

Cardiac pain and its relief / by G. A. Gibson.

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Publication/Creation

Edinburgh : Young J. Pentland, 1896.

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Cardiac Pain and its Relief. By G. A. Gibson, M.D.,
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The existence of painful subjective sensations in circulatory disturbances has long been known. In the first decade of last century such symptoms were observed by Morgagni, and about fifty years later described by him. Since that time they have greatly occupied the attention of the physician, but the scientific investigation of the subject has, nevertheless, made but little progress until recently.

The sensory disturbances are of different kinds; uneasiness, tightness, weight, and oppression are varying degrees of subjective sensation which culminate in a feeling of pain. One and all of these sensory phenomena may be accompanied by sensations of sinking, of fainting, of dying; or attended by feelings of disturbed movement within the chest, of troubles affecting the respiratory processes, and of disorders connected with the cerebral functions.

Pain is of very frequent occurrence. Attempts have been made to ascertain the relative proportion of cases in which it is present, and Nothnagel, in a recent investigation of 483 cases of valvular disease under treatment in his wards during seven years, gives the following results:—

Nature of Disease.	Sensory Symptoms.		Percentages.	
	Present.	Absent.	Present.	Absent.
Aortic incompetence,	69	45	60	40
Aortic incompetence and stenosis,	15	8	68	32
Aortic stenosis,	2	3	40	60
Aortic and mitral incompetence,	3	14	18	82
Mitral incompetence,	14	169	8	92
Mitral stenosis,	4	18	18	82
Mitral stenosis and incompetence,	20	98	17	83

The contrast between the aortic and mitral cases, as regards the incidence of pain, is very striking.

The pain in cardiac disease varies infinitely in degree. Between the slight uneasiness of an evanescent heart strain and the profound anguish of fatal angina pectoris there seems to be a wide gulf; there is, nevertheless, no absolute distinction between them,—the difference is not in kind, only in degree. The milder examples of pain are linked with the more severe by an unbroken series of intermediate forms, and it often happens that in the same individual a feeling not so much of definite aching as of vague discomfort passes into such a sensation of severe pain as to be intolerable agony.

Cardiac pain is usually exaggerated by exertion, and sometimes is only experienced after muscular effort, more especially in ascending a hill or a stair. All kinds of excitement tend to induce it, and a full meal is liable to be followed by pain. Needless to say, when several of these factors act simultaneously, the effect is more marked.

The pain in cardiac disease is not, for the most part, felt by the patient in the heart, but is chiefly referred to the surface of the body. From the time of Harvey it has been known that the heart is by no means sensitive to painful impressions. It is no doubt true that certain sensations are referred to the heart itself,—feelings of disturbed movement are often present; pain, however, is always, on careful investigation, found to be superficial.

The usual situations of pain are in front of or behind the chest, corresponding to the distribution of the spinal nerves. The most common nerves affected are those arising from the eighth cervical and the upper six dorsal segments of the cord, but pain is also felt over the areas connected with the cord as high as the third cervical and as far down as the lower dorsal nerves. In some cases there may be pain over the spines of the vertebræ corresponding to the areas affected, particularly in the lower cervical and upper dorsal regions.

The pain, further, is felt in the areas of the upper limbs innervated from the spinal segments implicated. The pioneer in tracing out the connections of the cardiac nerves, the spinal segments, and the peripheral distribution of the brachial

plexus, was undoubtedly Lussana, whose labours have merited much more recognition than has generally been accorded to them.

Tenderness is almost invariably present when there is pain, and this increased sensitiveness is often found when there are no subjective sensations. The best method of testing this exalted sensibility is by gentle pressure with a fine point; over areas not affected, the stimulus is only felt as a touch, but when the hyperalgesic region is entered there is a painful sensation.

Another very simple and most effective method of testing the sensibility of the skin consists in gently seizing part of the area suspected of exalted sensitiveness between the thumb and first finger of one hand, while another part, exactly corresponding on the opposite side of the body, is similarly grasped by the other hand. By slightly and equally squeezing the two parts so seized, it is easy to determine which is the more tender to pressure. In some cases this gentle stimulus is sufficient to excite a paroxysm of pain, as Mackenzie has shown.

The tenderness was thought by Peter to be situated in the heart itself; this, however, is not the case. It is easy to determine that it has its seat in the superficial textures of the thorax. Not only the integumentary structures, but the underlying muscles also, are tender; the pectorals, the sternomastoid, and the trapezius of one or both sides may be sensitive to gentle pressure.

Pain resulting from affections of the heart and aorta is sometimes confined to one half of the thorax, sometimes it involves both sides. When unilateral it is far more commonly situated over the left than the right side; when bilateral it is almost always symmetrical.

The increased sensitiveness of the surface of the body in painful cardiac affections did not entirely escape the acute observation of Laennec, but he gives this aspect of the subject very scant notice.

Although the terms employed by Laycock are not free from ambiguity, he seems to have grasped the fact of hypersensitiveness of the skin in cardiac pain; the great value,

however, of his remarks on the subject lies more in their suggestiveness than in their fulness.

The explanation of the pain of cardiac disease by a study of the relations of the cardiac nerves to the spinal cord was, as we have seen, suggested by Lussana; it was further advanced by Sturge; and the segmental distribution of such pain arising from visceral disturbance was clearly brought forward by Ross.

A great step was taken by the brilliant and original researches of Mackenzie into the presence of exalted sensibility, as well as of pain, in these visceral affections. His painstaking observations on the exact areas of subjective and objective sensory changes constitute a most important advance, and mark the commencement of a new epoch.

The beautiful and elaborate series of observations made by Head on this subject have still further elucidated many of the difficult problems connected with the sensory symptoms of visceral disease.

It may be regarded as established beyond doubt that afferent impulses travel upwards by means of the sympathetic as well as the pneumo-gastric nerves. The distribution of the sensory disturbances in disease, involving areas which can only be reached through the two channels, is in itself an ample proof of this fact.

Of the two paths, that furnished by the sympathetic system is most frequently implicated, and this more especially in its lower cardiac attachments. The inferior cardiac nerve, taking its origin from the inferior cervical and the first dorsal ganglia, is the afferent channel by which impulses seem most commonly to reach the centres.

The sympathetic ganglia are connected with the spinal nerves by two different kinds of communicating branches, the grey and the white, which have been thoroughly investigated by Gaskell. The superior cervical ganglion is connected with the first, second, third, and fourth cervical nerves; the middle with the fifth and sixth; the inferior with the seventh and eighth. According to Gaskell, the heart receives its visceral nerve supply mainly from the second dorsal pair.

The sensory path enters the cord by the posterior root and passes upwards to the brain. It is almost certain that its course is interrupted at least three, perhaps even four, times—in the sympathetic ganglion, in the posterior root ganglion, and in the grey matter of the cord, probably also in the optic thalamus. An impression upon the end organ always produces an influence upon the centre with which it is in direct connection. We are ignorant of the nature of the effect that occurs in consequence of this influence, but that some molecular change takes place cannot for a moment be doubted, for, as Virchow says, "jede Function ist an mechanische Veränderungen der Substanz geknüpft." Sometimes the effect of the impression is sufficiently powerful to reach the higher centres, where it can be perceived; at other times it does not travel beyond the proximate centre. That the effect of a stimulus is not always conducted to the brain is proved by the existence of hyper-sensitiveness without pain, which has been specially referred to by Nothnagel and Mackenzie.

The heart, like most of the viscera, is but slightly sensitive. A sensory stimulus is carried to the cord in the region from which the sensory nerves have their origin, and in that segment comes into relation with the nerves for painful sensation connected with the segment. "But," as Head has so well put it, "the sensory and localising power of the surface of the body is enormously in excess of that of the viscera, and thus, by what might be called a psychical error of judgment, the diffusion area is accepted by consciousness, and the pain is referred on to the surface of the body instead of on to the organ actually affected."

The explanation of tenderness in association with pain which is given by Head is worthy of careful consideration, and merits general acceptance. Impulses passing to the cord from a diseased viscus produce a disturbance in the segment to which they pass, and induce a condition of unstable equilibrium, so that any stimulus applied to the area connected by sensory nerves with the segment will be more powerful in its effects and will give rise to exaggerated sensations.

The greater frequency of pain in the left half of the

chest can only be due to the fact that the left ventricle and its attachments are connected mainly with the left coronary and left deep cardiac plexuses, which, along with the entire superficial cardiac plexus, are connected with the left nerve centres. The left ventricle and aorta are, on account of the higher pressure to which they are subjected, much more liable to degenerative changes than the right ventricle and pulmonary artery. And as the left ventricle has no means of relief from strain, such as is provided for the right by the safety-valve functions of the tricuspid valve, long-continued excess of pressure acts more seriously upon it.

It is scarcely necessary to mention that pain in the head has been from comparatively early times recognised as accompanying heart affections. No exact observations, however, seem to have been undertaken to ascertain the relations of this pain until the elaborate investigations of Head made their appearance. He gives good reasons for believing that certain areas of the forehead and scalp are associated with some of the thoracic regions. The naso-frontal area, for example, is related to the distribution of the third and fourth cervical nerves; the mid-orbital, with the second and third dorsal; and the fronto-temporal, with the fifth and sixth dorsal nerves.

Upon all the aspects of this subject, in so far as they have been touched upon, modern writers are in substantial agreement, but on inquiring into the origin of the impulses travelling towards the sentient centres, a great diversity of views is unfolded. It would be out of place in this sketch of subjective symptoms to attempt a criticism of the varying opinions which have been held regarding their immediate causation; it is of more importance to ascertain whether the sensory disturbances may be classed in etiological groups. That they are produced by many diverse influences cannot for a moment be doubted, and by a process of analysis they may be arranged in distinct classes.

That pain having its origin in the sensory nerves of the heart may occur in conditions of anæmia must be admitted, and instances of this kind may be considered analogous to forms of neuralgia occurring in cases where the blood is

deficient in corpuscles or hæmoglobin. The exact nature of the change in the nervous structures in such cases is matter for speculation. It may be merely an irritable weakness, but, as in anæmia there are often profound structural alterations in the nervous system, there may be definite lesions in some part of the complex mechanism.

Toxic influences constitute a frequent source of cardiac pain. Chief amongst the agents belonging to this class are alcohol, tea, and tobacco. There is no general rule as to the relative potency of these substances; to some persons one of them may be a powerful poison, while the others are comparatively harmless; it may be accepted, however, as the result of experience, that tobacco gives rise to more pronounced and more persistent sensory effects than the others. In the greater proportion of such toxic cases absolute recovery takes place, and the production of the sensory symptoms is, therefore, probably due to a chemical combination between the poison and the protoplasm of the nervous structures—not to any degenerative change in the latter. It is only right, however, to add that in many of these cases undoubted lesions of the heart are present.

Toxic influences may arise from faulty metabolism within the body. Lithæmia and glycæmia are the best examples of such auto-intoxication affecting the nervous connections of the heart, as they have not only been recognised for a considerable time, but are of comparatively frequent occurrence. The mode of operation is most likely analogous to that of poisons introduced from without.

Direct pressure on some of the cardiac nerves by sclerosed coronary arteries was thought by Home to be the cause of pain in the classical instance of John Hunter; analogous pressure was seen by Heine to be the apparent cause of certain of the symptoms of angina pectoris; and pressure on the phrenic was found by Haddon in a pronounced case of angina pectoris. In this last case, however, there were aortic lesions, and the implication of the phrenic nerve may probably have been an accidental concomitant.

Neuritis of some of the cardiac nerves and plexuses was

found by Lancereaux in association with aortic disease and coronary sclerosis in angina pectoris, and a similar observation was made by Peter in a case in which, however, coronary, aortic, and pericardial lesions were found after death.

Organic disease of the heart is present in a large proportion of instances of cardiac pain. Simple cases of heart strain, and dilatation of the heart from almost every cause, furnish numerous examples of sensory symptoms. Degeneration of the muscular wall, and lesions of the aortic orifice or its cusps, as well as changes in the walls of the aorta, are likewise associated in a large number of cases with such painful sensations; but above all, arteritis deformans of the coronary vessels, linked, as is almost invariably the case, with consecutive changes in the myocardium, is the underlying lesion in the graver painful affections connected with the heart.

These organic cardiac lesions have afforded a fertile field for controversy in attempting to explain well-known facts, and the difficulties which surround the subject on every side only seem to increase on closer examination. It is not possible in these remarks to analyse all the different views which have been brought forward to explain cardiac pain, but a rapid glance at certain of the doctrines which have been advanced may be helpful. The pain was regarded by Heberden and Latham as produced by spasm of the heart itself. It was, on the other hand, regarded as an expression of failure of the heart by Parry and Stokes, and this has been well expressed in recent times by Lauder Brunton, when he says that cardiac pain is generally due to weakness of the heart in proportion to the resistance which it has to overcome. The sensory symptoms have further been attributed to ischæmia of the cardiac muscle. This view was originally propounded by Burns, whose words, with their quaint punctuation, are well worthy of being quoted:—

“In health, when we excite the muscular system to more energetic action than usual, we increase the circulation in every part, so that to support this increased action, the heart and every other part has its power augmented. If, however, we call into vigorous action, a limb, round which

we have with a moderate degree of tightness applied a ligature, we find that then the member can only support its action for a very short time; for now its supply of energy and its expenditure, do not balance each other; consequently, it soon, from a deficiency of nervous influence and arterial blood, fails and sinks into a state of quiescence. A heart, the coronary vessels of which are cartilaginous or ossified, is in nearly a similar condition; it can, like the limb, be girt with a moderately tight ligature, discharge its functions so long as its action is moderate and equal. Increase however the action of the whole body, and along with the rest, that of the heart, and you will soon see exemplified, the truth of what has been said; with this difference, that as there is no interruption to the action of the cardiac nerves, the heart will be able to hold out a little longer than the limb."

This theory, espoused with various modifications by many writers, has been revived by Potain, who has applied to it the theory of Charcot termed "claudication intermittente." It is exemplified by the transient paraplegia which follows exertion in thrombosis of the iliac arteries or abdominal aorta. The collateral circulation is adequate when the limbs are not in active use, but when they are exerted a relative ischæmia causes temporary paralysis. Sée accepts ischæmia as a valid cause, and it is admitted by Huchard that a spasm of the coronary vessels may cause the pain.

The sensory disturbances were regarded by Laennec as neuralgic in character, and this view has been adopted with more or less modification by many authors, and especially by Anstie. Romberg regarded them as due to hyperæsthesia of the cardiac plexus. That the cardiac pain may have its origin in, or, at least, be connected with, neuritis, has been placed beyond dispute by the observations of Lancereaux and Peter.

Connected with the idea of increased peripheral resistance, Cahen enunciated some vague speculations regarding the possible dependence of painful sensory symptoms upon some vasomotor influence. Landois attempted to place the subject on a philosophic basis by classifying the various possible causes of painful affections of the heart, and in his

contribution he specially mentioned pain arising through vasomotor influence (produced by a spasm of the arterioles), and pain taking its origin in reflex impulses.

Nothnagel, following somewhat in his footsteps, further expanded the idea of vasomotor pain, and described anginous cases without cardiac lesions, in which numbness of the extremities, induced by exposure to cold, was followed by precordial pain, palpitation, and faintness, accompanied by a pulse of small size. Eichwald advanced the opinion that they might be produced by the efforts of a weak heart to overcome peripheral resistance by excessive activity.

The careful clinical observations and brilliant therapeutic suggestions of Lauder Brunton, so well known as to require no description, gave powerful support to the belief that in at least a proportion of cases the pain of angina pectoris had its origin in a vasomotor spasm. The pulse changes, however, described by many observers are by no means constant, as has recently been clearly shown by Morison; and relief does not always follow the use of drugs which dilate the vessels, a circumstance originally noticed by Fagge. These undeniable facts are in themselves enough to demonstrate that vasomotor influences are not a valid explanation in all cases.

The more modern views bring us face to face with the probability that a large number of different factors are at work in producing irritative impulses, which travel by the afferent nerves to the centres, and there produce an explosion of nerve energy which is referred to those peripheral tracts corresponding to the central segments involved. This conception probably contains the truth. Malnutrition of the sensory endings—as in general anæmia or local ischæmia; toxic influences, such as tobacco; direct irritation, as in the hyperæmia of pericarditis; and interference by means of structural changes—produce either stimuli which travel in a centripetal direction, or give rise to a condition of irritability in which, when an additional strain is undergone (if the heart is struggling to overcome a resistance to which it is inadequate), afferent impulses will be carried to the nerve centres.

The most masterly criticism of the theories regarding the pain of angina pectoris is beyond all question that of

Gairdner. No one can read his well-weighed conclusions without being convinced that the origin of cardiac pain is certainly manifold. The same is admitted by Douglas Powell and by Grainger Stewart. And Balfour, in his latest work, states that, like other neuralgiæ, angina has its origin in a lowering of the functions of the affected nerves, usually from prolonged malnutrition, which is sometimes brought to a climax by some positive cause of ischæmia such as vascular spasm, or more rarely by pressure on part of the plexus.

The means of relief in sensory disturbances connected with the heart will be sought in directions according to the views held with regard to their causation. Yet it must be admitted that the treatment of cardiac pain rests, for the most part, with a few noteworthy exceptions, on the results of empiricism.

The treatment of painful cardiac sensations necessarily resolves itself into the management of the general health, and the immediate relief of pain when present.

The general treatment of any patient in whom pain is a prominent symptom must be an attempt, through restoring the general health, and more especially improving the circulatory and nervous systems, to procure prophylactic influences as regards pain. The inculcation of fresh air and sunlight, the regulation of rest and exercise, the arrangement of food and drink, and the employment of such remedies as experience or experiment have shown to be useful, require due attention.

In the treatment of cardiac pain it is necessary that the whole digestive apparatus should be in good working order. Not merely does a sluggish digestion cause mechanical interference with the circulation in many ways, but chemically through the blood it interferes with the metabolic functions of the heart. The respiratory organs must in the same way be watched, and if there be any mechanical interference, by means of bronchial affections, with the proper aëration of the blood, it must be rectified. The nervous system must, further, be calmed if there be any excitability or irritability in regard to it.

When cardiac pain is obviously associated with failure of

the energy of the heart, cardiac tonics will be required, and according to circumstances such a drug as digitalis, or strychnine, or arsenic may have to be employed.

Amongst the remedies useful from the prophylactic point of view, the iodides are pre-eminent. One of the most remarkable effects produced by the iodides is the relief of painful affections. The most famous of these drugs is iodide of potassium. This drug, first introduced by Graves in the treatment of painful diseases of the fibrous tissues and nervous system, was observed by Craig to have produced perfect relief from pain in a case of aneurism, as he stated in a private communication to Balfour. The use of iodide of potassium appears shortly afterwards to have been almost simultaneously investigated in Europe and Asia by different observers. Nelaton and Bouillaud in Paris, and Chuckerbutty of Calcutta, found that great relief was obtained by the use of iodide in cases of aneurism. Roberts of Manchester, somewhat later, employed this remedy on a considerable scale, but it is to Balfour of Edinburgh that we owe the extended employment of the drug. Unfortunately, we do not yet understand the mode of action of the iodides. It is, however, well known that they have some influence in reducing the pressure and in diminishing the frequency of the pulse. The amount of reduction of blood pressure, however, is extremely small, and the diminution in the rate of the heart is inappreciable with ordinary doses of the drug. It has been shown by Sée and Lopicque that the first effect of iodide of potassium in a small dose is to increase the blood pressure and to diminish the frequency of the pulse, and that, if the dose is increased, the blood pressure falls, while the rate of pulsation rises. We know, further, that in addition to these effects upon the circulation the iodides have considerable effect in removing morbid products and restoring healthy structure.

When all these effects have been taken into account, we are still left uncertain as to the precise mode of action of the iodides in relieving pain, but its removal is one of the most constant and one of the most useful effects produced by this series of drugs.

Amongst the iodides, iodide of potassium is the one which has been most continuously employed, and which is probably in most respects the best. Sée has pointed out that, in comparing the iodides, the salts of calcium, sodium, potassium, and strontium stand in this order with regard to the amount of iodine which they respectively contain, that of calcium containing the most, and that of strontium the least, while the salts of sodium and potassium occupy an intermediate position. The difference between the different members of the series is, however, insignificant; and as, so far as we know, these agents owe their beneficial results to the iodine which they contain, and not to the base, such conditions cannot be allowed much weight.

In addition to the iodides of the alkalies or alkaline earths, hydriodic acid may be usefully employed, and it may be administered in the form of Gardner's Syrup. Another way in which iodine may be continuously administered is by means of the iodine wine of Nourry, a preparation which has in my hands given excellent results.

Since the observations of Lauder Brunton, previously referred to, the nitrites have been most extensively used in the treatment of every form of cardiac pain. Nitrite of amyl, applied by Lauder Brunton in the first instance, is, from its nature, more especially applicable to the relief of paroxysms of pain when present, and in this connection it will be mentioned immediately. Every member of the group of nitrites is endowed with the special action of dilatation of the arterioles, and the choice of any of them must be based upon their relative value in this respect, and their respective freedom from danger. Spirit of nitrous ether, long employed, in ignorance of its vaso-dilator effects, for many purposes; nitro-glycerine, suggested by Murrell; and nitrite of sodium, introduced by Hay, produce similar effects, in different degrees. There are, however, immense differences in regard to the dangers attendant upon these drugs. While nitrous ether is practically free from all dangers, and nitro-glycerine has few disagreeable attendants, sodium nitrite is often followed by alarming symptoms, and cannot be regarded as a drug to be indiscriminately prescribed.

In addition to the dilatation of the vessels, the fall of arterial pressure, and the acceleration of the pulse, which all these drugs produce, there is invariably an increased frequency of respiration and a tendency to the formation of methæmoglobin. The presence of glycosuria has occasionally followed the administration of these remedies, and it is hardly necessary to add that the whole nervous system undergoes some reduction of irritability.

As regards the practical question of the comparative utility of the iodides and nitrites, it must be frankly admitted that the latter are in every respect less useful than the former.

In very many cases of cardiac pain, more particularly in elderly people, the use of opium is absolutely imperative. A dread of opium in cardiac disease has lurked in the minds, and has been expressed in the writings, of many authors, but in a large proportion of cases, more particularly of senile heart disease, opium appears to have almost a tonic effect upon the heart. It may be administered in a large variety of different ways, and combined with other remedies in accordance with the special needs of individual cases. Opium and its derivatives, in addition to putting an end to cardiac pain, have a slight effect in increasing blood pressure and in increasing the activity of the heart.

Chloral reduces the activity of the heart and the excitability of the vasomotor centres. It is, however, of comparatively little importance in the treatment of serious cardiac pain; in addition, nevertheless, to other remedies it is occasionally of service through its hypnotic and sedative effects.

Of the bromides, practically the same remarks may be made as of chloral, but there are many cases in which minor degrees of uneasiness may be relieved by their administration in combination with cardiac tonics.

Phenazone has been strongly recommended by Sée, and its employment in the minor forms of cardiac pain is often followed by excellent results.

Coca, in one of the many forms available, may be usefully exhibited as a means of producing a feeling of comfort, or, it would perhaps be better to say, of lessening the feeling of discomfort; while it, at the same time, certainly has some

tonic effect on the circulation. The drug does not, however, possess in any degree the power of alleviating cardiac pain.

During an access of cardiac pain, as for instance in a paroxysm of angina pectoris, the prompt employment of appropriate remedies is required. Of remedies suitable for such an occasion, iodide of ethyl is certainly, in my opinion, the most important. Its action is probably due to the liberation of free iodine, which is rapidly absorbed by the blood. The chief disadvantage which has attended its use in my hands has been the occurrence of severe headache after it has been employed.

Nitrite of amyl is the classical remedy of modern times for such paroxysms, and given in a sufficient dose to produce the physiological effect, vascular dilatation, fall of arterial pressure, and cardiac acceleration, it is without a doubt in many instances wonderfully useful in cutting short the paroxysms. There are, however, as has been known from the earliest days of its employment, many cases in which it is absolutely useless. Isobutyl nitrite has, during the last two or three years, been employed with very considerable benefit. It is at present impossible to compare its value with that of amyl nitrite; their action must be nearly identical, but their effects no doubt vary in degree.

Many attacks of cardiac pain are only amenable to the administration of chloroform or ether. In most instances the former is more serviceable from every point of view; but in some cases, where the condition of the circulation is extremely feeble, ether is certainly a safer drug.

The subcutaneous injection of morphine in a certain proportion of cases is absolutely necessary, and its effects may be beneficially increased by giving it in combination with atropine.

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