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Original Article

Radiology Section

Multidetector Computed Tomographic Evaluation of Proptosis

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ABSTRACT

Introduction: Forward protrusion of the eyeball with respect to the orbit is known as proptosis. There are various causes of proptosis, among which lesions within the orbit are the commonest while para-orbital lesions, like extension of cranial or sinus lesions into the orbit are less common. Causes of proptosis can be classified either anatomically or pathologically. The pathological classification is the most commonly followed and easier to comprehend.

Aim: To analyse the diagnostic role of CT-scan in evaluation of proptosis.

Materials and Methods: The study population comprised of 50 patients of various age groups and both sexes who were clinically diagnosed to have unilateral or bilateral proptosis and were referred to our department for imaging. After informed consent, they were subjected to plain CT-scan of both orbits. Further, intravenous contrast study was done wherever necessary and results were interpreted after reconstruction. CT findings were correlated with MRI, histopathological and intraoperative findings wherever feasible.

Results: Of the 50 cases, 38 patients had unilateral proptosis, while 12 patients had bilateral proptosis. Out of all, 23 (46%) were neoplastic, 12 (24%) were infective, 11 (22%) were inflammatory, 3 (6%) were traumatic and 1 (2%) were vascular in origin. Lymphoma was the most common orbital tumour observed in our study. Thyroid ophthalmopathy was the most common cause of bilateral proptosis. Overall, CT diagnosis was accurate in 80% of the cases.

Conclusion: CT's ability to characterise a lesion based on density, calcification, and enhancement helps to formulate a differential diagnosis and decide further management. Knowing the precise location of the lesion in the orbit facilitates planning of an appropriate surgical approach. CT is also useful to demonstrate the extra orbital extension of the lesion. CT is ideal to detect bony erosion/expansion when present.In view of non specific findings in cases of some orbital tumours and in pseudotumours, a correlation with clinical and laboratory data is essential to arrive at a diagnosis.

Keywords: Exophthalmos, Inter zygomatic line, Lymphoma, Orbit

INTRODUCTION

Forward protrusion of the eyeball with respect to the orbit is known as proptosis. Wide variety of lesions arising from the orbit per se, skull, intracranium, sinuses etc., can cause proptosis. Proptosis may be due to many causes, among which space occupying lesions within the orbit are the most important, and less frequent are herniation or extension of cranial or sinus contents into the orbit. Causes of proptosis can be classified either anatomically or pathologically. The pathological classification is the most commonly followed and easier to comprehend [1].

The intra orbital portion of optic nerve is longer (25 mm) than the distance between the back of the globe and the optic canal (18 mm). This allows for significant displacement of the globe without excessive stretching of the nerve.

The lesions included are thyroid ophthalmopathy, tumour, infection, trauma, vascular lesions and orbital inflammatory syndromes [1].

The distance from inter zygomatic line to the anterior surface of the globe should be >23 mm to label the patient as proptotic [2-4].

The most common causes of proptosis in children include dermoid and epidermoid cysts, haemangiomas, lymphangiomas, optic nerve gliomas, rhabdomyosarcoma, leukaemias and metastases (neuroblastoma). In adults the common causes of unilateral proptosis are metastases

from the breast, lung and gastrointestinal tract, cavernous haemangiomas, mucoceles, lacrimal gland tumours, lymphoid tumours and meningiomas. Overall, thyroid ophthalmopathy is the most common cause of proptosis in adults. It accounts for 15% to 28% of cases of unilateral proptosis and 80% of cases of bilateral proptosis [5,6].

CT is useful to demonstrate the precise extension of the orbital lesion,especially in tumours. The involvement of the adjacent para nasal sinuses and nasal cavity, the evidence of the bone erosion and intracranial extension are all factors which helps in the pre treatment evaluation and post treatment follow-up [7].

MATERIALS AND METHODS

This prospective study was conducted between March 2016 to March 2017 in the Department of Radiodiagnosis, Victoria Hospital, Bangalore Medical College and Research Institute, Bengaluru, India.

Total 50 patients of both the sexes belonging to varying age groups who were clinically diagnosed with unilateral or bilateral proptosis and were referred from Minto Regional Institute of Ophthalmology, attached to Bangalore Medical College and Research Institute were considered for the study. Sample size was calculated based on the established prevalence rate in our hospital. Patients with deranged renal functions (serum creatinine 2.0 mg/dL) and those with hypersensitivity to contrast media were excluded from the study.

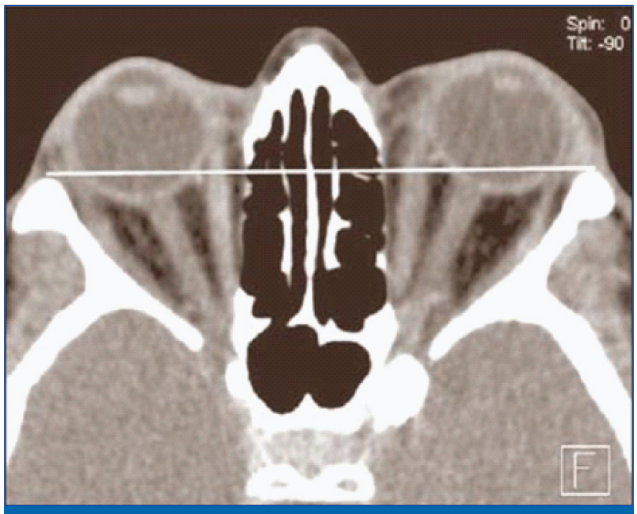
Informed consent from all the patients and ethical committee approval was obtained prior to the study.

Procedure: CT-scan of both the orbits using 6 slice MDCT scanner "SIEMENS SOMATOM EMOTION 6" was done. A lateral scannogram with the patient supine was first taken.

Contiguous axial sections, parallel to the orbitomeatal line, with slice thickness of 5 mm were obtained in spiral protocol, later reconstructed to 3 mm.

Coronal 3 mm sections were taken when required, with the patient in prone position. The scans were obtained both prior to and after administration of non-ionic intravenous contrast. Bone and soft tissue windows were used for viewing.

In axial sections, the interzygomatic line was drawn and with globe protrusion >23 mm anterior to the interzygomatic line at the level of lens were diagnosed to have proptosis [2,3]. Further, evaluation into the etiology of proptosis was analysed. In cases of tumours, the density and type of enhancement was done along with the invasive properties which helped to narrow down the diagnosis. In inflammatory lesions, the pattern of involvement was evaluated along with the clinical and laboratory findings to arrive at a diagnosis. Maximum intensity projections were used to analyse vascular lesions with special concern to identify the feeders. The findings were correlated with histopathology wherever necessary [Table/Fig-1].



[Table/Fig-1]: Inter zygomatic line - line joining the anterior borders of the zygomatic arches.

RESULTS

The age of patients included, ranged from 2 months to 80 years. Majority of the patients (22%) were between 31-40 years. Male to female ratio was 1.3:1.

Out of all, 38 patients had unilateral proptosis while 12 patients had bilateral proptosis [Table/Fig-2-3].

Cases	n (%)
Unilateral	38 (76%)
Bilateral	12 (24%)

[Table/Fig-2]: Distribution of cases based on laterality.

Location	Number of cases
Conal	2
Globe	3
Intra-conal	6
Extra-conal	12
>1 compartment	27

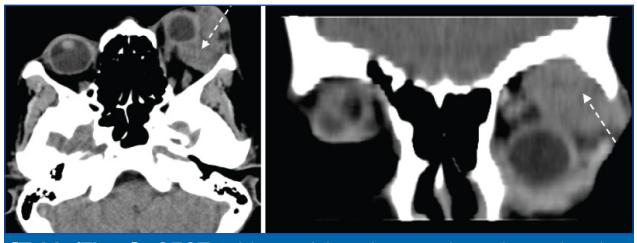
[Table/Fig-3]: Distribution of cases based on location.

The most common lesions causing proptosis in our study were tumours (46%). Orbital tumours accounted for 15 cases while eight cases of paraorbital tumours from sinonasal and intracranial origins were found. Lymphomas were the most common orbital tumours in our study (four cases). Others included metastases (three cases), primaries of which were from neuroblastoma, lung and breast carcinoma. Retinoblastoma (three cases), rhabdomyosarcoma (two cases), cavernous hemangioma, optic nerve meningioma and optic nerve glioma (one case each) etc., were the others found in the study [Table/Fig-4].

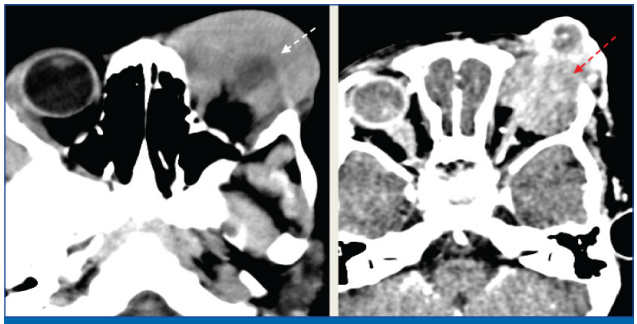
Second most common etiology was infection - orbital cellulitis (seven cases), orbital mucocoele and invasive sinusitis were the diagnoses. Thyroid opthalmopathy (included under inflammatory) was the most common cause of bilateral proptosis (7 out 12

Etiology	Number of cases
Neoplastic	23
Infective	12
Inflammatory	11
Traumatic	3
Vascular	1

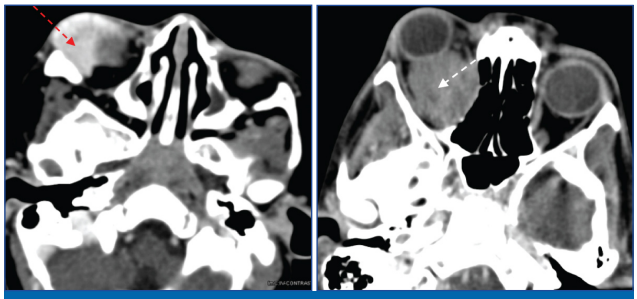
[Table/Fig-4]: Distribution of cases based on etiology.



[Table/Fig-5]: CECT orbit - axial and coronal sections showing lymphomas presenting as homogenously enhancing soft tissue masses in extraconal space (arrows).



[Table/Fig-6]: Plain and CECT of the orbit axial section showing a homogenously enhancing extraconal mass with involvement of extraocular muscles - rhabdomyosarcoma.

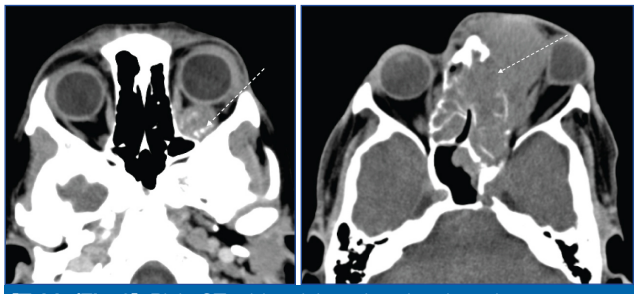


[Table/Fig-7]: CECT of the orbit-axial section showing a homogeneously enhancing mass turned out to be a retinoblastoma (arrows).
[Table/Fig-8]: CECT orbit-axial section showing a optic nerve sheath meningioma appearing a fusiform enlargement of optic nerve with central lucency (arrow). (left to right)

patients). While four cases of inflammatory pseudotumour were found. All three cases of trauma had intra-orbital haemorrhage with fracture of the bony orbits. One case of carotico-cavernous fistula (vascular cause) was found [Table/Fig-5-10].

DISCUSSION

Abnormal protrusion of the globe with respect to the orbit is known as proptosis or exophthalmos. It is much commoner



[Table/Fig-9]: Plain CT orbit-axial section showing a homogeneous mass occupying the ethmoid sinuses invading (arrow) the orbit.
[Table/Fig-10]: CECT orbit-axial section showing hemangioma appearing as an hyperdense intraconal mass with calcifications (arrow). (left to right)

than abnormal retraction or enophthalmos. Exophthalmos is a term which is usually reserved for describing the protrusion of the eyes secondary to thyroid disease, while proptosis is used to denote a protrusion of the eyeball due to any cause. Proptosis may be due to many causes, among which space-occupying lesions within the orbit are the most common, while herniation or extension of cranial or sinus contents into the orbit are less common (paraorbital cause). Pseudo-proptosis or a slight prominence of the eyes, can occur in high myopia, paralysis of the extrinsic muscles, stimulation of Muller muscle by cocaine, and idiosyncrasy, especially in obese people [8].

Unilateral proptosis is commonly due to orbital cellulitis, orbital inflammatory disease, thrombosis of the orbital veins with or without involvement of the cavernous sinus, vascular malformation, tumours of the orbit and its contents, and orbital haemorrhage or emphysema. Bilateral exophthalmos is almost always in the presence of endocrine abnormalities (thyroid), but bilateral proptosis is also seen in the later stages of thrombosis of the cavernous sinus, empyema of the accessory sinuses of the nose, bilateral orbital tumours (lymphoma, pseudo leukaemia) and diminished orbital volume in oxycephaly or 'tower-skull' and leontiasis ossea.

The proptosis can be axial, where the eye is pushed directly forwards. In such cases, the etiology will commonly be found to originate in the optic nerve or central space, e.g., optic nerve gliomas, meningiomas and cavernous haemangiomas. The eye can also be displaced from its centre, to the side opposite to the origin of the space occupying lesion. Supero temporally located dermoids and lacrimal gland tumours push the eyeball downwards and inwards. Concurrent involvement of the ethmoidal sinuses causes the medial canthus to displace laterally with an apparent widening of the bridge of the nose. Proptosis may remain static in congenital lesions, or increase gradually in cases of slow growing tumours such as meningiomas. Proptosis that increases at a fast rate is often due to haemopoietic tumours, rhabdomyosarcoma and neuroblastoma. Pulsatile proptosis could be a carotid cavernous fistula. Other causes include neurofibromatosis

Type-I, trauma, arteriovenous malformation and arachnoid cysts (rare). Proptosis that increases on the Valsalva manoeuvre or on bending forwards is usually caused by a vascular lesion such as orbital varix. Diplopia is common with orbital tumours, while papilloedema may be present, especially with optic nerve tumours. Optic atrophy due to pressure on the nerve also can occur with other orbital tumours.

Etiology

The causes of proptosis were broadly classified into five categories - neoplastic, infective, inflammatory, traumatic and vascular.

Neoplastic: The most common lesions causing proptosis in our study were tumours (46%) of which 65% were orbital tumours and 35 % were para-orbital tumours. Our findings correlated well with the findings of Masud MZ et al., who described neoplasms (33%) as the most common causes of proptosis in their study [9]. On the other hand, Sambasivarao K et al., in their study, found tumours to be much more in frequency (51%) than our study, with orbital tumours accounting for 75% of them [10].

Lymphomas were the most common orbital tumours in our study. Margo CE et al., reported orbital lymphoma to be the most common malignant orbital tumours [11]. On imaging, lymphoma appeared as a homogeneously enhancing mass in the extraconal space. Involvement of the intraconal space was seen in one of the cases.

The second most common tumour in our study was metastases. Two of which were in middle aged females (breast and lung) appearing as metastatic extra conal mass while one was in a child (neuroblastoma) which presented as extraconal masses in bilateral orbits with a mass per abdomen. Three cases of retinoblastoma were found in our study, of which one had bilateral but asymmetrical involvement. Retinoblastoma appeared as homogeneously enhancing masses with calcifications occupying the entire orbit. Rhadomyosarcoma was found in two cases, both of which appeared as intensely enhancing extraconal masses involving the extraconal muscles with destruction of bones. Optic nerve glioma was found in one case, who was a middle-aged adult with unilateral involvement (non syndromic). They appeared as homogeneously enhancing fusiform thickening of the optic nerve extending upto the orbital apex. Optic nerve sheath meningioma was found in one case which showed an intraconal mass lesion with central tram-track hypodense optic nerve.

Sinonasal carcinomas (4 out of 8) were the most common paraorbital tumours causing proptosis, of which the maxillary sinus was involved in three of the cases. They appeared as destructive masses involving the maxillary and ethmoid sinuses with intracranial involvement in one of them. Two cases of Juvenile nasopharyngeal angiofibroma were found in our study, both of them presenting with epistaxis with concurrent proptosis. One case of esthesio neuroblastoma and one case of nasopharyngeal carcinoma with intracranial involvment were found.

Infections: They were the second most common cause of proptosis in our study (24%). Seven cases of orbital cellulitis and five cases of sinonasal infections were found. This correlated well with a study conducted by Sabharwal KK et al., where infections accounted for 28% of cases [12] while in a study conducted by Masud MZ et al., it accounted for 20% of cases [9]. Sub periosteal involvement was seen in three patients with formation of abscess in one patient. Orbital mucoceles were found in three cases of which frontal sinus was involved in two cases.

Inflammatory: Seven cases of graves' disease (thyroid opthalmopathy) were found, all of them were bilateral. Grave's disease accounted for 14% patients of proptosis in our study compared to the study by Narula MK et al., where Grave's disease accounted for 6% patients [13]. Another study by Sabharwal KK et al., showed 10% percent of cases [12].

Inferior rectus was the most commonly involved muscle, followed by medial and superior recti. The tendinous insertions were spared.

Four cases of inflammatory pseudo tumour of orbit was found. One had bilateral involvement. Mutiple extra ocular muscles were involved with involvement of the tendinous insertions. Lacrimal gland was involved in one of the cases with orbital apex involvement in one.

Trauma: All three cases of trauma (6%) had vitreous haemorrhage, with one patient having retrobulbar haemorrhage. Fracture of the orbits were found in all of them, while one of them showed orbital floor fracture with herniation of contents into the maxillary sinus.

Vascular: One case of vascular cause was found (2%) which was a carotico-cavernous fistula who presented with pulsatile proptosis. In the study of Masud MZ et al., 7 % cases of proptosis were caused by vascular lesions [9] while, Sambasivarao K et al., had 2.5% of cases of proptosis with vascular lesions [10].

Significance: Out of 23 patients with orbital tumours, CT diagnosis correlated with the histopathological diagnosis in 17 patients (73.9%). Sabharwal KK et al., showed a correlation of 78.2% [12].

CT provided an accurate diagnosis in 88% patients of orbital cellulitis in our study. Clary RA et al., analysed the accuracy of CT in orbital cellulitis in children and showed a correlation of 84.21% cases [14].

Correct diagnosis of Grave's disease was made in three out of four (80%) patients.

Correct diagnosis of pseudo tumour was made in only 50% of patients in our study because of the nonspecific radiological findings.

In the present study, overall CT diagnosis was found to be right in 40 patients (accuracy=80%). Studies conducted by Mahsud ZS et al., showed an accuracy of 80% [15], Sabharwal KK et al., an accuracy of 82% [12], Sambasivarao K et al., an accuracy of 85% [10].

With the accuracy, consistently averaging more than 80%, CT plays an important role for the clinician as the first imaging modality to be considered in patients with proptosis.

The statistics in our study correlated well with most of the studies conducted previously in various regions of the world, which reiterates the prevalence of the lesions.

LIMITATION

Contrast study could not be completed in a few patients due to allergy and deranged renal functions which limited the diagnostic accuracy. No other significant limitations were there in our study.

CONCLUSION

Ability of CT-scan, to characterise a lesion based on density, calcification and enhancement helps to formulate a differential diagnosis and decide further management. Knowing the precise location of the lesion in the orbit facilitates planning of an appropriate surgical approach. CT is also useful to demonstrate the extra orbital extension of the lesion. CT is ideal to detect bony erosion/expansion when present.In view of non-specific findings in cases of some orbital tumours and in pseudotumours, a correlation with clinical and laboratory data is essential to arrive at a diagnosis.

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