RECENT ADVANCES IN RADIOLOGY

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THIRD EDITION

by

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To

MY FRIENDS AND COLLEAGUES

J. L. A. GROUT, C.B.E., M.C.

AND

JOHN WILKIE

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PREFACE

WHEN Dr. Peter Kerley, faced with greater tasks, asked the author to undertake that of compiling the present volume, it was felt that it was no longer within the competence of a single individual adequately to survey the whole of modern work in radiology with its many ramifications and its affiliations with so many branches of clinical medicine and research. This edition of "Recent Advances in Radiology" is therefore written rather from the standpoint of the radiologist working in a general hospital, in an endeavour to relate recent work to his particular requirements and problems as opposed to those of the specialist radiologist. Much of importance has, of necessity, been omitted, for example, modern apparatus design and research techniques.

Perhaps the time has now come for a stocktaking in radiology and a consolidation of gains. For this reason and for the sake of giving continuity and perspective to work carried out during the last few years it has been thought advisable herein to refer to work which is not strictly recent but which has an essential place in the development of current radiological thought. The reader's indulgence is accordingly sought for a wide interpretation of the word "recent" in the title of this book which does not pretend to be a summary of all modern work. Inevitably there has had to be considerable selection of subjects for inclusion and undoubtedly this has been influenced to a large extent by the author's particular interests.

The altered status of radiology has promoted a wider appreciation of its value in medicine and a greater measure of co-operation with clinical colleagues in its application. These are the excuses for brief reference to clinical syndromes so that both the clinician and the radiologist may better appreciate the contribution which radiology has to offer in the solution of their mutual problems.

It is never possible to thank all who have helped an author in his task but I would like to acknowledge my debt to Sir Ernest Finch for much encouragement and advice; to Dr. J. L. A. Grout and Dr. J. Wilkie for help in ways too numerous to detail; to Mr. A. L. Watson, Mr. W. H. J. Coombs and the Department of Medical Photography, United Sheffield Hospitals for preparing the illustrations; to Mr. A. S. Foster, medical artist, for lettering and line

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T. LODGE.

Sheffield, 1955.

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CHAPTER I

NEURO-RADIOLOGY

RECENT advances made during and since World War II in the field of neurological radiology are usually thought of as the more spectacular contrast techniques such as percutaneous cerebral angiography. Research at the present time is directed towards the elaboration of safer contrast media for myelography and ventriculography and of contrast substances capable of demonstrating the peripheral nerves. Much has been done, however, in improving the established techniques and in applying them in new ways to the investigation of disorders of the nervous system.

STRAIGHT RADIOGRAPHY OF THE SKULL

The development of rotating anode tubes, finer grain intensifying screens and high ratio moving grids has made possible a greatly improved quality in films of the skull and the radiography of difficult or restless patients has been facilitated by the use of higher milliamperages and high-speed film emulsions. Much can be learnt by an experienced or careful observer from straight radiographs of the skull without recourse to the more elaborate contrast techniques. In this present age of high speed and frequent accidents, fractures of the skull are often sought by radiography. Fractures of the vault are usually demonstrable by the standard examination which consists of, at least, a postero-anterior view, a Towne-Twining projection and either both lateral views or a stereoscopic lateral pair. Fractures of the orbit and anterior fossa require in addition the occipito-mental and optic foramen projections, fractures of the middle fossa the vertico-submental view and fractures of the petrous bone the Stenvers and other special projections. Though films of high quality are essential, they may fail to reveal a fracture even when one is present and often its presence can only be deduced from collateral evidence; for example an opaque antrum due to hæmatoma may be due to a concealed fracture of the maxilla and the only evidence of fracture of the malar bone may be a widening of the fronto-malar articulation on the affected side.

RADIOLOGICAL EVIDENCE OF INTRA-CRANIAL DISEASE

In the diagnosis of intra-cranial lesions, straight radiography of the skull may provide essential information in the following ways:—

Changes in the Vault

Widening of the sutures or deepening of the convolutional impressions denote raised intra-cranial pressure in infants. Convolutional

FIG. 1. Cholesteatoma of skull. The patient presented with neurological symptoms.

impressions are a normal feature in infants and may persist with varying degrees of visibility certainly to the age of six and probably to the early teens. A marked accentuation producing the so-called "beaten-silver" skull is always pathological. Cranial hemi-atrophy or an asymmetrical skull is frequently the result of cerebral aplasia or porencephaly. Thickening of the outer table and the pericranium may be the late result of an old cephalhæmatoma whilst a small percentage (about 5 per cent) of subdural hæmatomata calcify and give the impression of a fusiform thickening of the inner table. Tumours close to or involving the cranial convexity may produce

either sclerosis or osteoporosis according to whether they stimulate bone production or directly invade and erode the bone. Such tumours are usually meningiomas of which further evidence may be seen in the form of deepened arterial or venous grooves, when the tumour is a very vascular one. Secondary deposits from tumours elsewhere in the body usually produce round osteoporotic areas in the skull (a common source of tumour metastasising to the skull is carcinoma of the lung or breast) but new bone formation is sometimes seen in the form of sun-ray spicules in deposits from neuroblastoma of the supra-renal. Primary bone tumours are rare in the cranial vault except in the anterior fossa or a sarcoma superimposed on osteitis deformans. Hæmangiomas, cholesteatomas and giant cell tumours have been reported. Fig. 1 shows a cholesteatoma (epidermoid). Multiple small rarefactions in the skull are encountered in myelomatosis, leukæmia of childhood and hyperparathyroidism. Paget's disease (osteitis deformans) may be revealed in the skull, which is one of the classical sites according to Brailsford, either by general thickening, multiple round woolly patches of sclerosis or by large areas of osteoporosis—the so-called osteoporosis circumscripta. Changes in the frontal sinuses may be significant; they may be small or absent in Kartagener's syndrome or enlarged in acromegaly.

Changes in the Base

An infrequent finding in osteitis deformans affecting the skull is that of basilar impression or platybasia in which the bone around the foramen magnum is displaced upwards into the skull and the base is deformed. The most important structures of the base of the skull from the viewpoint of radiographic diagnosis are the sphenoid and petrous temporal bones. The latter is best seen in the Towne, vertico-submental and Stenvers projections and is the site of acoustic neuroma, the characteristic sign of which is widening and erosion of the internal auditory meatus on the affected side together with evidence of raised intra-cranial pressure, e.g. thinning of the dorsum sellæ. The radiological changes are slight or absent in some 15 per cent of cases but, if no treatment is given, are usually slowly progressive until there is complete destruction of the auditory canal and the apex of the petrous bone. Hodes, Pendergrass and Young described six degrees of radiological changes and claim that 80 per cent of all acoustic neuromas can be diagnosed and localised by radiological examination. The degrees are progressive stages of rarefaction or bone destruction. In a more recent survey of tumours of the cerebello-pontine angle the same authors observe that increased density of the bone adjacent to the lesion is only seen when the tumour

is a meningioma, that gliomas tend not to cause changes in the petrous bone and that cholesteatomas of the cerebello-pontine angle not only erode the internal auditory meatus (in 50 per cent of cases) but also induce changes in the wing of the sphenoid. Lysholm had an experience of 236 operatively verified acoustic tumours of which 90 per cent could be diagnosed accurately on the basis of the bone changes alone.

In the case of the sphenoid bone the important indicators of adjacent or more distant intra-cranial disease are the sphenoidal wings and the sella turcica. Relative overgrowth of the lesser wings compared with the greater is the basic causative factor in the production of ocular hypertelorism (wide-apart eyes). Early changes, consisting of either rarefaction or sclerosis, in the superior margin of the lesser wing may be the first indication of sphenoidal wing meningioma. Changes in the sphenoid give valuable evidence of chronic subdural hæmatomas in children according to Bull (1949) who in a careful and detailed study of the subject pointed out that many such hæmatomas produce elevation of the lesser sphenoidal wing, bulging of the greater wing and increased anterior convexity of the middle fossa. Such changes are best demonstrated on the vertico-submental projection and the postero-anterior projection with 20° tilt towards the feet. The sella plays an even more important part in the diagnosis of intra-cranial abnormalities. The causes are two-fold:— distal obstructions of the ventricular system giving rise to hydrocephalus particularly of the anterior end of the third ventricle and local expanding lesions within, above or close to the sella turcica itself. Twining's famous monograph (1939) on the "Radiology of the Third and Fourth Ventricles" makes it clear that it is not always possible on the basis of the sellar changes alone to differentiate between these two main causative factors. The so-called "ballooning" of the sella may as readily derive from pressure by a dilated third ventricle as from a primary pituitary tumour. The mechanism of sellar enlargement resulting from hydrocephalus is shown in Fig. 2. The anterior end of the third ventricle normally lies about 1 cm. above the sella and when dilatation occurs it extends downwards to touch and finally to enter the sellar recess. First the posterior clinoid processes and later the anterior clinoids become porosed and destroyed by the pressure of the advancing ventricle. These changes are usually only seen in adults and are twice as common as sellar changes due to pituitary tumours. Assessing the importance of this sign, Twining concludes "The sella is the most sensitive radiological index of increased intra-cranial tension which we possess, and no change should be overlooked or passed without comment, simply because

other signs (e.g. widened suture, deepened convolutional impressions, enlarged vascular channels, calcifications, etc.) are absent". Camp classifies the sellar changes due to intra-cranial lesions as erosion, decalcification and bone destruction, and considers that focal erosion may arise from the pressure of an aneurysm whilst local decalcification is often the result of invasion by tumour cells. More marked changes such as gross enlargement, extensive bone destruction and obliteration of the sella were investigated by Epstein and Davidoff who found pituitary adenomas responsible for such changes in 28

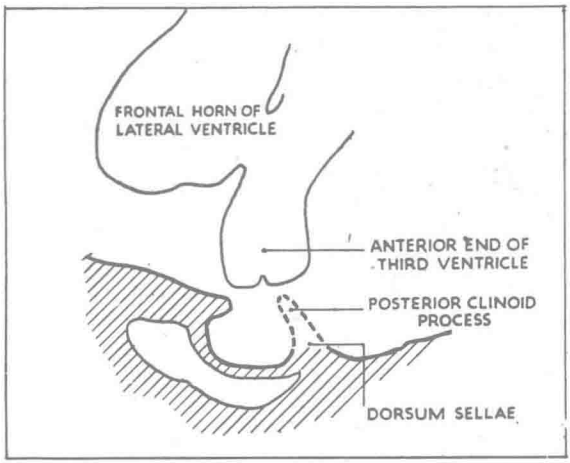

FIG. 2. Diagram showing how a hydrocephalic dilatation of the third ventricle may erode the posterior clinoids and the sella turcica. (Redrawn from Twining).

of their 50 cases. Associated extra-sellar or intra-sellar calcification affords a valuable aid in diagnosis and usually means a craniopharyngioma or an aneurysm.

Intra-cranial Opacities

Though changes in the bony cranium constitute the commonest radiological evidence of intra-cranial disease, it nevertheless sometimes happens that part or whole of the lesion itself may be visualised by reason of calcium deposits within it. Albeit infrequent, calcification when present indicates clearly the site and less often the nature of the lesion. Calcification as an incidental finding without pathological significance is seen in the falx, the pineal body (which thereby becomes an "indicator" in regard to expanding lesions) and the

choroid plexuses of the lateral ventricles, whilst ossification may "normally" be seen in the diaphragma sellæ and the petro-clinoid ligaments. Calcification is never a guide to the size or extent of a tumour or inflammatory lesion which may have calcium in only one portion but it may afford valuable evidence of the type of lesion. Examples are the flakes or round opacities, either cerebral or basal, seen in toxoplasmosis, tuberous sclerosis or after tuberculous meningitis, the "goat's hair" picture in astrocytoma, the curved parallel lines of Sturge-Weber disease, the curvi-linear shadows of carotid aneurysm and cranio-pharyngioma or the boat-shaped opaque cysts of some parasitic diseases.

An exact radiological classification is not possible but calcification has been reported in the following lesions.

TRAUMATIC

Sub-dural hæmatoma: a small percentage calcify.

Convexity or intra-cerebral hæmorrhages due to birth injury.

INFLAMMATORY

Cerebral abscesses occasionally have calcium in their walls.

Tuberculoma very frequently calcifies and when the capsule is calcified the exact size and situation is shown.

Meningitis, particularly tuberculous meningitis, gives rise to calcifications which are seen as plaques or groups of spots situated intra-cerebrally or in the basal exudate. They become apparent between two and three years after the onset of the meningitis and because of the increased survival rate in this condition following the use of streptomycin it may well be that at some future date tuberculosis will be the commonest cause of intra-cranial calcifications (Lorber, 1952).

Toxoplasmosis. Multiple sub-cortical curvi-linear streaks or flakes are seen in this condition and when associated with basal ganglia calcification are practically pathognomonic (Sutton).

PARASITIC

Cysticercosis. When the cerebral cysts become opaque they have a characteristic round or boat-shaped outline and are usually multiple. Often the calcifications in the grey matter of the cerebral hemispheres are too tiny to be radiologically visible during life and their presence in cases of epilepsy has to be deduced from the presence of calcified cysts in the skeletal muscles.

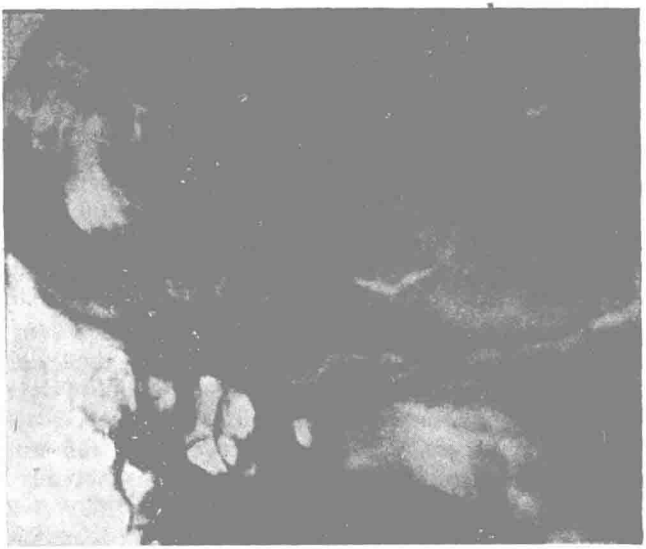

FIG. 3. Basal calcifications following treated tuberculous meningitis. A common situation.

CYSTIC

Cystic lesions of the type usually arising from errors of development may have visible nodules or flakes of calcium, e.g. epidermoids, chordomas, tuberous sclerosis.

Craniopharyngioma or cyst of Rathke's pouch is the commonest of this group. The lesion is seen in the middle fossa in the mid-line either within or just above the sella. The calcifications which are present in a large number of craniopharyngiomas are often in curvi-linear flecks.

NEOPLASTIC

Benign neoplasms are relatively rare but when they occur and especially if they are slow-growing they show a tendency to calcify as in the case of osteomas, lipomas, fibromas and pinealomas.

Malignant cerebral tumours sometimes calcify. The glioma group which constitutes almost half of the intra-cranial neoplasms often show opacities, particularly the astrocytomata and oligodendrogliomata but there is no typical pattern.

Other true tumours in which opacities due to calcium may be seen much less commonly are meningiomas, ependymonas and intracranial cholesteatomas.