



# TRANSCRANIAL SONOGRAPHY AND RLS

by Regina Patrick RPSGT

A person with restless leg syndrome has uncomfortable, irritating or painful sensations in the legs that usually manifest as the person is settling down before going to sleep. The sensations may feel like burning, tugging, or insects creeping or crawling inside. To relieve the sensations, the person feels an irresistible urge to move his legs by walking, rubbing them, stretching, etc.

These actions only bring short relief. Inevitably, the RLS sufferer must continue to move his or her legs to bring about relief once again. This process can last up to several hours and prevent the person from going to sleep at a desired time. The sensations usually subside with the onset of sleep. But if the person awakens, the sensations may resume and once again interfere with sleep. This can subsequently result in daytime sleepiness.

Scientists are not sure why RLS occurs. One possibility may be that it results from a dysfunctional neurological process in the brain. Brain imaging technology has revealed some differences in the brains of people with and without RLS. Most recently, transcranial sonography has found that the substantia nigra (SN) in people with RLS has a decreased echogenicity — in other words, a decreased ability to return a signal in response to an ultrasound signal. This feature may some day be useful in diagnosing people with RLS.

Sonography, also called ultrasonography, uses ultrasound waves to visualize structures within the body. When ultrasonic signals are transmitted through a body tissue, a portion of the waves passes through the tissue while a portion of the waves bounces back toward the source of the ultrasound signal.

Continuous wave Doppler sonography and pulsed wave Doppler sonography are commonly used. In continuous wave Doppler sonography, a transducer contains two piezoelectric crystals, which convert electrical impulses into sound waves and vice versa. One crystal in the transducer continually transmits ultrasound waves through a tissue while the second crystal continually records the reflected signals. The strength of the reflected signals is plotted as a waveform called an A-scan (A stands for “amplitude”). The vertical axis of the wave represents the strength of the returned

signal, and the horizontal axis represents the time it takes for the signal to return to the transducer.

In pulsed wave Doppler sonography, the transducer contains one crystal which sends a pulse of ultrasound waves through a tissue, waits for the signal to return, and then records the strength of the reflected signals before sending out another pulse of waves. The greater the distance a wave travels, the longer it takes for the signal to return when it is reflected.

Unlike continuous Doppler, pulsed wave Doppler allows a sonographer to determine the distance a structure is from the transducer, thereby making it possible to focus on specific structures such as a blood vessel within a tissue. Additionally, with pulsed wave Doppler sonography a two-dimensional (2-D) grayscale image called a B-scan (B stands for “brightness”) can be created based on the density of the tissue being scanned. The greater a tissue’s density, the more it reflects ultrasound waves, and the lighter it appears on a B-scan.

Continuous wave Doppler sonography first allowed scientists to noninvasively determine that a structural abnormality existed in the brain. In the late 1950s, scientists demonstrated that ultrasound frequencies could penetrate the skull to the brain tissue beneath and be reflected from structures lying in the midline between the cerebral hemispheres.

Nevertheless, based on the characteristics of the reflected signals on an A-scan, neurologists could determine if the midline between the cerebral hemispheres had been displaced. This could indicate the presence of a tumor or cyst. This technique — midline echoencephalography — was nearly usurped by the advent of computer axial tomography (CAT) which could visually provide more information about brain tissue beneath the skull.

In 1982, Rune Aaslid used a pulsed Doppler transducer to propagate 1 to 2 MHz waves through the adult human skull and for the first time was able to accurately determine the velocity of blood flow through specific cerebral arteries encircling the base of the brain. His technique is now known as transcranial sonography.

In his technique, the transducer is placed on the temporal bone just above the cheekbone. He chose this site because the skull is relatively thin in this area in adults and, therefore, can be more easily penetrated. The sound waves penetrate through the skull, pass through brain tissue and are reflected from the middle cerebral artery, the anterior cerebral artery and the posterior cerebral artery. The Doppler Effect helped Aaslid to determine the velocity of the blood through these vessels. In the Doppler Effect, the closer a moving object (such as blood within a vessel) approaches a stationary sound source (in this case the transducer), the stronger or higher pitched is the moving



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object's reflected signal. Aaslid plotted this information as an A-scan image.

Since the early 1990s, improvements in B-scan imaging has allowed scientists to sonographically visualize the brain in a 2-D format. Structures such as the ventricles, the brainstem, tumors and even small areas such as the substantia nigra (SN) can now be clearly identified.

The SN is a layer of gray matter that runs through the central portion of the midbrain. It consists of dopaminergic neurons. Dopamine is a neurotransmitter that plays a role in movement. Disruptions in dopamine transmission in the SN may be a factor in movement disorders.

In several studies, researcher Thomas Becker noted that the SN is hyperechogenic (it reflects sonographic waves to a greater degree than expected) in people with major depression and in people with Parkinson's disease. He concluded that the echogenicity of the SN could possibly be used to diagnose certain neurological disorders.

Many people with Parkinson's disease have symptoms of RLS long before receiving a diagnosis of Parkinson's disease. Since alterations in the SN may play a role in Parkinson's disease, some scientists have begun investigating whether a degenerative process or some other dysfunction in the SN could be playing a role in RLS. With this in mind, German researchers Jana Godau and coworkers investigated whether the hypoechogenicity of the SN could be a unique marker for RLS in a recent study.

Their study involved 132 subjects with RLS and 42 controls. Seventy-five percent of the RLS subjects had idiopathic RLS while the remaining 25 percent had symptomatic RLS. RLS symptoms in the symptomatic RLS group were due to other neurological problems such as polyneuropathy, Parkinson's disease, stroke, spinal cord injury, multiple sclerosis and end stage renal disease (ESRD). All subjects and controls underwent transcranial sonography.

Godau and colleagues found that the SN was hypoechogenic in 81.8 percent of the RLS subjects while only 16.7 percent of the controls had a hypoechogenic SN. When the researchers compared SN echogenicity in the idiopathic RLS group with SN echogenicity in the symptomatic RLS group, they found that there was a greater prevalence of SN hypoechogenicity in the idiopathic group. Nearly 88.9 percent of the idiopathic RLS group had a hypoechogenic SN while 60.7 percent of the symptomatic RLS group had a hypoechogenic SN.

In another aspect of their study, the researchers determined the specificity and sensitivity of hypoechogenicity in diagnosing RLS. (To confirm whether or not a person had RLS, all subjects and controls had undergone an examination by a neurologist who was blinded to the results of the transcranial sonography.) Specificity is the ability of a test to correctly identify a person who does not have a disorder. Sensitivity is the ability of a test to correctly identify a person who does have a disorder.

Hypoechogenicity correctly identified 81.8 percent of the people who had RLS (this percentage includes both RLS groups collectively). Therefore sensitivity of SN hypoechogenicity is 81.8 percent. In the control group, hypoechogenicity would have falsely identified 16.7 percent with RLS, meaning that 83.4 percent would have accurately been diagnosed as not having RLS based on the lack of a hypoechogenic SN. Therefore, the specificity of hypogenicity is 83.4 percent.

Godau and colleagues concluded that because hypoechogenicity of the SN is a highly specific and sensitive marker for RLS, transcranial sonography could therefore be a useful tool in diagnosing RLS.

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Transcranial sonography is a promising technique for diagnosing RLS. Some of its benefits are that it does not involve the use of radiation as do other brain imaging technology such as a CAT scan. It can therefore be safely performed repeatedly in a person. It is a noninvasive test and relatively inexpensive to perform.

One drawback of transcranial sonography is that it can be difficult to transmit ultrasound waves through the thicker temporal bone of elderly people in whom RLS is more prevalent. Future studies may determine how to counteract this.

It is not clear to what extent RLS subtypes can be distinguished by transcranial sonography. Godau and colleagues in their study found no sonographic difference between the idiopathic and symptomatic RLS groups. Nevertheless, they believe that transcranial sonography may prove to be helpful in differentiating RLS subtypes.

If future research studies corroborate that SN hypogenicity is a highly specific and sensitive marker for RLS, transcranial sonography could potentially be used as a differential diagnostic tool. That is, it could help distinguish between RLS and other disorders that share some of its symptoms such as Parkinson's disease. For example, transcranial sonographic evaluation of a person complaining of RLS symptoms could determine whether the person has a hypoechogenic SN (indicating RLS) or a hyperechogenic SN (indicating Parkinson's disease). This could mean the difference between being accurately diagnosed and therefore receiving the correct treatment more quickly or being misdiagnosed and struggling unnecessarily with symptoms of untreated RLS.

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