The plain radiograph in ophthalmology: a wasteful and potentially dangerous anachronism

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Summary

The indications for 822 consecutive referrals for skull radiography were prospectively studied in a large eye hospital over a one year period. In 85.9% of patients the results were normal, and in 89% of the remainder they had no positive effects on management; all patients in whom a 'beneficial' effect could be identified would have been more appropriately investigated by other means. Fourteen of 25 patients whose skull radiographs were normal were shown by computed tomography or magnetic resonance imaging to have orbital or intracranial lesions. Views of the optic canals, orbits or paranasal sinuses were also requested in 336 patients. With appropriate use of alternative imaging methods, no patient's treatment would have been adversely affected if none of the skull radiographs had been obtained.

Introduction

It is perhaps inevitable that clinicians and radiologists within a specialty develop patterns of investigation different from those used by generalists faced with the same clinical problems. The latter may continue to employ imaging techniques whose lack of utility has led to their being abandoned by specialists, even in circumstances where a more sophisticated procedure is not indicated. Thus, the decline in the use of skull radiographs by neurologists and neurosurgeons[1,2] reflects not only the availability of more specific and reliable methods such as X-ray and magnetic resonance computed tomography (CT, MRI), but also an awareness of the unsuitability of plain radiographs as 'screening tests'. However, in Britain at least, this decline has not been matched by a reduction in the number of patients referred for skull radiography by ophthalmologists. This paper looks at the patterns of referral in a large eye hospital, and assesses the contribution to management of the radiographic results obtained.

Subjects and methods

The study concerns all patients referred for standard skull radiography at Moorfields Eye Hospital, City Road, London in 1988: their age and sex, the source of the referral (ward, outpatient, accident and emergency department or staff), the indication for the examination, and its results as reported by a consultant ophthalmic radiologist.

For the purposes of this study, 'skull radiographs' constituted routine lateral and anteroposterior projections, sometimes supplemented by half-axial and/or basal projections; views of the facial bones (for trauma), optic canals, and orbits, including studies for foreign bodies, were not included, but requests for such special views or further imaging investigations, other than ultrasonography, were recorded.

Indications were classified as visual loss (patients with impaired acuity or visual fields, or those found to have optic atrophy); headache, orbital or periorbital pain; disordered extraocular movements (or diplopia); proptosis or a palpable mass in the region of the orbit; orbitocranial trauma; papilloedema or suspected raised intracranial pressure, and miscellaneous. Each patient was placed in the single most appropriate group.

Results were categorized as normal; irrelevant findings (insignificant congenital variations, trivial and clearly unrelated deviations from normality, etc.); questionable abnormalities; and definite abnormalities, even if not related to the clinical presentation. Recommendations for further radiological studies were noted. The casenotes of all patients whose films were reported as definitely or questionably abnormal were reviewed, to assess the correctness or otherwise of the reports, and their influence on management of the patient. The latter was assessed as beneficial, none or adverse (when radiological or other examinations which subsequently proved unnecessary were engendered, when an incorrect diagnosis was suggested or when appropriate treatment was delayed).

Results

In all, 822 patients were referred for skull radiographs; the numbers of patients from the various departments of the hospital, and the indications for the examinations, are shown in Table 1, and the results, analysed by indication and source, in Tables 2 and 3. No formal report was issued on 29 sets of films; subsequent requests for other examinations did not indicate that those formed a diagnostically significant group. There was no significant difference between the proportions of normal and other reports in patients referred from different sources; visual loss and orbital pain yielded smaller proportions of positive findings (although not of beneficial effects on management), while patients with proptosis or a mass lesion were more likely to show a plain film abnormality; in many cases this took the form of increased soft tissue opacity or other nonspecific findings which did not contribute to management.

Additional radiographs of specific regions of the skull, including views of the optic canals (144 patients), orbits (76), paranasal sinuses (50) or combinations of these, were requested in 336 cases (41%) (Table 4); in about 50 cases radiographs of other parts of the body were also requested, but these were not analysed further.

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Table 1. Indications for skull radiographs

	All	*Clinics*	*A&E*	*Wards*	*Unknown/staff*
Visual failure	404 (49.0)*	301 (54.7)	89 (40.3)	10 (45.5)	3 (10.0)
Pain	107 (13.0)	69 (12.5)	36 (16.7)	—	1 (3.3)
Orbital mass	101 (12.3)	61 (11.0)	37 (16.7)	2 (9.1)	1 (3.3)
Ophthalmoplegia	78 (9.5)	47 (8.5)	29 (13.2)	1 (4.5)	1 (3.3)
Trauma	25 (3.0)	12 (2.2)	10 (4.5)	2 (9.1)	1 (3.3)
Papilloedema	24 (2.9)	13 (2.6)	11 (5.0)	—	—
Miscellaneous	59 (7.1)	43 (7.8)	8 (3.6)	7 (31.8)	1 (3.3)
Unknown	26 (3.2)	4 (0.7)	—	—	22 (73.5)
Total	822	550 (66.9)†	220 (26.8)	22 (2.7)	30 (3.6)

*Percentage of patients from each source referred for given indication
†Overall percentages from each source

Table 2. Radiological results and indications for examination

	Total	*Normal*	*Incidental finding*	*Possibly abnormal*	*Abnormal*	*No report*
Visual failure	404	316 (78.3)*	43 (10.6)	16 (4.0)	28 (6.9)	1 (0.2)
Pain	106	89 (84.1)	7 (6.6)	1 (0.9)	8 (7.5)	1 (0.9)
Orbital mass	101	64 (63.4)	7 (6.9)	2 (2.0)	26 (25.7)	2 (2.0)
Ophthalmoplegia	78	60 (76.9)	7 (8.9)	1 (1.3)	9 (11.6)	1 (1.3)
Trauma	25	20 (80.0)	1 (4.0)	—	4 (16.0)	—
Papilloedema	23	17 (74.0)	2 (8.7)	—	3 (13.0)	1 (4.3)
Miscellaneous	59	39 (66.1)	5 (8.5)	4 (6.8)	10 (16.9)	1 (1.7)
Unknown	26	4 (15.4)	—	—	—	22 (84.6)
Totals	822	609 (74.1)†	72 (8.8)	24 (2.9)	88 (10.7)	29 (3.5)

*Percentage of radiological findings in patients referred for each indication
†Percentages of total

Table 3. Radiological results and source of referral

		Source of referral			
Report	*Totals*	*Clinics*	*A&E*	*Wards*	*Other and unknown*
Normal	609 (73.7)*	417 (75.7)	169 (75.9)	18 (81.8)	5 (16.7)
Incidental finding	72 (8.8)	49 (8.9)	20 (9.1)	2 (9.1)	1 (3.3)
Possible abnormality	24 (2.9)	16 (2.9)	8 (3.6)	—	—
Abnormal	88 (11.1)	64 (11.8)	22 (10.9)	2 (9.1)	—
No report	29 (3.5)	4 (0.7)	1 (0.5)	—	24 (80.0)
All	822	550	220	22	30

*Percentage of radiological findings in patients referred from each source

In the large majority (85.9%) of cases in which a radiological report was issued the skull radiographs rendered no positive information, or showed trivial variants or irrelevant abnormalities. Real or supposed abnormalities in the remaining patients were clearly relevant to the disease under investigation (but not necessarily helpful) in 45 (40%), 24 of whom had clinically evident orbital mass lesions (and were therefore candidates for CT or MRI). None of 24 questionably relevant abnormalities proved significant.

Cranial and/or orbital computed tomography (CT) was subsequently carried out in 25 patients whose plain films were reported as showing no significant abnormality. Relevant lesions were demonstrated in 14 (56%). The data do not indicate the number of additional false negative reports.

The casenotes of the 112 patients in whom a definite or possibly significant abnormality was reported revealed that in 73 (65%) these findings had no evident effect on management; in 27 (24%) any effect was adverse: in 23 (20%) unnecessary examinations were generated, and in 4 (4%) incorrect reports deflected attention from the correct diagnosis, or resulted in delayed treatment (Table 5).

Nine of the 11 patients whose skull films indicated a treatable cause for visual loss were known to have a bitemporal hemianopia before referral to the

Table 4. Additional skull views requested

	Source				
Indication	*Clinics*	*A&E*	*Wards*	*Others and unknown*	*All*
Visual loss	106 (35.2)*	36 (40.4)	3 (30.0)	2 (66.7)	147 (36.4)
Pain	31 (44.9)	10 (27.8)	—	1 (100.0)	42 (39.6)
Orbital mass	42 (68.9)	28 (75.7)	2 (100.0)	1 (100.0)	73 (72.3)
Ophthalmoplegia	14 (29.8)	8 (27.6)	—	1 (100.0)	23 (29.5)
Trauma	6 (50.0)	3 (30.0)	—	—	9 (36.0)
Papilloedema	3 (23.1)	5 (45.5)	—	—	8 (34.8)
Miscellaneous	20 (46.5)	4 (50.0)	—	1 (100.0)	25 (42.4)
Unknown	2 (50.0)	—	—	7 (31.8)	9 (34.6)
All	224 (40.7)	94 (42.7)	5 (22.7)	13 (46.7)	336 (40.9)

*Percentage of patients from this source with given indication for whom extra projections were requested

Table 5. Contribution of abnormal reports on skull films to management

		Effect of abnormal or equivocal report			
Indication	*Number*	*Beneficial*	*None*	*Adverse*	*Unclear*†
Visual loss	44	5 (11.4)*	23 (52.3)	14 (31.8)	2 (4.5)
Pain	9	2 (27.2)	6 (66.7)	1 (11.1)	—
Orbital mass	28	2 (7.0)	17 (58.6)	7 (24.1)	2 (7.0)
Ophthalmoplegia	10	1 (10.0)	6 (60.0)	2 (20.0)	1 (10.0)
Trauma	4	—	5 (75.0)	1 (25.0)	—
Papilloedema	3	1 (33.3)	1 (33.3)	—	1 (33.3)
Other	14	1 (7.1)	11 (78.6)	2 (14.3)	—
Totals	112	12 (10.7)	67 (59.8)	27 (24.1)	6 (5.4)

*Percentage of effects on management in patients with given indication
†Clinical findings appeared to prompt request for CT simultaneously with that for skull radiographs

radiology department, and one had documented chronic progressive unilateral optic neuropathy (Table 6); CT was carried out in all but two cases, apparently lost to follow-up (and presumably treated in other institutions). Plain films and CT were requested simultaneously for many of the patients with proptosis or orbital masses. Apparently significant sinus disease was demonstrated in five patients: two with periorbital pain, one with thyroid ophthalmopathy, one being followed for a known xanthogranuloma and one with an orbital mass which proved to be an abscess. Although the effects of the skull films have been assessed as beneficial, views of the paranasal sinuses had been requested at the same time as the skull radiographs for all five patients.

The reporting of the skull radiographs by the radiologist as definitely or possibly abnormal was commented upon in the casenotes in only 45 of the 112 cases, and acted upon in 27; there were 66 cases in which there was no record that the clinician acknowledged the report.

When plain film findings unquestionably indicated further radiological studies, as in most patients showing signs of a pituitary tumour, the radiologist's report did not necessarily contain a concrete recommendation to that effect. However, in 23 cases with equivocal findings and 11 patients with definite abnormalities, further studies were explicitly suggested. These recommendations were commented upon in the casenotes in 17 (52%) and acted upon in only 15 cases (45%).

Discussion

This survey did not set out to determine the relative accuracies of skull radiographs and other types of imaging in detecting significant abnormalities; such studies are already to hand, and indicate unequivocally the superiority of techniques such as CT and MRI[3-7]. Its purpose was rather one of audit: an exploration of the way in which ophthalmologists use of the skull radiograph has been altered or informed by such studies.

Most striking is that, in addition to the 85.9% of patients in whom skull radiography demonstrated no abnormality, there were another 12.6% in whom demonstration of real or supposed abnormalities made no positive contribution to management; in the large majority of patients in whom skull films showed an unequivocal, relevant abnormality, other techniques (CT or MRI) were clearly indicated on clinical grounds alone and were not avoided by carrying out plain radiography.

In more than half the cases in which the radiographs were reported as suspicious by the radiologist, no further comment was made about this in the casenotes. This often appeared to be because the ophthalmologist (or neurologist) had seen the films (without the radiological report) and decided that they

Table 6. Skull radiographs with 'beneficial' effect on management

Case	*Indication*	*Findings*	*Effect*	*Notes*
1	Visual loss	Pituitary tumour	Surgery	Bitemporal hemianopia
2	Visual loss	Pituitary tumour	Surgery	Bitemporal hemianopia
3	Visual loss	Pituitary tumour	Surgery	Bitemporal hemianopia
4	Visual loss	Pituitary tumour	Surgery	Bitemporal hemianopia
5	Visual loss	Clinoid meningioma	Surgery	Progressive unilateral optic neuropathy
6	Pain	Sinusitis	ENT referral	Sinus views at same time
7	Pain	Sinusitis	Antibiotics	Sinus views at same time
8	Orbital mass	Sinusitis	Surgery	Orbital abscess; sinus views at same time
9	Orbital mass	Bone erosion	Surgery	Rhabdomyosarcoma; clinically inflammation - sinus views at same time
10	Ophthalmoplegia (Graves)	Sinusitis	ENT referral	Sinus views at same time
11	Papilloedema	Pituitary tumour	Surgery	Bilateral papilloedema
12	Other	Sinusitis	Antibiotics	Xanthogranuloma follow up, with skull and sinus views

were normal, or because the findings were clearly irrelevant, eg when a firm diagnosis of glaucoma or cataract had been made. The former course of events is questionable, although only one patient was identified in the present study for whom correct treatment was thereby delayed; in the latter, ignoring even potentially relevant positive findings suggests that 'exclusion' plain films were being requested on a purely routine basis when there was clearly nothing to exclude. The documented tendency of British doctors significantly to underestimate the costs of radiography[8] may contribute to this.

It may be argued that the absence of pathological findings on skull films does indeed contribute positively to management, but this cannot be substantiated. In the present study, more than half the patients referred for CT or MRI after their plain films had been reported as normal were thereby shown to have lesions within the orbits or cranial cavity. These findings are in keeping with earlier surveys, in which less than half of orbital metastases, which involve bone more often than most intraorbital lesions[3] and only 14% of intracranial tumours[4] caused plain film abnormalities. More importantly, the notion that normal plain films effectively exclude mass lesions around the pituitary fossa compressing the visual pathways is potentially dangerous: Moseley *et al.*[5] found that plain radiographs were reported as normal by expert neuroradiologists in three (7%) of 41 cases of pituitary adenomas, 10 (48%) of 21 craniopharyngiomas and six (50%) of 12 of meningiomas causing visual loss in adults - 26% of false negative findings overall; other workers have noted normal appearances in 40% of adults with craniopharyngioma[6] or intracranial meningiomas[7].

Localized projections are not necessarily more informative. A review of 174 patients referred for radiography of the optic canals during the 12 months covered by the present study disclosed no case in which the results contributed positively to management[9].

The inference that all patients with progressive visual loss or eye movement disorders which could be due to compression, particularly with a classical bitemporal hemianopia, with papilloedema or with proptosis, etc, should have the benefit of a more reliable test than skull films, and that the latter be used only when it is necessary to elucidate abnormalities on, for example, CT[10] is inescapable. If these guidelines had been followed, and films of the paranasal sinuses only had been obtained as indicated clinically, none of the patients in the present series would have been adversely affected.

These comments do not necessarily apply to the use of special projections for demonstration of facial fractures, simple imflammatory sinus disease or possible intraocular foreign bodies, although their contribution to management is frequently negligible. The custom of obtaining plain films of the skull and/or orbits in patients known to have orbital or periorbital masses, even when CT was (or would be) available, is largely historical and in decline. Once again, selective use of plain films to clarify certain aspects may still occasionally be desirable.

It can be concluded that:

(1) skull radiographs (excluding views of the paranasal sinuses) very rarely contribute positively to management except in patients (with evident orbital mass lesions, papilloedema or highly suggestive patterns of visual loss) for whom other investigations are essential on clinical grounds, whether or not the plain films show an abnormality;

(2) lack of clinical follow up of reports of other radiographic abnormalities suggests that many skull radiographs are requested purely as a wasteful routine;

(3) reliance on negative findings on plain radiographs is confirmed to be potentially dangerous; and thus

(4) that plain skull radiographs have no useful role in ophthalmology.

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