PG Snippet

Radiological Features of Thyroid Eye Disease (TED)

Ayushi Agarwal, Samreen Khanam, Akash Raut, Ruchi Goel
Department of Ophthalmology Guru Nanak Eye Center, Maulana Azad Medical College, New Delhi, India

Abstract *This article highlights the importance of imaging and its current utility in Thyroid Eye Disease (TED). Assessment of various disease parameters, surgical planning, characterization of severity and activity, identification of sight-threatening disease and differentiation from other orbital inflammatory disorders, makes imaging an indispensable tool in TED.*

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Introduction

Thyroid Eye Disease (TED) is a chronic inflammatory disorder affecting the orbit and the periorbita. Although imaging is not a mandatory criterion for diagnosing TED, it is a vital tool to assess abnormalities in clinically challenging cases. It not only aids in early detection but is also helpful in assessing the response to treatment. Radiological evaluation in TED plays a major role in identification of optic nerve involvement, characterization of disease activity, surgical planning prior to decompression and differentiating from other causes of orbital inflammation and proptosis. Herein we discuss the two most preferred imaging investigations in TED, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).

CT Scan

CT Scan is one of the most widely used imaging modalities in TED owing to its ready availability and a shorter acquisition time. It also aids in surgical planning in TED as it offers better visualization of osseous structures.

Measurement of proptosis– The technique for assessment of proptosis using mid-axial orbital CT scan was first described by Hilal and Trokel in 1977.[1] A straight line is drawn between the anterior margins of zygomatic processes, using the mid-axial orbital scan. The distance between the anterior aspect of cornea and the inter-zygomatic line is then measured. Values > 21 mm or an asymmetry greater than 2 mm between the globes, is highly suggestive of proptosis. Another technique of assessing proptosis is by measuring the distance between the inter-zygomatic line and posterior sclera. Less than 1/3rd globe lying behind the inter-zygomatic line is strongly indicative of proptosis. (Figure 1). It is worth noting that the above two methods can be applied to both CT as well as MRI scan.

"Coca-Cola" sign[2] – It refers to bilateral fusiform enlargement of medial rectus muscle belly with sparing of tendinous insertions (unlike myositis, where tendinous involvement is common), leading to bowing of the medial orbital wall, and thus giving an impression of a Coca-Cola bottle. It is seen in chronic, long-standing cases of TED with characteristic medial wall remodeling resulting due to increased intra-orbital pressure. (Figure 2)

Figure 1: *Measurement of exophthalmos. CT scan, axial view, suggestive of right – sided exophthalmos*

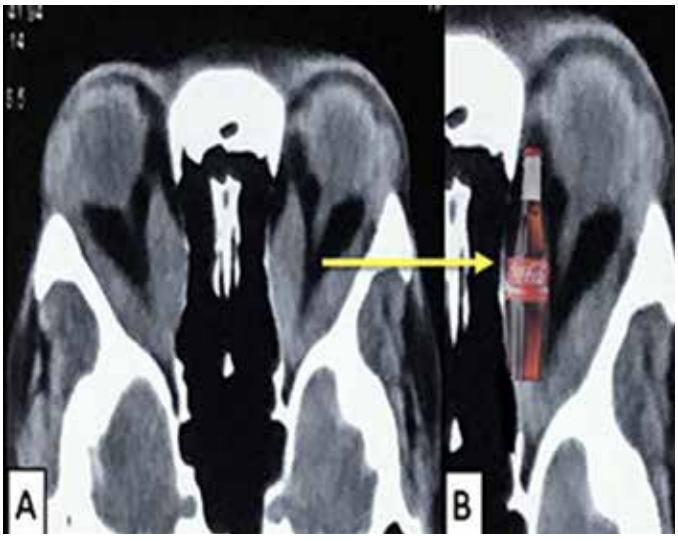

Figure 2: *Coca Cola Sign. A)Fusiform enlargement of bilateral medial rectus muscle belly, with sparing of tendinous insertions. The enlarged muscle belly results in bowing of the medial orbital wall, B) also known as the Coca-Cola sign.*

CT scan is the imaging modality of choice for surgical planning- It provides an excellent visualization of the bony orbit, fat, paranasal sinuses and extra-ocular muscles (EOMs). This yields necessary information required prior to surgery. Pre- and post-operative volumetric CT studies have been utilized for the assessment of orbital decompression. Recently, Navigation-assisted Three-dimensional (3D) reconstruction of CT for surgical planning of multiwalled orbital decompression has become popular.[3]

MRI Scan

Preferred modality for assessment of activity – MRI signal alterations of Extra-Ocular Muscles (EOMs) can detect active TED. Signal Intensity Ratio (SIR) is defined as the ratio of the Signal Intensity (SI) of the most inflamed extra-ocular muscle and the adjacent temporalis muscle. Potential biomarkers of active disease include higher Signal Intensity Ratios (SIRs) on T2 and T1 with gadolinium (T1 Gad) sequences and increased normalized-Apparent Diffusion Coefficient (n-ADC) of the EOMs. Increased fat density, eyelid edema and enlarged lacrimal glands are the other findings seen in active disease.

Distinguishing acute phase from fibrotic phase. A prolonged T2 relaxation time is seen in the presence of edematous changes in EOMs owing to inflammation, suggestive of acute phase. This differentiation is specifically important for assessing response to treatment.

Assessment of EOMs- MRI is a more sensitive and specific tool for detecting EOM enlargement as compared to CT scan. Contrast-enhanced T1-weighted MRI combined with fat suppressed sequences, helps in delineating fatty degeneration. Fat suppressed sequences enable the differentiation of the intense signal enhancement of EOMs, which would otherwise look as intense as fat. Interstitial edema within the EOMs can be effectively demonstrated on Short T1 Inversion Recovery (STIR) sequence, T2 weighted imaging and TIRM (Turbo Inversion Recovery Magnitude) sequence.

Stripe Sign – It is best appreciated on Contrast-enhanced T1-weighted fat-suppressed MRI scan. The extra-ocular muscles have an outer orbital layer and an inner global layer (except levator palpebralis superioris). The inner global, hypointense region expands progressively anterior to posterior and terminates prior to insertion on the globe, whereas the outer hyperintense region ("stripe", representing the orbital layer of the rectus muscle) doesn't expand to the same extent.[4] (Figure 3)

Orbital Apex: MRI is a more precise imaging modality than CT scan for visualization of optic nerve, orbital apex and soft tissue details.

Predictors of Dysthyroid Optic Neuropathy (DON) on Imaging[5,6]

- Enlarged Superior Ophthalmic Vein (SOV) diameter
- Barrett's Muscle Index – Every patient with a muscle index of > 60% must be screened for DON. The sensitivity varies between 32% - 100%, the average being 67% (Figure 4)
- Intracranial herniation of orbital fat through Superior

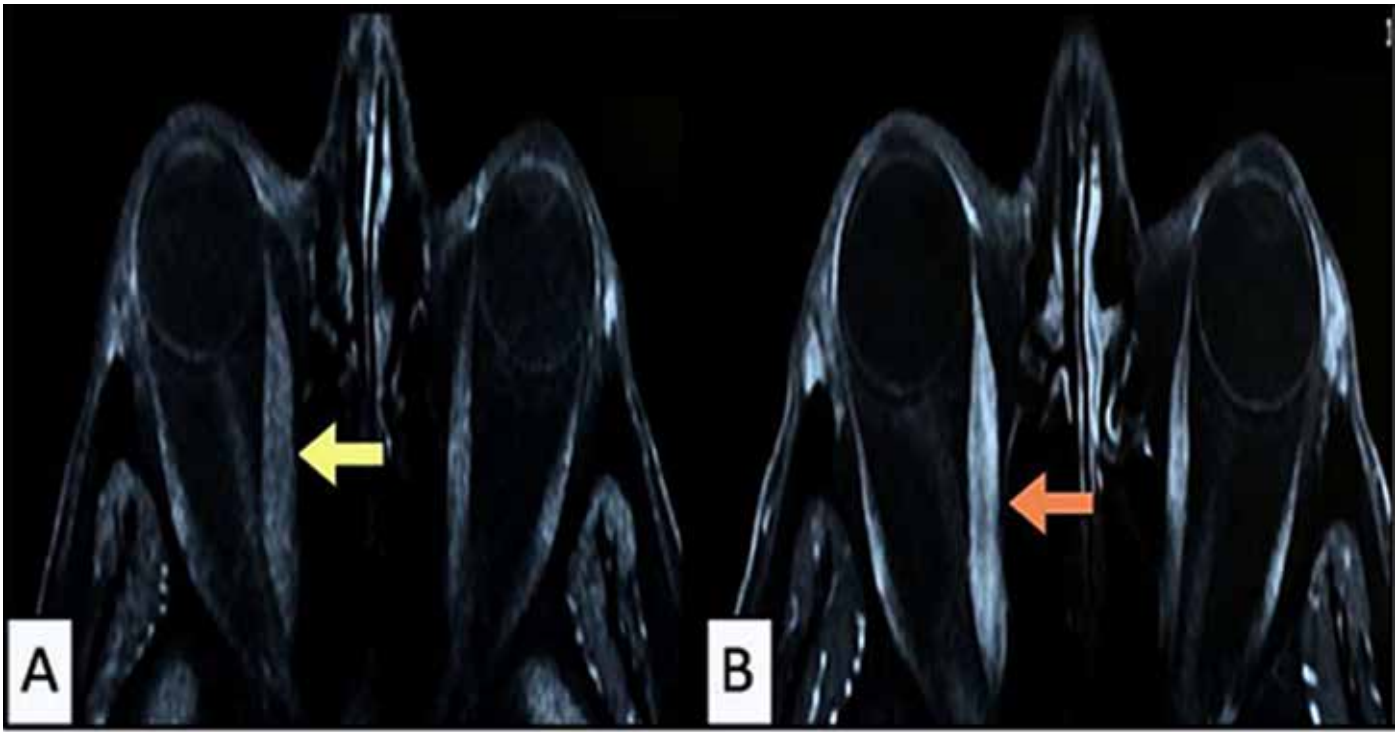

Figure 3: *Stripe sign. A) T1-weighted MRI (pre-contrast) B) T1-weighted fat-suppressed contrast-enhanced sequence showing inner hypointense region surrounded by outer hyperintense area ("stripe") in the right medial rectus muscle (orange arrow).*

Orbital Fissure (94% sensitivity, 91% specificity)

- Apical crowding (Figure 5) – Specific but less sensitive indicator of DON
- Enlarged lacrimal glands may be present.
- Increased Muscle Volume/Orbit Volume (MV/OV), a ratio of > 20% is suggestive of DON
- Positive correlation between severity of perineural fat effacement and DON has been observed.

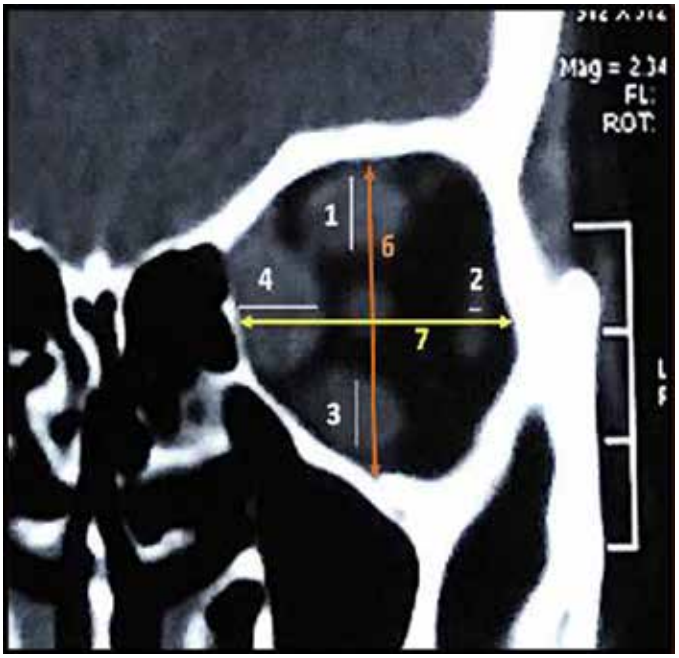

Figure 4: *Barrett's Muscle Index. Vertical index is the percentage of orbital height occupied by vertical recti (1+3) along a line drawn through the optic nerve (6). Horizontal index is the percentage of orbital width occupied by the horizontal recti (2+4) along a line drawn through the optic nerve (7). The greater of the two is the muscle index.*

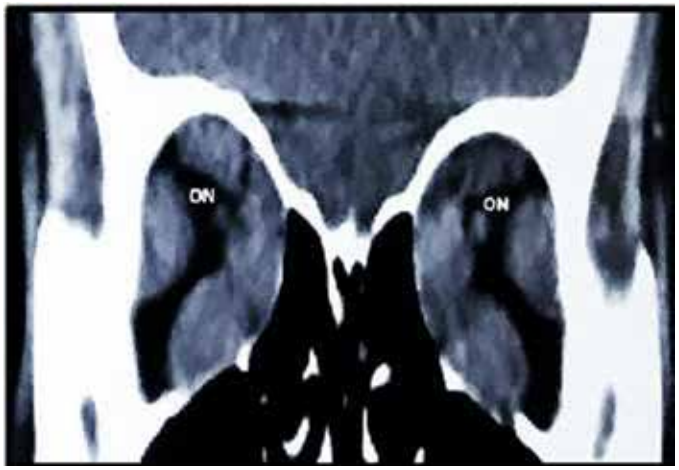

Figure 5: *Apical crowding. Specific but less sensitive predictor of DON.*

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Address for correspondence

Ayushi Agarwal **Resident**
Guru Nanak Eye Center,
New Delhi, India
Email : ayushiagarwal.2110@gmail.com

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