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INTRACRANIAL CAUSES OF HEADACHE *

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Causes of Head Pains

The causes of pains in the head are customarily, and for diagnostic purposes conveniently, grouped on an essentially anatomical basis:

1. *Intracranial*—namely, diseases of the brain and meninges.
2. *Cranial*—namely, diseases of the skull bones and the enclosed air sinuses.
3. *Extracranial*—namely, diseases of the scalp. For example, fibromyositis of the occipito-frontalis muscle or its aponeurosis: trigeminal, spheno-palatine (Sluder's), and occipital neuralgias; herpes supra-orbitalis; temporal arteritis, etc.
4. *Reflex*, from diseases of the eyes, teeth, and nose, though nasal causes might produce their effect through the air sinuses—for example, by inflammatory changes spreading to them or the production of so-called "vacuum" headache.
5. *Toxic*: the source being (a) exogenous—for example, alcohol, tobacco, lead, poisonous fumes, CO₂, etc.; or (b) endogenous—for example, uraemia, constipation, fevers.
6. *Migraine*: an incomplete diagnosis signifying a syndrome—that is, a constantly recurring group of symptoms—which is the clinical expression of a disturbed mechanism common to many pathological states. It merits a separate category because the syndrome itself is significant even when the exciting cause remains unmasked (cf. epilepsy).
7. *Psychogenic*—occurring in psychoneuroses, psychoses, and exhaustion states.

This paper is concerned chiefly with the first and sixth groups. Let me stress at the outset that headache is a symptom unaccompanied by specific physical signs capable of quantitative assessment. Hence in any given case in which headache is the presenting symptom we are dependent on the patient's descriptive powers for a knowledge of: (1) its *site and duration*, which are often vague, especially in retrospect; (2) its *character*, including its quality; its mode of onset and decline; whether it is constant, intermittent, or subject to paroxysmal exacerbations; the circumstances which aggravate or alleviate it—an accurate description of which often defeats the verbal resources of even the more intelligent of patients; and (3) its *intensity*, which varies not only with the severity and rate of development of the cause but also with the patient's threshold for pain—the same noxious stimulus in one patient producing "slight

headache," in another "excruciating pain." Hence the patient's account of headache may be of little diagnostic value, and it is not surprising that a recent annotation in the *British Medical Journal* (May 6, 1939, p. 929) should speak of headache as "a symptom which has for long been one of the commonest, most unintelligible, and most intractable with which the practitioner has to deal." While it is true that few human beings can claim never to have suffered from headache, recent advances in therapeutics, both medical and surgical, have rendered many types more amenable to treatment, and recent observations, both experimental and clinical, have thrown considerable light on the mechanism of production of headache. This knowledge is of fundamental importance for a proper understanding of the problem under discussion. It is to-day beyond reasonable doubt, for example, that the mechanism of cardiac pain is the same—myocardial anoxia—whether the pathological cause be coronary thrombosis, angina of effort, myocardial fibrosis, or profound anaemia. If it could be demonstrated that the mechanisms of headache were similar, whether brought into play by a systemic disturbance such as fever, or local intracranial lesions such as injury, inflammation, tumours, etc., we should then be led to the significant conclusion that there is no type of headache which is of itself pathognomonic of an intracranial lesion, and we should have to look to other characters of the headache—its site, intensity, mode of evolution, the circumstances which affect it, and associated symptoms and signs—to suggest not only its intracranial origin but the nature of the causative lesion. To examine this problem as it affects all head pains exceeds the scope of our immediate inquiry. I propose, therefore, to confine myself to a consideration of certain pertinent questions.

1. How often does Headache indicate Organic Nervous Disease?

Physicians with differing special interests will give widely varying answers to this question. Spriggs found organic nervous disease in twenty-six out of 500 patients with chronic headache. Of my last 500 patients in whom headache was a dominant symptom, ninety-six were suffering from organic nervous disease. Doubtless the neurologist would find an even larger proportion among his patients. It is thus only a relatively small number of sufferers from chronic headache who are the victims of organic intracranial disease.

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2. Of what Intracranial Lesions is Headache a Common Presenting Symptom ?

At some time in their evolution all intracranial lesions may be associated with headache. In some, however, headache is a dominant and often the presenting symptom; in others it is merely incidental and overshadowed by other symptoms and signs. For reasons which will become clearer as our argument develops it is useful to classify the former group as follows:

Group I.—Those which trespass on the space occupied by normal intracranial structures ("expanding lesions"): (a) "*tumours*"—namely, neoplasms, cysts, abscesses, aneurysms, granulomata, subdural haematoma, hyperostosis interna frontalis, etc.; (b) *swelling of the brain itself* due to oedematous and inflammatory changes (for example, encephalitis, disseminated sclerosis, etc.), vascular lesions such as haemorrhage and thrombosis, injuries with resulting haemorrhages and oedema.

Group II.—*Meningeal irritation*, by inflammatory exudate (that is, meningitis of all types, whether acute or chronic), haemorrhage into the subarachnoid space, and cancer cells (as in meningitis carcinomatosa).

Group III.—*Disease of the cerebral arteries*—cerebral arteriosclerosis, syphilitic endarteritis, hypertension, etc.

Group IV.—A miscellaneous group with no demonstrable gross pathology—for example, post-traumatic headaches, migraine, and epilepsy.

Much overlapping will be detected in this grouping. A cerebral tumour is not infrequently associated with haemorrhage and oedema; trauma with a subdural haematoma or intracerebral haemorrhage, and so forth.

In relation to this classification three points are worth stressing. First, that the more rapid the development of the causative pathological lesion the more intense is likely to be the accompanying headache. Secondly, that the earlier and more marked the interference with the circulation of the cerebrospinal fluid, the earlier in onset and more intense is the associated headache. For example, while headache is the presenting symptom in 90 per cent. of patients suffering from tumours of the posterior fossa, in only 33 per cent. of supratentorial tumours is it the initial complaint. The former early obstruct the outflow of cerebrospinal fluid from the fourth ventricle and cause internal hydrocephalus. Moreover, patients with temporal lobe tumours, which more easily disturb the third ventricle, complain of headache as their initial symptom much more frequently than patients with frontal lobe tumours, where the circulation of the cerebrospinal fluid is unlikely to be disturbed in the early stages. And thirdly, whilst in adults the skull is a closed and, for all practical purposes, an inexpandable box, in children expansion of the cranium is possible before closure of the sutures, hence space-occupying lesions may not so grossly disturb intracranial pressure relations.

Before considering the significance of our classification, let us turn to the third question.

3. What Varieties of Headache may be Found Associated with Intracranial Pathology ?

There are four varieties of headache commonly complained of by patients suffering from intracranial disease.

Type 1.—A pain vaguely described as dull or throbbing, but sometimes as a "sharp stab," "bursting," or "splitting" pain. It is usually felt "inside the head," and the localization is indefinite, though during an attack, which is the best time to determine its site, it may be described as unilateral, frontal, occipital, or temporal. It is usually worse on waking, and careful questioning will

often reveal that the exciting factor at this time is the sudden turning over in bed or sitting up. Its most characteristic feature is its aggravation by coughing, sneezing, stooping, or straining at stool, and often each pulsation of the heart, or on walking each step, gives a "thump in the head." Usually jugular vein compression aggravates though carotid artery compression eases the pain. It may be constant or intermittent, but paroxysmal exacerbations occur, and with these projectile vomiting is not uncommon. *This type of headache is complained of most commonly in "expanding lesions" of the brain.* Even when remote areas of the brain are affected the pain is usually referred to the forehead. If unilateral it is on the same side as the lesion in about 75 per cent. of cases; in 10 per cent., however, it is referred to the side opposite to the lesion. Occasionally we encounter attacks of sudden excruciating generalized pain "as if the head were going to burst." These come like a bolt from the blue and attain their maximum intensity within a few seconds, during which time the patient is quite uncontrollable and not infrequently semi-conscious. The attacks last a varying period, from a few seconds to a few minutes, and disappear quite rapidly. They are sometimes accompanied by vomiting and are usually followed by profound exhaustion. From such descriptions as I have been able to elicit this type of attack is simply an acute and intensely severe, if transitory, exacerbation of the type above described. Though rare, it is almost invariably associated with tumours, especially of the posterior fossa, and is a symptom of grave import because it indicates foramenal or tentorial crowding.

Type 2.—A sharp pain at the back of the head and radiating down the back of the neck, but which is referred also to the temporal and frontal regions and is accompanied by rigidity of the retronuchal muscles. It is aggravated by movements of the head and attempted flexion of the neck. This type of pain is seen in its most acute and severe form in basal subarachnoid haemorrhages which extend into the posterior fossa and irritate the medulla and upper cervical cord. It is also an almost constant accompaniment of all forms of meningitis. It occurs in about 50 per cent. of posterior fossa tumours and in about 25 per cent. of supratentorial tumours. Occipital neuralgia and neuritis are associated with a similar type of pain. In occipital neuralgia, however, there is a long-standing history of paroxysms of shooting pains with completely free intervals; neither neck rigidity nor fronto-temporal radiation of the pain accompanies a simple neuralgia. Where, however, an occipital neuritis results from vertebral disease or cervico-occipital fibromyositis, though the accompanying pain has neither frontal nor temporal radiation, limitation of neck movements might be present. This rigidity, however, differs from that of meningeal irritation both in its type and in its extent. The rigidity of meningeal irritation is confined to the extensor muscles of the neck, giving rise to neck retraction and to Kernig's and Brudzinski's signs; vertebral rigidity limits neck movements in all directions; fibromyositis causes pain on attempted stretching of the affected muscles. Moreover, the local tenderness and other evidences of spondylitis and fibromyositis serve easily to distinguish meningeal from extracranial causes of neck rigidity.

Type 3.—The *migrainous* type of headache—namely, a recurring paroxysmal headache often, though not necessarily, unilateral, accompanied by nausea, vomiting, dizziness, and frequently preceded by disturbances of vision or other sensory and motor auras. Between the attacks the patient is free from headache, but during the attack the pain corresponds to that of Type 1.

A fourth type, which not infrequently accompanies pituitary tumours, is that of a dull ache, usually frontal and temporal, rarely spreading to the occiput, and associated with *neuralgic pains radiating to the eyes, eyebrows, or face*. This neuralgic element is thought to be due to direct involvement of the upper roots of the fifth nerve. Its first component does not differ from the pain described as Type 1; hence it does not merit differentiation into a separate type, and we can therefore limit our clinical description of the headache found in intracranial lesions to three types.

Correlation of Types and Lesions

When we tabulate these types and the intracranial lesions with which they are associated, a significant correlation becomes evident. Type 1 is commonest in Group I lesions—the “space-trespassing” group; Type 2 in Group II lesions—the “meningeal irritation” group. Type 3 is commonest in vascular lesions, especially intracranial aneurysms, cerebral arteriosclerosis, hypertension, and the migraine of allergic, endocrinous, biliary, etc., origin. All three types of headache (and this is to be specially noted in regard to migraine) are consistent with, though not necessarily indicative of, gross intracranial pathology. All types have been found on occasion associated with cerebral tumours, abscesses, encephalitis, thrombosis, head injuries, etc. Yet all have occurred in the absence of demonstrable cerebral pathology, thus suggesting that the essential mechanisms are functional and not dependent on an irreversible structural change.

The mechanism of Type 2 headache is clearly related to irritation of the meninges: a knowledge of the nerve supply to the meninges and meningeal vessels suggests that pain is referred to the skin areas supplied by the same sensory nerves (frontal, facial, and temporal pain arising from the fifth nerve which is distributed to the anterior and middle fossae; occipital and retrorhinal pain from the upper cervical roots which supply the posterior fossa) and that the accompanying retrorhinal rigidity owes its origin to an accompanying sensori-motor reflex. Direct irritation from pressure of the brain (for example, in internal hydrocephalus), or of a tumour itself, might cause similar “meningeal” pain. This type of pain can, as Northfield suggests, be regarded as analogous to somatic pains elsewhere in the body in that their characters (sharp, stabbing, and continuous) are similar and accurate localization is in both cases possible (cf. the pain of peritonitis, pleurisy, and pericarditis). When we analyse migraine (Type 3) we find that the headache component corresponds in all respects to Type 1. What serve to differentiate migraine as a syndrome are the auras, the paroxysms, the common hemicrania, the short duration, and the free intervals.

It is tempting to regard the headache of Type 1 as being the expression of increased intracranial pressure and the resulting irritation of the dura mater. Indeed, until very recently this view was generally held. It was known that the cerebrospinal fluid pressure in this type of headache is usually high and that factors increasing intracranial pressure cause exacerbations of the headache. But similar headaches are found with low or normal cerebrospinal fluid pressures. In 15 to 20 per cent. of intracranial tumours the ventricular pressure is not raised. After lumbar puncture a headache clinically similar in all respects to Type 1 not infrequently develops. The experimentally induced headache following histamine injections occurs after the cerebrospinal fluid pressure, transiently raised following the injection, has returned to normal. Hence it seems likely that both high and low cerebro-

spinal fluid pressures may bring into play the mechanism responsible for Type 1 headache.

The most recent work points to the sources of pain being closely related to the intracranial arteries and the dura mater around the large venous sinuses, and that “an abnormal state of tension in the walls of the cerebral blood vessels causes headache.” It is, however, useful to pursue Northfield’s suggestion further and regard Type 1 headache as corresponding to a visceral pain. On the analogy of cardiac pain I would postulate that the main factor producing Type 1 headache is cerebral anoxia, and that any condition which interferes with adequate oxygen utilization by the brain may result in this type of headache. I have not the space to pursue this conception in greater detail, and I am aware that oxygen deficiency itself may disturb vascular tone, but I would stress the striking benefit which results from oxygen administration in all forms of Type 1 headache (especially migraine and hypertension) and often in meningeal headaches—for example, after encephalography.

On this view all headaches of Type 1, whether the cause be general or intracranial, are an expression of a similar mechanism. Hence the description of the quality of this headache *per se* is not of great diagnostic significance. The features which suggest that a Type 1 headache might be associated with intracranial disease are: (1) its *site* (especially predominantly hemicranial); (2) its *course* (especially if progressively intense); and (3) accompanying signs of (a) *increased cerebrospinal fluid pressure* (papilloedema and manometry), (b) *focal nerve signs*—irritative and paralytic, or (c) *Type 2 headache*.

To summarize: (1) Type 2 headache invariably points to an intracranial lesion associated with meningeal irritation by blood, inflammatory exudate, neoplastic cells, parasites, cyst fluid (for example, hydatid), or direct pressure. (2) Type 1 headache might be due to any general or intracranial lesion which leads to cerebral anoxia. An intracranial origin is suggested not by the description of the headache but by the associated symptoms and signs.

A few words must be added on migraine, epilepsy, and post-traumatic headaches. The focal auras of migraine which precede the hemicrania by a variable though short period may be accompanied by phenomena of angiospasm and relieved by alleged vasodilators (for example, ergotamine tartrate); but for the headache which follows, if the attack is not aborted in an early stage, these drugs are of no value, though the inhalation of oxygen (100 per cent.) will in most cases give complete relief. Similar beneficial effects have been observed after giving oxygen in post-epileptic headaches. The headache following trauma often has a Type 2 component, though Type 1 is dominant. The relief from post-traumatic headache which occasionally follows air injection into the subarachnoid spaces may be the direct result not only of the breaking down of meningeal adhesions but also of preventing traction on the smaller cerebral arteries by these adhesions, with resulting alterations in vascular tone.

A Scheme for Investigation of Patients

On the basis of the above observations it is possible to formulate a scheme for the investigation of the patient in whom headache is a dominant and early symptom. It must aim at providing answers to three questions: (1) Is an intracranial lesion present? If so, (2) what is its site? and (3) what is its nature?

In the first instance a careful *anamnesis* is essential, for in most cases it will provide the major evidence on which

the presence of an intracranial lesion is suspected. We must inquire closely into how long headaches have been present and how often they recur. What is their site, duration, intensity, and character? Are they improving or becoming worse? Is there an aura? Does a late meal, fatigue, worry, or excitement precipitate an attack? Are they related to the menses? Is there a family history of similar headaches, of hay-fever, asthma, eczema, or urticaria? Does heat relieve and cold aggravate? Is the scalp tender to touch? (If so, a "rheumatic" cause is likely.) Does reading bring on the headache? Have glasses relieved them? Is the nose stuffy before the attack? Has there been a recent cold? Is there a nasal discharge? These and a host of other questions may be put, and a correct interpretation and assessment of the answers will almost invariably guide the physician to the seat of the trouble.

Next a careful *clinical examination* should be carried out. It must in all cases include an examination of the fundi for papilloedema, retinitis, arteriosclerosis, choroiditis, etc., and a detailed examination of the central nervous system for evidence of focal disease, increased intracranial pressure, meningeal irritation, etc. Palpation and auscultation of the skull must never be omitted. If necessary, the assistance of an ophthalmologist to exclude local ocular causes—for example, errors of refraction, impaired ocular muscle balance, glaucoma, etc.—and of a throat specialist to exclude causes in the nasopharynx, sinuses, and ears must be sought, though the unmasking of unsuspected pathology in these sites does not necessarily reveal the cause of the headache. In my experience careful questioning will usually decide whether a headache has an ocular or a sinus origin: the characteristics of these headaches do not resemble those we have described as occurring in intracranial lesions. The occurrence of meningitis and cerebral abscess as a complication of sinus disease and otitis must be remembered. Physical examination will include also a search for cardiovascular sclerosis, hypertension, toxæmias, etc.

Accessory Methods of Investigation

If the suspicion of an intracranial lesion is raised, accessory methods of investigation might have to be undertaken. Of these, two are of prime importance: first, an examination of the *cerebrospinal fluid*; secondly, *radiological investigation*. If a tumour is suspected, lumbar puncture must not be lightly undertaken, because of the danger of foraminal or tentorial crowding. In all cases the cerebrospinal fluid pressure should be measured; and a full chemical and bacteriological examination will usually show characteristic changes where meningeal irritation or infection is present. Syphilis, subarachnoid haemorrhage, uraemia, lead encephalopathies, etc., often produce pathognomonic changes in the fluid. X-ray examination of the skull and sinuses has become a routine in the investigation of chronic headache. Contrast radiography (after the injection of air into the subarachnoid space or ventricles, or, when aneurysms are suspected, after the injection of thorotrast into the cerebral arteries through the common carotid) is a measure of growing importance, but should be undertaken only by the expert.

In coming to a decision about the *nature of the intracranial lesion* responsible for headache the physician will consider the age of the patient; the site of the lesion; the duration and mode of evolution of the symptoms; evidence of disease elsewhere—for example, syphilis, scar of radical mastectomy, neurofibromatosis, etc.—all of

which lesions might have accompanying intracranial pathology; and accessory tests—serological, cutaneous, blood and cerebrospinal fluid examinations, auscultation of the skull, and radiography. A detailed consideration of the significance of these is beyond the scope of my contribution.

Conclusion

I have attempted to formulate the principles which should govern the diagnosis of the intracranial causes of headache, with special emphasis on that aspect of the problem which confronts the general physician. The commoner pitfalls should be avoided by remembering

1. That headaches which are progressively severe or recur in paroxysms of increasing frequency and severity, and are accompanied by dizziness, vomiting, mental deterioration, epileptiform attacks, or focal nerve signs, must be regarded as due to organic brain disease until the contrary is proved.
2. That the onset of migraine after the age of 40 should arouse the suspicion of gross intracranial disease. The most commonly associated lesions are cerebral tumour, syphilis, and hypertensive cerebral arteriosclerosis.
3. That migraine constantly localized to the same side and followed by ocular paresis is almost diagnostic of a basal intracranial aneurysm.
4. That recurring attacks of so-called cyclical vomiting in children, if accompanied by a severe headache, usually indicate a posterior fossa tumour.
5. That the diagnosis of a "psychogenic headache" is often the refuge of the diagnostically destitute. It should be the last and not the first suspicion, and the diagnosis must be based on positive evidence, not solely on "the absence of any evidence of organic disease."
6. That an intracranial lesion, even a tumour, may run its course without at any time giving rise to a complaint of headache.

Summary

The customary classification of the causes of head pains is given.

The following questions are considered: (1) How often does headache indicate organic nervous disease? (2) Of what intracranial lesions is headache a common presenting symptom? (3) What varieties of headache may be found associated with intracranial lesions?

From an analysis of the clinical histories two types which finally emerge are reviewed.

Migraine, epileptic, and post-traumatic headaches are discussed.

A scheme is formulated for investigation of the patient in whom headache is a dominant and early symptom.

Small-pox Vaccination.—The intradermal injection of vaccinia virus which has been cultivated in a medium containing chick embryo tissue produces no untoward reaction and a considerable though possibly not fully adequate degree of immunity. It is suggested that this proceeding should be applied six to twelve months before ordinary dermal vaccination with calf-lymph virus in order to minimize the undesirable effects which the latter may cause. The authors resent the attitude which regards an extensive vaccination scar as a "badge of health"; such a scar is not only unnecessary but gives a sense of security which with the lapse of time ceases to be justified.—Amount and Duration of Immunity induced by Intradermal Inoculation of Cultured Vaccine Virus. T. M. Rivers, S. M. Ward, and R. D. Baird.—*J. exp. Med.*, June, 1939, 69, 857.