Orbital imaging – Scanning a patient, reading a disease

"It was eerie. I saw myself in that machine. I never thought my work would come to this" - said a perplexed Isidor Isaac Rabi upon seeing the magnetic resonance image (MRI) of his own face. The design of MRI was based on his early experiments in the field of nuclear magnetic resonance, which won him the Nobel prize in 1944. Imaging continues to spook clinicians. Recent advances in imaging and the technical jargon associated with it have made it difficult for them to even venture to understand it, let alone try interpreting it.

Clinical-radiological correlation in medicine dates back to 1897, when Antoine Louis Gustave Béclère used X-rays (only two years after the discovery of X-rays by Wilhelm Röntgen) to identify tuberculosis and created the first laboratory of radiology in Paris. Clinical-radiological correlation is the key to the diagnosis and appropriate management of orbital disorders. The role of an ophthalmologist in orbital imaging includes identification of the optimal imaging tool based on the clinical differential diagnosis, generating a detailed prescription, providing relevant clinical information to the radiologist, interpreting the images, planning management and approach to surgery, and finally, learning from the hindsight of treatment response or histopathological diagnosis if surgery is performed.

Selection and Prescription of Imaging

McClelland *et al.*[1] elucidated the role of an incomplete area of imaging, wrong imaging type, and poor image quality as the main causes for suboptimal neuroimaging at the time of specialist referral in 38% of patients, necessitating re-imaging in 29%. In a review of errors in MRI interpretation, Wolintz *et al.*[2] identified four common prescriptive errors - failure to apply a dedicated study, inappropriate use of a dedicated study, omission of intravenous contrast, and omission of specialized sequences. They also identified misleading clinical information as an important cause for the interpretive error.[2] The role of communicating detailed clinical information (including relevant history, examination findings with clear identification of the putative location and possible nature of the pathology, clinical differential diagnosis, and information expected from the radiological evaluation) to the radiologist cannot be overemphasized.

It is important to select the most appropriate primary imaging modality based on the clinical differential diagnosis. There are specific indications for computed tomography (CT) scan and MRI.[3] CT scan is preferred as a quick screening modality in a patient with proptosis where the cause is not easily discernible on clinical evaluation. It is also appropriate for patients with orbital trauma with suspected foreign body, orbital fracture, traumatic optic neuropathy (CT of the optic canal with thin sections), orbital cellulitis, acute hemorrhage, optic nerve head drusen, and to rule out retinoblastoma from simulating conditions based on intraocular calcification.[3] CT scan is indicated for the initial assessment of thyroid eye disease, while additional MRI is indicated to evaluate dysthyroid optic neuropathy. Baseline CT scan is advised for all suspected orbital infections, inflammations and tumors and is followed by MRI with appropriate parameters where indicted (fungal infection, granulomatous infection/inflammation, specific inflammation, orbital apex syndrome, suspected perineuritis, lesions with possible compressive optic neuropathy, or intracranial extension, and for all tumors where further tissue characterization is considered necessary). CT scan helps in the evaluation of the orbital bone for preoperative planning of surgical access in orbitotomy and orbital decompression. Three-dimensional reconstruction of CT scan is ideal for orbital fractures, foreign bodies and contracted socket with bony orbital hypoplasia. CT scan is also indicated in an emergency or if MRI is contraindicated. A checklist of relative contraindications for MRI, requiring individual risk assessment, is shown in Table 1.[4]

Primary MRI is the preferred approach for all neuro-ophthalmic conditions and in a diagnosed case of

Table 1: Checklist of relative contraindications for MRI

Relative contraindications for MRI needing individualized risk assessment
• Aneurysm clip
• Any metallic fragment or foreign body
• Coronary and peripheral artery stents
• Aortic stent graft
• Prosthetic heart valves and annuloplasty rings
• Cardiac occluder devices
• Vena cava filters and embolization coils
• Hemodynamic monitoring and temporary pacing devices, e.g., Swan-Ganz catheter
• Hemodynamic support devices
• Cardiac pacemaker
• Implanted cardioverter-defibrillator (ICD)
• Retained transvenous pacemaker and defibrillator leads
• Electronic implant or device, e.g., insulin pump or other infusion pump
• Permanent contraceptive devices, diaphragm, or pessary
• Cochlear, otologic, or other ear implants
• Neurostimulation system
• Shunt (spinal or intraventricular)
• Vascular access port and/or catheter
• Tissue expander (eg, breast)
• Joint replacement (eg, hip, knee, etc)
• Any type of prosthesis (eg, eye, penile, etc)
• Tattoo or permanent makeup
• Known claustrophobia
• Body piercing jewelry
• Hearing aid
• Renal insufficiency
• Known/possible pregnancy or breastfeeding

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retinoblastoma to assess choroidal invasion, optic nerve invasion, extraocular extension, intracranial extension, and pineoblastoma. It is important to image the head and orbit in all neuro-ophthalmic conditions and specifically ask for a detailed study of the brainstem for the evaluation of nystagmus and hemifacial spasm, magnetic resonance angiography (MRA) for hemifacial spasm, and MRI up to second thoracic vertebra and MRA of the neck in Horner's syndrome.[3] It is also indicated in vascular malformations of the orbit, carotid and dural-cavernous fistula, transient monocular vision loss, and third nerve palsy with a suspected aneurism.[3] Magnetic resonance venography may be indicated in the evaluation of bilateral optic disc edema.[3] CT or MRI with contrast is advisable in all conditions, except thyroid eye disease and trauma, if not systemically contraindicated.[3]

Ophthalmologists must be familiar with MRI protocols and sequences and request as appropriate - fat suppression for post-contrast study for orbital inflammations and tumors, diffusion-weighted imaging for orbital inflammations and tumors and specifically vascular tumors, fluid attenuation inversion recovery for white matter lesions, gradient recall echo for hemorrhage, etc.[3] It is essential to have a constant radiology facility, build a professional relationship and discuss with the radiologist before imaging complex clinical situations, or explain the expected information and leave the decision on MRI protocols to the radiologist.

Interpretation and Clinical-Radiological Correlation

The clinician must learn to interpret CT scans and MRI and indulge in a detailed clinical-radiological correlation before planning the medical management or surgical intervention. If the information provided by imaging fails to meet the requirements for decision-making, does not correlate with the expected pathology or if the imaging shows no abnormality, the clinician must discuss with the radiologist and review the scan together. There would be scope for thinner sections, evaluation with higher magnification, and even re-imaging with a different strategy. We have earlier published detailed guidelines to interpret a CT scan of the orbit.[5] This issue of the Indian Journal of Ophthalmology carries two of our informative articles on the basics and interpretation of MRI as relevant to an ophthalmologist.[6,7]

Application of Imaging to Patient Care

The goal of imaging is to optimize patient care. It is used to screen for, exclude and diagnose orbital pathologies, correlate with clinical information and characterize the pathology enough to make a management decision (referral to an expert vs observation vs medical management vs surgery), prognosticate and appropriately counsel the patient, plan the surgical approach and extent (incisional biopsy vs excision), determine the need for intraoperative adjuncts - navigation, rapid intraoperative pathology, etc, plan postoperative adjuvant therapy, and determine the effect of intervention by serial and comparative follow-up scans. Unless the treating clinician is familiar with the scope, strategies and interpretation of imaging, the direct application of imaging to patient care may be suboptimal.

Learning from the Hindsight

"Traditional scientific method has always been at the very best, 20 - 20 hindsight. It's good for seeing where you've been. It's good for testing the truth of what you think you know, but it can't tell you where you ought to go," said Robert M. Pirsig. There lies the importance of clinical-radiological-pathological correlation and correlation with the outcome of medical management where histopathology is not available. With such correlation over time and feedback to the radiologist, immense learning can happen within the team and the training environment, imaging protocols can be optimized, interpretation can become more accurate, and plan of treatment can be improved with fewer complications and better patient outcomes.

The clinician managing orbital pathologies must work in sync with the radiologist to extract hope from the cursed Pandora's box. With such a synergy possibly "*ne Hercules quidem contra duos*" (not even Hercules himself could contend against the two).

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References

1. McClelland C, Van Stavern GP, Shepherd JB, Gordon M, Huecker J. Neuroimaging in patients referred to a neuro-ophthalmology service: The rates of appropriateness and concordance in interpretation. Ophthalmology 2012;119:1701-4.
2. Wolintz RJ, Trobe JD, Cornblath WT, Gebarski SS, Mark AS, Kolsky MP. Common errors in the use of magnetic resonance imaging for neuro-ophthalmic diagnosis. Surv Ophthalmol 2000;45:107-14.
3. Lee AG, Johnson MC, Policeni BA, Smoker WR. Imaging for neuro-ophthalmic and orbital disease - A review. Clin Exp Ophthalmol 2009;37:30-53.
4. Dill T. Contraindications to magnetic resonance imaging. Heart 2008;94:943-8.
5. Naik MN, Tourani KL, Sekhar GC, Honavar SG. Interpretation of computed tomography imaging of the eye and orbit. A systematic approach. Indian J Ophthalmol 2002;50:339-53.
6. Nagesh CP, Rao R, Hiremath SB, Honavar SG. Magnetic resonance imaging of the orbit, Part 1: Basic principles and radiological approach. Indian J Ophthalmol 2021;69:2574-84.
7. Nagesh CP, Rao R, Hiremath SB, Honavar SG. Magnetic resonance imaging of the orbit, Part 2: Characterization of orbital pathologies. Indian J Ophthalmol 2021;69:2585-616.

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