"ANGINA CAPITIS"

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A HUNDRED consecutive cases of headache due to refractive errors were collected with the object of investigating the mechanism by which ocular headaches arise. Headaches caused by many other conditions of the body such as rheumatism are often found associated with a refractive error. In each of the 100 cases, however, the aetiological significance of the refractive error was established on the criterion that the headache was cured by the use of a correcting glass.

The commonly accepted mechanism of ocular headache is that it is a reflex pain due to the stimulation of the endings of the nasal branch of the ophthalmic division of the 5th cranial nerve being reflected along other divisions of this nerve. Thus changes in the eyeball are felt as pain in the region of the brow because the excitation is reflected so as to appear to come from the supra-orbital nerve; or as pain deep in the skull because the excitation is reflected so as to appear to come from the dural branches of the 5th cranial nerve.

A study of the facts, however, suggests a possible different mechanism.

The 100 cases divide themselves, according to the varying lengths of the eyeball, the varying curvatures of the corneal surface, and the senile condition of the accommodating mechanism, into (1) Hypermetropia, (2) Myopia, (3) Hypermetropic Astigmatism, (4) Myopic Astigmatism, and (5) Presbyopia. In these cases the part of the eye chiefly affected is the ciliary muscle. It is the main mechanism whereby the eye as a refracting medium can be so altered as to focus, or to endeavour to focus, on the retina incident corneal rays which otherwise, because of the refractive errors, would not be so focused. Abnormal use of the ciliary muscle must then be considered to be the stimulus for the reflex headache as it is the only condition in the eye which is common to all the headache-producing conditions mentioned above. The facts, first that this muscle consists of smooth unstriated muscle fibres, and secondly that the referred pain is in many cases, as will be shown later, felt outwith the skin distribution of the 5th cranial nerve, suggested to us that these headaches and faceaches are the result of a visceral reflex, with a mechanism similar to that which produces angina in cardiac disease, abdominal pain in diseased conditions of the intestine or the colic of a ureteric impaction.

The suggestion gains strength from the interesting and stimulating

ideas of Maitland Ramsay concerning the analogy which exists between the musculature of the ciliary body, the heart, and the intestinal tract.¹ He showed their anatomical and physiological similarity—hollow viscera bounded by unstriated muscle and innervated by the reciprocally interacting sympathetic and autonomic systems. He showed the similarity in the actions of such drugs as cocaine and atropine on these organs, and made a strong analogy between such diseases as heart block and the Argyll Robertson pupillary reactions.

Perhaps the best way to prove this contention will be: first to consider in detail what is already known of referred visceral pain, and then, secondly, to show how the conditions found in ocular headaches coincide anatomically, physiologically, clinically, and experimentally with the accepted facts of referred visceral pain.

(1) *The Mechanism of Referred Visceral Pain*.—James Ross in 1888 called attention to the fact that the pain in visceral disease was often felt at a distance from the organ which caused it and described the pain as “referred.”² He drew attention to the fact that the sympathetic nerve, which supplied the affected organ arose from the same part of the spinal cord as did the nerve supplying the area of skin in which the pain was felt.

Head said that the mechanism of the pain was as follows:—excitations arising from the stimulation of the sympathetic nerve endings in the viscus are carried through the sensory root posterior to the ganglion into the cord.³ In the cord the sympathetic fibres come into contact with the fibres of the sensory somatic system and so incite them to reaction that the brain perceives the original visceral stimulation as coming from the peripheral distribution of the somatic nerve involved.

A study of the anatomy and physiology of the eye shows that it possesses the necessary machinery whereby the somatic sensory and the sympathetic afferent and efferent nerve fibres can interact in the manner required for the establishment of a reflex visceral mechanism as postulated by Head³ and Mackenzie.⁴ The eye may be considered as a hollow organ with a portion of its area covered by unstriated muscle fibres—the ciliary muscle. Its autonomic efferent nerves are supplied from the mid-brain *via* the 3rd nerve and the motor root to the ciliary ganglion. These fibres carry stimuli for contraction of the ciliary muscle and the sphincter pupillae. Whether they contain inhibitory fibres or not has been debated, but Poirier says that the sensory root of the ciliary ganglion contains sympathetic fibres which relax the ciliary muscle and others which dilate the pupil.⁵ Whitnall, however, denies that it has been shown that the sympathetic can produce a negative accommodation.⁶

The pupillo-dilator fibres are considered to arise from a supposed centre in the mid-brain near the origin of the constrictor tract in

the fore part of the 3rd nerve nucleus. They pass down through the medulla into the lateral columns of the spinal cord, from which the preganglionic fibres pass out by the anterior roots of the 1st, 2nd and 3rd thoracic nerves to run in the cervical sympathetic up to the superior cervical ganglion where they terminate. Their further course is problematical. They reach the dilatator muscle either *via* the cavernous plexus and the sympathetic root of the ciliary ganglion or else *via* the Gasserian ganglion and the long ciliary nerve of the nasal branch of the ophthalmic nerve. The afferent sympathetic fibres from the eye pass out from the ciliary ganglion either by its sympathetic or else its sensory root which conducts them to the Gasserian ganglion. Their precise course is unknown but in all probability they pass to the superior cervical ganglion. This ganglion by means of four grey rami-communicantes is associated with the upper four cervical nerves.

The somatic sensory nerve supply for the eye and the greater part of the face and head is the 5th cranial nerve. Its three divisions supply the eye and the face with sensation. Its root ganglion is the Gasserian ganglion which may thus be considered as the fused posterior ganglia of those somatic afferent nerves which correspond with all the motor nerves originating in the brain stem. The trigeminal system contains three main nuclei: the mesencephalic, the bulbo-spinal, and the motor. On entering the pons the afferent fibres divide into ascending and descending courses. The ascending fibres pass to the mesencephalic root, close to the grey matter surrounding the aqueduct of Sylvius. The descending fibres run as far as the level of the second cervical vertebra where they establish relationship with cells close to the substantia gelatinosa of Rolando. The exact nature of the mesencephalic root has not yet been definitely elucidated, but the generally accepted view is that it subserves the proprioceptive sense of the mandibular muscles (Kappers, Kidd, Parsons).

The bulbo-spinal root is sensory and somatic. Its lowest portion, called by Winkler the nucleus gelatinosus, extends as far as the level of the second cervical vertebra and is concerned with exteroceptive impulses. From below upwards the nucleus gelatinosus receives fibres from the ophthalmic, the maxillary and the mandibular divisions of the 5th nerve, thereby retaining the early metameric arrangement of the somatic afferent nerves. We have thus the necessary anatomical framework whereby sympathetic afferent nerve impulses from the ciliary muscle can form a cord relationship with the 5th cranial and 1st, 2nd and 3rd cervical nerves and thereby with extensive skin areas of the head and neck. Moreover from *a priori* considerations it can be postulated that the referred pain will be felt in those skin areas which are supplied by the upper cervical nerves and the lowest part of the

nucleus gelatinosus, that is the ophthalmic division of the 5th cranial nerve (Diagram A).

(2) *The Skin Area Involved.*—The pain is felt superficially in the skin, voluntary muscles or loose underlying connective tissue (Mackenzie), and each viscus is associated with a definite skin area which, however, does not correspond to the entire distribution of a

DIAGRAM A.

particular nerve but rather to the cord segment with which the viscus has sympathetic connection (Mackenzie). These areas are most likely the zone areas of Head. Thus in cardiac disease we often have pain (angina) in the left side of the chest, left arm and sometimes along the jaw and behind the ear at the back of the head. This is explained in the former cases by the assumption that afferent sympathetic impulses pass from the heart to the cord at the level of the last cervical and the first thoracic segments and in the latter cases by means of the vagus nerve and its roots to the level of the upper cervical segments where the 2nd and 3rd cervical nerves are more particularly involved.⁴ On considering the

DIAGRAM B.

100 collected cases we found the analysis of the pain distribution to be as follows:

WITHIN THE DISTRIBUTION OF THE 5TH CRANIAL NERVE.						
Eyes.	Lower Frontal.	Temple.	Upper Frontal.	Mid-Frontal and Root of Nose.	Cheek.	Side of Nose.
16%	40%	7%	29%	7%	1%	1%
OUTWITH THE DISTRIBUTION OF THE 5TH CRANIAL NERVE.						
Occiput.	Nape of Neck.		Vertex.		Mastoid.	
15%	3%		6%		2%	
26%						

It is to be noted that several of the patients located the pain in two distinct areas, as for example in the brow and in the occiput.

The analysis shows that those areas are affected which anticipation demands to be affected if the mechanism be that of referred visceral pain. The skin areas mainly affected are those supplied by the ophthalmic division of the 5th cranial nerve and the 1st,

DIAGRAM C.

2nd and 3rd cervical nerves. In 26 per cent. of the cases the pain was felt outside the distribution of the 5th cranial nerve. Can this extra-ophthalmic distribution be explained on the basis of a purely somatic reflex whose afferent path is the ophthalmic division of the 5th cranial nerve? To our mind this incidence is difficult to explain in any way other than by the mechanism postulated above.

(3) *Nature of the Stimulus.*—The nature of the stimulus whereby the afferent sympathetic fibres can be excited has been the subject of much discussion. There is no general agreement. Cannon and Washburn believed contraction of the visceral muscle to be the necessary stimulus.⁷ Mackenzie suggested that vigorous peristalsis is the stimulus. Sherrington said that mechanical stimuli to be sufficient must be distensible.⁸

Hurst combined the above theories.⁹ He suggested that a down-wave of peristalsis produces a ballooning of the viscus just beyond the contraction and that the pain-inciting stimulus is that ballooning of the muscle. Poulton experimenting with the oesophageal bag showed that the effective stimulus was distensible and produced by the stretching and consequent deformity of the nerve endings subserving the sense of pain which are situated in the wall of the viscus.¹⁰ He showed that a peristaltic contraction may relieve pain and that on the other hand pain may be felt during a relaxation of the contraction.

There is thus great diversity of opinion as to the precise visceral condition which is necessary in order that stimulation of the nerve-endings in the visceral wall may take place. At one end of the proposed explanations we have an increased muscular contraction and at the other end the distensile theories of Sherrington, Hurst and Poulton. It is not unlikely that in the same organ the adequate reflex inciting condition varies from time to time. The tension of a cylindrical body is represented by the equation :—

$$T = pr$$

where *p* is the pressure inside the structure and *r* is its radius. Therefore any variation in the size of a viscus (*r*) may or may not cause a corresponding change in the tension of its wall according to whether the pressure of its contents rises or falls with the changed visceral posture.

It is possible that another pertinent circumstance is the precise position of the sympathetic afferent nerve endings. If they are outwith the muscular layer, contraction of that muscle will relieve the tension on the nerve endings, and so relieve the pain (Poulton). If they are within the muscle layer contraction of the muscle will stimulate them and so give rise to pain (Mackenzie).

We have thus tried to group the various visceral conditions which may suffice to stimulate the pain nerve-endings. We believe that they can be shown to exist in those eyes which produce headache because of hypermetropia, myopia, astigmatism or presbyopia. The following table shows the relative frequency of these conditions as found in the 100 collected cases :

	Per cent.
Hypermetropia	5
Myopia	13
Hypermetropic astigmatism	47
Myopic astigmatism	22
Presbyopia	13

In compound astigmatism the case was considered to be one of simple astigmatism unless the hypermetropia or myopia played the obviously preponderating rôle. Let us consider the visceral condition in each of these divisions.

In *hypermetropia* there is an increased contraction of the ciliary muscle in order to overcome the shortened condition of the eyeball. Increased contraction of smooth muscle is one of the accepted stimuli in the production of visceral pain.

In *myopia* the nature of the stimulation is more difficult of explanation. We have here an inhibition of the ciliary contraction which usually accompanies convergence. It is possible that the effective stimulus is Poulton's "increase of posture" resulting from the ciliary relaxation. Or is it possible that the upset of the normal

muscular co-ordination is in itself a sufficient stimulus? It is difficult to say why one case of myopia should suffer from headache and another not do so. Other things being equal it may depend on the accidental anatomical position of the sympathetic afferent nerve-endings as suggested above. If these nerve-endings are within the muscle layer, relaxation of the muscle might be expected to relieve the tension on them. While if they are without the ciliary muscle layer, a myopic relaxation will have a contrary effect and so give rise to a headache.

In *astigmatism* we hoped to find a stimulus for the headache which was more specific for the astigmatic cases than those detailed above under hypermetropia and myopia. With this end in view we made an analysis of the frequency of the different kinds of astigmatism found in the cases under discussion, and we made a study of the literature with regard to the nature of the contraction of the ciliary muscle. The frequency of the different kinds of astigmatism in the collected cases is tabulated below:

			Hypermetropic astigmatism. Per cent.		Myopic astigmatism. Per cent.
Direct astigmatism ...	...	...	54	...	50
Indirect astigmatism ...	...	...	18	...	15
Symmetrical axes ...	...	...	41	...	50
Homologous axes ...	...	...	16	...	None
Non-related axes ...	...	...	43	...	50

Cases were considered to have an axis of 90° and 180° if they were within 15° of those axes.

A similar latitude was taken in differentiating axes into symmetrical and homologous types.

In a consideration of 4,000 unpicked cases of astigmatism Lang found 38 per cent. cases of direct astigmatism and 24 per cent. cases of indirect astigmatism.¹¹ We thus found in our cases no abnormal prevalence of any particular variety of astigmatism. Our findings do not confirm the generally accepted view that indirect astigmatism is more prone to headache-production than direct astigmatism. Moreover in a study of the literature we found that nothing is known of a path of nervous conduction or a wave of muscular contraction in the ciliary muscle. Nor has a partial contraction of the ciliary muscle been shown to take place.¹² With these negative findings in mind we cannot at present postulate any stimulus for the visceral reflex which would be more specific to these cases of astigmatic headache than those suggested above for simple hypermetropic and myopic headaches. Astigmatism is, however, by far the commonest cause of ocular headaches, and it is probable that another, secondary, non-muscular factor is brought into play. No action of the ciliary muscle can prevent the image

cast on the retina of an astigmatic eye from being blurred, and it is possible that the visceral reflex is facilitated by the consequent disturbance in consciousness. It is a well-known fact that slight psychical disturbances can provoke an attack of angina pectoris.

In *presbyopia* there is an attempt at accommodation by contraction of the ciliary muscle. If the physiological theory of presbyopia as suggested by Donders and supported by Duane be correct, the maximal ciliary contraction serves as an ideal stimulus for the excitation of the visceral reflex.

In analysing the visceral condition in these cases of hypermetropia, myopia, astigmatism, and presbyopia we have laid stress on the condition of the ciliary muscle, and have made no mention of the internal pressure of the eye-ball. Our considerations above suggest that this is as causally important as the condition of the ciliary muscle and we hope in a further report to study the association between ametropia, intra-ocular tension, and the reflex headache.

(4) *The Effect of Fatigue*.—Mackenzie has emphasized the causal importance of the accumulation of fatigue products in cases of angina pectoris. He suggested that this condition obtains when:

1. The muscle is repeatedly contracted.
2. The muscle is insufficiently supplied with blood because of capillary changes or because of the morning ischaemia following sleep.

In order to establish the importance of repeated muscular contraction we made an analysis of the time and work incidence of the headache in each of the 100 cases under consideration. It was as follows:—

Headache produced by near work, 55 per cent. of cases	} 81 per cent.
Headache worse in the evening, 26 per cent. of cases	

The 26 per cent. of cases who experienced the headache in the evening were among the 45 per cent. who did not confess to the headache being produced by near work.

Thus in a great many cases increased muscular activity and fatigue were necessary before the headache was felt. Muscle fatigue is then an important contributory factor just as Mackenzie has shown it to be in the production of angina pectoris.

Again in 23 per cent. of the cases under consideration the headache was felt on rising in the morning. In these cases we may suppose that the ciliary muscle was insufficiently supplied with blood because of the morning ischaemia following sleep. We have thus present in those eyes, yet another muscle condition, which in other parts of the body, can serve to waken the visceral reflex.

(5) *The Nature of the Referred Pain*.—The nature of the referred pain differs from other pains in that it is usually of a wave-like character, beginning gradually, reaching a maximum and then subsiding (Mackenzie). Moreover it leaves a vague impression of

locality, being regional rather than local (Mackenzie). Although in certain circumstances the viscus may be the seat of a "low" form of protopathic sensation, acute pain felt in it is usually the result of the stimulation of somatically supplied adjacent tissues, for example the sub-peritoneal tissue, the pleura, or the pericardium.

Each of the 100 cases under consideration was asked the nature of the pain; it was variously described as follows:

	Per cent.
Dull, aching throb	43
Sharp, knife-like pain	24
Heavy, tired feeling	10
Tight, gripping feeling	8
(Chiefly in the occipital headaches occurring with hypermetropic astigmatism.)	

It will thus be seen that the majority suffered from the typical wave-like, stunning pain of muscular origin. Nearly all the patients showed reluctance or difficulty in "placing" the pain. They nearly all said it was "about the head" and only on enquiry could it be localized to a definite area of the head. In the reflex pain of tooth-ache or glosso-pharyngeal neuralgia where the nerve-implication is purely somatic there is not the same difficulty in locating the pain. 16 per cent. of the cases complained of pain in the eye. In nearly all cases the pain was a "dull ache," corresponding to the "low" form of direct protopathic sensation found in the viscera generally, and unlike the more acute pain experienced in iritis or during an iridectomy. The somatically supplied iris and ciliary body may be considered to bear a relationship to the ciliary muscle analogous to that which exists between the peritoneum and intestine, the lung and the pleura, or the pericardium and the heart.

(6) *Relationship between Hyperaesthesia and the Pain.*—Segmental hyperaesthesia is often found in the abdomen during an attack of ureteric colic. Mackenzie showed its frequency in angina over those areas where the pain was felt. He also demonstrated that the hyperaesthesia often outlasts the pain, making the inference that the nerves remained in a state of hyperexcitability.

Owing to the exigencies of an out-patient department the state of the skin was not tested in all the cases. Hyperaesthesia was looked for in 55 cases about the distribution of the supra-orbital nerves. It was found in 15 cases all but one of which were unilateral. In six of these cases the hyperaesthesia disappeared with the headache.

Tenderness on deep pressure over the supra-orbital foramina was also tested for in these 55 cases. It was found in 20 cases, four of which were bilateral. Ten of these cases showed no deep tenderness after the headache had gone.

We thus found hyperaesthesia of the skin in a fair proportion of cases, which in only 50 per cent. of these cases had disappeared several weeks after the cure of the headache.

(7) *Effect of the Reflex on Voluntary Muscle.*—Transmission of the stimulus to the cord also affects the adjacent muscle centres, thus causing a tonic muscular contraction in the area supplied by the efferent somatic nerve. This is seen typically in the abdominal rigidity of appendicitis and in the retracted testicle of renal calculus. Mackenzie has pointed out that this visceromotor reflex may be present although the viscerosensory reflex be absent.

The statistics were not made with respect to the accompanying visceromotor reflex in the collected cases. It is a well-known fact, however, that the corrugator supercilii and the frontalis muscle are often tonically contracted in subjects suffering from ciliary headaches. This visceromotor reflex, moreover, is often observed in cases of ametropia even although no headache is complained of. These motor reflexes demand an association between the afferent impulses from the eye and the 7th cranial nerve nucleus. This contraction of the corrugator supercilii is thus comparable with the contraction of the cremasteric muscle in renal colic and the rectus abdominis in appendicitis.

(8) *Effect of the Visceral Reflex on Other Reflexes.*—In some cases the visceral lesion may produce an irritable focus in the cord so that stimuli coming to this level of the cord would be perceived as pain. For example liver disease is sometimes associated with the painful entrance of food into the stomach (Mackenzie).

In "ciliary headache" this effect is seen in the tachycardia, flatulent and other types of dyspepsia which occasionally accompany it. The afferent sympathetic stimuli from the ciliary muscle may be considered to produce an irritable focus in the cord whereby the vagal and sympathetic nerve supply to the stomach and heart are reacted upon. In this connection it is interesting to quote that in the opinion of Behan "all the thoracic and abdominal viscera which refer pain into the dorsal area of the scalp are supplied by the vagus and glosso-pharyngeal nerves which represent the visceral branches of a set of nerves whose somatic sensory root is to be found in the sensory portion of the 5th cranial nerve."¹³ Again the considered opinion of Maitland Ramsay may be noted. "Neurasthenia makes the use of glasses imperative if any error of refraction exists and in such cases the use of glasses is a valuable therapeutic measure because the cure of the patient is aided by removal of one cause of irritation to the nervous system."¹

(9) *Effect of the Condition of the Nervous System on the Visceral Reflex.*—The degree of pain in a visceral reflex depends on the changing nervous excitability of the nervous system. The hyperexcitability may be local or general. In the former case it is due to a particular level of the cord being sensitized by afferent stimuli. In the latter case the central nervous system is rendered more sensitive by such general conditions as

- (a) Toxic conditions.
- (b) Overwork or lack of sleep.
- (c) Mental worries.
- (d) Sex disturbances.

The result is that impulses, which in normal healthy conditions would produce no recognizable effect, give rise to demonstrable results such as reflex pain. This state of affairs is seen typically in secondary angina.

In each of the 100 collected cases some inquiry was made into the existence of these general sensitizing conditions. It was not possible in the circumstances to make any thorough investigation regarding the co-incidence of the headache with constipation or other toxic conditions. Most of the patients said that otherwise they were in very good health. Only six confessed to some systemic disturbance. In four cases the headache commenced after taking food. It is a well-known fact, however, that a patient convalescing from an illness may complain of ocular headache which requires the use of temporary glasses, although in health the refractive error or the presbyopia may have been unsuspected or absent. The general debility probably produces a too early ciliary exhaustion as well as a too sensitive nervous system. In this connection may be mentioned the frequency with which lactating mothers suffer from temporary ciliary headache.

Similarly it was not feasible to enquire into the sex history of the patients. The sex and age incidence of the cases was as follows :—

Male 36 per cent. Average age 28 years.

Female 64 per cent. Average age 28 years.

Below are separately graphed the age incidence curves among the males (---) and females (—) of the collected cases:

DIAGRAM D.

Most of the cases occurred in the third and fourth decades of life. It is interesting to note in the female a rapid rise of the curve in the 10-15 years period, which in the male is delayed until the 15-20 years period, and likewise the difference between both curves during the 40-45 years period.

Only seven cases were outside the active sex period. In each of the female cases a note was made regarding the relationship of the headache to menstruation. Fifteen of these cases, *i.e.*, 25 per cent., showed a menstrual incidence of the headache, usually two or three days prior to the onset. Occasionally the headache persisted during the flow. Such a fact is rather important therapeutically because headaches occurring about these times are usually relegated into the category of "menstrual headache" and treated from the wrong standpoint. We were told of a patient with a diseased ovary which invariably gave rise, on being palpated *per vaginam* to a severe ipso-lateral parietal headache. In this case the afferent visceral stimuli from the ovary after reaching the cord affected the cervical region presumably by association. In general, however, the sex association is causally important in that it increases the excitability of the central nervous system and so permits otherwise innocuous afferent ciliary stimuli to produce their reflex.

(10) *Effect of Age on Referred Visceral Pain.*—It has been observed in angina pectoris that advancing years often diminish the frequency of the pain. Elderly people have an earlier sensation of tiredness which inhibits the muscular activity from reaching that pitch which would act as a sufficient stimulus for the pain reflex.

In correcting elderly astigmatics it is not unusual to be told that although now quite free from pain they once suffered severely from what we can reasonably conclude from their descriptions to have been ciliary headache. In the 100 collected cases apart from the presbyopic ones, only four patients were over the age of 40. It must be noted, however, that numbered among the presbyopic cases are several hypermetropes and astigmatics who were able to read Jaeger 1 without an addition to their distance correction. These have been described as presbyopes because their inability to overcome their ametropia is essentially due to the presbyopic condition of their lenses.

Moreover, although presbyopic cases formed 21 per cent. of all the cases coming for spectacles to the out-patient department of the Glasgow Eye Infirmary, the number of presbyopic headache cases was only 13 per cent. of those collected.¹⁴ The reflex should be easily provoked by the nature of the ciliary contraction in the presbyope, and one can only assume that in these cases the same process is at work as that to which Mackenzie ascribed the lapsing incidence of angina pectoris with the ageing of the patient. The

presbyope does not have headaches as often as he might because he readily feels the sensation of ciliary tiredness and so by ocular rest prevents the ciliary muscle from reaching that condition which would act as a sufficient stimulus for the production of the viscerosensory reflex.

(11) *The Reversibility of the Viscus-Skin Reflex.*—The relationship between the skin sensation and the visceral activity is a reversible one. That is to say that a stimulus applied to a skin area produces changes in the corresponding viscus. This is the principle underlying the use of counter-irritation which has for long been employed for the relief of visceral disease. The counter-irritant in virtue of the fact that it relieves visceral pain might be expected to do so either by removing, or by producing, the converse of that visceral condition which excited the reflex. Thus Poulton experimenting with the oesophageal bag showed that friction over the sternum relieved oesophageal pain by means of an "increase of posture" accompanied by a fall of pressure, or by a contraction of the smooth oesophageal muscles whereby the strain on the nerve-endings was relieved.

This postulate of reversibility is remarkably seen in the dilatation of the pupil which follows stimulation of the skin. Head has shown that dilatation of the pupil follows pinching of the hyperalgesic areas and that it is more marked ipso-laterally. He also showed that if areas other than the hyperalgesic zones be pinched, the stimulation must be more severe in order to produce the same dilating reflex. This reaction presupposes an association between the somatic nerve supply, particularly of the hyperalgesic zones, and the efferent sympathetic nerve supply of the eye, which probably because of the wide latitude of the skin area involved takes place in the spinal cord. Moreover this visceral effect of the skin-pupil reflex is the more significant when it is appreciated that besides the stimulation of the dilatator pupillae there is an inhibition of the sphincter pupillae (Whitnall) and in all likelihood a corresponding inhibition of the ciliary muscle. Clinically this beneficent skin-eye reflex is made use of by the application of poultices and blisters to the brow and temples for such conditions as iritis and cyclitis where it is considered advisable to dilate the pupil and relax the ciliary muscle.

Experimentally the following method was used to show that a relaxation of the ciliary muscle takes place when the skin of the brow is stimulated.

A series of nine consecutive cases of hypermetropia was taken in each of which there was a fair degree of latent hypermetropia. A mustard-leaf was applied to the forehead in each case for 10-12 minutes and the subjective test repeated. The differences between

the latent hypermetropias before and after the application of the counter-irritant is tabulated below :—

CASE.						Differences in dioptries of latent hyper. before and after counter-irritation.
1	...	...	...	...	...	+ 1·50
2	...	...	...	...	...	0·75
3	...	...	...	...	...	0·50
4	...	...	...	...	...	0·25
5	...	...	...	...	...	0·75
6	...	...	...	...	...	0·75
7	...	...	...	...	...	0·50
8	...	...	...	...	...	Nothing
9	...	...	...	...	...	0·50
Average						0·60

We see thus that on an average 0·60 dioptries of relaxation was obtained in the ciliary muscle as the result of the application of an irritant to the brow. This seems to establish the reversibility of the relationship between the ciliary muscle and the skin and thereby to fulfil one of the postulates which our presumption of a viscerosensory mechanism demands. Moreover it is comparable to the "increase of oesophageal posture" which Poulton demonstrated to be a consequence of friction applied over the sternum.

Summary

(1) A resumé has been made of the chief known facts of referred visceral pain, physiological, clinical and experimental.

(2) A study has been made of the activity and innervation of the ciliary muscle, of the clinical features of ocular headache, and of an experimental relationship between the skin and the ciliary muscle.

Conclusion

There has been shown a sufficient concurrence between both sets of facts to justify the suggestion that the mechanism which underlies ciliary headache is analogous to that which gives rise to referred visceral pain in other parts of the body. More particularly that ciliary headache arises from ciliary dysfunction in the same way as angina pectoris arises from cardiac dysfunction. The work for this communication was carried out at the Glasgow Eye Infirmary in the unit of Dr. J. Barbour Stewart. I wish to thank him and Dr. A. J. Ballantyne for their kind assistance and advice.

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 SCHOOL MYOPIA*

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THE problem of school myopia is the problem of the development of myopia. This is a truism which needs stressing in these days when the conception of myopia as a physiological variation in a scale of refractive errors is becoming more established. If it was a fallacy to regard myopia as something distinct from other refractive conditions, it is equally fallacious to regard it purely as the antithesis of hypermetropia, in a graduated series in which refraction approaching emmetropia is the peak and centre.

Though it raises more problems than it solves, the work of Steiger and his school is undoubtedly the most important contribution to myopia that has been made during the present century. By pointing out that hypermetropia cannot be divorced from myopia, that emmetropia is an artificial conception, and myopia a continuation in an unbroken process, the whole of which can be represented by a curve corresponding to a theoretically derived

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