ORIGINAL ARTICLE

Role of Cross-Sectional Imaging in Diagnosing Thyroid-Associated Orbitopathy and Dysthyroid Optic Neuropathy

Samia Iftikhar[1], Kalsoom Nawab[1*], Anwar ul Haq[2], Irsa Shuaib[1], Mehmood Akhtar[1], Hina Gul[1] and Humaira Anjum[1]

[1]Department of Radiology, Khyber Teaching Hospital, Peshawar, Pakistan
[2]Hayatabad Medical Complex, Peshawar, Pakistan

ABSTRACT

Background: Thyroid-associated orbitopathy (TAO) is the most common and devastating manifestation of Graves' disease. Cross-sectional imaging plays a crucial role in evaluating TAO and quantifying its severity, although TAO is diagnosed clinically. Furthermore, CT and MRI are essential to identify its vision-threatening complications, such as dysthyroid optic neuropathy (DON).

Objective: To assess the diagnostic role of cross-sectional imaging (CT and MRI) in identifying Thyroid-associated orbitopathy (TAO) and dysthyroid optic neuropathy (DON).

Methods: This cross-sectional study was conducted at the Department of Radiology, Khyber Teaching Hospital, Peshawar, over 3 years (March 2017 to March 2020). The study included 45 confirmed TAO patients (29 women and 16 men) with symptoms for less than 2 years, with no history of prior orbital surgery or optic nerve disease. All patients underwent MRI and CT of the orbits with contrast.

Results: Proptosis was observed in 92% of cases. Extraocular muscle (EOM) enlargement was present in 80%, while 32% demonstrated retrobulbar fat infiltration. Indicators of DON, such as orbital apex crowding, were identified in 32% of patients. Four cases showed exclusive fat expansion without EOM changes.

Conclusion: CT and MRI are invaluable tools for evaluating TAO and quantifying its severity, especially when there is diagnostic uncertainty or a clinical dilemma, although TAO is diagnosed clinically.

Keywords: *Thyroid-associated orbitopathy, dysthyroid optic neuropathy, orbital MRI, CT scan, Graves' disease.*

INTRODUCTION

Thyroid-associated orbitopathy (TAO), a prominent extra-thyroidal complication of Graves' disease, presents with symptoms such as eyelid retraction, exophthalmos, ocular dryness, double vision, cosmetic disfigurement, and, in severe cases, visual impairment [1-5]. It predominantly affects women, with an annual incidence of 16 females and three males per 100,000 [6].

Although often bilateral and symmetric, up to 15% of TAO cases manifest unilaterally [7]. The underlying mechanism of TAO is not fully understood, but salient features include inflammation, leading to the proliferation of orbital fat and muscles, and fibrosis [8, 9]. TAO is characterized by extraocular muscles (EOM) enlargement with inferior and medial rectus muscles being most involved, and orbital fat proliferation [9, 10].

There are two subtypes of TAO according to prior studies: one characterized by orbital fat proliferation and the other by muscular enlargement [11, 12]. Research is scarce on subtype TAO, with only orbital adipose tissue involvement [5, 13].

The most severe and vision-threatening complication of TAO is Dysthyroid optic neuropathy (DON), though it is rare (4-8%). It is due to optic nerve compression or stretching [14, 15]. Unfortunately, it is difficult to diagnose because its symptoms overlap with those of other milder forms of TAO [15]. Imaging (CT and MRI) plays a pivotal role in assessing optic nerve compression and evaluating disease severity, although TAO is diagnosed on clinical grounds, aided by thyroid function tests. MRI provides excellent contrast resolution for the optic nerve and soft tissues, while CT helps assess bone and muscle details [12, 14, 16].

Thus, this research aims to critically evaluate the diagnostic role of cross-sectional imaging in TAO and particularly for early DON, which is often not clinically evident. The goal of imaging is to supplement and augment clinical diagnosis of TAO, improve therapeutic timing, and thereby improve outcomes for TAO patients with DON. This study aims to evaluate the diagnostic utility of imaging in TAO and DON and assesses the different imaging patterns of EOMs and orbital fat involvement.

MATERIALS AND METHODS

The cross-sectional study was conducted at the Department of Radiology, Khyber Teaching Hospital, Peshawar, over 3 years (March 2017 to March 2020). After obtaining approval from the hospital research committee (DIR/KMU-EB/PD-000971) and informed consent.

*Corresponding Author: Kalsoom Nawab, Department of Radiology, Khyber Teaching Hospital, Peshawar, Pakistan, Email: kalsoomnawab@gmail.com
Received: July 07, 2025; Revised: November 25, 2025; Accepted: December 01, 2025
DOI: https://doi.org/10.37184/nrjp.3007-5181.2.4

All articles are published under the (https://creativecommons.org/licenses/by/4.0) ISSN: 3007-519X (Online)

The study included 45 patients *via* a consecutive sampling method. Participants aged 20 to 60 years with a TAO duration of less than 2 years were included. Participants with a history of previous orbital surgery or radiotherapy, orbital pathologies (*e.g.*, cataracts, glaucoma), pregnancy, lactation, and liver or kidney dysfunction were excluded from our cohort.

All participants underwent a detailed history and clinical examination. MRI and CT with orbital protocol were performed on all participants. MRI was performed on a 1.5 Tesla scanner (Siemens Magnetom Avanto), including T1W, T2W, STIR, and post-contrast axial, coronal, and sagittal sequences. A CT orbital protocol was performed on a single-slice Toshiba scanner, capturing 2 mm-thick axial and coronal sections, both pre- and post-contrast. Findings related to EOMs, orbital fat, proptosis, optic nerve compression, and lacrimal gland positioning were analyzed.

Statistical analysis was performed using SPSS 22. Frequencies and percentages were computed for categorical variables. Numerical variables were summarized as mean ± standard deviation.

RESULTS

In this study, of 45 patients, 29 (64%) were female and 16 (36%) male, with a mean age of 41 years (range 20-60). Clinical signs included proptosis (88%), lid retraction (80%), diplopia (40%), chemosis (26%), and clinical DON (24%). Most patients (92%) had thyroid dysfunction (38 hyperthyroid, 4 hypothyroid, 3 euthyroid).

Radiologically, proptosis was detected in 41 (92%) patients. EOM enlargement was noted in 36 (80%), with the inferior rectus most frequently involved (76%), followed by the medial rectus (56%). Bilateral symmetrical enlargement of the inferior, medial, and superior rectus muscles **(Fig. 1A)** was observed in 16 (36%) patients with TAO. Bilateral symmetrical

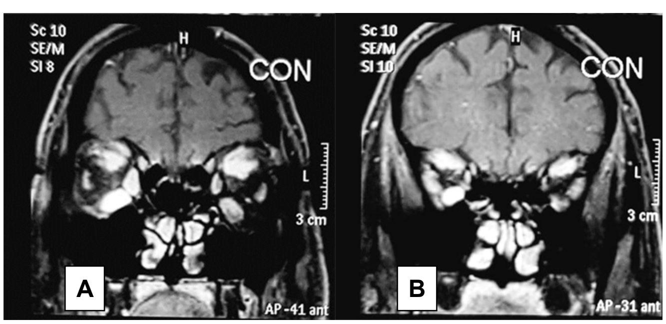

Fig. (1): Coronal post contrast T1-weighted MR images in a subject with active TAO. **(A)** Bilateral symmetrical enlargement of the inferior, medial, and superior recti with sparing of lateral rectus muscle and post contrast enhancement. **(B)** Image showing apical crowding with compression of optic nerve due to enlarged EOMs.

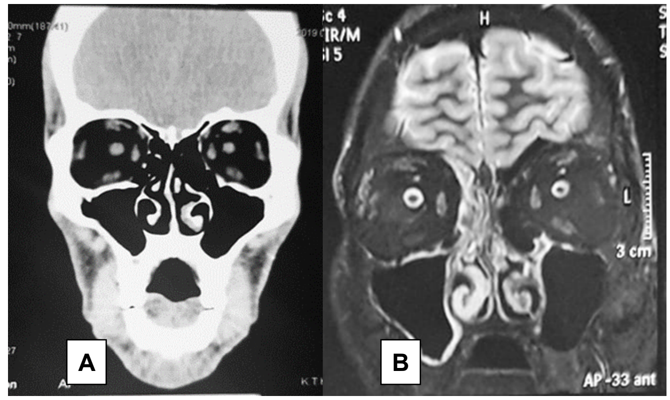

Fig. (2): Coronal CT **(A)** and fat suppressed T1-weighted MR orbits **(B)** images from two different patient with active TAO, showing increased orbital fat bilaterally with normal EOMs.

Table 1: Comparison of CT and MRI findings in patients with thyroid-associated orbitopathy (TAO) and dysthyroid optic neuropathy (DON).

Imaging Feature	CT Findings (n=25)	MRI Findings (n=20)
Proptosis	23 (92%)	18 (90%)
Extraocular Muscle (EOM) Enlargement	20 (80%)	16 (80%)
Inferior Rectus	18 (72%)	16 (80%)
Medial Rectus	13 (52%)	12 (60%)
Symmetrical Bilateral Muscle Enlargement	8 (32%)	8 (40%)
Retrobulbar Fat Stranding / Infiltration	10 (40%)	16 (80%)
Compressive Optic Neuropathy (DON)	7 (28%)	7 (35%)
Orbital Fat Predominant Involvement (Normal EOMs)	1 (4 %)	3 (15%)
Anterior Displacement of Lacrimal Gland	5 (20%)	2 (10%)

Data is expressed as n(%)

enlargement of the inferior rectus and medial rectus muscles was noted in 7 (16%) patients, while bilateral symmetrical enlargement of the inferior rectus muscle only was present in 9 (20%) patients. One (4%) patient showed bilateral symmetrical enlargement of the superior and lateral recti muscles. The inferior rectus enlargement was most commonly found (76%), followed by medial rectus muscle involvement (56%). Unilateral involvement of the inferior, medial, and superior recti muscles was observed in 2 (4%) patients. Associated retrobulbar fat stranding was noted on imaging in 14 (32%) patients. Imaging findings of mechanical compression of the optic nerve at the orbital apex by the enlarged EOMs **(Fig. 1B)** suggesting DON were observed in 14 (32%) cases, 2 more than clinically suspected. Predominantly orbital fat involvement only with normal EOMs **(Fig. 2A** and **B)** was found in 4 (8%) patients. Lacrimal gland anterior displacement was noted in 7 (16%) cases **(Table 1)**.

DISCUSSION

Cross-sectional imaging helps assess disease activity and treatment response in TAO. CT and MRI also play a role in disease monitoring, guiding management, and distinguishing between active inflammatory and inactive fibrotic stages [14, 17].

Our study showed that both CT and MRI have similar sensitivities for detecting proptosis and EOM hypertrophy. However, MRI was superior to CT in identifying retroorbital fat infiltration (80% *vs.* 40%) and the fat-predominant subtype of TAO (15% *vs.* 4%). Conversely, CT offered superior visualization of bony orbital details. These results align with a study by Kirsch *et al.* [17].

Previous studies have demonstrated that EOM enlargement is the most common imaging finding in TAO, most frequently involving the inferior rectus muscle. Furthermore, multiple EOMs were more commonly involved than isolated muscles [14]. Our results are in agreement with these findings. Similarly, in our cohort, multiple muscles were more widely affected, with the most frequently enlarged muscle being the inferior rectus (76%), followed by the medial rectus (56%). Although rare, unilateral TAO was observed in 4% of our patients.

In our study, the most common symptoms were proptosis, lid retraction, and diplopia; these results are consistent with previous research by McAlinden [18].

Any form of thyroid dysfunction (hyper, hypo, or euthyroid) can cause TAO. In our study, 92% patients had abnormal thyroid function, with the majority being hyperthyroid. These findings are in agreement with a previous study that reported that hyperthyroidism was the most frequent thyroid dysfunction associated with TAO [19].

In our study, DON findings were confirmed by imaging in 14 patients compared to 12 clinically suspected cases. Imaging findings of DON, such as optic nerve compression at the orbital apex by enlarged EOMs, were identified in almost 30% patients. This incidence is slightly higher than in prior research [15]. These results highlight the critical role of cross-sectional imaging in the early detection of this vision-threatening complication of TAO.

In addition, our study validates the presence of a distinct fat-predominant subtype of TAO, as reported in previous studies [12, 20]. Our results confirmed that 8% of patients had only orbital fat proliferation with normal-sized EOMs; this finding could only be identified with imaging. Thus, this supports the complementary role of cross-sectional imaging in diagnosing TAO subtypes and guiding therapeutic options.

This study has certain limitations. Because our inclusion criteria allowed for participants with a long duration of symptoms up to two years, the possibility that some participants have a fibrotic and inactive stage of disease cannot be excluded. Furthermore, the lack of imaging follow-up limits our ability to understand disease progression over time.

CONCLUSION

Cross-sectional imaging (CT and MRI) is an invaluable tool for evaluating TAO and quantifying its severity, especially when there is diagnostic uncertainty or a clinical dilemma, although TAO is diagnosed clinically. Furthermore, CT and MRI are crucial to identify vision-threatening complications, such as DON. In short, the primary role of imaging in TAO is to supplement and support clinical findings rather than serve as a sole diagnostic tool.

ETHICS APPROVAL

The study was approved by the research committee of Khyber Teaching Hospital, Peshawar, Pakistan (Approval no. DIR/KMU-EB/PD-000971). All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Written informed consent was obtained from the participants of this study.

AVAILABILITY OF DATA

All of the collected data is presented within this manuscript.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

AUTHORS' CONTRIBUTION

Samia Iftikhar contributed to the study's conceptualization, data collection, literature review, and initial manuscript drafting.

Kalsoom Nawab supervised the imaging protocols, guided image interpretation, performed data analysis, and critically revised the manuscript.

Anwar ul Haq provided clinical expertise, supported patient selection, and assisted in overall review.

Irsa Shuaib contributed to image acquisition, data organization, and literature support.

Mehmood Akhtar assisted with radiological reporting, imaging guidance, and manuscript editing.

Hina Gul helped with data collection, image preparation, and proofreading.

Humaira Anjum supported data management, statistical compilation, formatting, and final manuscript review.

REFERENCES

1. Şahlı E, Gündüz K. Thyroid-associated ophthalmopathy. Turk J Ophthalmol 2017; 47(2): 94-105.
DOI: https://doi.org/10.4274/tjo.80688
2. Xu L, Li L, Xie C, Guan M, Xue Y. Thickness of extraocular muscle and orbital fat in MRI predicts response to glucocorticoid therapy in Graves' ophthalmopathy. Int J Endocrinol 2017; 2017: 3196059.
DOI: https://doi.org/10.1155/2017/3196059
3. Boddu N, Jumani M, Wadhwa V, Bajaj G, Faas F. Not all orbitopathy is Graves': Discussion of cases and review of literature. Front Endocrinol (Lausanne) 2017; 8: 184.
DOI: https://doi.org/10.3389/fendo.2017.00184
4. Kilicarslan R, Alkan A, Ilhan MM, Yetis H, Aralasmak A, Tasan E. Graves' ophthalmopathy: The role of diffusion-weighted imaging in detecting involvement of extraocular muscles in early period of disease. Br J Radiol 2015; 88(1047): 20140677.
DOI: https://doi.org/10.1259/bjr.20140677
5. Siakallis LC, Uddin JM, Miszkiel KA. Imaging investigation of thyroid eye disease. Ophthalmic Plast Reconstr Surg 2018; 34(4S Suppl 1): S41-51.
DOI: https://doi.org/10.1097/IOP.0000000000001139
6. Rutkowska-Hinc B, Maj E, Jabłońska A, Milczarek-Banach J, Bednarczuk T, Miśkiewicz P. Prevalence of radiological signs of dysthyroid optic neuropathy in magnetic resonance imaging in patients with active, moderate-to-severe, and very severe Graves orbitopathy. Eur Thyroid J 2018; 7(2): 88-94.
DOI: https://doi.org/10.1159/000486828
7. Machado KFS, Garcia MM. Thyroid ophthalmopathy revisited. Radiol Bras 2009; 42(4): 261-6.
8. Rabinowitz MP, Carrasco JR. Update on advanced imaging options for thyroid-associated orbitopathy. Saudi J Ophthalmol 2012; 26(4): 385-92.
DOI: https://doi.org/10.1016/j.sjopt.2012.07.006
9. Maheshwari R, Weis E. Thyroid associated orbitopathy. Indian J Ophthalmol 2012; 60(2): 87-93.
DOI: https://doi.org/10.4103/0301-4738.94048
10. Bahn RS. Graves' ophthalmopathy. N Engl J Med 2010; 362(8): 726-38.
DOI: https://doi.org/10.1056/NEJMra0905750
11. Al-Bakri M, Rasmussen AK, Thomsen C, Toft PB. Orbital volumetry in Graves' orbitopathy: Muscle and fat involvement in relation to dysthyroid optic neuropathy. ISRN Ophthalmol 2014; 2014: 435276.
DOI: https://doi.org/10.1155/2014/435276
12. Wiersinga WM, Regensburg NI, Mourits MP. Differential involvement of orbital fat and extraocular muscles in Graves' ophthalmopathy. Eur Thyroid J 2013; 2(1): 14-21.
DOI: https://doi.org/10.1159/000348246
13. Kim HC, Yoon SW, Lew H. Usefulness of the ratio of orbital fat to total orbit area in mild-to-moderate thyroid-associated ophthalmopathy. Br J Radiol 2015; 88(1053): 20150164.
DOI: https://doi.org/10.1259/bjr.20150164
14. Gonçalves AC, Gebrim EM, Monteiro ML. Imaging studies for diagnosing Graves' orbitopathy and dysthyroid optic neuropathy. Clinics (Sao Paulo) 2012; 67(11): 1327-34.
DOI: https://doi.org/10.6061/clinics/2012(11)18
15. Blandford AD, Zhang D, Chundury RV, Perry JD. Dysthyroid optic neuropathy: Update on pathogenesis, diagnosis, and management. Expert Rev Ophthalmol 2017; 12(2): 111-21.
DOI: https://doi.org/10.1080/17469899.2017. 1276444
16. Kahaly GJ. Imaging in thyroid-associated orbitopathy. Eur J Endocrinol 2001; 145(2): 107-18.
DOI: https://doi.org/10.1530/eje.0.1450107
17. Kirsch E, Hammer B, von Arx G. Graves' orbitopathy: Current imaging procedures. Swiss Med Wkly 2009; 139(43-44): 618-23.
DOI: https://doi.org/10.4414/smw.2009.12741
18. McAlinden C. An overview of thyroid eye disease. Eye Vis (Lond) 2014; 1: 9.
DOI: https://doi.org/10.1186/s40662-014-0009-8
19. Wong M, Inder WJ. Alternating hyperthyroidism and hypothyroidism in Graves' disease. Clin Case Rep 2018; 6(9): 1684-8.
DOI: https://doi.org/10.1002/ccr3.1700
20. Kaichi Y, Tanitame K, Terada H, Itakura H, Ohno H, Yoneda M, *et al.* Thyroid-associated Orbitopathy: Quantitative evaluation of the orbital fat volume and edema using IDEAL-FSE. Eur J Radiol Open 2019; 6: 182-6.
DOI: https://doi.org/10.1016/j.ejro.2019.05.003