cell affection. In vestibular neuritis both type 1 and type 2 are affected. So in vestibular neuritis you can get early affection of both of them. Like caloric and video Head impulse. But over a period of time the video head impulse test recovers because of this covert sacades.

But the caloric still can remain abnormal. So there can be dissociation and bilateral vestibulopathy. Also these hair cells can get affected menier disease. Mainly type 2 hair cells are involved and even in age related vestibulopathy. Now that's what I was talking about.

So video head impulse test usually abnormal on the affected side in case of acute unilateral vestibular and even the calorics can be abnormal. So both type one and type two are involved. So both tests show deficits. But over a period of time there is regaining of function of type 1 and type 2 it is slower to recover. So caloric defic deficits can still be there.

Many disease type two are type one are spared. And so often the video head impulse test in early men years can be normal and but as the patient gets recurrent attacks patients can have vestibulopathy and caloric testing is abnormal in case of you know, Meniere's disease in early phases. So classic pattern is V hits normal and caloric weak or hydrops effect. We can see in case of Meniere's disease. Now coming to acute unilateral vestibulopathy.

What it reflects like spontaneous nystagmus, it reflects static imbalance and it normalizes within days to weeks. The patient starts getting you know, severe vertigo which lasts for a day or two. So that is a some that gets, you know, this is a static at rest. The patient is getting this issue which resolves over a few days, uh two weeks. And the patient has subjective gets subjective visual vertigo because of static autolith imbalance.

It often normalizes within two to three weeks. The video head impulse test that is high frequency vestibul ocular reflex which reflects the dynamic canal function may normalize in four to six weeks if compensated. So compensation starts happening early. And there could be scattered over sacade which becomes gathered and then it converts into the, you know like covered circuits. And in caloric test that is low frequency vestibule ocular reflex which assesses that the dynamic canal it also checks the dynamic canal function but may remain abnormal for months or longer.

Like it it is very slow to recover because it tests very low frequency vestibular ocular reflex and it is very difficult to recover in short period of time. And the autolith dysfunction which is reflected by O and C may show long term deficits if it is severe. Now let us with that introduction we will start on today's you know, topic of this next part of this video head impulse test. So as you can see in 2009 first article came on to to this video head impulse test. And there have been almost thousand publications until date.

And there this test is. You know, like has gained popularity. Uh. It tests different frequency spectrum in the vestibulogram. It.

It is not a replacement for the other testing. It is. It complements the caloric test. It complements the rotary chair test. It is not a replacement.

It adds to the higher frequency spectrum of the vestibulogram. So last time we also discussed about. There are various video head impulse test systems which are available in the market. That is one is remote camera based system. That is Synapses VHIT and rest of the all systems are head mounted systems using the goggles.

That is ICS Impulse, IC cam and all most of the other systems head velocity measurement in case of synapsis is image based. That is Head pose estimation via the camera with the remote camera helps in assessing the head position as well as the eye position. But in case of head mounted system it is accelerometer based. The eye tracking for remote camera based is facial video video analysis via infrared camera. And in head mounted it is infrared eye camera with mirror inside the goggle the slip.

There is no question of slippage artifacts in case of this remote camera based system. Because doesn't use the goggle. And the patient comfort is more because the patient is. We are testing without any wearable gear. And we can use it in children also even infants and super.

But only thing is Supine testing is not feasible. Because the camera is placed like we it. It is placed at a fixed distance from the patient from sitting. And uh. We cann use this test in supine position.

But the other systems can be used in supine. The repeatability that one. Another good part is only five impulses are sufficient for a like. You know. Recording.

But more trials are needed with the other systems. Uh. Because of. Sometimes there could be uh. The goggle movement and other artifacts.

And for clean. Because to obtain a clean data there can be like more impulses are needed to achieve the cleaner data. Then coming to the calibration is very simple. In case of synapses I.e. it is SIM focus based.

We have to focus the eyes and the pupil inside that particular pupillary tracker. And but in case of head mounted systems it requires laser target calibration and the complexity of setup. In remote camera based synapses system it requires camera patient patient distance and angle. This angle. This distance is very important.

For the the setup and in head mounted systems it requires firm accurate headgear fit. That is a very important requirement. So Ulmer we hit Radis synapsis we hit and ICS impulse show there was one study to correlate between these two like video head impulse systems and there was strong correlation with comparable accuracy. Now let us look at various tests which are being utilized for analyzing the vestibular system. So if we look at the video head impulse test, it checks the high frequency vestibular ocular reflex and it assesses all the semicircular canals I.e.

posterior semicircular canal, lateral semicircular canal, superior or anterior semicircular canal. And that's how it helps this superior and lateral canal is supplied by superior vestibular nerve. So it assesses superior vestibular nerve. And the posterior canal is supplied by inferior. So it assesses the inferior vestibular nerve function.

Then the caloric test assesses the low frequency vestibular ocular reflex for horizontal canals. So it it assesses the low frequency of horizontal canal. Only it doesn't check the vertical canals. The OEM is for secular function and the secular function goes into the inferior vestibular nerve. So the ovamp is for

secular and function and inferior nerve function.

That that was sorry. C vamp. C vamp is for saccular funct inferior nerve function and the OAMP is for utricular and superior vestibular nerve. So that's how this OAMP and C assess the otolith function. That is C is for saccule and O is for utricular function.

Now coming to the rotational chair testing that is V across various frequencies can be checked with rotational chair testing. And it assesses bilateral horizontal canals and of course other other canals can be also assessed. But mainly it assesses the horizontal canals. And posturography is not just a vestibular test, but there are multi sensory integration while we stand and we we have it can check visual vestibular somatosensory contribution to the posture. So it offers a wide spectrum.

So these are the various tests which are available. And this is the natural bandwidth of our frequency of head movement that is 0.05 Hz to 5 Hz. This is the natural bandwidth of our head movements. And if we look at the caloric test which assesses 0.003 Hz frequency spectrum of the vestibule ocular reflex. So it is, it assesses very low frequency part of the vestibule ocular reflex which is natural a part of natural head movement that Frequency spectrum.

Then if we look at the rotary test rotate rotary chair Test it assesses 0.01 to 0.64 Hz frequency spectrum. And some of it. Some of it matches to the natural head moment. So the natural V function. So if we if you look at the V, the V is one here like the gain of the V during the natural these frequency head movements that is 0525 Hertz or more than that up to 7 Hertz it is around 1, but it declines with higher frequency head movements.

And it is also supplemented or replaced by the visual system at lower frequencies. That I'm going to discuss. Then the head shaking test. As we know we do it at at 2 Hz frequency. And that assesses 2 Hz frequency of the vestibular ocular reflex.

And the video head Impulse test specifically analyzes 3-7 Hz frequency of head rotation. So three rotations of the head in a second to seven head rotation. That that much speed or frequency range of the vestibular ocular reflex is assessed by head impulse test. And usually we what commonly we give head impulses are for between 4-6 Hz. We give that frequency spectrum.

We mainly analyze around 5 Hz. And the newer technologies like the skull vibration induced nystagmus test assess high frequency that is 100 Hz. We use 100 Hz tuning fork and keep an at different places like mastoid and vertex. And that can assess the higher frequency spectrum of the vestibule ocular reflex. Now this is the diagram of vestibulogram.

Again to summarize the caloric test assess low frequency horizontal 0.003 Hz very slow. And it is not a natural stimulus. We give a thermal stimulus. And that thermal stimulus creates endolymph movement. And that is very very low frequency movement gradient is created.

And that leads to like the caloric stimulation of the only horizontal canal. In rotational chair testing. The horizontal canals are assessed from.01 to 1 Hz in the low to mid frequency rotation video head impulse test. As we discussed, all six semicircular canals in high frequency head impulses shaking test is assesses the horizontal canals from 2.2Hz mainly not 5Hz mainly we do it at. We give in 10 seconds.

20 shakes to the head and it is passive. Mid to high frequency head shake skull vibration. We use 100 Hz frequency. And still there is not clarity on. There is lot of research going on on where it originates the nystagmus and likely utrical both canals.

So it is a high frequency mechanical Stimulus and the other testings are not frequency based like OMCWAMP and posturography. They are not frequency specific. Now coming to last time I have shown this that all these reflexes, all these functional classes of eye movements which are happening,

they are, they can be divided into two types. One is a visual mediated or vestibular mediated. The vestibular mediated are very having short latency like short latency of less than 15 millisecond.

It is one of the fastest reflex in the body around 7, even 6 to 7 milliseconds. But it is fatigable because it is fast and the visual mediated have a longer latency and there is no fatigue. That's why fast frequency head movement, the vestibular ocular reflex is the first to respond. But at lower frequencies the other, the visually mediated reflexes are important for stabilizing the vision. So there are two ways to stabilize the vision.

One is visually mediated reflexes and vestibular mediated. So basically what these, these, these functional classes of movement, eye movement are trying to do is they are giving signals to the brain and they are trying to maintain clear vision. The main target, main goal is clear vision despite of head movement. Whether they are small frequency head movement or high frequency head movement. The goal is to maintain the clarity of vision.

So the camera has a function of image stabilizing softwares are there inside the camera. So in our brain the image stabilization is done by visual visually mediated reflexes and with the help of vestibulo ocular reflex at higher frequencies. So like the VOR response just I will mention this about blindness. Many of many, in many times, in many forums this question comes up. You know, like what happens in blindness.

Coming to that, like the V in congenital blind people, the brain stem, uh, see the visual reflexes will be impaired because uh, the VIS functional classes of eye movement, uh, which are uh, visually mediated, uh, they will be absent. But the vestibular mediator, the vestibular system is intact. In patients who are either congenitally blind or acquired blindness. That's why the VOR is present whenever they move their head. There is a reflexive eye movement.

But there is a problem in that the accuracy of the gain. The gain is not accurate in patients who are congenitally or acquired blind. Initially the gain is normal because the VOR has, is adapted in case of acquired blindness. But again the, the VOR adaptation goes down over a period of time and the VOR gain loss is there in case of acquired blindness. Now coming to the visual feedback for adaptation is missing in case of blindness.

So that's why the gain cannot get adapted, because vision is there to correct the errors. Error signals. For example, you change the glasses. Like I started using progressive glasses six months ago and it was a terrible month. Like I used to feel so tired in the evening.

And it was very difficult to adjust my head movements and psychedic movement. And I learned over a period of time. And with that visual error signal, the cerebellum helps in adapting the VOR gain. And that visual error signal is very important for adaptation. And that is not missing in case of blindness.

And that's why the V gain is less. V reflex is present, but the gain is not proper. And the plasticity is also limited. V plasticity and the satic eye movements are often poorly developed and may show roving eye movements. There you can see many a times there are roving eye movements or pseudon stagmus and reflex modulation is impaired.

And clinical implications VOR is present, but may be imprecise. And the balance, the balance we discuss that the vision is important, proprioception is important, vestibular system is important. Out of that the vision component is not there. That's why mainly the balance is maintained by the somatosensory and the visually, the vestibular correction by vision is also absent. So the adaptation in vestibular reflexes is also not impaired.

But the reflexes are there, but the adaptation is missing. So mainly it is with the help of proprioception. I would like to like present this slide with Professor Enrico who presented in 2023. I took a picture of this

slide in one of the meeting in Dubai. And it's such a precious slide where uh, the GAZ stabilization mechanisms are mentioned and with different head frequency.

So when we are moving our head very, at very low frequency, like whenever the, whenever there is a postural movement, their head is slightly moving. Very low frequency head movement. The predominant gaze stabilization is done by the visual mechanisms along with the proprioceptive mechanisms. In the mid range there is a combination of vestibular, visual vestibular, you know, the both work together and then they help to stabilize the image on the retina and at higher frequency. As I was telling only the vestibular control is.

Is important for that gives information about the position of the object at high frequency. And it helps to stabilize the image on the retina while walking. Active movements of the head and running. So they work in cooperation with each other. And the retinal slip is a very important driving factor for these mechanisms to stabilize the gaze.

So this is again the same thing. Shown in a different way. Like at low frequencies, the oculomotor moments, ocular motor moments and vestibulo in mid range, along with the vestibular ocular reflex, they helps to stabilize the image on the retina. And at higher frequencies the vestibul ocular reflex is important. Now the frequency spectrum for gauge stabilization, if it is less than 0.1 Hz, these are the visually mediated reflexes.

That is optokinetic reflex is important. And cervical ocular reflex is not that prominent. But in very low frequencies it supplements the visually mediated through the somatosensory or proprioceptive mechanisms. And it helps then 0.1 to 1 Hz, smooth pursuit and 1 to more than 1 Hz. It is the VOR which helps us to stabilize the image on the retina.

It prevents the retinal slip and it helps to, you know, maintain the clarity of vision despite of high frequency head movements. Now I'll show you a few like this thing I have shot some videos on me. Now suppose my head is moving very slowly, even slower than this, like less than 20 degrees per second. What happens is the vestibular system, the cupilla, the endolium doesn't move in very low frequency head movement, just the cupula because of its elasticity, it just moves without any movement of endolim. And because of that elastic property of the cupola, the nerve, the vestibular system or vestibular nerve senses the acceleration and that little shift in the body.

Head movement at low frequency are detected because of the acceleration. And but with this sensory stimulus the brain cannot stabilize the gaze with such with this information is inadequate for the brain at low frequency to stabilize the image on the retina. Then it uses the visual system comes into play, that is occipital lobe and superior colliculars and the pathways and it gives position signal and that helps in the low frequency during the slow head turns and postural sways. And even the calorics can, can't help in this frequency. Calorics are detect.003 Hz at very very low frequency.

See, if suppose I, I do moderate in like head movement. Then what happens is it, it is from 0.1 to 1 hertz, that is 20 to 100 degrees per second. And uh, what happens is that time the endol starts moving because of its viscosity and it's it, it can move and it can stop also it is a moderate intensity movement. And that's why the endol starts moving and stabilize also quickly. It can give the brain the information about the position.

But it needs visual correction. So both the systems work in work together. And that helps to stabilize the image on the retina. But if we give high frequency head movement. If we do high frequency head movements that is 1-5 Hz here not only the endolymph moves very fast because of its mass.

And this is like this analogy last time I have shown. And then brain can exactly did. It gives a position signal to the brain because of sudden movement. And that is helpful for the brain to measure the

position signal alone. With the help of vestibul ocular reflex.

In case of rapid head movements which have less latenc and visual visually mediated reflexes have longer latency. That's the importance of video head impulse test or the in detecting this high frequency vestibular ocular reflex in isolation. Another very important thing why we need to deliver high frequency head movements while doing the testing is at rest. When you are currently now keep looking at the dot in the center. Your both right and left vestibular system is functioning equally.

There is a tonic equal and opposite input which is coming to the brain from the vestibular system. It is firing at rest. Also even your head is stable. There is a baseline firing rate. But suppose you slowly move the head towards the right side side.

Then the right sided firing increases and the left side there is left lateral canal. There is a inhibition during the slow or moderate pace movement. But suppose like Suppose you do a high frequency head movement toward the right side. Then there is activation of the right lateral canal and complete inhibition of the left lateral canal. It cannot go beyond zero.

Therefore you when you give high frequency head impulses you are exactly checking one sided semicircular canal in isolation. Independently you are checking the semicircular canal when you are delivering the high frequency head impulses. That's the importance of doing doing the video head impulse test. It can check the canals in isolation. There are certain differences between video head impulse test and rotary chair testing.

That is, video head impulse test checks higher frequency range and rotary chair lower frequency head movements are passive. In case of video head impulse sinusoidal or step rotation canals assessed are all semicircular 6 semicircular canals. Horizontal canals only and side of lesion can be provided by video head impulse test test. Video head impulse test is quick setup is less complex and sensitivities.

But sensitivity and bilateral loss is lower in case of video impulse test.

And the gold standard is like rotary chair testing. In that case and compensation detection is possible with the help of COVID and over circuits. In case of video ad impulse test and in case of differences between caloric testing and video ad impulse test. We have seen that difference difference. Video impulse test assesses high frequency.

It assesses all six canals. It is well tolerated less than 10 minutes. The sensitivity to mild loss is lower. Detects compensation with the help of the COVID sacades and common abnormalities low gain covert and over sacades. And there was one question last time like I thought I will answer during this webinar nerve.

So when we do the video head impulse test we have a earth fixed target and the eye movement result is compens. Compensatory eye movement like we. We are I'm suppose moving the head to the right. Right. The eyes are moving to the left.

Okay. There is a compensatory eye movement opposite to the head movement. And the outcome is V gain overt and covert sacades. And it is used for to diagnose canal specific vestibular deficits and require as eye tracking. There is another test called as shims suppression head impulse test where there is a head fixed target like the.

The target is fixed to the head either like a laser which is projected on the wall. It is a head fixed target. And it doesn't check for the compensatory circuit. There are anti compensatory circuits which can be detected by this. And it helps in assessing the VOR suppression.

VOR suppression, how good it is working. It has to assess and functional. Head impulse test is another important test which is gaining popularity. In which there is a brief visual stimulus during the head

impulse. And it helps to test the ability to identify symbols amid the head turns.

And we have to check the visual perception performance. There is no checking of gain vor gain or seconds actually whether the patient is able to see the target on during that particular head movement. And sacates are not measured. But it is very helpful in evaluating real life visual function of the patient. And for patient it is something which even patient can understand that when that that head impulse is done they are not able to see during that particular.

On that particular in that particular place brain. So it's a very. You know another very interesting test which is gaining popularity. And there is no need to eye tracking and all is not seen. So in case of video head impulse test as I am using it now.

This sentence by Professor Enrico in his famous book on video at impulse test is such a nice sentence. That is Video head impulse test is an art. It expresses itself with the examiner's ability to perform appropriate head impulse head impulses. So as you become Expert in performing appropriate head impulse. Head impulses.

The test will start revealing itself. You know it. With your ability to perform the head impulses properly, the test will yield very nice results. And it is a. Such a nice test which can be performed in a matter of minutes.

And it will give such a valuable information. So synapsis is the only system based on the analysis of presence or absence of the corneal reflection which is present. And it helps in, you know, analyzing the. The. It gazes the head movements and eye movements based on the calculations which are based in the.

From the remote camera. And the advantages if we look at this system is there is no goggle on the patient's face. Uh, there is no goggle on patient's face. Simultaneous binocular record of lateral canals, uh, can be obtained. Automatic detection of eye position and stimulation plane.

Minimum. Only five impulses are needed. I am going to show in video. And it is best suited for children because there is no need to wear any goggle and there is no need of calibration before starting. So these are the advantages of this VHIT system.

As you can see, there is no goggle and there is a camera which remotely, you know, analyzes the head and eye movements. And so what are the contraindications now? What are the contraindications of video? Head impulse test. If the patient has recent cervical injury, if patient has severe acute neck pain, recent head or neck surgery, patient is very uncooperative or cognitively impaired because the fixation on the target is very important.

And the other relative contraindications are patient has active vertigo or patient has vestibular migraine. Then these patients are very sensitive to head, head movements and they can be started on prophylaxis. And then, you know, then we can do the head impulse in later occasion. Because even the video stymography also triggers the vertigo and dizziness in, and headache in this group of patients. Patients.

If the patient has severe motion sensitivity, recent eye surgery and younger children. But of course, it can be still performed in young, young children. Now coming to the setup. Patient should be seated on a fixed chair. Okay?

It should be a fixed chair. If it moves, that's a problem. It can change the, you know, the, whatever calibrations are. Then head should be upright. Patient's head is upright and aligned eyes focused on the central target.

The patient focus his eyes throughout the test. That is a very important precaution. Uh, then, uh, patient focuses on a small object or a light, uh, which is placed at more than than or equal to 1.9 m. Distance uh, and this distance from the chemistry era and the patient eyes is fixed distance that is 90 centimeter. It has to be a fixed distance in case of synapses and the this distance could be more than like around 1 meters distance from the camera to the target on the wall.

This distance can be 1 meters. There should be good lighting condition and avoid glare or shadows on the face. Pupils adjust brightness, contrast and interpupillary distance should be adjusted so that exactly the pupil is in the center of this square. And we need to adjust for pupil detection. The height of the is adjustable camera and it can be adjusted to eye level level using adjustable stand.

And there are various planes in which we need to test which I am going to come to that. And we need to deliver short rapid unpredictable impulses at 5 Hz. A minimum velocity for horizontal canals should be 150 degrees per second. And it should be more than 100 degrees per second for vertical canals. So these are the various planes like horizontal plane and LARP plane.

The left eye we have to bring into the this particular plane. You can select the plane. The selection can be automatic or manual and ralp plane. So we can select the plane and we can conduct the impulses in these particular planes. So we have enough discussed about this rapid.

Why rapid head impulses are needed? It helps to check the one side in isolation like single side function in isolation we can check and it eliminates the visual and or central compensation which happens at medium or low frequency. At low frequency only visual reflexes are important important for the retinal sleep correction or clarity of vision. At intermediate frequency both vestibular visual interaction happens and at higher frequency. If we want to check truly the VOR integrity we have to check do the rapid head impulse then simulates the head movement.

Simulates the real life head movement which happen between 0.525Hz around around. So like head impulses are delivered between 4-7Hz. Usually it should be given at around 5Hz frequency and precautions There are certain precautions should be taken that if it is a goggle based system Ensure that the goggles are fitted tightly. There are some cuff manometers for goggle based video head impulses. Calibrate the system properly.

Again for the goggle based best deliver quick small amplitude head impulses. Avoid large or jerky head movement. Keep the patient's head aligned with the canal plane exactly it should be in the canal plane. Use random direction and timing for head thirst thrust monitor for and reject trials with blinks or tracking loss run for that Is again true for the other systems like here. In case of synapses, even five impulses, if they are appropriately delivered, they are sufficient.

And avoid repositioning goggle during the test. Again it will disturb the calibration. And watch for muscle tension or jaw clenching of the patient. Again for the goggle based video head impulse test. So there are certain precautions we need to follow in order to get accurate results.

So instructions to the patient are keep your eyes fixed on the target. That's a very important instruction. Try not to blink during the head movement because if the patient blinks they are not able to see and the VOR will not get, you know, it will not record. The system automatically rejects this particular impulse. Avoid moving your head voluntarily.

If there is a voluntary head movement moment, it will, you know, change the VOR calculations. It should be a passive head moment, not active head movement. Keep your face relaxed and avoid jaw clenching. This one is applicable for because it can change the goggle position. Uh, do not speak during the test because again that also can change the goggle, uh position.

It can uh, create uh, you know, artifacts, uh, patient should be sitting still and upright in the chair. And again another thing is if the goggle feels very loose then the patient should inform. And if the patient feels dizzy or unwell, also patient because some patients are very sensitive to the motion and they should like that should be taken care of. So these are the instructions to the patient. Now I am demonstrating how a lateral canal testing is done in a matter of 20 seconds.

Lateral left lateral front, lateral front, lateral left, lateral left lateral left lateral, left lateral completed. Right lateral, right lateral completed. So in a matter of, you know, 20 seconds. Now this lateral canal bilateral both sided lateral canal testing is done. Done.

And now I will show you LARP looking at the stimulus. Wide open eyes.

Left anterior, left anterior. Left anterior, left anterior, left anterior completed. Right posterior, right posterior. Right posterior, right posterior, right posterior completed. So you know, like suppose for LARP, 32nd RALP, 32nd, 1 minute and 20 seconds.

So in a matter of one and a half minutes I could complete the test. But of course there are a lot of other things are needed. Like we need to, you know, properly place the patient camera, etc. And it is a very useful test to detect VOR function. And the software provides real time feedback on speed, eye movement, canal activation and common rejections are pupil not detected, head already moving before the impulse too weak or strong acceleration.

And there are various like you know, parameters which needs to be checked. That is first is this canalogram like it gives a canalogram where it gives the gain. Green means it is normal, red means it is abnormal. And how many number of impulses which were delivered and the gain whether it is falling into green zone or it is like less gain. And that is shown in the canalogram.

Then you can choose the display mode of sequence. Then there are, there is a graph, you can choose which type of graph you want want and the video slow motion you can play the video and there is a result table. And again there are, there is a test result display selector here. So this is one of the patients test where uh the video head impulse test is normal with normal gain uh in all the canals. And there is no uh significant uh symmetry which can be seen.

So these are the some interpretations additional parameters which we need to check that is catch up circuits and vor gain, vor morphology, check for artifacts, clinical interpretation and report generation. So I'll cover these two things quickly, that is catch up sacades. So what happens is in normal subjects when we give a high velocity head impulse the that is 5 Hz head impulse. This is a position graph where the head has moved from here and it has come to rest here like after the movement. And then the eyes will remain, it will appear as if the eyes are steady at the same place because of the presence of vor, because the eyes, because of the vestibule ocular reflex which does a quick corrective eye movement equal and opposite direction.

Therefore the it appears as if the eyes are staying steady. So this is a velocity graph. I head eye velocity. When the head moves okay, the eyes also moves equally okay but in opposite direction. And this is overlapping which is done.

And the gains, you can see the gain, the gain graph. The gain is 1. Either you can decide to keep it like from 0 to 1 or from like going internally or from uh, like like this. So either of these you can select. And so I will show you now different patterns of V8 abnormalities.

So the first is deficient vestibul ocular reflex with non early overt sacade. Let us see when the head head has moved. So the eyes until here they go along with the head and then later on realize that the head is going along with the, the head and it has to you know remain stable like do equal and opposite movement. And then it realizes and does it after the head has stopped, okay, the head has stopped

here and then the eyes are doing corrective movement velocity, high head velocity. The head has moved from here to here and come to rest at this point point.

And after the Head has come to rest. Then the eyes, you know, make a corrective sacate. Then that is called as a over sacate which is visible. And you can see the gain, the gain of the vestibul ocular reflex. Here is Logan.

Here in this case it is zero. Now coming to the another thing that is deficient VOR with an efficient covert circuit. Let us look at this. The head has moved from here to here in the position graph the eyes until the head has moved. Until this point it moves along with the head.

But that then the brain realizes and compensate and suddenly does this covert sacade. And then brings the eyes back to the target. And that is nothing but a covert sacred. Like the head has moved. But until the head comes to the rest.

This sacade which happens is nothing but a covert sacred. It happens until the head comes to the rest. So the visible it is not visible to the naked eyes and but it can be picked up by the video head impulse test. So the actual gain is suppose low. But because of the this ketchup sacate the apparent gain becomes normal.

Okay, because of that covert sacade. Now let us look at deficient VOR with a covert sacred followed by an overt sacade. So there this is the head movement. And the the eyes are not making equal and opposite movement moment. But here it realizes during the head movement it make does a covert catch up circuit.

But it is not sufficient to go back. Then the brain after the head has come to the rest. Then the there is a compensation with a over sacade. So it is a combination of overt with over sacade which is seen here.

So you can see the gain is less.

Yes. So there is a combination of COVID with over sacade. Then the apparent gain is also low. And that because of the over sack that that's why which is visible. It makes correction.

Okay, so difference between covert and over sacade is covert sacade occurs during the head impulse. And over sacate happens after the head impulse impulse. The visibility covert sacred is not visible. Detection method is detected only via video head impulse test. But not by clinical head impulse test.

It has shorter latency. Obviously until the head comes to rest it obviously it will have shorter latency. The significance is compensation. The central compensation it is present and over sacate indicate incomplete compensation. Functional role of COVID sacade is it maintains the gaze stability during motion.

And over sacade it restores gaze after the head stops. And the diagnostic value of COVID sacade is it enhances detection of mild or compensated vestibular loss. And in over sacade it Indicates uncompensated or early vestibular deficits. So there are four important things. Whenever we see the corrective sacates there are four important things.

Consistency, direction, latency, timing, velocity and amplitude. These are very important things. Because whether really this corrective sacred is abnormal or normal, we can, you know, it will. It will help in case of consistency. For nearly all the impulses it should be present because it has to be consistently present in every impulse.

The direction of the. This corrective sacred is in the direction of the VOR for low VOR gain. Okay, but in case of this anti compensatory eye movements like it will be in opposite. It will be exactly opposite in case of high VOR gain. There are certain conditions where the VOR gain will be high like cerebellar

cerebellar lesions or investibular migraine.

In some cases there will be high VOR gain will be anti compensatory quick eye movements. The latency obviously the COVID sacket latency will be less and over will be more. After the head head has stopped. And the velocity we are going to discuss in next slide. I will show the time window for overt sacade is.

Covert sacade is during the head movement during the head while the head is moving its itself the COVID sacred happen and the over second happen after the heads has stopped moving. Okay, but it should be happening within 200 milliseconds, not after that. That that could be a voluntary circuit. And the timing and amplitude like the timing should be like the normal catch up circuit. Suppose in some sometimes it can happen with very high velocity head impulses.

There can be a catch up circuit at 200 milliseconds. And. And the most very important thing is the if, if we see the over second it should be consistent and in the same direction as the VOR is happening. And so whenever there are corrective sacades along with the reduced or normal gain, it is pathological physical. And if there is reduced VOR gain with with no corrective sacades then it should be taken with a pinch of salt and.

But sometimes like bilateral V gain loss without corrective circles can be seen in central lesions. But it's very important that to check for artifacts in such cases. And lastly regarding the V gain. V gain is calculated by this parameter. That is eye velocity divided by the head velocity.

It is a unitless number. So the what we are investing is head velocity and what we are getting in output out of this input is head velocity. The output we are checking is eye velocity should happen equal and opposite point more than 0.8 for lateral canals and more than 0.7 for the vertical canals is the normal VOR gain. And there are three gain calculation methods. I'll just finish in another few minutes.

There are three methods. First, first method is a velocity gain velocity gain method where there is a ratio at 60 milliseconds, exactly at 60 milliseconds from the beginning of head movement, either 40 or 60 milliseconds it is gain is calculated. Then the regression gain method is the linear regression of eye and head velocity around the peak acceleration. And the third is position gain where the ratio of area under the curve, I.e. i versus head velocity post descading is done.

Of course there are limitation for each one of them and there are advantages offered by each one method over the other method. And what happens is the gain obtained by one method by one equipment may not be comparable to other device. That's a very important thing because if the gain calculation method methods are different methods are used, then it may not be comparable. So key takeaways from this very nice article about VOR gain calculation and these three methods which I just told There is no single method which is clearly superior in all situations. Velocity at 60 milliseconds and position gain are most consistent and commonly used.

Artifacts like blinks, oscillations, goggle sleep affect gain values difference. Currently depending on again which method is used and best practice is like use multiple impulses. The more the impulses we use, the accuracy of the data will be more. Then there is a plot of VOR gain versus peak head velocity. Suppose this is a peak head velocity and this is the VOR gain.

So as we increase the head velocity, the VOR gain normally also is it can fall at higher velocity head impulses it can fall. But if there is a clear cut fall that is really abnormal, like you know, for example in this patient, the V gain is, you know, consistently it is reducing on affected side. The gain reduces rapidly with increasing head velocity. The gain is uh, reduced producing but not on the other side. So and there was a presence of spontaneous nystagmus.

So this is a case where we, if we plot the head velocity against the V gain, you can see this. And the path physiology of reduced V gain on the normal side in early stage is because of the loss of this inhibitory component from the legion side of vestibular signal tunneling. And again, this difference between corrective sacred and spontaneous nystagmus is a very important thing. The spontaneous nystagmus will create a spike even before the head impulse before and after the head impulse and it will have slower velocity and the spikes are in the same direction. If you see same direction on legion side and opposite direction on the health this side.

Okay. On the legion side it will be on the same direction because right vestibulopathy will cause left sided nystagmus. That's why the head impulse is. Suppose it's given on the right. So it will be in the same direction.

Okay. And the gain is normal. So sorry, gain in bilateral lesions. For example, uh, the corrective sacates are present on both sides. The there is there.

The gain will be reduced pilater laterally and there will be absence of significant symmetry. And can you see this proportionate loss of gain on both the sides as the head velocity is increasing. So with that I will stop here today and we have a lot of things to cover in the, in the next, in the next talk I'm. I will cover all the, you know, peripheral lesions where the. There, there are V hits abnormalities.

All the central conditions where the V8 shows abnormalities. And there are other conditions also where you know, the V8 can cause abnormality. As I was telling there are thousand articles and I was going through and I have created a compiled summary of what are the various peripheral lesions where V8 is used for useful central lesions and where what are the other condition. So in the next talk we will be discussing all of them. And I request all of you to attend the last and third session on the video impulse test.

With that I thank you all for attending. Now I will open up the forum for this discussion question and answers. So I will just go to the chat and.

Okay, so, so first question is one of the prominent neurotologist from India, Dr. Ramesh Rol. He's asking minimum how many correct jerks needed in video head impulse test. It depends on which equipment you are using. I, I use synapsis VX equipment where five correct jerks are sufficient to you know, if we do it in a correct fashion, like 10 degree rapid unpredictable table.

And like if we give correct head impulses, even Phi U are sufficient. Excellent presentation. Are the normal cut points similar in inventive synapses, remote system and other system? No, like one equipment. Ah, the cutoff points.

Uh, cutoff points by and large are similar. Like 0.8. Uh, less than 0.8 for lateral canals and less than 7 for the vertical canals. But I will check this point. As far as synapsis is concerned, I, I am using these particular values, but I will recheck that.

Okay.

I couldn't understand this question. Like canals view our gain time. So VR is basically we are investing input is head impulse like and the output is eye moment equal and opposite. And so there are three methods of calculation of void are position velocity and the regression method. And the.

The. The different methods are used by different equipment. So the gain which is calculated by one equipment cannot may not be comparable to another one. And so I hope I answered that question. Canals v gain time.

That is viewer. It's canal viewer gain. We can say that is more than.08 is normal for lateral canal and more than.07 for vertical canals.

Functional head impulse test is really the qu. Another question is, do you recommend using functional head impulse test in vestibular re education and when. So functional head impulse test is gaining popularity clarity. It is a test which will complement the video head impulse test again by telling the recovery and rehabilitation strategies. Because it will help us to know whether the patient is able to, you know, the.

The video at impulse test will give parameters like V gain. It will give covert sacred. It will give over sacades. It will help us in planning the rehabilitation. Similarly.

Similarly, the functional head impulse test is a very helpful test. And the patient also can appreciate that in that particular head impulse, in that particular semicircular canal pain, they are not able to, you know, see. And they can ob. Objectively see that that. And they.

And. And that can help in rehabilitation also. Definitely functional head impulse test adds value value. And it can help in patients planning the rehabilitation.

Higher gain. Yes, the. If you how to interpret higher gain. More than one. Especially anterior canals.

Nice question. See, whenever you obtain higher gain, check for artifacts. Many a times it could be artifacts, goggles, uh, sleeping page or change of position or active head movement. So higher gain can be obtained because of various artifacts. Of course, there are certain pathologies in which higher gain can be seen.

Like cerebral flocular lesions where the, you know, there. There is a change in the V Adaptation Gain adaptation. And you can see in some cases of vestibular migraine grain. But whenever you see gain more than you know, more than 1, especially in vertical canals, you should be careful and try to see if there are any artifacts.

So like latency and timing for the corrective circuit means latency since the onset of head movement. Yes, absolute. Absolutely. See, like the latency of the COVID sacade or the over sacade that is corrective sacred. The time starts from the beginning of the head movement.

Thank you.

Do you agree that in clinical practice the caloric test is still valid as it is the only one Differentiate unilateral vestibular canal. Yes. See the. As you. As you have seen in my slide.

If we look at the vestibulogram different frequency spectrum is calcul is measured by different test. So caloric test has a unique, uh. You know, tests the low frequency V. And it is one of the abnormality which will stay persistent even in late stages of ve acute unilateral vestibulopathy. So see, video head impulse test is not something.

There are many articles on this subject. It is not a test which. Which is there to, you know, replace caloric test. It is a test which will complement the caloric test. The more the test which you do in the vestibulogram you will get a, you know, like.

Like, you know, frequency spectrum of the vestibular system. And there are diseases which different diseases which affect difference frequency spectrum. Like the menus disease affects the lower frequency spectrum. And there are certain diseases like traumatic head injuries can affect the higher frequencies. So different frequencies can get affected by different pathologies.

And there is uh. Caloric state test is still a valid test.

Small eyes pupil can not be proper detected. Yes, that's one issue which can happen that if the small eyes are present people is not detected properly. But it's very important to tell the patient that to, you know, keep the eyes wide open. And there is a pupillary correction which is present in the soft software. If we click to that particular, you know, function, then it can take the impulses.

Even the pupil is little, you know, getting covered by the eyelid. But it's very important to tell the patient to, you know, keep the eyes wide open because while doing the impulses, if they are not getting detected, just tell. Telling the patient to keep eyes wide open will help you suddenly in, you know, detecting the. These, getting these impul detected. Okay.

If we lift upper eyelid. So the calculation of length and frequency. Yes, it will not change because if even if you lift the upper eyelid, it will not change. But best is to ask the patient to voluntarily lift it. But it will not change the uh, calculation questions.

Okay.

Yeah. I wonder the range of the ideal video head impulse test the presentation as the presentation should be 100 to 200 degrees per second. Yes. For the horizontal canal impulses it should be more than 150 degrees per second. And for this vertical canals, it should be 100 minimum 100 degrees per second.

Is it possible to do a video head impulse test in visually impaired individuals, considering their difficulty in fixating on the target? See what happens in patients who are visually challenged or blindness is there. They have ocular reflex because the vestibular. Ocular vestibular system is intact. But the vision

is impaired.

So obviously, as you have said, the. They are not able to fix it on the target. Definitely it will be a very challenging thing to do a video head impulse test. But it's a kind of, you know, scientifically we are discussing. Because this question comes always ways that whether what will happen in.

But they have preserved vestibul ocular function. Whenever they are moving their head, the eyes are moving in equal opposite direction reflexively. Okay. But unfortunately the purpose of that movement is to fix the target. You know, the clarity of vision.

But if they don't have vision that reflexes despite being present, it doesn't serve the purpose purpose. And the adaptation part of the. That reflex is absent because. Because of the vision is not giving the error signals to the brain. And the view are brain and cerebellum.

And mainly the cerebellum. And the cerebellum will not adapt for the vestibular ocular.

If child has low height, would it be possible we had perform in standing? I think it should be possible. I haven't done that, but I think I will get back to this question next time. But it should be possible because you are not using a goggle and it can be possible.

Can you tell?

Yeah. So very important question by like Dr. Pratishta from India. That is phase V gain and V phase difference. So there are two things in this vestibulogram.

V gain and V your phase. So naturally our low frequency, very low frequency was at very low frequency head movements like. Which is detected by the caloric test, that is 003 Hertz and the high frequency

spectrum also like which is the. Which is uh. We use the skull vibration and the phase phase Also the phase is also important the VOR phase difference.

Because I actually in that slide it was clearly mentioned maybe this particular point I will explain when I during the next presentation I will present that slide because I will be able to visually explain you that particular point. That is vor phase difference. It's a very important thing. In the vestibular kilogram, does the normal gain decrease with the age? Yes.

What happens as we age? Initially the type 2 hair cells undergo degeneration and. And then the type 2 type 1 hair cells are affected later. But vor gain loss does happen as aging happen happens. Yes, it.

It happens with aging.

Is the normative gain value you mentioned for the different canal similar for children as well? Yes, it is same for children.

If you have your gain in LARP but not in rp. Is it more probable to be an artifact than pathologic? Yeah. Yes. If you have higher gain in LARP plane like both LARP and not in ralp, that could be artifact.

So whenever you get higher gain, as I told, take it with a pinch of salt and check for anti compensatory sacades. If anti compensatory movements eye movements are present, it is a true high high again. And. But if they are absent, then it could be artifact.

And there are various articles on this anti compensatory sacades which the importance of which I will explain in the next. You know, in the last webinar there are. I'm really happy that there are so many questions questions and, and the questions are really intriguing. So can the presence of spontaneous nystagmus of type 2 modify the response of Vhit? Yes, the grading of nystagmus is like grade 1, grade

2, grade 3.

Grade 1 is present only in the opposite uh, to the vestibulopathy. Grade 2 is also present in the central gaze like primary gaze and gaze 3. Grade 3 Nystagmus is presence of nystagmus even to the affected side, the unidirectional nystagmus. So the. The.

Can the presence of spontaneous nystagmus type 2, I.e. grade 2 modify the response of VHIT? Yes, it. It can modify but you will be able to identify that in the VHI traces. And because it's.

It will be in the same direction on the affected side, it will be in the opposite direction on the contralateral side. And the velocity of that sacade is less than 100 degrees per second in case of nystagmus. But in case of corrective sacade it will be way higher and more than half of the amplitude of the head impulse. It should be more than that then only it should be considered as pathological. So there are certain criteria areas to differentiate the nagus versus the over sacades.

Okay. Do you recommend to keep lights off during the video head impulse test? No. The amp ambient light should be there during the video head impulse test. Uh, that is a.

That is. Is a.

For caloric testing. But.

Okay.

Okay.

One comment from Professor Yona Voda from Romania. Congratulations. Very nice presentation. We are very lucky to have both the systems normal gain bilateral on lateral canal. But we find a lot bilateral symmetrical over cycles.

Yes, that's a very nice observation.

Another. Another very important question is in your experience when video head impulse test is indicated. So it's a very important question. Whenever especially video ad impulse test is indicated, where we divide the vestibular syndromes into three types, I.e. acute vestibular syndrome, episodic vestibular syndrome and chronic vestibular syndrome.

So especially the video head impulse test is very important in cases of acute vestibular syndrome to differentiate between central and peripheral. Because there the two important differential diagnosis are whether it is acute inilateral vestibular or is it a stroke. And in chronic vestibular syndrome also it is very important because to check whether it is bilateral vestibulopathy pris bathy because the V gain is one of the diagnostic criteria of this PR bathy bilateral vestibulopathy and even in episodic vestibular syndromes to see whether the patient has menier distribution disease. Vestibular migraine video impulse test is, you know, it can give information in that vestibulogram. It can give very important information.

Okay, after unilateral vestibulopathy, what are the mechanisms of compensation? How can it normalize? Video impulse test See, in unilateral vestibulopathy, initially the patient will have. What will have. The patient will have is scattered over sacades in the.

There will be V gain, less V gain and scattered over sacades. But as the time passes, these over sacade will become organized and gathered. They will become gathered over sacade. Then the patient will start developing covert sacade along with the over sacade over a period of time. In the natural

history of acute unilateral vestibulopathy, the patient will have have normalization of gain because the patient develops the COVID sacate, okay.

And the over sacates will completely disappear. So this is the natural history of acute unilateral vestibulopathy. And it will happen with starting early rehabilitation. Many patients go into decompensation with scattered over or presence of over plus covert sacade. That happens because of not doing the vestibular rehabilitation in time.

And early, as early as you, within first week of, you know, neuritis, even in lying down, they can start the supine, uh exercises and then we can do uh, progr progression in the var various exercises as the time passes. But it's very important to begin the vestibular rehabilitation in time so that we, we can, you know, the V gain improves and some patients it can improve completely if the patient, you know, is treated in time with ste. With the steroids or medications and even with the vestibular rehab. But the patients can show the COVID sacade many a times. And with normal V gain they can show this Particular abnormality in the followup.

How far from the ground is the target?

The target is basically target height is decided by. It should be at the eye level of the patient. It should be exactly at the eye level. Gain larger than one in one horizontal canal with normal gain in the contrast contralateral. Okay.

One could be due to vestibular migraine or other central disorder. See again, in this case the. There are variety of differential diagnosis which can be there many a times. What happens? We.

We have dominant right hand. So when we perform the head impulses. Now when we do the left sided head impulse impulse. Okay, the gain could be, you know, we. We are giving high velocity head

impulse and the gain can be little less.

And when we give the other sided head impulse with using the non dominant hand, it could be of lesser velocity. So there is role of horizontal dispersion. The horizontal concept of horizontal dispersion is giving proper, you know, head velocities on both sides. They should be comparable. Okay.

Whenever we are doing the head impulses to the and to the left, they should be com degrees per second or same frequency. If they are not comparable, then you can, you know, see this gain asymmetry. And then you can start thinking of different issues. Okay. How can V hit be performed on a child?

What strategy can be used to attract his attention to the target, his experience? See, to be honest, I will tell you, I'm adult neurologist. I haven't performed like, you know, video impulse in children. And Professor S.H. gupta is a authority in, you know, pediatric vestibular disorder.

And I will ask this question to him and maybe in the next talk I will present on this.

In your experience, when VHI test is indicated, considering the price see V video Head impulse test is a very important test which will help you to plan the rehabilitation in the diagnosis in differentiating between central and peripheral disorder disorder. So it is one of the test which is indicated because it is there in the diagnostic criteria of PR vestibulopathy. Bilateral vestibulopathy. So it is one of the very important test to diagnose these conditions. If radio impulse test is not done in a patient who is having chronic unsteadiness, we will not be able to do.

We will not be able to identify the bilateral vestibulopathy or PR bathy in this group of patients. Patient, how far the from the ground is the target? Again, the same question. It depends on at the. It should be at the level of eyes.

It should. Patient should be looking with a head neutral. It should be that at that level.

Last question. Last Two questions for patients who have cognitive problems. How do you manage the test? Test please. If it's not possible, what other tests you do?

You choose. See if the patient has. I do get difficulties in some patients where they are not able to fix it on the target. They are not able to keep their eyes wide open. And like the time of the day.

Suppose the patient has taken lunch and feeling very drowsy. Then it sometimes there. There are a lot of difficulties of we get routinely. So it's very important, you know, to counsel the patient that they need to do these things. They need to focus on the target, not to blink during the head impulse and keep their eyes wide open, keep their neck relaxed.

That's a very important, you know, thing. But if they have cognitive problems, then it is very difficult to do. Then you have to rely on the clinical history history and other tests. Okay, then can gain be more than one and will it affect gauge stabilization? What management we have to correct it.

See if the gain is more than one as I told earlier. Also check if there is any artifact and will it affect gay stabilization? Yes, it can affect. So that. That's why the patient can develop anti compensatory sacates.

Means for example, when the head is moving to the right, the eyes should move to the left. Okay, equal and opposite. But if they are moving more than what they are supposed to do, then there will be a correction opposite to the direction of vestibul ocular reflex. There be will will be a movement so that that anti compensatory quick movement can be covert or can be over again in that also it can be covert or overt and that the video and impulse test will help us and it can affect the gain stabilization. It's a very important question.

And if the patient has anti compensatory sacades, then there are certain specific etiologies which I going to discuss in my next presentation.

I wonder how do we differentiate if the abnormal gain or eye movements coming from the vestibular pathology or the cognitive impairments as we had a participant seems hard to understand fixing you eyes on the target until one of our staff standing and pointing the target during the the test. Yes, that's a very relevant question. This can happen. It's very important that you know. And another very important problem is lack of attention.

If the patient's consciousness is not good, patient is having confusional state or patient is not able to maintain sustained attention at the target, then that could be a difficulty to, you know, do the testing. There are. These are practical difficulties which can Happen happen while doing the test.

Artificial eye there is a problem. Yes, definitely. Like in case of artificial eye you have to do norm from the normal eye. You can check the. This.

That particular plane you can check. And uh. Even for the lateral canals you can check uh. The good thing about synapses video ed impulse test test is for bilateral. It can check the lateral canal both the eyes.

Okay. And for the vertical planes it can. We can use the normal eye in such cases in patients who have artificial eye. So with that I completed most of the questions. I think there were almost 38 different comments.

I hope I have answered all your queries satisfactorily. For those who. Whom I couldn't answer properly. I will go through these questions again. Again.

I will come up with, you know, refined answers during my last talk. I request all of you to attend next you know presentation you will get an email. Thank you so much. Thank you for attending this webinar. I hand over to you Anna.

Sure. Thank you Dr. Pawar for another outstanding presentation. I would say reaching knowledge, clarity and and passion. In my opinion, your commitment to sharing clinical insight with such dedication is deeply appreciated by all of us at Inventis and by our global audience.

So thank you so much. You are great. And so we look forward to welcoming you again on May 20 for the final chapter in this dhat journey. Fundamentals of a Video heading presentation test lesson number three, Advanced techniques and case studies. In the meantime, don't miss our upcoming event on May 7th featuring Professor Stavros Axopoulos with a special webinar titled Revolution in Auditory Hearing Screening Methods and Best Practice.

Thank you all for being here and for supporting Inventis academia. Thank you so much once again Dr. Pawar and we'll see you soon. Bye. Thank you.

Thank you. Bye.