JOHN CHEN: Hello, my name is John Chen, one of the neuro-ophthalmologists at the Mayo Clinic. And I'm here today to talk to you about our recent research in using MR elastography to detect raised intracranial pressure. Before I introduce MR elastography, I would like to discuss pseudotumor cerebri, the most common cause of raised intracranial pressure. These patients present with bilateral papilledema which can be quite severe, as can be seen on this slide.

In pseudotumor cerebri, there is no tumor causing raised intracranial pressure, hence the name pseudotumor. Interestingly, 90% of patients affected with this condition are young adult females and 90% are overweight. Despite this specific demographic being affected, the cause for this condition is still unknown, which is why the disease is also called idiopathic intracranial hypertension, IIH for short.

Patients with pseudotumor cerebri typically have headaches, which can be quite debilitating. However, the main reason we need to diagnose and treat this condition is the potential for vision loss, which can be permanent in up to 40% of patients. Here is a patient who had severe papilledema at initial presentation. And even after treatment, ended up with significant pallor of the optic nerves and some persistent visual field defects.

One of the old names for this condition was benign intracranial hypertension. Again, trying to note that there is no tumor. However, we now know that this disease is far from benign because of the significant risk for vision loss. To make a diagnosis of pseudotumor cerebri, patients must have normal neuroimaging.

A lumbar puncture is then required to confirm an elevated open pressure and to rule out other causes of raised intracranial pressure, such as infection, inflammation, or neoplasm. Interestingly, a recent paper out of Emory showed that idiopathic intracranial hypertension is often overdiagnosed. In fact, they found that almost 40% of patients referred with the diagnosis by age, actually do not have the condition.

Many of these diagnoses were incorrectly made because of single lumbar punctures, which showed elevated opening pressures. Therefore, we clearly need better methods of detecting raised intracranial pressure. Lumbar puncture is the typical method used in the outpatient setting to confirm raised intracranial pressure. However, it is quite invasive and can be quite variable.

For example, Valsalva alone can increase the pressure up to 47 centimeters of water. The gold standard is direct intracranial pressure monitoring, such as intraventricular catheters. However, this is an invasive procedure and requires hospitalization. One of the holy grails of neuro-opthamology is a noninvasive method of detecting raised intracranial pressure. MRI, ultrasound, OCT, and tympanic membrane displacement have all been proposed as methods to detect raised intracranial pressure, but none of these are universally sensitive or specific. And therefore, we need better tools.

I've been collaborating with Dr. John Houston, III from neuroradiology on a novel tool for detecting raised intracranial pressure, which is brain MR elastography. Essentially, this device causes soft vibrations which are then used to measure stiffness. In combination with the new compact 3-Tesla MRI machine, we are now able to get detailed images of the brain stiffness.

This is a [INAUDIBLE] with stiff inclusions to show how MR elastography works. It is a three step process. First, we induce shear waves into the body with a vibration source we call driver. For the head, it is a soft pillow-like device that results in vibration, similar to an electric toothbrush. In over 250 patients, we have never had a subject complain of discomfort.

Second, we perform a phase-contrast MRI sequence that images the waves within the brain. Finally, complex mathematical inversions translate the wave information into maps of stiffness that we call elastograms. Dr. Houston and his colleagues have used this imaging modality in various diseases.

For example, it can be used to differentiate hard and soft tumors, which can provide diagnostic information. It can also help neurosurgeons in their surgical approach. Here, the upper images are of a stiff meningioma shown in red, where the wave image in the middle has a longer wavelength. The bottom is of a soft meningioma, which is actually softer than normal brain. And you can see on the map that it's actually blue.

Recently Dr. Houston and his colleagues have explored the possibility of using MR elastography to detect raised intracranial pressure. They used a porcine model and placed a catheter in the ventricles to change intracranial pressure. Increasing the pressure resulted in stiffer brains, which can be seen here.

The mean brain stiffness increased by about 25% from baseline and had a nice correlation with the intracranial pressure. This preliminary data in pigs allowed us to obtain a grant to study MR elastography in humans with raised intracranial pressure. We are currently enrolling patients with pseudotumor cerebri, and also normal patients as a control.

We are obtaining baseline brain stiffness in all patients. Then patients with raised intracranial pressure are then undergoing a lumbar puncture as part of the disease work up. And we are repeating measurements immediately after the lumbar puncture to see if we can detect acute changes in brain stiffness. We will also repeat the measurements after long-term treatment to detect long-term changes in brain stiffness.

We have just recently started collecting patients and data. And therefore, we don't have any of the preliminary data to share, but the pilot study will be completed at the end of the year. And we will be able to provide an update on our progress at that point. In summary, pseudotumor cerebri is the most common cause of raised intracranial pressure.

It typically affects young obese females. This condition is important because it can cause debilitating headaches, but more importantly, has a risk for permanent vision loss. MR elastography may be a way of noninvasively detecting raised intracranial pressure, which would improve both diagnosis and treatment of this condition. We will also be exploring other forms of raised intracranial pressure in the future, such as shunt failures and obstructive hydrocephalus.

We are very excited about the possibilities in applications of MR elastography, and plan to have data to share at the end of this year. Once again, my name is John Chen from neuro-opthamology at the Mayo Clinic. And I enjoyed sharing our current research in exploring MR elastography and its possible applications in detecting raised intracranial pressure.