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An Algorithmic Approach in Diagnosis and Management of Proptosis: Demographic Patterns, Frequency and Aetiology of Proptosis

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ABSTRACT

***Objective*:** To evaluate the demographic patterns, frequency, and etiological profile of proptosis in patients presenting to a tertiary care eye hospital, and to develop an algorithmic approach for its diagnosis and management.
Study Design: Cross-sectional study.
Place and Duration of Study: Armed Forces Institute of Ophthalmology, Rawalpindi Pakistan, from Aug 2024 to Aug 2025.
***Methodology*:** Two hundred participants presenting with proptosis over one year were divided into two age groups: 0-30 years, and 30 years and above. All patients underwent detailed ophthalmological examinations, including a comprehensive proptosis assessment, neuroimaging correlation, and systemic evaluation. Data collected included age, gender, visual acuity, pupil response, diplopia, laterality, symptom duration, clinical features, imaging findings, and final diagnosis. An evidence-based diagnostic and management algorithm was developed and implemented to streamline clinical decision-making.
Result: Of 200 patients with proptosis, 170(85%) were males and 30(15%) were females. Fifty (25%) were under 30 years of age, while 150(75%) were aged above 30 years. Aetiology comprised endocrinological causes 40(20%), followed by inflammatory 36(18%), systemic 34(17%), arteriovenous malformation 30(15%), pseudo-proptosis 28(14%), infective 26(13%), and idiopathic 6(3%). Surgical intervention was indicated in 68(34%) of patients, while conservative management was employed in 118(59%). Patients underwent both surgical and conservative treatments comprised 14(7%).
Conclusion: Endocrinological, inflammatory, and systemic causes were most frequently identified. The suggested diagnostic and management algorithm demonstrated effectiveness in facilitating efficient clinical decision-making.

Keywords: Algorithmic Approach, Hertel, Proptosis, Thyroid.

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INTRODUCTION

Proptosis, defined as anterior displacement of the globe beyond the lateral orbital rim, represents an important clinical sign that can indicate orbital, systemic, or intracranial pathology. It is a key sign of underlying pathology, whether innocuous or sinister. Early and accurate diagnosis is crucial, as etiologies range from benign inflammatory conditions to life-threatening malignancies and space-occupying lesions that can harbor a permanent disability for the patient. The global burden of proptosis is heterogeneous, varying with geographic, genetic, and systemic disease prevalence.[1,2]

Among adults, thyroid-associated orbitopathy or exophthalmos remains the most frequent cause, whereas inflammatory, infectious, and vascular etiologies dominate in younger populations.[3,4] The evolution of imaging especially high resolution and contrast enhanced CT and MRI has revolutionized orbital diagnostics by providing detailed anatomical and pathological characterization and has been used as a baseline to monitor disease progression.[5] Nevertheless, diagnostic delays persist, particularly in low-resource settings where systematic approaches are lacking. The most common cause of delayed presentation is the gradual onset and painless nature of lesions such as optic nerve sheath meningioma and cavernous hemangioma.[6] Misinterpretation or under-referral, such as early-stage thyroid eye disease, may be misattributed to allergic conjunctivitis or dry eye by a non-specialist, which may lead to delayed presentation as well. Some patients present where cosmesis is the primary concern.

Algorithmic strategies that combine structured clinical assessment, imaging interpretation, and systemic evaluation can enhance diagnostic precision and streamline management decisions.[7] Despite the availability of multiple case series exploring the causes of proptosis, few studies have proposed an integrated diagnostic algorithm grounded in prospective clinical data.[8]

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This study aimed to analyze the demographic distribution and etiologies of proptosis among patients presenting to a tertiary eye hospital, to implement and assess an algorithmic diagnostic and management approach.

METHODOLOGY

This cross-sectional study was conducted at the Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan, from August 2024 to August 2025. Ethical approval was obtained from the Institutional Ethics Committee (reference number 124/ERC/AFIO, dated 26 July 2024).

Inclusion Criteria: Patients aged 1 to 75 years, with measurable proptosis (Hertel exophthalmometry >18 mm or an interocular difference ≥2 mm), including those with prior orbital trauma, craniofacial deformities, or previous orbital surgery, both unilateral and bilateral proptosis cases were included.
Exclusion Criteria: Pregnant women, due to contraindications to radiologic imaging involving ionizing radiation or contrast media, were excluded.

Sample size was calculated using WHO sample taking reported prevalence of ABO incompatibility 17.33%.[9] The estimated sample size came out to be 225. Informed consent was obtained from patients, or their guardians in case of minors.

Confounding variables were minimized through strict inclusion and exclusion criteria, standardized proptosis assessment, and uniform ophthalmic and neuroimaging evaluations. Consecutive recruitment reduced selection bias, and all diagnostic and treatment procedures were performed by a dedicated oculoplastic/ophthalmology team, supported by radiology specialists for imaging interpretation. Management decisions and procedures were carried out by the same senior ophthalmology team following the institutional clinical protocol (Figure).

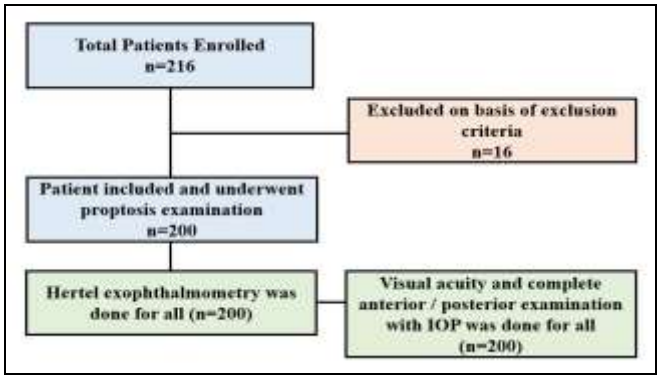

Figure: Patient Flow Diagram

The study evaluated the aetiology, clinical presentation and outcomes of proptosis among patients seen in the outpatient and inpatient departments or referred from other hospitals. Participants were informed about the study and consented in the local language. Data collected included demographic details, duration, laterality, visual acuity, pupil response, diplopia, and systemic findings. All patients underwent detailed ophthalmic assessment: uncorrected and best-corrected visual acuity, colour vision, visual fields (via confrontation and Humphrey visual field analysis), Hirschberg and cover tests, pupillary examination, ocular motility, diplopia assessment through charting and Hess tests, and anterior and posterior segment examinations for optic disc appearance, edema, and choroidal folds.

Patients with large cup-to-disc ratios (>0.3) or pallor were further evaluated with optical coherence tomography of the retinal nerve fibre layer, along with contrast-enhanced CT and/or MRI of the orbit, paranasal sinuses, and brain to determine lesion location and characteristics. Vascular malformations were assessed with magnetic resonance angiography and CT angiography. Systemic investigations included thyroid function tests, CBC, ESR, and targeted tests as indicated.

An algorithm was developed to guide diagnosis and management, focusing on onset (acute or chronic), laterality, and associated pain. Emergency conditions such as infectious or vascular causes were prioritized through urgent imaging and radiology collaboration. Lesions were classified anatomically as intra or extraconal, or diffuse. Etiologies were correlated with clinical and imaging findings, distinguishing between: i. Endocrine causes (bilateral, symmetric proptosis, eyelid retraction, thyroid dysfunction), ii. Inflammatory/infective causes (painful, acute, elevated systemic markers), iii. Vascular causes (pulsatile features, bruit, confirmed on angiography), and iv. Neoplastic or systemic causes (gradual, painless, mass effect, systemic association).

Following algorithm (Table-I) was developed by a multidisciplinary team of consultant ophthalmologists with subspecialty expertise in oculoplasty and orbital diseases. The algorithm is based on clinical experience, current evidence-based guidelines, and consensus opinion following multiple clinical case discussions with purpose to analyses a case of proptosis critically and to provide adequate clinical cues to aid prompt diagnosis.

Table-I: Approach to Case of Proptosis - An Algorithmic Approach

Name: Age: Gender: Occupation:	Essentials	Ocular Investigation	Neuro Imaging	Systemic
Presenting Complaint:	IOP Cranial Nerve Other Eye Lids Sensation Triple Mirror Gonioscopy	OCT Macula OCT RNFL Visual Fields Anterior Segment OCT UBM U/S B Scan HESS chart	CECT CEMRI MRA MRV	As per the differential diagnosis
History of Presenting Complaint	Symptoms (Pain / Progression / Double vision)			
	Duration Trauma Radiation	Onset Tumor Others	Course Immunosuppression	
Co-Morbid	DM	HTN	IHD	RA
	Pregnancy	Thyroid Functions		Smoking
Systemic	CNS / CVS	Respiratory	GIT	Rheumatology
Examination	**Inspection**			
	Profile View	Worms Eye View	Birds Eye View	Asymmetry Pigmentation
	Scaring	Nasal & Oral	Surface lesion (if present)	
	VA / EOM			
	VA	BCVA / NV	Colour vision	VFD
	HCB	Cover-Uncover	EOM / Pupil	Diplopia charting
	Measurement			
	Hertel	Dystopia	Lagophthalmos	Lid lag
	Lid retraction	PFH/ MRD1& 2		
	Palpation			
	Lymph Node	Thyroid Gland	Orbital rim	Pulsation
	Thrill	Retropulsion	Temp	Tenderness
	Protective Mechanism → Corneal staining/ sensation and Bell's			
	Auscultation → Bruit			
	Vascular → Bending and Valsalva			
Slit Lamp Exam	Anterior Segment		Posterior Segment	

**VA: visual acuity, BCVA: best corrected visual acuity, HCB: Hirschberg, NV: near vision, VFD: visual field defect, IOP: Intraocular pressure, DM: diabetes mellitus, HTN: hypertension, IHD: ischemic heart disease.*

Management strategies were tailored accordingly: medical therapies included cortico-steroids, antibiotics, immunosuppressants, and endocrine treatments; surgical options involved decompression, excision, and biopsy where necessary.

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 20. Frequencies and percentages described categorical variables. Means and standard deviations were calculated for numerical data.

RESULTS

A total of 200 patients presenting with proptosis were included. The mean age was 43.8±12.7 years (range: 1–75 years). Fifty patients (25%) were aged ≤30 years, while 150 patients (75%) were >30 years of age. There was a marked male predominance with 170 males (85%) and 30 females (15%), giving a male-to-female ratio of 5.6:1. Proptosis was unilateral in the majority of cases, with visual impairment observed in 74% of patients. Abnormal pupillary responses were noted in 37%, and diplopia was present in 68% of patients. Associated systemic conditions included diabetes mellitus in 31% and immunosuppression in 20% of cases. The distribution of aetiologies is summarized in Table-II.

Table-II: Distribution of Proptosis according to Etiology (n=200)

Distribution of Proptosis according to Etiology	Frequency n(%)
Thyroid Orbitopathy	40(20%)
Inflammatory	36(18%)
Systemic diseases	34(17%)
Arteriovenous malformations	30(15%)
Pseudo-proptosis	28(14%)
Infective	26(13%)
Idiopathic	6(3%)

Based on algorithm guided decision making, management included surgical intervention in 68(34%) patients, whereas 118(59%) were indicated for conservative management and 14(7%) patients underwent both surgical and conservative management (Table-III). The algorithm contributed to streamlined diagnostic pathways, reduced diagnostic ambiguity and appropriate selection of management strategies across different etiological categories. Surgical management mainly comprised orbital decompression (30%), tumour excision (4%) and lid surgeries (29%). Conservative management included lifestyle modification, cessation of smoking, and control of systemic risk factors. Use of corticosteroids was indicated in 76% patients who presented with thyroid orbitopathy and inflammatory disease. This was rationalized after ruling out systemic infections and immunosuppression. Antibiotics, both topical, oral, and intravenous, were administered for infectious aetiology (13%). Endocrine regulation was performed according to the aetiology.

Table-III: Management of Proptosis Patients (n=200)

Management	Cases (%)
Surgical	68(34%)
Conservative	118(59%)
Both	14(7%)

DISCUSSION

The present study demonstrated a male predominance (85%), aligning with the findings of Sharma *et al.,* and Zahir *et al.,* who attributed this to

occupational exposure and sociocultural health-seeking differences.[9,10] In contrast, Western data report a female predominance due to the higher incidence of autoimmune thyroid disease among women.[11,12] Thyroid eye disease (TED) or Graves' ophthalmopathy is the most common cause of unilateral or bilateral proptosis.[13] In many patients with Graves' disease, ocular signs may precede, accompany, or follow thyroid dysfunction. Because of this, understanding the pathophysiology, clinical features, and management of TED is important to endocrinologists, ophthalmologists, and rheumatologists.[14]

Inflammatory and systemic causes together contributed 35% of cases, consistent with data from Nepal, India, and Southeast Asia, where idiopathic orbital inflammation remains prevalent.[15,16] Idiopathic Orbital Inflammation (IOID), also known as *orbital pseudotumor* or nonspecific orbital inflammation, is a benign, non-infectious inflammatory condition of the orbit for which no definitive local or systemic cause can be identified.[17] It is a diagnosis of exclusion. There is a dramatic response to steroids both orally and locally. Biopsy shows granulomatous and lymphocytic infiltrates.

Vascular malformations accounted for 15% of cases. Vascular malformations are congenital or developmental malformations of the vessels in the orbit: it can be venous, arterial, lymphatic, or mixed.18 Arterial malformations are high flow, venous are low flow. Arterial malformations are positive for bruit. Unlike tumors, they are not primarily proliferative but are abnormal vascular channels. Digital subtraction angiography is a specialized imaging technique used to visualize blood vessels with great clarity by removing ("subtracting") background anatomical structures (bone, soft tissue) from images and rendering the actual pathology to be elicited clearly.[19]

Infective causes (13%) were higher, reflecting endemic sinus infections and delayed presentation. Sinusitis was the most common infectious cause. In addition, trauma, localized infections, insect bites, and sinus disease are frequent risk factors for preseptal or orbital cellulitis leading to proptosis. A cross-sectional study in the oral/maxillofacial surgery dept in Jamshoro found that among patients with maxillary tooth infections, a high proportion (≈18.7%) developed orbital cellulitis, leading to proptosis.

Our diagnostic algorithm effectively integrated clinical features with imaging and systemic evaluation. A similar approach was suggested by Xu *et al.,* who emphasized structured workflows to optimize diagnostic efficiency.[20] Implementation in our cohort reduced both delay and redundancy, similar to findings from the Singapore Ocular Network Study.[21]

Pseudo proptosis is apparent forward displacement of the eyeball, but measurement of the corneal apex from the lateral orbital rim measured on Hertel is within normal limits. Causes of pseudo-proptosis were identified, including high myopia, contralateral enophthalmos, contralateral orbital floor fracture, lid malposition, buphthalmos, and orbital asymmetry, confirmed by CT scan measurements of orbital margins.

By adopting algorithmic decision-making, we streamlined the diagnostic flow. This structured methodology proved particularly valuable for differentiating overlapping clinical entities such as thyroid eye disease and idiopathic orbital inflammation.

Surgical management (34%) was primarily indicated for vascular and neoplastic etiologies, comparable to global series, in which 25–40% of cases require surgical intervention.[22] Conservative therapy was predominant (66%), reflecting the success of medical management in inflammatory and endocrine causes. Douglas *et al.,* similarly reported favourable outcomes with corticosteroids and immuno-modulatory therapy.[23] Our findings reaffirm that individualized management guided by structured algorithms can significantly improve outcomes and reduce morbidity.

This study highlights the vital role of an algorithmic, evidence-based approach in diagnosing and managing proptosis. The findings, showing that endocrine and inflammatory causes are most prevalent (particularly among adult males), demonstrate that utilizing a structured algorithm enhances diagnostic precision and reduces unnecessary investigations. Standardizing clinical pathways based on these results can facilitate early detection, optimize treatment strategies, and improve prognostic outcomes in tertiary ophthalmic settings, with appropriate referrals made as indicated.

LIMITATIONS OF STUDY

This study was single-centre and hospital-based, which may not reflect community-level epidemiology. The follow-up period was limited to one year, precluding long-term outcome evaluation. Future research should involve multicentric datasets, inclusion of pediatric subgroups, and

AI-based imaging analytics for automated etiological prediction.

CONCLUSION

Endocrinological, inflammatory, and systemic causes were most frequently identified. The suggested diagnostic and management algorithm demonstrated effectiveness in facilitating efficient clinical decision-making.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AR & SAZ: Data acquisition, data analysis, critical review, approval of the final version to be published.

AA & UUY: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AHN: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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