

Congenital fibrosis of type II extraocular muscles, diagnosis by MR imaging. A case report

Fibrosis congénita de músculos extraoculares tipo II, diagnóstico por imagen en resonancia. A propósito de un caso

Juan P. Manrique Salas[1]
Massiel Duarte González[1]
Beatriz M. Navarro Estrada[2]

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Summary

Congenital fibrosis of the extraocular muscles is a very rare ocular motility disorder that presents in the first months of life due to restricted vertical eye movement, palpebral ptosis, and chin elevation to correct the visual field. Muscular fibrosis occurs secondary to abnormal development involving part or all of the nucleus and oculomotor nerve and its innervated extraocular muscle; the trochlear and external oculomotor nerves are less frequently affected. Complete knowledge of the cranial nerve course, MRI correlation, and clinical features of cranial nerve palsy is important for radiologists and neurologists to evaluate patients thoroughly. Cranial nerve imaging is usually performed using thin section T2-weighted images based on gradient echo imaging or turbo spin echo sequences, which show the cranial nerves as dark linear structures in contrast to the high signal intensity of the surrounding cerebrospinal fluid. In this article, we review the radiological findings of congenital fibrosis of the extraocular muscles based on brain anatomy and high-resolution magnetic resonance imaging.

Resumen

La fibrosis congénita de los músculos extraoculares es un trastorno de la motilidad ocular muy raro, que se presenta en los primeros meses de vida con restricción del movimiento ocular vertical, ptosis palpebral y elevación del mentón para corregir el campo visual. La fibrosis muscular es secundaria a un desarrollo anormal que afecta parte o la totalidad del núcleo y del nervio oculomotor y su músculo extraocular inervado; los nervios troclear y motor ocular externo están menos frecuentemente afectados. El conocimiento completo del curso de los nervios craneales, la correlación con resonancia magnética y las características clínicas de la parálisis del nervio craneal son importantes para que los radiólogos y neurólogos evalúen a los pacientes a fondo. Las imágenes de los nervios craneales generalmente se realizan utilizando imágenes ponderadas en T2 de sección delgada basadas en imágenes de eco de gradiente o secuencias de eco de espín turbo, que muestran los nervios craneales como estructuras lineales oscuras en contraste con la alta intensidad de señal del líquido cefalorraquídeo circundante. En este artículo se revisan los hallazgos radiológicos de la fibrosis congénita de los músculos extraoculares en función de la anatomía cerebral mediante resonancia magnética de alta resolución.

[1]Resident Physician, Specialization in Diagnostic and Therapeutic Imaging. National Autonomous University of Mexico. Department of Diagnostic and Therapeutic Imaging, Hospital Centro Médico Nacional 20 de Noviembre. Mexico City, Mexico.

[2]Neuroradiologist, Manuel Velasco Suarez National Institute of Neurology and Neurosurgery. National Autonomous University of Mexico. Chief of Neuroradiology, Department of Diagnostic and Therapeutic Imaging, Hospital Centro Médico Nacional 20 de Noviembre. Mexico City, Mexico.

Introduction

Congenital fibrosis of the extraocular muscles (CFEOM) is a very rare ocular motility disorder that presents in the first months of life with restriction of vertical eye movement, ptosis, and chin lift to correct the visual field. The muscle fibrosis is secondary to abnormal development affecting part or all of the nucleus and oculomotor nerve and its innervated extraocular muscles (EOM), while the trochlear and external oculomotor nerves are less frequently affected.

There are some genetic subtypes of this disorder. CFEOM1 is the most common with autosomal dominant inheritance; the mapped gene is KIF21A, which impairs the development of the motor neurons of the upper division of the third nerve innervating the upper rectus and levator muscles of the upper eyelid, leading to bilateral ptosis and restriction of upward gaze in abduction. CFEOM2, with autosomal recessive inheritance; the mapped gene is PHOX2A, which affects nerves 3 and 4 bilaterally and leads to bilateral ptosis and exotropia. CFEOM3 is dominantly inherited and the corresponding genes are KIF21A in CFEOM3A and TUBB3 in CFEOM3B with global involvement of motor neurons of the third nerve with unilateral or bilateral asymmetric

ptosis and restricted ocular motility, which is frequently associated with other neurological and mental abnormalities (1).

The most common imaging finding in CFEOM is absence or hypoplasia of cranial nerve III. Although not typically associated with CFEOM, neuroimaging may also reveal central nervous system malformations. Magnetic resonance imaging (MRI) findings have been found in patients with CFEOM including agenesis of the corpus callosum, brainstem atrophy, cerebellar hemisphere atrophy, absence of the cerebral peduncle in the midbrain, colpocephaly, cerebellar vermis hypoplasia, ventricular system expansion, pachygyria, encephalocele, and hydrancephaly (2).

The anatomy of the course of the cranial nerves is of utmost importance in diagnosing the associated pathology.

The oculomotor nerve nucleus is located in the midbrain of the deep periaqueductal gray matter in the superior colliculus anterior to the cerebral aqueduct. The fibers pass through the tegmentum, the red nucleus and the medial aspect of the substantia nigra to emerge on the medial side of the cerebral peduncle into the interpeduncular cistern. It passes anteriorly between the posterior cerebral artery and the superior cerebellar artery medial to the uncus piercing the dura mater just lateral to the clinoid process to rest in the superomedial compartment of the cavernous sinus.

Within the cavernous sinus, the oculomotor nerve is located superior to the lateral wall above the trochlear nerve (Figure 1) (3).

To visualize the cranial nerves, thin-section T2-weighted images based on gradient-echo or turbo spin-echo sequences are generally used, which show the cranial nerves (CN) as dark linear structures in contrast to the high signal of the surrounding cerebrospinal fluid.

Thin-section T2-weighted images in an axial plane of the brainstem, which includes the lower midbrain, pons and upper part of the medulla oblongata, are used for CN III and VI. Adequate image resolution with voxel size of approximately 0.5 × 0.5 mm in the X-Y plane and 0.7 mm section thickness that is sufficient to identify the nerves because the mean diameters of CN III have been reported to be 1.8 to 1.9 mm. The diameter of CN VI is approximately 1.0 mm. Therefore, both nerves can be evaluated with a single imaging method using a 1.5- or 3-tesla MRI system.

The image of CN IV must be obtained at a higher spatial resolution than that used by the other CN because it is very small (mean diameter of 0.54 mm). Therefore, a voxel size of approximately 0.3 × 0.3 mm in the X-Y plane and 0.3 mm section thickness is needed to clearly image the CN IV, which can best be achieved with a 3-tesla MRI system.

Imaging should be performed in the inferior midbrain and superior pons region, including the inferior margin of the inferior colliculus. It is recommended that the oblique axial imaging plane be perpendicular to the long axis of the aqueduct, i.e., the imaging plane should be approximately parallel to the course of the CN IV (4).

The nucleus of CN IV is located in the dorsal midbrain, anterior to the periaqueductal gray matter. Its fibers run dorsally and decussate posteriorly to the periaqueductal gray matter before emerging from the brainstem immediately inferior to the inferior colliculus.

from the brainstem immediately inferior to the inferior colliculus. It is the only cranial nerve that emerges from the brainstem posteriorly. The nerve surrounds the cerebral peduncles in the cisterna. Together with the oculomotor nerve (CN III), it courses between the superior cerebellar artery and the posterior cerebral artery, pierces the dura mater of the cerebellar tent between its free edge and the abducens nerve. It is the longest cranial nerve in the cisternal tract (Figure 2) (2).

Clinical case

Female patient, 6 years old, second child of a 33-year-old mother, a housewife, and a 38-year-old father, a welder. The mother had four prenatal check-ups starting at 12 weeks, two obstetric ultrasounds were performed with no abnormalities reported; delivery by elective cesarean section at 38 weeks, without complications, with low birth weight (2,300 g), with neurodevelopment appropriate for her age. She was taken to the ophthalmology office because her mother reported that she had to "turn" her head when looking; since birth, her mother reported that her left eye was "closed", with bilateral eyelid ptosis, she noticed exotropia at 18 months of age with cephalic supraversion to observe and occasional vertical nystagmus. On examination there are eye movements in the right eye with limitation to supraversion, infraversion and adduction, paralysis of the superior rectus and inferior oblique, paresis of the inferior rectus; eye movements in the left eye with limitation to supraversion and infraversion with paralysis of the superior rectus, inferior and oblique. No nystagmus or diplopia. Facial symmetry, central uvula, gag reflex present and examination of the rest of cranial nerves without alterations.

Brain MRI was performed with Siemens Magnetom Verio 3 T equipment, with intravenous contrast medium; T2 FSP and T2 FS sequences with thin slices of cranial nerves, the bilateral III cranial nerve was not visualized in its apparent origin in the interpeduncular cistern (figure 3), the bilateral IV cranial nerve was not visualized in its cisternal portion (figure 4). The VI cranial nerve is observed with localization and signal intensity without alterations bilaterally.

Asymmetry of the mammillary bodies is observed due to smaller dimensions of the right one, decrease of the anteroposterior diameter of the eyeballs with external deviation of the right one and medial displacement of the optic nerve bilaterally in its intraorbital segment (figure 5). Lacrimal glands with morphology and signal intensity without alterations.

Lateral rectus muscle is visualized bilaterally with unaltered caliber and signal intensity, decreased caliber of the medial rectus, superior and inferior rectus, superior and inferior oblique and levator of the upper eyelid bilaterally (figures 6 and 7).

Discussion

CFEOM has had several names over the years, including congenital ophthalmoplegia, generalized fibrosis, imperfect ophthalmoplegia, and hypotrophic external ophthalmoplegia. CFEOM is rare, with a minimum prevalence of 1/250,000. It was discovered relatively recently to be a developmental anomaly of the nucleus and oculomotor nerve (CN III); and is one of a group of disorders now known as congenital cranial denervation disorders (CCDD) involving abnormal development of cranial nerves and/or their nuclei.

Los CCDD comparten una serie de características. Son anomalías congénitas, no progresivas del desarrollo de uno o más núcleos de los nervios craneales. Pueden estar asociados con otras anomalías del desarrollo, ya sean neurológicas o sistémicas, incluidas las anomalías

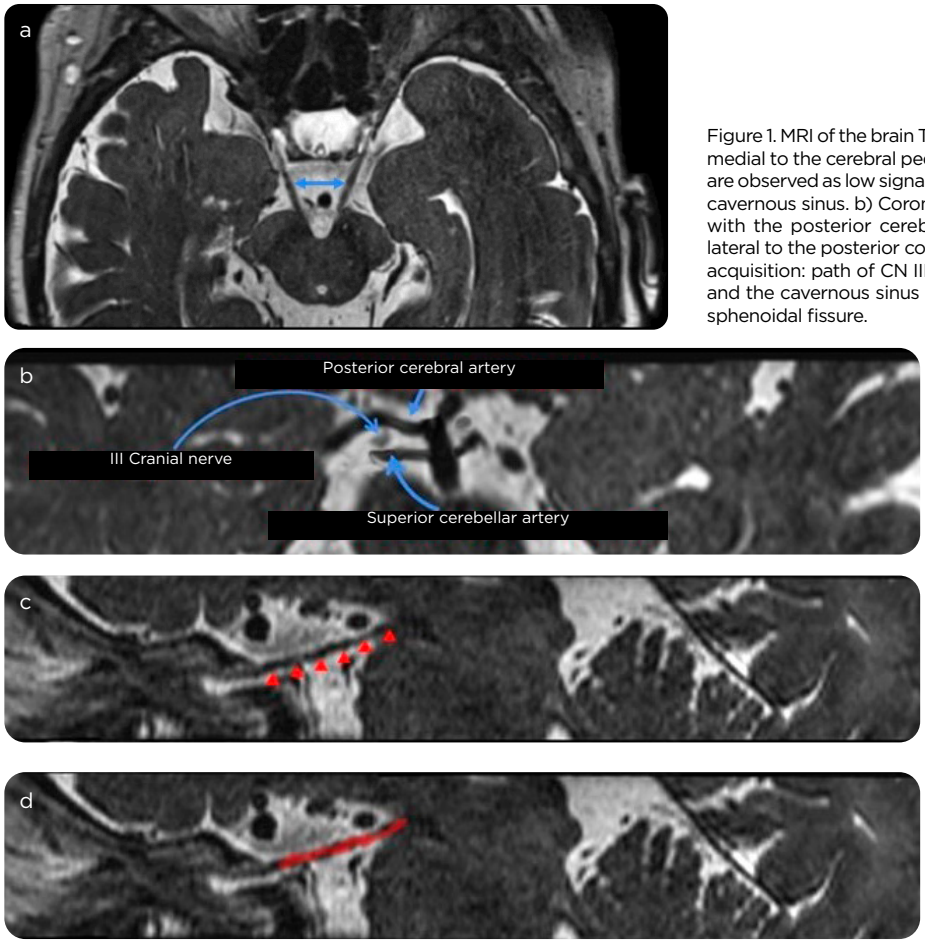


Figure 1. MRI of the brain T2SPC sequence. a) Axial acquisition of the midbrain: medial to the cerebral peduncles, the cisternal segments of the CN III (arrow) are observed as low signal linear structures that run anterolaterally towards the cavernous sinus. b) Coronal acquisition: CN III and its anatomical relationship with the posterior cerebral artery and the superior cerebellar artery and lateral to the posterior communicating artery are visualized. c and d) Sagittal acquisition: path of CN III crossing the interpeduncular cistern (arrowheads) and the cavernous sinus and entering the orbital fossa, passing through the sphenoidal fissure.

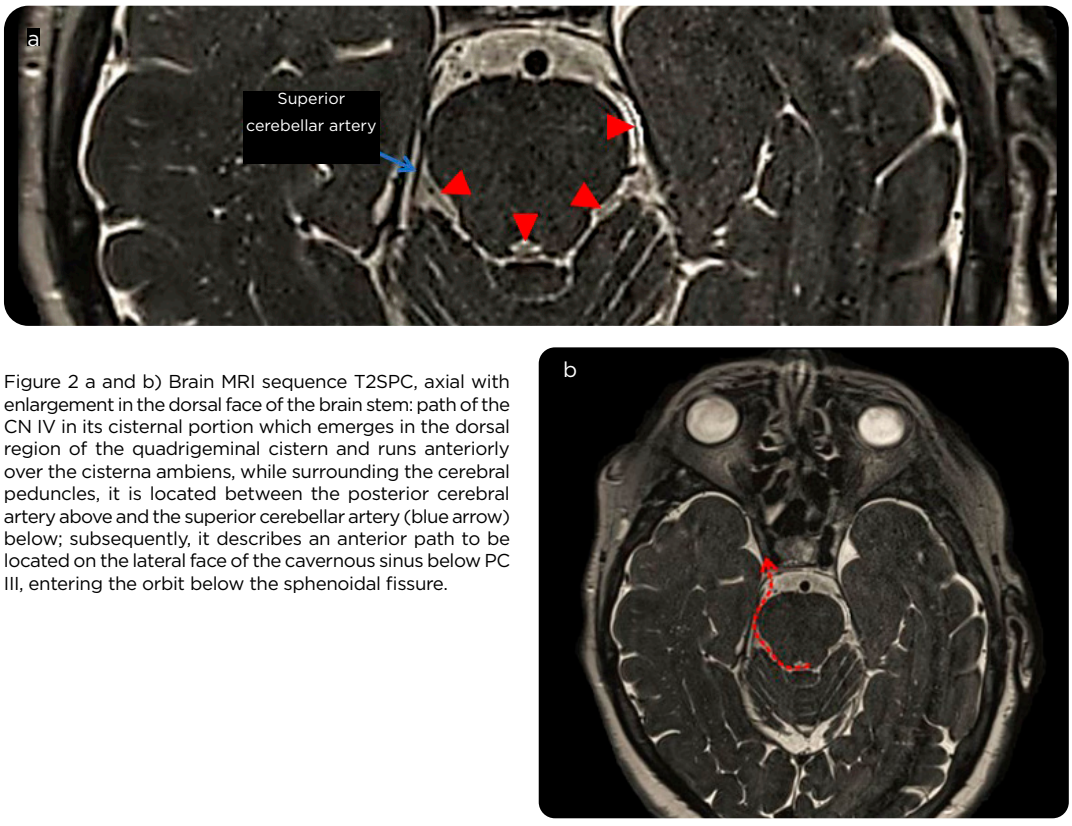


Figure 2 a and b) Brain MRI sequence T2SPC, axial with enlargement in the dorsal face of the brain stem: path of the CN IV in its cisternal portion which emerges in the dorsal region of the quadrigeminal cistern and runs anteriorly over the cisterna ambiens, while surrounding the cerebral peduncles, it is located between the posterior cerebral artery above and the superior cerebellar artery (blue arrow) below; subsequently, it describes an anterior path to be located on the lateral face of the cavernous sinus below PC III, entering the orbit below the sphenoidal fissure.

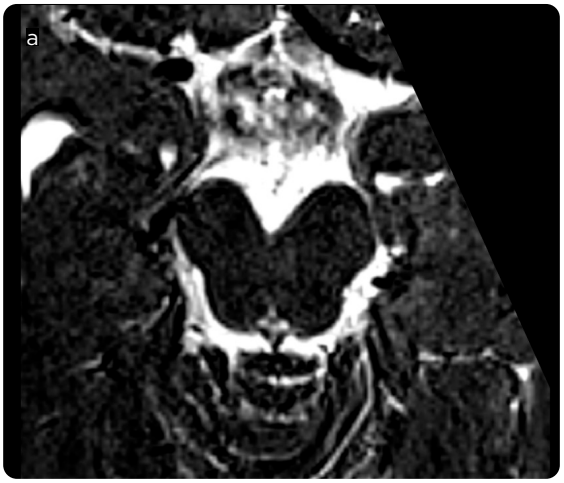




Figure 3. MRI sequence T2SPC, axial. a) Magnification, III cranial nerve is not visualized

bilaterally at its apparent origin in the interpeduncular cistern (red circle in b).

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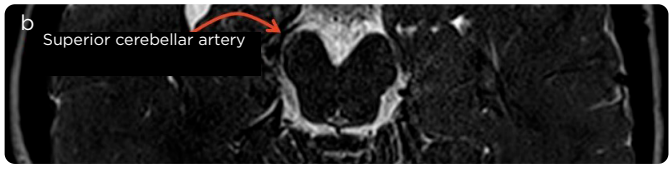


Figure 4. MRI sequence T2SPC, axial, magnification of the dorsal side of the brain stem, no visualization of the IV cranial nerve bilaterally in its course in its portion of the quadrigeminal cistern or over the cisterna ambiens.

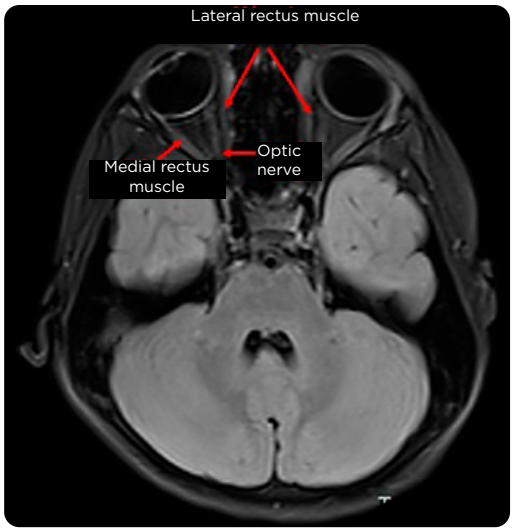


Figure 5. MRI FLAIR sequence, axial: decrease of the anteroposterior diameter of the eyeballs, with external deviation of the right one, medial displacement of the optic nerve bilaterally in its intraorbital segment. Decreased caliber of the medial rectus muscles.

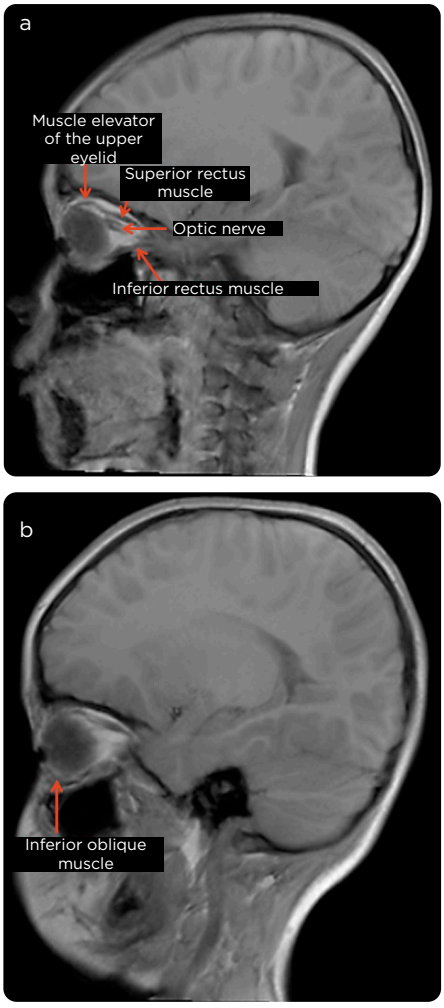


Figure 6 a and b) MR sequence with T1 information, sagittal: decrease of the caliber of the superior rectus, levator of the upper eyelid, inferior rectus and inferior oblique muscles.

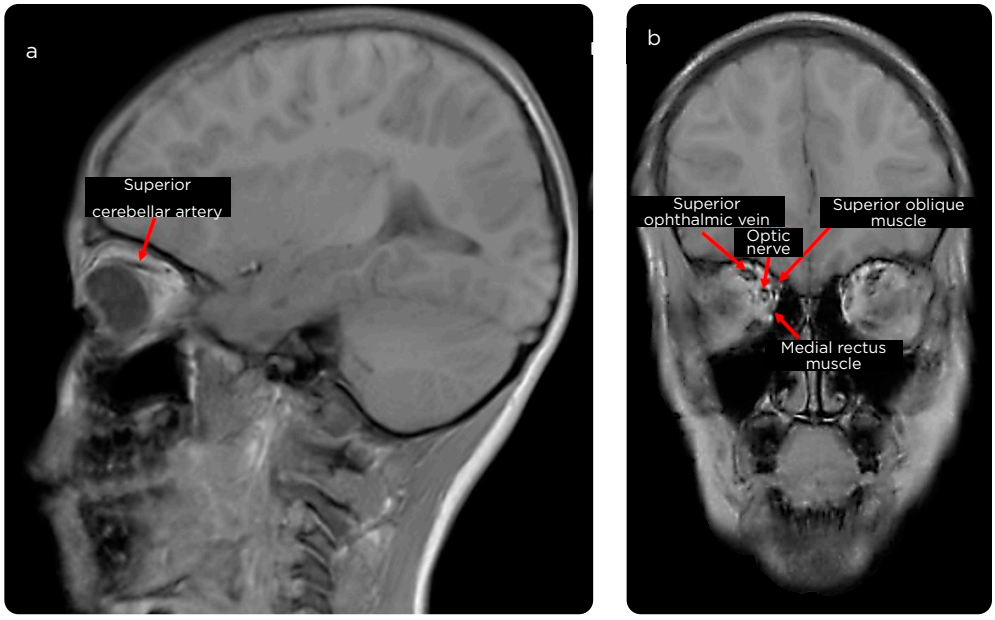


Figure 7. MR sequence with T1 information, a) sagittal and b) coronal: decrease in the caliber of the medial rectus and superior oblique muscles.

del desarrollo de las extremidades. Todos los CCDD son causados por una falla en algún lugar de los complejos procesos de desarrollo involucrados en la creación de unidades neuromotoras craneales. Se han identificado una serie de anomalías genéticas que han ayudado a dilucidar algunos de estos procesos. Sin embargo, la base genética y molecular de muchos de los CCDD sigue siendo oscura.

La anomalía de los nervios craneales es una falla de la inervación primaria con una ausencia de inervación normal de los músculos afectados en la que las neuronas no se desarrollan o están equivocadas. Puede haber una inervación aberrante secundaria de los músculos afectados por las neuronas de uno de los otros nervios craneales. Como consecuencia de la inervación reducida, los músculos afectados se atrofian y la acción sin oposición de otros músculos da como resultado una fibrosis que provoca una grave restricción del movimiento (5,6).

La ausencia no sindrómica aislada de nervios craneales, sin malformaciones craneales estructurales asociadas o retraso en el desarrollo, es relativamente rara con solo unos pocos informes de casos descritos en la literatura. Puede ser unilateral o bilateral con déficits neurológicos asociados, generalmente diagnosticados en la primera infancia.

El uso de secuencias ponderadas en T2 de alta resolución ayuda en la evaluación de los nervios craneales cerca de las zonas de salida de la raíz nerviosa en los espacios cisternales del tronco encefálico. El conocimiento adecuado del curso anatómico de los nervios craneales y el uso de secuencias de alta resolución fuertemente ponderadas en T2 pueden ayudar a diagnosticar esta rara condición. Por lo tanto, estas secuencias se deben incluir en la RM de rutina cuando se evalúa la patología de los nervios craneales.

El conocimiento completo del curso de los nervios craneales y la correlación de la RM con las características clínicas de la parálisis de nervios craneales son importantes para que los radiólogos y neurólogos evalúen a los pacientes a fondo (4).

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Correspondence

Juan P. Manrique-Salas
Universidad Nacional Autónoma de México
Avenida Félix Cuevas 540, Col del Valle Sur, Benito Juárez, 03229
Ciudad de México, México
jpmansa@gmail.com

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