RADIODIAGNOSIS IN OPHTHALMOLOGY WITH PARTICULAR REFERENCE TO PROPTOSIS

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SUMMARY

The value of plain films and special procedures in ophthalmic radiodiagnosis is discussed. Particular reference to the common problem of proptosis has been made. Lack of space has prevented the actual X-ray demonstration of many of the lesions which may be seen on plain films.

There are so many structures related to the orbit that neurologists, ENT specialists, paediatricians and plastic surgeons may be concerned in a vast array of conditions varying from trauma to congenital malformations.

It may be that many ophthalmologists do not realize the potentialities in radiology as applied to their field. Plain films of various views of the orbit and related structures may be diagnostic, but alternative techniques may be required. These include screening by television (especially in the case of small children), tomography, dacryocystography, orbitography, venography and arteriography.

Localization of opaque foreign bodies is done by means of straight films of the orbits and further views on movement of the eyeball. This enables one to say whether the foreign body is within the eye or not. For more definite localization the Sweets method is used. In unco-operative or young patients this is impractical and television screening may be of help.

Investigation for localization of a block in the nasolacrimal system is by means of a dacryocystogram. Contrast is injected into the lower punctum on the affected side, or if necessary, into the upper punctum. Fig. 1 demonstrates a block at the level of the lower part of the nasolacrimal sac.

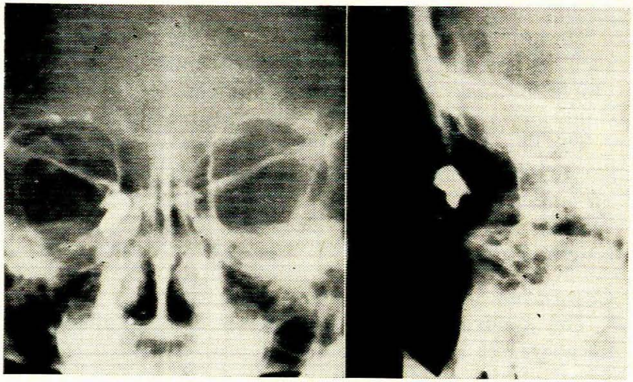

Fig. 1. Dacryocystogram showing a block at the lower aspect of the nasolacrimal sac.

Fractures involving the orbit can often be seen on plain films. Fractures occur most commonly in the weakest area, which is the floor of the orbit. However, better definition can be obtained by tomography (Fig. 2). This is particularly useful if a blow-out fracture is suspected

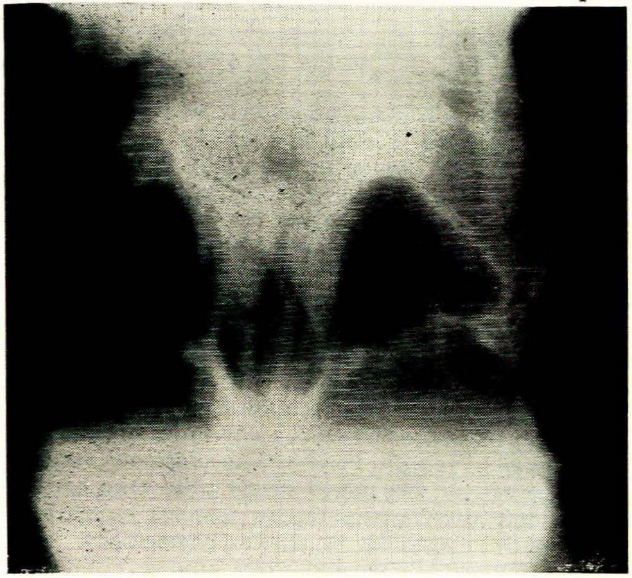

Fig. 2. Tomography demonstrating a fracture of the left orbital floor.

when a patient presents after trauma with a squint or enophthalmos. This may be associated with a fine fracture nipping orbital muscles within it. If the examination is left too long a thin linear fracture may have healed, and cannot be demonstrated.

If an intra-orbital mass or tumour of the optic nerve is suspected, orbital pneumatography can be done. About 15 ml of air is injected percutaneously through the temporal part of the lower lid with the straight needle directed medially, upwards and backwards towards the posterior part of the eyeball. Positive-contrast orbitography has the disadvantage of giving rise to serious immediate and late complications.

PROPTOSIS

Causes of Proptosis

Proptosis is a common cause for referring a patient to a Radiological Department. Some aspects in diagnosis (excluding those due to endocrine causes) will be discussed. A recent paper by Lloyd[1] presented the causes of proptosis in 212 patients (Table I).

TABLE I. CAUSES OF PROPTOSIS*

	No. of cases
Endocrine	46
Trauma and retro-orbital haematoma	17
Orbital cellulitis	7
Intracranial lesions	16
Lesions originating in the nasopharynx or paranasal sinuses	33
Intra-orbital lesions	37
Miscellaneous	15
Patients not yet diagnosed; defaulted or in which no final diagnosis was achieved	41
Total	212

*From Lloyd.[1]

If proptosis following injury or cellulitis is excluded, the causes can be grouped as follows:

(*a*) Intracranial lesions.
(*b*) Lesions of the sinuses or nasopharynx.
(*c*) Intra-orbital lesions.

Suspected intracranial lesions can be diagnosed on the plain films or by carotid angiography. If these investigations are negative then an intracranial cause for the proptosis is unlikely.

Lesions of the sinuses or nasopharynx can nearly always be diagnosed on plain films (and tomography if necessary) (Fig. 3).

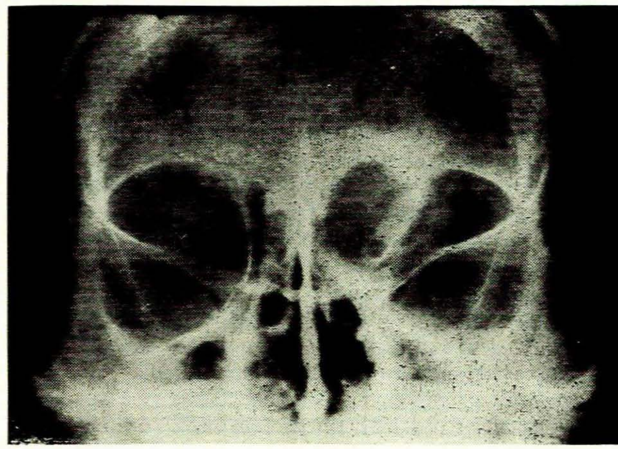

Fig. 3. Proptosis of left eye due to a fronto-ethmoid mucocele.

The most difficult group are the intra-orbital lesions, with their diagnosis on plain films, tomography, contrast orbitography, carotid angiography and orbital venography.

Plain Film Changes

Lloyd[1] also gave a classification of the plain film changes to be seen (Table II).

TABLE II. PLAIN FILM CHANGES

1. Enlargement of the orbit: A—Local
   B—General
2. Bone destruction: A—Localized, clear-cut
   B—Diffuse osteolysis
3. Increased bone density
4. Calcification
5. Enlargement of the superior orbital fissure
6. Enlargement of the optic foramen

Enlargement of the orbit. A local enlargement of the orbit usually results from a lesion outside the muscle cone and indents the orbital wall. Any mass could do this if it were present for long enough, but in Lloyd's series a benign growth of the lacrimal gland was the commonest cause. Generalized enlargement of the orbit is seen in long-standing lesions causing a raised intra-orbital pressure, similar to intracranial lesions resulting in a raised intracranial pressure. One of the earliest changes is depression of the floor of the orbit below the infra-orbital margin.

Oblique and transverse measurements are of little value as exact reference points are not easy to determine; but the heights of the orbit are relatively easy to compare. This measurement is taken from the highest point on the roof of the orbit to the lowest part of the floor, ignoring the infra-orbital margin. From these measurements Lloyd[1] concluded that there is no increase in height in unilateral exophthalmos of endocrinal origin; but any increase in height of 2 mm or more indicates an intra-orbital, space-occupying mass.

Bone destruction. Localized bone destruction with a clear-cut margin may indicate an intra-orbital dermoid or epidermoid.

Diffuse bone destruction is usually due to neoplastic invasion of the orbital bones from direct spread (e.g. lacrimal gland neoplasm) or invasion by tumours from sinuses or nasopharynx; but metastases from distant sites may occur.

Increased bone density. Associated with unilateral proptosis, this can be due to fibrous dysplasia, chronic osteitis, meningioma of the lesser wing of the sphenoid or osteoplastic secondaries from distant sites. This last group can be resolved by skeletal survey.

Intra-orbital calcification. Intra-orbital calcification associated with exophthalmos may be due to phleboliths which are often associated with varices. Phleboliths can also occur in the cavernous spaces of haemangiomata.

Enlargement of the superior orbital fissure. Proptosis with enlargement of the superior orbital fissure has been seen due to neurofibromatosis, infraclinoid aneurysm of the carotid artery and cavernous haemangioma.

Enlargement of the optic foramen. There is a variation in the shapes of normal optic foramina, even in the same patient. At birth the diameter is about 4 mm.[2] It increases to 5 mm at 6 months and is adult-size ($5\frac{1}{2}$ - 6 mm) at 5 years. Unilateral enlargement of the optic foramen *per se* is usually due to tumours of the optic nerve.

Arteriography

Carotid arteriography is a most useful procedure in that it provides information not only in local orbital conditions, but also in those intracranial and cerebrovascular lesions in which the signs are primarily or predominantly related to the eye. As many as 10% of individuals with intracranial tumours may present to the oculist or ophthalmologist with defective vision, double vision, headache or protrusion of one or both eyes.[3] Carotid arteriography is indicated in most cases of proptosis in which the cause is not evident clinically or on plain X-rays.

Technique. To obtain optimum information from this investigation when an orbital abnormality is suspected, the standard frontal and lateral views are supplemented by a modified axial view and by lateral macro-arteriography. The technique and value of these additional views are fully discussed by Lloyd.[4]

Subtraction greatly enhances the diagnostic value of these films and is considered essential for the recognition of smaller branches of the ophthalmic artery and lesser degrees of a tumour circulation. The ophthalmic artery can be demonstrated in virtually 100% of cases[2] but the degree of visualization varies. Elective internal-carotid injection and rapid serial films improve visualization[5] as do subtraction studies.

Anatomy. The anatomy and angiographic anatomy of the ophthalmic artery have been well described.[2,6-8] It should be noted that there is a considerable normal variation in position, branching and size of the ophthalmic artery which limits the value of ophthalmic arteriography in localizing small masses.[10] It is also difficult to identify individual branches of the ophthalmic artery. The vascular plexus in the choroid can often be recognized as a sharp curvilinear crescent—and marks the posterior aspect of the globe.

Diagnosis. The conditions which may be diagnosed by arteriography may be grouped as follows:

(a) *Orbital lesions.* Orbital tumours may show enlargement, occlusion or displacement of the ophthalmic artery and/or a pathological circulation. As regards displacement, this may be difficult to evaluate for the artery pursues a somewhat tortuous course to accommodate eyeball movement, so that displacement must be reasonably pronounced to be significant.[5] The pathology of a tumour may sometimes be deduced from the nature and pattern of the tumour circulation.[11] Ophthalmic artery aneurysms, although uncommon, are readily shown by arteriography.

(b) *Intracranial masses.* Virtually any intracranial mass may present with eye signs. Periorbital meningiomas (which often derive part of their blood supply from branches of the ophthalmic artery) and parasellar tumours, which are perhaps better diagnosed by air-encephalography, are examples of intracranial tumours which produce proptosis.

(c) *Cerebrovascular lesions.* Lesions causing eye signs demonstrable by carotid arteriography include aneurysms (infraclinoid aneurysms are a not uncommon cause of proptosis), caroticocavernous fistulae and occlusions of both the internal carotid artery and its intracranial branches and the vertebrobasilar system. Non-occlusive cerebrovascular disease (i.e. atheromatous degeneration) may also present with eye signs.

Orbital Phlebography

This examination has gained in popularity in the past few years; it has the advantage of ease of technique and virtually no risk. The technique and anatomy have been well covered in recent articles.[12,13] The greatest difficulty is the frequency with which non-filling of the affected side occurs and this, of course, vitiates the procedure. To overcome this a more forceful injection of a larger amount of contrast has been recommended,[1] but this has seldom been successful in our hands. We have tried diverting the contrast to the affected side by appropriate compression (over the glabella) but this also has not always been satisfactory. On the lateral series the two superior ophthalmic veins overlap, and for this reason Lloyd[1] has substituted a modified axial view for the lateral film. However, the lateral view can be of value in showing asynchronous filling or displacement, and so we have retained this view, and circumvent overlap by moving the patient to a slightly oblique position. Alternatively suitable compression allows unilateral filling on occasions.

Phlebography is of value: (*i*) in demonstrating venous orbital lesions—varices, venous haemangiomas and ophthalmic vein thrombosis, and (*ii*) in the investigation of orbital masses and unilateral proptosis. A striking example of the value of phlebography in a case of benign neurofibromatosis is shown in Fig. 4.

Pneumo-encephalography

In children with diminished vision and optic atrophy, arteriography is of less value than air-encephalography, as

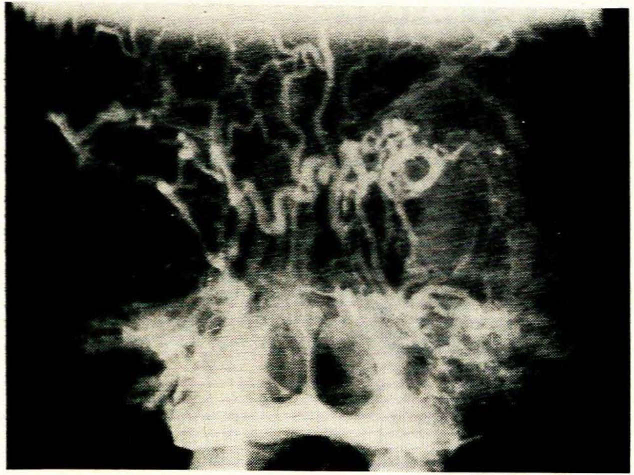

Fig. 4. Extensive venous abnormality in case of benign neurofibromatosis.

vascular malformations and perisellar aneurysms are not common causes of these lesions in this age-group. The value of air-encephalography in detecting ventricular dilation and suprasellar lesions is undoubted. Sellar and parasellar lesions may present on the plain films but air-encephalography may fully demonstrate such lesions as optic glioma, craniopharyngioma, solid third ventricle gliomas, suprasellar dermoids, teratomas, and chromophobe adenomas.

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