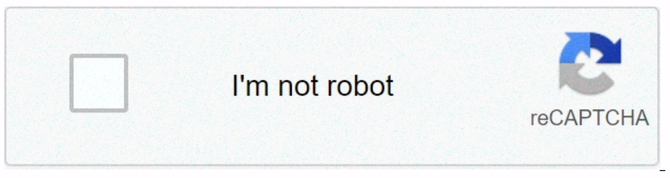

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Vestibular evoked myogenic potential pdf

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Retrieved April 10, 2017.Page 2Sensitivity and specificity of practical guidelines findings on vestibular potential evoke myogenic (VEMP) testing for superior canal dehiscence syndrome (SCDS)2 Author Hesham M Samy, MD, PhD Associate Professor of Audiovestibular Medicine, Minia Unversity, Egypt Hesham M Samy, MD, PhD is a member of the following medical community: American Academy of Audiology, American Auditory Society, Association for Research in Otolaryngology, Egyptian Society of OtorhinolaryngologyDisclosure: Nothing to disclose. 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Confessions of Marc Friedman, Head of Neurology DO, Parma Hospital, Consultant, Department of Neurology-Neurology, Cleveland Hearing and Balance Disclosure Center: Nothing needs to be disclosed. Spiros Manolidis, MD Associate Professor of Otolaryngology and Neurological Surgery, Columbia University Spiros Manolidis, MD is a member of the following medical communities: American Academy of Otolaryngology-Head and Neck Surgery, American Auditory Society, American Head and Neck Society, American Medical Association, Canadian Society of Otolaryngology-Head & Neck Surgery, Society of University Otolaryngologists-Head and Neck Francisco Talavera, PharmD, PhD Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference Disclosure: Medscape Reference Salary Jobs Timothy C. Hain, MD • Last modified page: July 26, 2020 • Back to testing index See also: introduction to oVEMP testing Figure 1: Schemes of utricle and saccule. The sensory organs in the inner ear mainly respond to linear acceleration such as due to orientation to gravity, but saccule is also somewhat sensitive to sound. This is the basis of the VEMP test. We will use cVEMP terminology to indicate the vestibular resurrected myogenic potential arising from the sternocleidomastoid muscle. When we use the term oVEMP or tVEMP or whatever, lowercase indicates that muscles other than SCM are being monitored -- such as oculars or triceps. When we use unqualified VEMP, we mean any vestibular resurrected myogenic potential (i.e. cVEMP, oVEMP, tVEMP, etc.). The purpose of the cVEMP test is to determine whether succulents, one portion of autolith, as well as lower vestibular nerves and central connections, are intact and working normally. Both otolith orgais have little sound sensitivity and this can be measured. This sensitivity is considered to be the remains of the otolith organ used as a auditory organ in lower animals. How is cVEMP generated? Figure 2. cVEMP circuit. The sound stimulates the saccule, which activates the inferior vestibular nerve, the lateral vestibular nucleus, the 11th nerve nucleus, and then the sternocleidomastoid muscle (mostly ipsilaterally). In general, one needs to consider inputs, central processing, and outputs for physiological responses. The path that should take into account the cVEMP response is shown in figure 2 above. The sound stimulates succulents, crossing the vestibular nerve (especially lower, but slightly also in the top) and ganglion achieve achieved core in the brain. From there, impulses are sent to the neck muscles through the medial vestibulospinal tract (MVST), then the spinal accessory nucleus, and the accessory nerve. For most muscles, the net effect of saccule stimulation is inhibition, but excitation from electrical stimulation of saccule has also been reported in some muscles in animals (Uchino et al., 1997; Kushiro et al., 1999). This cable diagram may be appropriate for normal people, but due to the above considerations, it may be wrong for interference where a semicircular channel becomes sensitive to sound, such as in a SCD or fistulae channel. Input: While clinical literature on cVEMPs suggests that they are almost entirely secular, animal literature does not support this claim. Many studies on monkeys show that all 5 keys of the vestibular endorgan phase up to a hard click (Xu et al, 2009). It is also currently estimated that the contrast responds to sound (see ovemp page). It also seems very likely that in certain ear disorders, such as SCD, or cholesteatoma, the semicircular canal may also be a source of cVEMPs. In this disorder, the canal becomes sensitive to sound, and the sound can make the eye move through the activation of the semicircular channel. It seems very likely that it also activates the neck as well as the vertical eye muscles (i.e. lower rectus and lower tilt, as measured by the oVEMP test). According to Naranjo, VEMP amplitudes enhanced by threats and fears (Naranjo et al, 2016) indicate that there are also other inputs to consider. The implication is that cVEMPs are not a simple saccule reflex, but have some input. So overall, things are falling apart. It is quite reasonable to assume that the main source of cVEMPs in normal people is sacrifice. It may not be correct to assume this is the case for patients with ear disease, and because of this, it is also unsafe to assume that vemp cables are as simple as those shown in figure 2 above in all cases. Center: According to Oh et al (2016), cVEMPs are mediated by vestibular nuclei and medial vestibulospinal channels that are not equalized down in the lower brain stem and spinal cord. Therefore, lesions involving the vestibular nucleus can present abnormalities of cVEMPs and medullary lesions involving decreased MLF or spinal accessory nuclei damaging cVEMPs. CVEMPs who evoke sound recorded from the neck are claimed to be almost entirely unilateral. (Colebach et al., 1994; Uchino et al., 1997; Kushiro et al. 2000; Murofushi et al. 1996; Wilson et al, 1995), but in clinical practice this cannot be calculated (see example below). It may also be wrong when a semicircular channel is activated by sound as discussed above. Output: The output for the cVEMP response is by definition sternocleidomastoid muscle (SCM), the deepest by the accessory cranial nerve (the 11th). If one of these structures one would expect a change in cVEMP cVEMP Good. One would expect there may be many other muscles that activate the neck and are relevant to postures that are also activated by sound. In addition, when the semicircular channel is sensitive to sound, such as in SCD or some fistulae canals, it also seems very likely that vertical eye muscles on both sides of the head may be activated by the VEMP protocol. Thus the assumption of ipsilateral cables may be wrong in certain ear diseases. Figure 3 : Equipment used to record VEMP, Bio-Logic Navigator Pro. Methodology: VEMP is recorded using a resurrected response computer, sound generator, and surface electrode to take activation of the neck muscle or other muscles if this is interesting. Figure 3 above illustrates the basic equipment that is rather minimal as needed. In the author's lab, Bio-Logic Navigator Pro does almost all the work, and sends the results to a desktop computer. TESTING VEMP is not difficult, but there are many technical pitfalls. The basics can be learned by technicians in about 30 minutes. This is a very large response, and as long as the person doing the test pays attention to detail (getting the sound in both ears with the proper placement of inserts or headphones, having the person lift their head through the entire trial, electrodes in the right place with the right impedance), it is very easy. The details (see below) take longer to learn. The image below illustrates the printout of the cVEMP test. The cVEMP response consists of initial positivity (p1 or p13) followed by negativity (n1 or n23), see figure 4 below. This is a potential that is raised. Although P1 is positive, it is shown negatively in many cVEMPs, due to the placement of electrodes (basically putting them behind). The most reliable measure of cVEMP response is amplitude (Isaradisaikul et al. 2008). Later the cVEMP component has a lower stimulus threshold and is suspected to be nonvestibular. These are not well understood and we frankly doubt this idea -- they may just be part of the same surge train. Since VEMP is easy to cause without the need for EMG repair, and emg surges occur at latency roughly the same as waves in cVEMP, a coherent surge train is a sensible alternative explanation. In other words, later waves may all be part of the same response. In our opinion, a VEMP

system that performs repairs is not required. To be fair, there are a few different from this opinion (Lee et al. 2008). Repairs can be partially corrected for technical faults involving head positioning, with the price of adding more noise to the entire system. Higher than the normal threshold or low amplitude can be found in people with saccule disorders as well as conductive hearing loss. Reduced amplitudes are commonly found in vestibular nerve. Lower-than-normal thresholds as well as asymmetric amplitudes were found personally with the Tullio phenomenon, which dizziness is caused by sound. Prolonged P13 delay found in central disturbances (Murofushi et al., 2001), but practically this is very rare, and technical faults are the source of the most prolonged latencies. Vemp normally uses Bio-Logic Navigator Pro.. The main potential, P1, is located at about 13 msec. Each side measures about 250 microvolts (which is well above the normal lower limit, about 70). There are electrical artifacts visible at 0 msec for the left side. This is negligible. A general rule of thumb with hearing and cVEMP is that conductive hearing loss obliterates VEMP air, and that sensorineural hearing loss does little or nothing for VEMP. The two plots below illustrate this. Figure: VEMP is obtained in individuals with simple left-side conductive hearing loss, using Bio-Logic Navigator Pro. VEMP on the right is normal, and VEMP on the left, absolutely nothing. P1 points to the potential that occurs at 13 msec (often called P13) Image: cVEMP is obtained in individuals with deep right sensorineural hearing loss, using Bio-Logic Navigator Pro. This indicates that (sensorineural) hearing is not necessary to obtain VEMP. This recording was obtained using binaural stimulation (see comments on this method). Audiograms directly with cVEMP are displayed on the right. There's a deep hearing loss, maybe sensorineural. A potential trap in a person with complete sensorineural hearing loss, is that a person has no way of determining whether they also have conductive components for their hearing loss. For example, a person may have much more advanced otosclerosis. Thus, one can mistakenly conclude that there is no vestibular function on one side based on VEMP that does not exist. Bone VEMP is one way to solve this problem. Basic head position and electrode layout Best practice, as shown below, is to apply EMG electrodes to the middle third of the anterior neck muscles (sternocleidomastoids) and supine patients hold their heads unsupported, using anterior neck muscles. Subjects are instructed to strain muscles during acoustic stimulation, and relax in between runs. If the neck muscles are not activated, no cVEMP is produced. Reflex scales for emg tonics -- again -- if you don't activate the neck muscles, you don't get a response. Koroller, is that if you get a response without neck muscle activation, it's not VEMP (maybe PAM? see below). EMG electrodes should not be the kind that use crocodile clips to stick to foil, as the head moves during cVEMP. This type of electrode produces a large amount of noise with movement. Instead, electrodes should be used that are hard wired to the cable. People with fat necks have a lower response, due to signals the muscles are below the fat and must travel a greater distance. Similarly, people with long necks then have a response, because the signal again has to travel a longer distance (Chang et al, 2007) Some patients can not resist to the indicated angle. In this case, some experts recommend simply tilting the whole body about 30 degrees, so that there is less torque required by the patient to hold their head (Colebatch, personal communication). We think this is a very good idea, but there is currently no amplitude norm for this procedure. Pictured: Patient positions recommended for VEMP testing. During the test, the patient lies flat on their back, lifting the head off the table. Another (but bad) method to get activation is to have patients sit upright with their chins behind counterlateral shoulders to strain SCM muscles. We think this is a bad idea because you have no way of knowing how much strain the patient is getting, it's exhausting, and the patient can do something different on the right than on the left, without you noticing. It is also known that the position of the head on the body can change the cVEMP response. This adds another variable. Since responses are generally ipsilateral (carefully record qualifications), one could theoretically use bilateral stimuli and bilateral recordings to reduce the number of trials (Huang et al., 2006; Young, 2006). We tried this method in our clinical practice, but disposed of it for the reasons described below. It has the advantage of using the same stimulus when recording each side, which reduces some considerable variability. The normal limit for amplitude with the technique of raising the head is about 70 to 700. Regarding the upper limit, there is no disease that we know that can be diagnosed by larger than normal cVEMPs on both sides, but in our clinical experience, we have seen this especially in people with hyperacusis. The Vemp Monaural shows the basic pitfalls of binaural/bilateral recording. Since there is a substantial response from the counterlateral side on the left, one can assume incorrectly that there is VEMP at the moment even in someone with a vestibular nerve part. We do not recommend binaural stimulation. We think that binaural stimulation is generally a bad idea. The picture above illustrates why we have discarded this technique. Although cVEMP is generally ipsilateral, this does not mean that they are always, 100% ipsilateral. Artifacts can also cross the midline, which reduces a lot of value using binaural stimulus. Since the sternum is rather close to the sternocleidomastoid muscle, there can also be artifacts due to volume conduction - meaning electrical activity from one side becomes confused with the other (Li et al. 1999). There is also the problem that in SCD, the channel can be activated by sound, and then all bets are off regarding laterality. If you really care that what you measure reflects the side you think you measure, don't use bilateral cVEMP. In our opinion, this pretty much eliminates the technique. The point is using bilateral VEMP. Sound stimulus: Click loud or bursts of tone (usually 95-100 DB nHL or louder) repeatedly to each ear at intervals of 200 msec (5/s). The optimal frequency is located between 500 and 1000 Hz. The sternum is generally used as a reference and the forehead as soil. There is some evidence that a related wrist might be a better option for reference (Li et al., 1999). We generally use Nav-Pro bio-logic set up with the parameters documented here. Note that binaural presentation sounds are not recommended (by us anyway). This is faster but reduces a person's ability to melis the localization of the lesion side due to crossovers. Our recommendations, based on some unfavorable clinical experience in which binaural stimulation got us lost, differ from others in the literature (e.g. Young, 2006). Myogenic potential is amplified, bandpass filtered (30-3K Hz), and averages for 200 presentations. The evocative response in emg neck is average and presented as cVEMP (see figure 2). Latency, amplitude, and threshold for p13-n23 waves are measured. Amplitude is the most reliable measure (Isaradisaikul et al., 2008). Latencies are less reliable but useful in deciding whether a particular waveform is cVEMP or just noise. Due to the high intensity of sound used to evoke this response, carefully examined inserts should be used. Headphones are less reliable than inserts, as small errors in the placement of headphones can result in large changes in sound intensity, and loss of cVEMP. When the head is held upright, the headphones can shift easily. CVEMP is generally fast and easy to obtain because it is of strong potential and only takes about a minute of stimulation to get 100 presentations. We usually use 200 presentations ourselves. This means that you can easily repeat the cVEMP test. In our opinion, a minimum of two repetitions should be obtained on each side, to ensure that VEMP can be reproduced or does not exist, as may be the case. Three are generally intended for. An exception to this can be made if the first two repetitions are large and almost identical amplitudes (e.g. see figure 2). We generally use monaural recordings. We recommend bursts of tone rather than clicks -- here's why. Similar responses were generated using bursts of tone instead of clicks (Murofushi, Matsuzaki et al. 1999; Welgampola and Colebach, 2001; Cheng, Huang et al. 2003). A tone of 500 or 1000 hz is presented at a rate of 5 /sec. They suggest using an intensity of 120 db SPL. The duration of the stimulus of 7 msec was found to be optimal. The advantage of stimulus bursts of tone compared to one click is that it requires a lower intensity of absolute stimulus. This is important if you use equipment that does not produce optimally harsh stimuli (see below). We suspect that it latencies are longer and more variable. But in the current paper, the clinical value of measuring latency (other than being sure you have VEMP), remains somewhat elusive. Amplitudes are much more reliable. Rauch et al (2004) also recommend using bursts of tone, tone, suggest an optimal frequency of 500 hz. They recommend monitoring ongoing EMG activity to ensure that SCM muscles are activated without muscle activation, cVEMP does not occur. In their study, cVEMP was rated none when no replicable response was observed and a fairly average response to residual noise became less than 3 uv. They suggest that thresholds are more useful than amplitude. We disagree - we feel that amplitudes are more useful than thresholds, given well-standardized protocols. Literature shows that amplitudes are more reliable than thresholds as well (Isaradisaikul et al., 2008). Practically, one can not do both - 3 repetitions as well as a threshold, due to fatigue. We have also found many patients with low thresholds, but no dehisence. See more discussion of the issues inherent in doing the threshold below under the technical pitfalls. Technical pitfalls in performing VEMP Almost all VEMP problems are caused by operator errors. VEMP is a relatively new test, and so far, manufacturers have not built quality assurance protocol methods. In fact, after an FDA review in the U.S., manufacturers had to withdraw some of the protocols they had put in to help. Our government limits innovation. When cVEMP does not make sense in the overall clinical context, we think it is a good idea to simply repeat it on a subsequent visit, and harm the technician if there is a big difference Ensuring neck muscle activation is the biggest problem. While one can run a highly successful cVEMP with the patient's head held vs gravity, this is exhausting. A common quality control problem in cVEMP is that technicians are too good to allow patients to put their head up during tests. cVEMPs can be run with the head actively switched to one side, so it is only tiring one side of both, but the procedure also has a trap, as it is less reliable and produces less potential (Wang and Young, 2006). A suggestion for any manufacturer that might read this is to add a method of determining whether the head is not on the table (a simple pressure switch will work). A few more comments about VEMP biomekanics are here. In people who can not cooperate, convincing activation of the neck muscles is a big problem. Consider, for example, trying to perform cVEMP on babies. How do you make sure that the neck muscles are activated? This is an intrinsic problem with doing cVEMP on very young children, and perhaps it should not be tried at all. However there have been some reports about doing oVEMPS on children. At a minimum, cVEMP is carried out in an individual who is (probably) uncooperative should be done with equipment that can monitor EMG. another technical gotcha in cVEMP is a sound that is not to the ear. This is very, very important! Common things that go wrong here are the placement of asymmetric inserts, candles that include one side, or faulty sound generators (which Bio-logic seems to very often be bad, when used to -- it has happened to us 3 times in just 2 years!). Since cVEMP is not far above the threshold provided by most of the potential equipment raised, small things like not inserting inserts as far in one ear as the other can make a big difference. Only 10 dB can be important. Regarding insert checking, we recommend sound checking with each VEMP. The easiest way to do this is to run the initial cVEMP without raising the head - these are both assessing PAM artifacts (see below), as well as being able to provide a good time to perform sound checks. It would make sense for the cVEMP protocol to include a threshold check at 500 hz, using inserts and potential machine transducers raised, but so far, this is not available. Thresholds can also be problematic. There are some big problems. The first is that there is a subjective element to choosing a threshold. One person's response may be someone else's noise. The second is that if you do the threshold, you can not do much repetition (because people are tired). The third is that they don't always work – the low threshold is NOT always accompanied by superior radiographic evidence of canal dehisence. We've found some patients with a threshold of 60, but normal temporal bone CT. Our current position is that thresholds should not be carried out regularly, as they prevent a person from performing a reliable amplitude. cVEMP artifact (squiggles at start) due to a technical fault in the placement of the sound generator too close to the electrode. Electrical artifacts. cVEMP is very large (compared to ABR or ECochG) and there should not be many random electrical artifacts. If you see a stimulus artifact, or sinusoidal undulation to the trace, it is quite possible that the electrode is bad, someone puts the sound generator box too close to the electrode, the impedance is too high, or the potential machine raised requires service. In our experience with the latter, things that routinely go badly with potential engines raised are connectors and insert drivers. In the cVEMP trail above, there is a stimulus artifact. Once lost when the sound generator is moved, we realize that the sound generator cannot be very close to the EMG prospect. The sound generator generates a magnetic field that induces powerful artifacts, if one places it close to one of the main electrical teams. Other artifacts. Sometimes patients have such VEMP potential (? VLP), it's not VEMP. In some cases, this is caused by the posterior auricular muscle (PAM), a sound that evokes ear twitches. PAM is a small muscle behind the ear that can wiggle the ears. In fact, there are three of these muscles - the posterior, superior and anterior auricle muscles -- all vestigial. Pam is in the facial nerve. Response latency 11 msec, making it overlap with VEMP. (Funahashi et al., 1992). Literature on PAM is confused – some authors may have mistaken a much larger cVEMP for pam responses, and deputy representatives See Gibson (1978) for an older literature review. To rule out potential PAM, you can run your cVEMP at first or perhaps among other runs, without contracting an SCM. In other cases, this is due to volume conduction - electrical activity from one side appears on the other. Volume conduction problems can be best solved by monaural stimulation. For the reasons developed above, we think that running or two of monaural stimulation is a very good idea. Logical conclusion. Although cVEMP is generally ipsilateral, this does not mean that they are always, 100% unilateral. If you try to override the rest of the vestibular function – do not use cVEMP binaural stimulation. Since almost always someone tries to melis the localization of the lesion side, we think that binaural cVEMP is best avoided. The exception is when one tries to diagnose bilateral vestibular loss, when it's okay. One can also broadly criticize all VEMP studies because the core dogma that drives enthusiasm in conducting VEMP tests makes no sense. The core dogma is that things are very simple, allowing one to make diagnostic conclusions. Although not particularly emphasized in the literature, vemp tests are likely to involve input from many senses, and are not limited to saccule or utricle inputs as has been suggested. Nor does it make sense that the wires are unilateral. Thus we have a large clinical database that has not produced very impressive results, perhaps based on an oversimplified idea of how the ear connects to the nervous system. Variants of vemp vemp method improved The term repair is used in a confusing way by some to indicate normalization -- uninfected VEMP signals are divided by the average repaired pre-stimulus surface of EMG (Lee et al, 2008). The reason is that the size of the surface EMG signal may vary according to the placement of the electrode or the difference in activation of the muscle or body build up. Chang et al (2007) showed that people with subcutaneous tissue of the neck in larger amounts (i.e. fat), have smaller cVEMPs. This makes sense and is just common sense, and a good reason for normalization. Variability due to this technical problem may be reduced by adjusting for these factors. This technique seems reasonable enough to adjust the difference in electrode placement as well as the anatomy of the neck. It seems to us it does not make sense to adjust the difference in muscle activation, since this may be easily changed for 2 minutes of cVEMP itself. We had experimented with this technique ourselves and decided that it was worse than using very careful electrode placement and having patients raise their heads straight (ensuring the same activation of both SCM). In other words, we threw it away. on the other hand, Lee et al reported that improvements were better (2008). They don't use our favorite techniques - instead of raising their heads straight, they have subjects lifting and turning their heads. Because this method introduces introducing because the head turned, in our opinion, their experimental design was only designed to fail. Overall, it seems to us that their method may be better than the (poor) method of turning heads because it controls intermittent efforts which is a problem with the head turning methodology. We currently continue to argue that VEMP lifts its head straight carefully and is not superior. However, as technology improves, we can change our minds. In this case, we'd like to see a cVEMP output that delivers more data to doctors – raw cVEMP amplitude, emg integrated and repaired raw, and normalized values. We would also like to see a cVEMP machine that prints out the entire EMG activation raster during the trial – to ensure that the patient activates their neck and that the electrode remains tightly attached. There is room for other improvements - for example, a VEMP stimulus that has a gap in sound stimulus might allow smart algorithms that use loopholes to calculate more useful normalization signals. Also, the corrected term VEMP, should be replaced with a more plausible term normalized VEMP. We don't think the corrected term VEMP is a reasonable one, because corrections cover too much ground. VEMPs in ocular muscles, oVEMPs. The number of studies using this test has grown rapidly, and we have devoted a separate page to oVEMP. VEMPs in the limb muscles. We have studied acoustically generated VEMP in gastrocnemius and triceps (Ruddissil et al, 2008; Cherchi et al, 2009). This response occurs at longer latency than VEMP SCM. Triceps size raises potential scales with strength (Cherchi et al, 2015). Triceps potential is reduced in cervical cord lesions (Shirley et al, 2015). Their clinical utility remains to be established, but they may be useful for diagnosing spinal cord lesions or cervical vertigo. Bone conduction VEMPs Skull faucets and bone conduction tones can also be used to elicit VEMPs. The tap can be sent to the forehead or lateral skull, with some differences in polarity and a sisis of the resulting potential. Bursts of bone conduction tone can also evoke VEMP, using a frequency of about 200 Hz. Clinical bone vibrators generally require additional amplification to produce stimuli strong enough for VEMP testing. VEMP performed bones are not also realized as click-uploaded VEMP. (Sheykholeslami, Murofushi et al. 2000) McNerney and Burkhard (2012) compared air to bones performed by VEMP, using 500 hz for both. TECA units are used for testing. SM stimuli are set to 120 db pFL, using bone vibrator B071. We're not entirely sure what the pFL is - maybe something bone-related rather than air conduction. We are not at all sure how the pFL level of 120 db relates to with a clinical bone vibrator that only produces 60 db. Well, however they found that amplitude is less variable for bone conduction. This is not surprising as bone conduction bone both ears and one would think that the average in two ears would be more reliable than one. They also found that bone masking reduced the air amplitude that VEMP performed. For us this indicates that the vemp response component that the air conducts is due to surprising or multisensory convergence. To summarize, although BC VEMP is undoubtedly more reliable, their obvious problem lies in their inability to limit stimulus to one ear. Galvanic VEMP Galvanic stimuli can also produce VEMP (Watson and Colebatch 1998). This technique passes through the mechanical part of the ear and thus can be used to separate the final organ from the nerves and more proximal lesions. Technically, the average electrical consequence of galvanized inputs is difficult because there are large electrical artifacts associated with the stimulus itself. This has been handled by the reduction methodology. Typical protocols using 4 ma cathodal current pulses, of a duration of 20 ms, are given at 2 Hz, with a total stimuli of 128 (Bacsi et al, 2002). Logically, to prevent artifacts, it seems better to record from muscles away from the current input (ear), such as in the legs or arms. Galvanized and acoustic vemp activate different populations of afferent vestibular. Galvanized stimulation excites the afferents of the distal vestibular nerve, especially those who have irregular releases, but any selectivity to this action in the afferents that arrive from various vestibular end organs is uncertain. (Bacsi, Watson and Colebatch, 2002) Since the entire vestibular nerve is stimulated by galvanized input, one would expect that the galvanized VEMP will be insensitive to partial nerve lesions (i.e. the failed part of the vestibular nerve), but also sensitive enough to resolve vestibular nerve loss. Thus the absent galvanized VEMP can be used as an excuse to avoid performing more operations. For the same reason, galvanized VEMP should also not distinguish between endorgan damage (saccule) and lower vestibular nerve damage because one would expect that galvanized VEMP would be present even if the lower vestibular nerve was damaged. VEMP Galvanized may prove useful using threshold or latency information. VEMP Galvanized is not suppressed by anodal currents, which indicates that VEMP does not require irregular afferents (Bacsi and Colebach, 2003). Vemp Galvanic may be more reliable than acoustic VEMP and thus be a better method for monitoring vestibulospinal connections through the spinal cord than acoustic VEMP. Further study is required. The VOR uploaded test clicks that are closely related to VEMP are described by Halmagyi and others (2003). Triggered events are on average used to detect electro-octulographic responses to hard clicks -- intensities ranging from 80 to 110 Db. clicks are delivered at a rate of 5/s from 60 to 110 db, in 10 db steps. Normal subjects did not have a very low amplitude or response < 0.25 deg at 110 db. Latency is 8 msec. These tests are generally not available, but appear to appear This technology is very similar to VEMP, and may even be obtained with the same instrumentation. This may be a good candidate to replace the Tullio test. Clinical utility VEMPs What is it tested? Figure 2 illustrates the pathways for acoustic VEMP response, which include saccule, lower vestibular nerve, vestibular nucleus, medial vestibulospinal tract, accessory nucleus, 11th nerve, and finally sternocleidomastoid muscle. Abnormal VEMP may be caused by abnormalities in one of these structures. VEMP-induced sounds also require sound conduction to the inner ear, which means that a whole middle ear is required. While VEMP is currently associated with sakula, the data presented so far suggests that hearing is not required for VEMP. This does not exclude the possibility that hearing is sufficient for low-level VEMP, since it is not unusual to deal with human subjects with well-documented vestibular lesions that are limited to succulents. However there is some data to suggest that the vestibular nerve part abolishes VEMP, which would contradict this idea (Watson and Colebatch, 1998). It is also possible that hearing synergizes with vestibular inputs – i.e. you get more responses with multisensory convergence. We are currently arguing, but this is an issue that needs to be worked out. Normal Values for cVEMPs In our clinic settings in Chicago, we consider VEMPS abnormal when they are highly asymmetric (one is 2 times or greater than the other – RVR 33% or greater), low amplitude (less than 70 for young population), or none (no wave can be reproduced, or P1 latency outside our norms). We use VEMP bursts of tone, which produces a considerable response rather than a click. We do this because our equipment (Bio-Logic Nav-Pro), oddly enough, does not produce as much stimulus as we would like (only 95 dB). As mentioned above, we tried bilateral binaural recordings and stimulation, but we switched back to monaural stimulation due to some poor diagnostic experience where there seems to be VEMP with binaural stimulation, but obviously no VEMP with monaural stimulation. Picture: VEMP amplitude up to click, as an age function, from Su et al (2004). Regarding the effects of age, 3 studies have been conducted - using 3 different techniques. For clicks, compared to young people, a decrease in amplitude (roughly a factor of two) was seen in people 70 and older (Su et al, 2004). Similarly, also using clicks but not using commercial equipment, Ochi reported amplitudes of about 250 for ages 20 vs. 90 for 80-year-olds. Basta et al reported similar results for bursts of 500 hz tones (2007) but with a lower overall amplitude using the Viking system. This system seems to produce lower amplitude results, due to calibration differences. It has become our common experience that the devices we use (Bio-Logic NavPro) generate greater potential than most Device. Author Value Stimulus Latency (p13) Su et al 11.33+-.82 Rarification click Latency n23 Su et al 18.24 +- 1.33 Rarification click Amplitude p13-n23 Su et al 126+-49.6 Click iad su et al ratio. 0.16+- .12 Click On current posts (2011), it seems to us that in normal people, and using Bio-logic Nav-Pro, the average VEMP amplitude decreases from about 150 at age 20 to about 75 at age 70. What data is there about certain disorders in the literature? Vemp literature is increasing rapidly and there seems to be enough valuable diagnostic information to be obtained. See the following sections for a brief discussion of VEMP, illustrated with traces of our practice, in For some of the more popular distractions in which VEMP is used, we have separate pages, and have combined data from other VEMP protocols as well. VEMP at Superior Canal Dehiscence Syndrome -- See this page for details. Vemps as a test of vestibular nerve disease -- sometimes works VEMP obtained in individuals with Ramsay Hunt syndrome on the left side, using the Bio-Logic Navigator Pro. Ramsay Hunt is a facial weakness, sometimes combined with 8th nerve neuritis, due to the recurrence of Shingles (chicken pox virus). Showing that cVEMPs are sensitive to saccule pathway disease, Ochi and associations (2003) reported the use of cVEMPs to diagnose vestibular neuritis involving lower division of vestibular nerves. Because saccule is provided by lower divisions, cVEMPs must be absent in this situation. cVEMP does not distinguish between saccule and inferior vestibular nerves, and the available techniques seem unlikely to be able to resolve between the two. Since most types of vestibular neuritis forgive inferior vestibular nerves, cVEMPs will generally be normal in vestibular neuritis. In fact, in our clinical practice in Chicago, we sometimes use a very abnormal VENG pattern, accompanied by a very normal cVEMP to strongly suggest Vestibular neuritis - that is, we use it to exclude total vestibular nerve disease rather than detect vestibular nerve disease. We also use the same logic to diagnose bilateral vestibular neuritis. When cVEMP is abnormal in vestibular neuritis, they recover faster than canal-related tests (Kim et al, 2008) Galvanic VEMP stimulation stimulates the entire vestibular nerve and therefore will be expected to be normal even if the lower vestibular nerve is damaged. Thus the voice-VEMP that does not exist and is now galvanized-VEMP will not distinguish between saccule lesions and lower vestibular nerve lesions. Prolonged latency of cVEMPs has recently been suggested to be a sign of retrocochlear lesions (vestibular nerves), as found in vestibular neuritis. We kind of doubted this and thought that in this case the first wave of cVEMP might just disappear, but then associated with the function of the cochlear is maintained, causing the appearance of prolonged latency. Abnormal CVEMPs (asymmetric or long latency) are reported in approximately 25% of people diagnosed with vestibular neuritis (Murofuschi et al, 1996). Prolonged latency also occurs in people with long necks (of course). VEMP asymmetry in patients with small intraanalicular acoustic neuroma, with no auditory deficit. In Vestibular neuritis, cVEMP is reported to normalize faster than canal-related tests (Kim et al, 2008). However, this conclusion is suspected to be the VEMP technique used in this study (turning heads) intrinsically flawed (see discussion above). VEMPS generally does not exist or is personally reduced by acoustic neuroma (see image above). Failed parts of the vestibular nerve: It is not very possible to work cVEMPs should and almost always does not exist in people with vestibular nerve parts. The vestibular nerve part failed to control intractable vertigo due to Meniere's disease in about 5% of patients. When they fail, the question may arise whether the nerve part is incomplete. VEMP may, in theory, be useful for detecting residual functions in the lower vestibular nerve, since these branches of the vestibular nerve sometimes intersect with cochlear fibers (Lehnen et al, 2004). However, since CVEMPs need very strong stimulus, it seems unlikely they will be particularly sensitive. Head impulse tests for posterior channels reveal residual function more often than cVEMPs (Lehnen et al, 2004). More studies on this question are needed. A potential pitfall in performing cVEMP personally with VNS is the contralateral response and foreign response (especially the posterior auricular muscle response). You may NOT bilaterally stim cVEMP's personally with VNS. You should also check the PAM (by doing a test with your head resting on the table) if there is something that seems to be a response on the side of the part. cVEMPs as a test for bilateral vestibular loss – work! cVEMP directly with complete bilateral vestibular loss due to gentamicin, but with some hearing. The potential shown is replicable but does not have displacement characteristics below the baseline for P1 (see below). VCEMPs will be expected to be reduced or none in people with bilateral vestibular loss, such as due to aminoglical muscleocytes. Gentamicin eliminates cVEMPs in guinea pigs. (Cheng et al. 2010) Only a few patients have been studied so far with gentamicin (Murofushi et al., 1998). In our practice, we have tested many patients with bilateral vestibular loss and normal hearing, and found that it was a good test (Hain et al, 2006). We have also tested two deaf patients with bilateral loss, one because of Cogan syndrome and another because of Mondini's malformations, and found responses that did not exist or were almost non-existate in both. as expected if one believes that succulents are affected in this condition. Nevertheless, this conclusion can be questioned as an intrinsic problem to test people with bilateral hearing loss is that a person does not not if they may also have conductive hearing loss superimposed on sensorineural loss. Because conductive hearing loss obliterates voice-induced cVEMP, one cannot clearly connect a none of the cVEMP with a saccule function that does not exist in this situation. cVEMP also appears to be absent after the unilateral gentamicin treatment used for Meniere's disease (Helling et al, 2007). They may be useful in deciding whether more drugs are indicated or not. The likely confusing problem is that there may be middle ear disease after injection due to the perforation required for transtympanic gentamicin. cVEMPs in BPPV -- not working. One might think that as VEMP assesses saccule (autolith organs), and because BPPV is considered due to other autolithic diseases (otoconia loose from kemetric), that there may be abnormal VEMP personally with BPPV. The et al (2008) asked this question, and reported that latency increased slightly. Since we doubt that latency is a useful measure at all, we also doubt the use of cVEMP in BPPV. On the other hand, there is literature that shows that oVEMPs are very helpful in BPPV. VEMP in Otosclerosis - -must not exist. In Otosclerosis, vemp that air is done should not exist. A person with air is currently performed VEMP and conductive hearing loss may have SCD. VEMPS in Meniere's disease -- see this page. VEMPs in the nuisance center - rarely work. We have not been impressed with the sensitivity of cVEMPs to central disorders such as brain stem scratches. The difficulty seems to be that latencies in cVEMPs (at least with bursts of tone), vary so much that there is inadequate sensitivity to the disease. This may be an artifact of our methodology (bursts of tone), which temporally constitutes a stimulus longer than a single click. We don't have any examples to show here, so we'll just mention what's in the literature. cVEMPs are often asymmetrical in spasmodic torticollis (Colebatch, Di Lazzaro et al. 1995). cVEMP is reduced in progressive supranuclear palsy (PSP), according to Liao et al (2008). PSP is a rare degenerative disorder of CNS that generally results in death within 5 years of diagnosis. The average VEMP amplitude was reported to be 54, with a range of 16.8 to 214. This range overlaps substantially with age-matching controls, but may be another useful method for identifying a PSP. There is no data available at this time regarding the development of VEMP in PSP patients from time to time. People will expect a decline. These patients are unusual however and longitudinal studies will not be easy to do. cVEMPS, like other potential tests raised, can also be abnormal in central diseases such as multiple sclerosis (MS). (Shimizu, Murofushi et 2000; Versino, Colnaghi et al. 2002; Murofuschi et al, 2001) and brain stem stroke (Chen et al. 2003). The VEMPs test primarily measures the function of the lower brain stem (medulla), while the ABR also tests the function of the upper brain stem (medulla pons and midbrain). Here, the latency action will appear more than the size of the amplitude. VEMP is normal in patients with Machado-Joseph disease (Sca-3). Low amplitude (30-50) but latency is normal in these middle-aged individuals with genetically proven sca3 for 5 years, with gait ataxia, small brain stem, and bilateral upgoing toes. cVEMP is reported to be abnormal in certain cerebellar degeneration (i.e. Machado Joseph's disease), but normal in others (e.g. OPCA, cortical cerebellar degeneration). (Tagegoshi and Murofushi, 2000). Since vemp circuits are not thought to involve the cerebellum, it would be surprising to find abnormal VEMP in pure cerebellar conditions. In our own practice (see above), but we studied only two patients and found abnormally reduced amplitudes for ages in one and VEMP that were not in the other. Because Machado-Joseph affects the brain stem, the mechanism for reduced VEMP can lie in damage to other locations than the cerebellum. cVEMPs in Migraine -- Follow this link for a discussion. cVEMPs in hearing loss – need more data. Although VEMP can be obtained in people with complete hearing loss, hearing loss should be of a sensorineural type. Just because cVEMP can be obtained does not mean that they are not related to hearing loss, and in our experience, both hearing and vestibular functions correlate with the amplitude of cVEMP. However, this conclusion is not (so far) well documented in the literature. People with conductive hearing loss, even only small amounts such as 10-15 dB, often do not have the air that cVEMPs do, perhaps because sound stimulus, which is conventionally delivered by earphones, does not get to the sacrifice. Succulents have a high threshold, and if you stimulate the ear close to that threshold (i.e. 95 dB), it is easy to get down under it. This means that cVEMPs are less useful in older people, who often have components of conductive hearing loss due to otosclerosis and related disorders, and should also be interpreted with recent audiograms, including testing of bone and air conduction, at hand. The way around this is possible to do cVEMP bone conduction when cVEMP air conduction is not there. While this replaces bone conduction audiograms, it requires more testing and may potentially make patients exhausted. Also, bone-conduction stimulation is generally not very strong. Several groups (Wang and Young, 2007; Akin et al, 2012) reported that cVEMP is personally reduced with noise-induced hearing loss. They associate this effect with saccule damage. While theoretically possible, we doubt that structures that require 70db to elicit a minimal response will be highly sensitive to noise. Sukuat will be more sufficiently damaged by excessive changes in acceleration because it is loaded by otoconia. On the contrary our opinion is that there is only a reduction in air that VEMP does from hearing reduction. Similarly, Zhou, Kenna, Stevens and Licameli (2008) reported reduced cVEMP in children with sensorineural hearing loss, and this effect is to sacrifice damage. We think that this writer made the same logical mistake as Wang and Young. CVEMP tests are generally normal in sudden hearing loss (Wu and Young, 2002). Who does VEMP testing and who should interpret the VEMP test? VEMP tests are generally performed by audiologists or electrophysiologists. Surprisingly, cVEMP is sometimes even performed by the practice of physical therapy. Audiologists are often associated with the practice of otolaryngology (TUT physicians), while electrophysiology technicians are often associated with neurology practices. cVEMP is easy to obtain, but there are many pitfalls involving hearing. We strongly recommend that an audiologist or audiology technician perform this test. We do not think that this test should be done by people who are not familiar with hearing - that is, the practice of physical therapy or general neurological practice, since a good understanding of how hearing interacts with VEMP is very important. We aregitating to think about what might happen in practices where testing is being conducted universally without knowing if the patient has a conductive hearing deficit, or a sound check performed on the equipment. Regarding interpretation, it makes absolutely no sense for a general audiologist, who has no neurological background, to make conclusions about brain function. Similarly, in our opinion, most physical therapists do not have appropriate audiology training to interpret cVEMP. Since the interpretation process involves peripheral pathways and CNS, we think that teams that combine audioologists and otoneurologists are optimally experienced. Device for VEMP testing. See this page for a discussion of what we've found to work. 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