TELENEURO-OPHTHALMOLOGY

Virtual options can almost always be offered to patients with neuro-ophthalmologic conditions.

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The global spread of the SARS-CoV-2 virus has pressured medical providers to examine new models for delivering high-quality medical care while minimizing direct patient face-to-face contact, as evidenced by the international surge in telemedicine.[1] For some subspecialties, appropriate telemedicine use remains debated. Physical examination accuracy, billing limitations, and liability are some of the ongoing concerns. However, the COVID-19 pandemic has prompted many countries to address some of these challenges in order to improve access to care while maintaining social distancing recommendations. For example, in the United States CMS has expanded access to reimbursable telehealth services, lifting restrictions on qualifying patients and service locations, and even declaring nonenforcement of HIPAA requirements for video software.[2,3] In turn, neurologists have had to rapidly adopt telemedicine, remotely treat conditions previously managed in person, and innovate solutions to increase access to already scarce subspecialists.[4]

These changes also provide an unprecedented opportunity for telemedicine in neurology. We believe that this temporary expansion of services will improve access to and facilitate communication among subspecialists within neurology. A recent report from the Telemedicine Work Group of the American Academy of Neurology noted that teleneurology provides "benefits in expediting care, increasing access, reducing cost, and improving diagnostic accuracy and health outcomes." Teleneurology was found to be noninferior to office-based care in subspecialties with workforce shortages (eg, movement disorders) and was beneficial for multiple sclerosis, neuromuscular disease, and inpatient general neurology.[5] An accompanying editorial declared "…the premise of telemedicine is no longer a research question. The question now is how we best implement the technology."[6] This article reviews the use of teleneuro-ophthalmology and provides two case examples performed via telemedicine.

TABLE. VALIDATED APPLICATIONS FOR TESTING VISUAL SYMPTOMS

Test	Applications	Available platforms and devices
Visual acuity	Peek Acuity	Android only
	Vision@home	Validated on Apple iPhone, but can be used on any smartphone web browser
Color vision	Eye Handbook	Apple and Android
Visual fields	Melbourne Rapid Fields	Apple iPad tablet; others in development

TELENEURO-OPHTHALMOLOGY CAPABILITIES

A teleneuro-ophthalmologic examination using validated mobile applications (apps) can assist with remote assessment of visual acuity and other tests of afferent visual function (Table).[7-9] Conceptually, conditions amenable to teleneuro-ophthalmologic examination can be categorized into three types:

1. Efferent disorders that are evident through external observations of the eye, lid, and eye movements (eg, anisocoria and other pupillary abnormalities, lid position and ptosis, eye movements, nystagmus, and gaze abnormalities). Commonly diagnosed conditions include Horner syndrome (Case No. 1), ocular myasthenia gravis (Case No. 2), and motility disorders secondary to cranial nerve palsies (ie, oculomotor [CN3], trochlear [CN4], and abducens [CN6] nerves).
2. Afferent visual or sensory complaints with previously established normal funduscopic examination and no evidence of intracranial pathology. Commonly diagnosed conditions include symptoms of visual snow, headache or eye pain variants, migraine with visual aura, and other positive visual phenomena.
3. Afferent visual disease that can be evaluated and managed with supplemental information from a referring provider (including fundus imaging, visual fields, optical coherence tomography [OCT] and MRI). Commonly diagnosed conditions include optic neuritis,

CASE NO. 1: HORNER SYNDROME TELENEURO-OPHTHALMOLOGY VISIT

A 53-year-old patient with a 6-month history of Horner syndrome OD was seen via teleneuro-ophthalmology for a follow-up video visit that included reviewing results of her recent emergent neuroimaging studies. Head and neck CT angiography (CTA) revealed chronic bilateral focal carotid artery dissections and a mass near the right carotid bifurcation. The patient gave consent for the use of and billing for telemedicine services and connected via a HIPAA-compliant third-party smartphone app. We obtained a focused history and performed a limited examination that demonstrated miosis and ptosis OD (Figure). We counseled the patient, initiated antiplatelet therapy, and made referrals to a neurovascular specialist and an otolaryngologist.

Figure. Patient with a right Horner syndrome, seen via telemedicine. Upper and lower eyelid ptosis is present in the right eye. The right pupil is smaller than the left pupil.

The following day, the patient saw the neurovascular specialist, who determined the carotid dissections could be managed medically. She was diagnosed with fibromuscular dysplasia and prescribed antihypertensives. The otolaryngologist did not recommend surgical biopsy or removal of the carotid body tumor because there was extensive vascular involvement. It is suspected that the patient has a benign paraganglioma, and she is being followed closely.

pituitary tumors, pseudotumor cerebri syndrome, or ischemic optic neuropathy.

The main limitation of the teleneuro-ophthalmologic examination is the inability to view the fundus, which is critical when evaluating for optic nerve swelling. Although there has been promising work in digital ocular fundus photography through nonmydriatic funduscopic cameras, which can be used in emergency department and outpatient settings, limitations include the need for greater portability, affordability, rapid interpretation by experts, and ease of use before there can be broader use in nonophthalmic settings.[10,11] Recent demonstration of using AI algorithms to evaluate funduscopic photographs to detect papilledema and differentiate it from other funduscopic abnormalities with high sensitivity (96.4%, [95% CI, 93.9–98.3%]) and specificity (84.7% [95% CI, 82.3–87.1])[12] may allow rapid screening and interpretation of digital ocular fundus images in the future. When there are exam limitations and signs of an acute neurologic problem or emergency, it is important to refer patients for emergent care.

TELENEURO-OPHTHALMOLOGY EVALUATION TIPS AND TRICKS

For any eye finding that can be evaluated with telemedicine, challenges arise when the clinical signs are subtle, and technologic challenges (eg, reduced video resolution) make adequate evaluation more difficult. To optimize the resolution of video visits, patients are encouraged to check their internet speed before the visit in order to establish whether they have download speeds of at least 15 Mbps and upload speeds of 5 Mbps. This can be easily tested on free websites such as speedtest.net or with their internet provider. If a patient is using wireless internet, it maybe helpful to confirm that he or she is physically close to the router to improve download speeds.

Some symptoms can be well evaluated at home with some extra assistance. For example, telemedicine is ideal for a patient with ocular myasthenia gravis who started a treatment and has a follow-up visit to assess double vision, eye motility, degree of lid ptosis, and any systemic signs. For patients with visual or mobility impairments, having a family member available to hold a flashlight to assess pupillary reactivity, obtain ice from the freezer for the ice test, or lift the patient's eyelids may also be helpful.

TELENEURO-OPHTHALMOLOGY TOOLS

Having clinic staff contact patients at least 1 day and preferably several days in advance of a teleneuro-ophthalmology visit is helpful to streamline care. Staff can inform and obtain consent from the patient (although we have clinicians reiterate this at the visit) and help them understand that this is a formal visit to the doctor and should be treated as such. The staff can reiterate the importance of arriving early and being prepared for the examination. This previsit counseling can also include confirmation that patients have appropriate video and audio capabilities through their device(s), assistance with downloading any vision apps that might be needed (Table), and a review of the process for the visit.

Additionally, patients are encouraged to use a tripod or stand for their mobile device to minimize camera shaking, place their device in landscape mode, and utilize adequate room lighting. A gentle light source about 2 feet directly opposite the viewer can provide even lighting and reduce glare. Providers can consider using a selfie light, which is an affordable (~$15) portable ring light, to maximize their own clarity and visibility to patients.

Because visual function testing requires utilizing a mobile device with vision apps, ideally the patient should utilize two connected devices (eg, a tablet and a mobile phone), the first for video communication with the physician and the second for the vision testing apps. In our practices, we also find tablets useful for apps that test visual acuity, color vision, and visual fields (Table). The Peek Acuity app has

CASE NO. 2: OCULAR MYASTHENIA GRAVIS TELENEURO-OPHTHALMOLOGY VISIT

Figure 2. Ice test in a patient with myasthenia gravis, seen via telemedicine. Patient attempting sustained upgaze with bilateral upper eyelid ptosis prior to ice test showing bilateral fatiguability (A). Ice test performed by patient (B). Patient with improved ptosis after ice test (C).

A 62-year-old patient was referred with a history of fluctuating ptosis and diplopia concerning for ocular myasthenia gravis. Test results ordered by the referring physician were positive for antibodies to the acetylcholine receptor (antiAChR). The patient gave consent for the use of and billing for telemedicine services and connected via a HIPAA-compliant third-party computer app.

We obtained a comprehensive medical history and directed portions of the neuro-ophthalmic examination that showed fluctuating and bilateral fatigable ptosis, Cogan lid twitch, a variable supraduction deficit OS, and resolution of ptosis after a 2-minute ice pack test (Figure). The patient had weakness of the orbicularis oculi and left frontalis muscles and flattening of the left nasolabial fold. Neck flexion and extension were intact. We counseled him about myasthenia gravis, initiated pyridostigmine therapy, ordered a chest CT, made a referral to a neuromuscular specialist, and arranged for a follow-up appointment.

been validated in adults and children for visual acuity testing, but it requires the presence of an assistant due to testing at 2 m away.[7] Vision@home has been validated on an iPhone but can be accessed for free for near and distance testing via any smartphone web browser.[8] Although Eye Handbook has various vision tests available, the only validated component is the color vision test.[9] The Melbourne Rapid Field (MRF Glaucoma) visual field test has been validated and can be useful for longitudinal evaluation of peripheral vision.[13]

SUMMARY AND CONCLUSIONS

Teleneuro-ophthalmology is useful in the evaluation and management of afferent and efferent disorders that can be adequately viewed on a screen, tested with a vision test app, or evaluated in the context of already existing imaging and laboratory test results. Conditions that require detailed visualization of the optic disc should be evaluated in person, and clinicians must be sensitive to the possibility of a true neurologic emergency requiring additional emergent care. Even if a telephone or video visit results in an in-person appointment or visit to an emergency department, the initial evaluation remains useful. Preparing patients in advance of an appointment to establish appropriate privacy, adequate lighting, and resources is crucial to success.

Despite the exam limitations, there is always something that can be gained via a phone or video visit and always something that can be offered to the patient. The ability to let people know whether or not they can wait for an in-person visit after a telemedicine visit has provided reassurance and satisfaction among our patients. There is a need for increased flexibility in the delivery of health care, especially within neurology and its subspecialties where we grapple with limited patient access and a challenging reimbursement landscape.[14] In neuro-ophthalmology, we continue to pursue ways to provide greater access to care, and telemedicine may be one way for us to cohesively continue to deliver high-quality neurologic care to patients. ■

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