New MR Imaging Techniques in The Diagnosis of Orbital Tumors

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By

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Abstract

Magnetic resonance spectroscopy applications in neuro-ophthalmology include differentiating ischemic, neoplastic, demyelinating, radiation necrosis, inflammatory, and mitochondrial disorders affecting the visual pathway.

Key word:

MR

Diagnosis

Tumors

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CONTENT

INTRODUCTION AND AIM OF THE WORK

A variety of tumors can involve the orbit. Cystic tumors, vasculogenic tumors, peripheral nerve lesions, optic nerve and meningeal tumors, fibrocytic lesions, osseous and fibro-osseous tumors, cartilaginous tumors, lipocytic and myxoid lesions, myogenic tumors, lacrimal gland lesions, primary melanocytic lesions, metastatic tumors, lymphoma and leukemia lesions, secondary orbital tumors, histiocytic lesions are known orbital neoplasms with malignancies being common in older patients because of the higher incidence of lymphoma and metastasis in the elderly. **(Shields et al., 2004)**

Magnetic resonance imaging (MRI), computed tomography (CT) and orbital ultrasound form the main stay in orbital imaging techniques. **(Fischbein et al., 2002)**

MRI is preferred for orbital imaging because its lack of ionizing radiation, fine delineation of detail and excellent demonstration of intracranial pathology. **(Ortiz and Flores, 1998)**

CT is reserved for evaluation of trauma, foreign body, lesion that may calcify orbital cellulitis and orbital disease secondary to sinus disease. **(Lee et al, 2004)**

Head surface coils and smaller coils with thin section fat suppressed T2 or short time inversion recovery (STIR) coronal images are required to study the orbits optimally. Sagittal, coronal, and axial T1 weighted images and T2 weighted scans with pre-contrast fat suppression in at least one plane, usually coronal and post-contrast axial and coronal planes may be supplemented to clearly show an optic nerve sheath lesion and intraorbital inflammation. **(Rizzo et al., 2002)**

Enhanced T1 weighted images are useful for neoplastic, inflammatory, ischemic, vascular, demyelinating and infiltrative processes. **(Ortiz and Flores, 1998)**

For evaluating the intracranial extent of a lesion, whole-brain sections are added when indicated including axial dual-echo spin-echo T2-weighted and post-gadolinium axial and sagittal T1-weighted images. Ultrathin-section 3-dimensional fast spin echo (3-D FSE) T2-weighted imaging is a new MRI technique that offers superior resolution of intraocular and orbital structures compared with conventional MRI. **(Fischbein et al., 2002)**

Magnetic resonance angiography (MRA) and venography can provide noninvasive static views of the orbital vasculature and some limited indirect information about blood flow. Dynamic MRA in the form of time-resolved imaging of contrast kinetics (TRICKS) is a newly available imaging modality with great potential for improving the evaluation and management of patients with complex orbital tumors. **(Kahana et al., 2007)**

Advanced quantitative structural MR imaging techniques include magnetization transfer imaging, diffusion weighted imaging and perfusion weighted imaging, their applications include evaluation of hyperacute ischemia, inflammatory, degenerative and neoplastic lesions. Magnetic resonance spectroscopy MRS is based on detecting various proton MR spectra with applications including differentiation of ischemic, neoplastic, demyelinating, radiation necrosis, inflammatory and mitochondrial disorders affecting visual pathway. MRS has also used anecdotally in evaluating intraorbital tumors. **(Lee et al., 2004)**

An integrated MR imaging-based strategy including these studies with conventional MRI can increase the accuracy, sensitivity and specificity for discrimination of neoplastic from non neoplastic lesions, further more it can

discriminate low grade neoplasms from high grade neoplasms and lymphoma lesions especially with associated brain lesions. **(AL-Okaili et al., 2007)**

The aim of that work is to evaluate the role of new MR imaging techniques in diagnosis and staging of orbital tumors as well as their role in operative and therapeutic planning and follow up.

LIST OF ABBREVIATIONS

ADC= Apparent diffusion coefficient
AML= Acute myelogenous leukemia
CN= Cranial nerve
CNS= Central nervous system
CT= Computed tomography
DCM= Dynamic color mapping
ENB= Esthesioneuroblastoma
FLAIR= Fluid-attenuated inversion recovery
FS= fat suppression
FSE= Fast spin echo
Gd – DTPA= Gadolinium diethylenetriamine penta-acetic acid
IR= inversion recovery
MRA= Magnetic resonance arteriography
MRI= Magnetic resonance imaging
MRS= Magnetic resonance spectroscopy
MRV= Magnetic resonance venography
NF= Neurofibromatosis
OCT= Optical coherence tomography
ONB= Olfactory neuroblastoma
ONSM= optic nerve sheath meningioma
PD= Proton density
PNETs= Primitive neuroectodermal tumors
RB= Retinoblastoma
SE= Spin echo
STIR= short-tau inversion-recovery
TE= Echo time
TR= Time repetition
TRICKS= Time-resolved imaging of contrast kinetics
2D= two dimensional
3D= three dimensional

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ANATOMY

Osteology

The orbit functions to protect, support, and maximize function of the eye. The orbit is shaped as a quadrilateral pyramid with its base in plane with the orbital rim. Seven bones conjoin to form the orbital structure. The orbital process of the frontal bone and the lesser wing of the sphenoid form the orbital roof. The orbital plate of the maxilla joins the orbital plate of the zygoma and the orbital plate of the palatine bones to form the floor. Medially, the orbital wall consists of the frontal process of the maxilla, the lacrimal bone, the sphenoid, and the thin lamina papyracea of the ethmoid. The lateral wall is formed by the lesser and greater wings of the sphenoid and the zygoma (figure 1). **(Petruzzelli et al., 2008)**

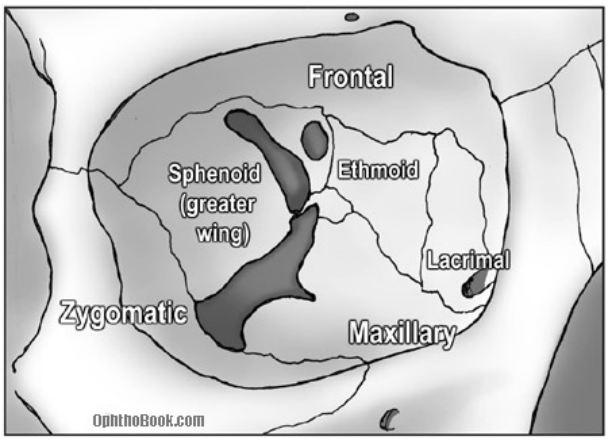

Fig.(1): Diagram of the right orbit shows the 7 bones that contribute to its structure. **(Layfield et al., 2006)**

The arc from medial to lateral wall in each orbit is 45°. Lines dropped through a central anterior-to-posterior axis of each orbit bisect at a 45° angle. The floor is two-thirds the depth of the orbit. The average dimensions of the orbit are as follows:

- Height of orbital margin - 40 mm
- Width of orbital margin - 35 mm
- Depth of orbit - 40-50 mm
- Interorbital distance - 25 mm
- Volume of orbit - 30 cm^3 **(Petruzzelli et al., 2008)**

The superficial bony orbit is defined by the orbital margin, which is rectangular with rounded corners. The margin is discontinuous at the lacrimal fossa. The supraorbital notch is within the supraorbital rim and is closed to form the supraorbital foramen in 25% of individuals. The supratrochlear notch is medial to the supraorbital notch. The trochlea is a cartilaginous ring that supports the superior oblique muscle. The trochlea attaches to the periorbita within the fovea trochlearis along the superior-medial orbit. The infraorbital foramen is located 10 mm inferior to the zygomaxillary suture. Laterally, the orbital rim is marked by the Whitnall tubercle, which is 10 mm inferior to the zygomaticofrontal suture. The tubercle is the site of attachment of the lateral canthal tendon. **(Petruzzelli et al., 2008)**