THE OPERATIVE TREATMENT OF GASTRIC CRISES.

A CRITICAL SURVEY.

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HISTORY.

THE history of the operative treatment for certain symptoms of tabes dorsalis probably dates from 1900, when Mingazzini⁴⁷ proposed cutting the posterior nerve roots for the relief of severe lightning pains. Posterior rhizotomy, as is known, had been practised with varying success in cases of intractable pain since Bennet and Abbé introduced the operation in 1886. Vallas and Cotte (1906)⁶⁵ treated a case of severe gastric crises by stretching the solar plexus. This was followed by complete relief for four months. Mingazzini's suggestion was not carried out until Förster (1908) resected the dorsal roots on both sides from the sixth to the tenth thoracic segments of the cord in a case of visceral crises. The operation, which was performed in two stages, was followed by such immediate and permanent relief that rhizotomy was practised on a second patient, who unfortunately succumbed a few hours after the operation. In a third case, Förster cut the sixth to the eleventh pairs of dorsal roots with permanent relief of pain.

The operation now became popular and good results were reported by Moskowitz,⁴⁸ Thomas and Hall,⁶¹ Hahn, Galene, Purves Stewart⁶⁰ and many others. By 1911, the operation had been performed twenty-nine times, with four deaths, twenty-three successes, and two cases of non-improvement. Hey Groves²⁶ in that year summed up the current opinion as to the scope of rhizotomy by saying: "For the relief of visceral crises the operation holds out the only prospect of radical cure which we know of at present. Only those cases are suitable in which other means have failed to give relief, but on the other hand, it is important not to wait until the patient has been debilitated by emaciation and morphia."

Although disappointing results were reported from time to time, posterior rhizotomy still remained the most popular operative measure for the relief of pain and vomiting. In 1917 Frazier²⁵ reviewed the literature on the subject and stated that seventy-three operations had been reported to date: of these only fourteen, *i.e.*, 19·18 per cent., could be claimed as 'cures'; the operative mortality was put at 15·7 per cent. Leriche (1922),⁴³ recording the cases of seven patients so treated, took up

a critical attitude : " Je n'ai jamais vu les crises tabétiques disparaître définitivement même après des radicotomies très étendues (7 à 8 racines de chaque côté)."

Modifications of Förster's original technique have at various times been extolled ; thus Förster later declared that an insufficient number of roots were cut in his early cases and stated that the fifth and sixth as well as the eleventh and twelfth pairs of thoracic roots should be included. Lotheissen, however, reports a case in which all the posterior roots from the sixth dorsal to the first lumbar segments were resected without benefit. Guleke treated a relapse after a rhizotomy of the seventh to the ninth roots by re-operating and cutting the tenth and eleventh pairs. In this instance 'cure' resulted, although the interval between the operation and the time of report is not stated. Franke,²² Guleke,³⁰ and Lamprecht⁴⁰ advise resecting the roots at a point outside the dura either by means of a laminectomy, or by an avulsion of the intercostal nerves. Von Frankl-Hochwart²³ also treated gastric crises by dividing the seventh, eighth and ninth intercostal nerves, with benefit to the patient for ten days only. Jean³⁵ advocated either resection of the thoracic ganglia or cutting of the great splanchnic nerve by a posterior extrapleural route ; he worked out his operation on animals and on the cadaver but never put it into actual practice.

Various operations have been devised and carried out for attacking the vagus nerve. Exner¹² divided both vagi in two patients, following the operation by a gastroduodenostomy or gastrojejunostomy to overcome the ill effects of paralysis of the stomach ; his first case relapsed after three months ; in the second case pain persisted, but there was complete cessation in the vomiting up to the time of death, three weeks later. Förster proposed cutting the sensory roots of the vagus at their medullary origin, and persuaded Tietze to put the operation into practice. Unfortunately the patient died shortly afterwards. Cotte resected the gastric twigs of the vagi in three patients. The first case was a complete failure : " les crises reparussent aussi frequentes et aussi fortes qu'avant l'opération." His second case relapsed six months later ; the third case remained free from pain and vomiting up to the time of report (six months).

Thomsen⁶² reports another case in which the gastric branches of the left vagus were severed, the patient remaining free from attacks to the time of report (one year). He points out that the effect of vagotomy in dogs is to produce an achylia lasting several weeks.

PERSONAL CASES.

The following five cases are examples of crises treated by ligation or section of the posterior nerve roots.

1. G. G., male, age thirty-three, was admitted to the National Hospital,

Queen Square, under Dr. Taylor, with a five years' history of vomiting and abdominal pain. Lightning pains and girdle sensation were also present.

The pupils were unequal and sluggish in their reaction to light. The musculature was everywhere poorly developed and grossly hypotonic. There was loss to pinprick across the chest and along the ulnar borders of the forearm, and over the legs. Biernacki's and Abadie's signs were present. Deep sensibility, the sense of position and appreciation of passive movement were grossly impaired. There was incontinence of urine; gait ataxic; tendon reflexes absent. Wassermann reaction in the blood was doubtful.

Posterior rhizotomy of the sixth to the tenth thoracic roots (Mr. Percy Sargent); the patient died three and a half weeks after the operation, during which interval the abdominal pain and vomiting persisted with unmitigated severity.

2. M. R., male, age forty-eight (patient of J. M. W.), complained of abdominal pain and vomiting of three years' duration.

Physical examination showed Argyll Robertson pupils with anisocoria; absent tendon jerks; hypotonus of the legs; loss to pinprick over the middle third of the face, the 'cuirass' area, and over the shins. Sense of position was lost in the toes. The Wassermann reaction was positive in the blood. Examination of the cerebrospinal fluid showed thirty cells and a trace of globulin; Lange, 001120000; W.R., positive.

The patient being unrelieved by a course of intraspinal mercurialized serum, a rhizotomy was performed. The dorsal roots of the fourth to the tenth thoracic segments were cut on both sides.

The patient remained free from pain and vomiting for over a year; at the end of this time the attacks returned, at first in a mild form, but later with their former severity.

3. C. D., female, age thirty-six (patient of J. M. W.), gave an eight years' history of abdominal pain and vomiting, occurring soon after taking food. Gastro-analysis revealed a juice of normal acid content; skiagraphy of the stomach suggested an ulcer on the lesser curvature near the pylorus. A laparotomy had accordingly been performed seven years ago, without revealing any evidence of an ulcer. A gastrojejunostomy was carried out and the patient remained symptomless for three or four months. At the end of that time, however, the pain and vomiting returned.

Physical examination revealed unequal and irregular pupils, which were inactive to light; a positive Schwabach test; absent knee and ankle jerks; analgesia from the fourth to the tenth thoracic segments and over outer aspects of legs; Wassermann reaction ++ in the blood. The spinal fluid showed no pleocytosis, no increase of globulin, and a negative Wassermann reaction. Lange's test, however, was positive (0022332000).

Owing to the failure of routine antisyphilitic treatment a laminectomy was performed four years after the onset of the symptoms; the posterior roots of the fourth to the eleventh thoracic segments were ligated. Vomiting and pain reappeared three weeks after the operation. The patient was treated for the following four years with arsenic and mercury without any relief of her symptoms. During this time she had several severe attacks of

hæmatemesis with the crises. In March, 1924, a partial gastrectomy was performed, with benefit to the patient for two months. In June, 1924, the pain and vomiting returned with increased severity. Physical examination revealed complete loss to cotton wool and pinprick over the trunk from the fourth to the eleventh thoracic segments, the sense of deep pressure being retained. The blood and spinal fluid were then normal.

4. A female patient, age forty-two (patient of J. M. W.), gave a four years' history of gastric crises. Neurological examination demonstrated Argyll Robertson pupils, absent tendon jerks, and diminution to pinprick over the cuirass area, the ulnar aspects of the forearms and over the shins. The spinal fluid contained eighteen cells. The Wassermann reaction was positive in the fluid and in the serum. After two intraspinal injections of mercurialized serum, a rhizotomy of the fourth to the ninth posterior roots of both sides was performed. The patient died three weeks later from meningitis following breakdown of the wound. During this interval there had been no return of vomiting, but severe shooting pains were present in the anæsthetic area.

5. J. H., male, was operated upon by Mr. Cecil Rowntree for gastric crises; the posterior roots of the fifth to the twelfth thoracic segments were resected on each side, with immediate relief. The patient has remained free from pain and vomiting up to the time of writing—over three years. He was shown before the Clinical Section of the Royal Society of Medicine in 1921.⁵² We are greatly indebted to Mr. Rowntree for allowing us to make use of his case.

These five cases, therefore, comprise two deaths, each occurring from three to four weeks after operation, and three recoveries. In both fatal cases the patients were unrelieved of all their symptoms in the interval between the operation and death. Of the three surviving cases, only one showed any definite improvement, and that has been maintained after three years. Case 2 is of interest in that the patient remained free of pain and vomiting for twelve months. Had his case been reported during this interval it would have been recorded as a 'cure.' The subsequent history, however, revealed that the attacks returned—at first in a mild form but later with all their old severity. Case 3 illustrates how operative measures of any kind are sometimes followed by a temporary relief. Thus, a gastrojejunostomy was followed by three to four months' freedom; posterior rhizotomy relieved the patient for three weeks only; partial gastrectomy benefited her for two months. Hanel's experience was similar—a simple laminectomy affording one of his patients relief for several months. Case 4 is of interest in that the *nature* of the crises was altered after rhizotomy; before operation the attacks had comprised pain and vomiting; for the three weeks after operation and before the patient's death no vomiting occurred, but the old lancinating abdominal pains were present unchanged.

Case 3 differed from the others in the nature of the operative procedure on the roots; in this case, they were ligated and not cut.

The possibility of nerve regeneration may be considered, especially in the second case, where the pains returned after twelve months' relief, at first in an attenuated form, only to become severe at a later stage. Sicard and Desmarests⁵⁶ emphasize this possibility, and are of the opinion that operations on the roots should take the form of ablation of the root ganglion rather than a mere transection.

THE RÔLE OF THE ANTERIOR ROOTS IN THE CONDUCTION OF PAIN IMPULSES.

The objective and subjective sensory phenomena persisting after posterior root section have occasioned a good deal of speculation. The postoperative anæsthesia in many cases has been (1) more limited, (2) less complete than expected, and (3) transient in nature. Thus, section of the sixth to the ninth dorsal roots has frequently failed to produce loss to pinprick over the whole area which one has been accustomed to regard as the cutaneous supply of these segments; moreover, whilst the appreciation of light touch and pinprick is abolished, there is a frequent persistence of deep sensibility and of vibration sense. Stimulation of the muscles in the abdominal wall may be perceived and accurately localized, in spite of the anæsthesia of the overlying skin. Less commonly the anæsthesia resulting from posterior rhizotomy is fleeting in character, persisting for some months and then gradually diminishing in area. The dissociation between subjective and objective manifestations after operation is well recognized; every surgeon is familiar with the occurrence of agonizing attacks of pain localized to the analgesic areas.

Various speculations arise in the attempt to explain these phenomena. In cases where only four or five roots have been divided the persistence of pain and objective sensibility may perhaps be explained on the ground of nerve overlap. There are cases on record, however, where pain has appeared even after the most extensive rhizotomies, and it is difficult to explain the operative failure upon these lines. Is it possible that the intensity of the pain stimulus produces an overflow into other conduction paths? One knows that sensations of light touch, heat and cold, if intensified, travel up the cord to be appreciated not as touch or temperature sense, but as pain. Do the so-called efferent tracts contain afferent twigs along which sensation may continue to be conveyed, even after an ablation of the usual sensory path? The rôle of the anterior roots in this connection has been suspected for many years. Leonard Kidd (1911),³⁶ although the basis of his argument is not clear, concluded that afferent fibres—"in some cases algetic and in others reflex"—exist in the spinal ventral roots of man. Lehmann (1920)¹¹ conducted experiments on dogs on the survival of sensation after posterior rhizotomy and concluded that pain sensations probably

travelled *viâ* the anterior roots. He therefore suggested that the operative treatment of gastric crises should include the anterior as well as the posterior roots. Shawe (1924),⁵⁵ after an admirable summary of the literature, published a quantity of original work conducted along clinical and experimental lines. He concludes that in rabbits afferent impulses are received from the deep tissues by way of the ventral roots. The operative treatment of gastric crises in his opinion should comprise division of the anterior as well as of the posterior roots.

Apart from the two cases reported below, we have been able to find one record only of gastric crises treated by this means. Shawe quotes a case of Thorburn's in which a unilateral rhizotomy of the fourth, fifth, sixth, seventh and eighth posterior roots was performed for the relief of tabetic crises. At the operation, which was performed in 1914, the anterior roots were accidentally sectioned as well as the posterior. The result was complete relief of symptoms, with paralysis of the sixth, seventh and eighth intercostal muscles on one side and absolute anæsthesia, superficial and deep.

The following two cases are illustrative of the results of anterior and posterior root division for tabetic crises.

CASE 6.—W. H., male, age thirty-five, was admitted to the National Hospital, Queen Square, under Dr. G. Holmes, complaining of lightning pains in the legs (three years), numbness of right side of chest (two years), and severe gastric crises (one year). For the past twelve months the patient had found difficulty in walking straight, his legs refusing to "go where he expected them to." There was some urgency in defæcation. The gastric crises were characterized by vomiting, severe pain in the back and epigastrium, and hiccough. No hyperalgesia or rigidity of the abdominal wall occurred during an attack.

There was a history of a syphilitic infection eight years previously.

Condition on Admission.—Patient had the typical tabetic facies; optic discs showed a patch of old choroiditis in the right eye. The fields of vision were full and pupils were equal, central, circular, and regular, reacting briskly on accommodation and only sluggishly to light. There was slight double ptosis; the ocular movements were normal. No facial analgesia could be detected. The tongue was somewhat tremulous.

Cotton wool and pinprick were not appreciated well over the cuirass area. The motor system revealed slight ataxia only in the legs. Knee and ankle jerks were absent. There was no response on plantar stimulation. The gait was high-stepping and slightly ataxic.

Wassermann reaction was weakly positive in the blood. Examination of the cerebrospinal fluid gave fifty-five to sixty cells, the majority of which were mononuclears; albumin 0.03 per cent.; no immediate reduction of Fehling's solution; Wassermann reaction strongly positive.

The patient failed to respond to treatment by arsenic and mercury. Operation (Mr. Percy Sargent): section of the posterior roots of the fifth to

the eighth segments on both sides, also of the fifth and seventh anterior roots on the left side and the fifth, sixth, and seventh anterior roots on the right side.

Patient had a bout of painful vomiting within a few weeks of the operation and continued to have periodic gastric crises for the following twelve months. The severity and nature of the attacks were quite unaltered.

The patient was readmitted four and a half years later under Dr. Aldren Turner, complaining of agonizing lancinating pains in the right side. There had been no vomiting for the past three years. The patient also complained of an inebriate gait, paræsthesiæ of the hands, and dysuria.

The pupils were now irregular and unequal, and Argyll Robertson in type.

Muscular tone was definitely diminished in the limbs and there was marked ataxy. Patient was unable to sit up unaided; the upper recti were wasted, and the umbilicus deviated downward three inches on attempting to sit up (see *Fig.*). There was some wasting of the mid-dorsal paraspinal muscles; the middle intercostals acted poorly.

There was pallanæsthesia at the ankles; sense of passive movement and of position was good in fingers and toes. There was complete loss to cotton wool and pinprick over the trunk in the areas D5-8. Deep pressure was not appreciated in this region, but the patient could feel tapping of the rib in the anæsthetic area.

The abdominal reflexes and tendon jerks were absent.

Examination of the cerebrospinal fluid showed seven cells. Total protein, 0.035 per cent. Nonne-Apelt reaction, positive; Lange's reaction,

2455333323; colloidal benzoin, 2233333333; colloidal gamboge, 11111; Wassermann reaction, strongly positive in fluid and blood (4444).

A fractional test meal showed :—

Resting juice	.	.	.	.	Trace free HCl.
Half hour after meal	.	.	.	.	No HCl.
One hour after meal	.	.	.	.	Trace HCl.
One and a half hours after meal	.	.	.	.	Free HCl present.
Two hours after meal	.	.	.	.	Free HCl present.

Skiagraphy of the stomach revealed almost normal peristalsis and normal emptying time.

CASE 7.—L. G., female, age forty-eight, was admitted to hospital under

Diagrammatic schema of points of attack for gastric crisis operations. A. Tietze; B. Exner; C. Vallas and Cotte; D. Förster; E. Shawe; F. Schüller; G. Jean.

Dr. Aldren Turner, for stabbing pains in the chest and abdomen, especially over the right side (nine years). Vomiting had been present for twelve months only. There was urinary incontinence.

Physical examination showed normal optic discs. The pupils were unequal and eccentric, and Argyll Robertson in type. Ocular movements normal.

There was loss to pinprick over the 'butterfly area' of the face. There was general muscular atrophy, hypotonia and ataxia. Sensation to pinprick and cotton wool was impaired in irregular areas over the arms, legs, and trunk, but there was over-reaction to pinprick over the areas D10-12 posteriorly. Appreciation of pinprick was delayed in the feet. Sense of passive movement and position was diminished and there was marked pallanæsthesia. Abadie's sign was positive at the left ankle. Knee and ankle jerks were absent.

Cerebrospinal fluid examination showed eleven cells. Total protein, 0.025 per cent. Nonne-Apelt, $\pm$; Lange, 1111011000; Wassermann reaction positive in fluid (4310), and in blood (4444).

The pain persisted with remissions in spite of vigorous antisypilitic treatment.

Operation (Mr. Percy Sargent): Anterior and posterior rhizotomy of the seventh, eighth, ninth, tenth and eleventh roots on the right side only.

Patient recovered from the operation and left hospital three weeks later declaring that the pain was 'easier.'

She was readmitted eight months later with rectal crises and with severe abdominal pain and vomiting. Patient stated that since the operation the pains round the right side of the abdomen had only been mitigated. The pain was localized to the areas of the eighth and ninth dorsal segmental supply.

There was loss of sensibility to cotton wool and pinprick over the areas D7-11 on the right side; deep pressure was not appreciated although she could detect percussion of the ribs in the analgesic area.

The neurological signs had not altered since the previous admission. Cerebrospinal fluid showed: one cell; total protein, 0.045 per cent.; Nonne-Apelt, $+$; Lange, 0001233211; colloidal gamboge, 00000; Wassermann reaction positive in fluid and in blood.

These two cases constitute, as far as we have been able to trace, the only records of gastric crises treated by deliberate transection of the anterior and posterior nerve roots. Thorburn's case, quoted by Shawe, was similarly treated, but there the anterior root division was accidental. The results of these three cases have not contrived to place the operative treatment of tabetic crises upon any sounder basis. Thorburn's case was apparently eminently successful, the case being seen as late as seven years after the operation.

In Case 6 the attacks of pain and vomiting returned within a few weeks of the operation, and persisted unchanged for twelve months. There was no alteration whatever in the nature or severity of the crises.

At the end of twelve months they ceased for the space of a year and a half; after that time intense pain appeared, which the patient localized in the anæsthetic area. There was no associated vomiting.

In Case 7, also, pain and vomiting persisted, although the character of the pain was somewhat modified after the operation.

THE FASCICULUS ANTEROLATERALIS.

The most efficient operative method of treating intractable pain is now directed towards the division of the pain fibres in the spinal cord. Schüller in 1910 suggested "chordotomy" or section of the anterolateral tracts for the relief of pain. His suggestion was not put into practice until 1912, when Martin performed the operation on one of Spiller's patients. Further cases have since been reported by Beer,² Förster,¹⁹ Frazier²⁵ and others. Knud Krabbe³⁷ in a recent paper has stated that the details of twenty-five chordotomies are on record.

The technique consists in exposure of two laminæ. The site of the operation usually taken is five segments above the affected region, in order to include all the crossed pain fibres. The denticulate ligament is grasped with mosquito forceps and a loop of silk is placed round the posterior root so as to rotate the spinal cord. At a point midway between the anterior and posterior roots a von Graefe keratome is inserted for a depth of 2.5 mm., and the incision is carried forward for a distance of 3 mm. so as to include the anterior root. Care is necessary to avoid injuring the lateral pyramidal column.

The result of the operation is heterolateral loss of pain and temperature sense below the section, with persistence of light touch and deep sensibility. There is a temporary zone of hyperæsthesia at the segmental level.

The scope of this operation in cases of gastric crises is still *sub judice*: Souttar⁵⁸ in 1915 operated upon a woman by dividing the anterolateral column on the right side between the first and second dorsal segments. The result was immediate relief of her symptoms, which, except for one bout of painless vomiting four weeks later, has persisted to date. Leighton⁴² performed this operation on three tabetics for the relief of crises or lightning pains. The three operations were recorded as successes, although the interval between the chordotomy and the report was a matter of only a few months. Sachs (1920) states that he performed the operation on two tabetics, but did not mention whether for visceral symptoms or not. Grant (1924) showed two cases before the American Association of Neurosurgeons in which chordotomy had relieved tabetic crises.

This operation commends itself as being superior to rhizotomy by reason of its lesser severity and by its rapidity. The resulting therm-analgesia is no more of a handicap than the atony and paralysis

of the abdominal musculature which follow posterior and anterior rhizotomy.

Further cases are needed, therefore, before a definite opinion can be passed as to the effect of chordotomy on gastric crises. On theoretical grounds it is necessary to recall that the problem of visceral sensations is not altogether comparable with that of the intractable pains of root irritation; we have no proof that the anterolateral tracts contain the somatic afferent fibres. Frazier and Spiller, indeed, remark on the perfect sphincter control and the lack of any evidence whatever of disturbed visceral function, even after bilateral chordotomies.

THE NATURE OF GASTRIC CRISES.

The most striking feature of the postoperative results is, therefore, their extreme variability. Whilst in the majority of cases the benefit is but slight, nevertheless several cases are recorded in which surgery has produced a marked and lasting result. Such an instance is furnished by Case 5. Moreover, the same varying results are found whatever the type of operative interference—posterior rhizotomy, vagotomy, or stretching of the cœliac plexus. Such a state of affairs calls for a revision of the pathogenesis of gastric crises.

Gastric crises appear to be essentially expressions of a syphilitic process. It is true that similar phenomena have been recorded in other conditions—for example, syringomyelia and generalized arteriosclerosis—but their infrequency prevents them from helping us in elucidating the pathological processes at work. The gastrointestinal manifestations of plumbism might be cited in analogy, but the resemblances are not sufficiently close to warrant any inferences.

Crisis are said to occur in 10 per cent. of all cases of tabes dorsalis. They usually occur in the early pre-ataxic stages, and may in fact be present before the existence of any of the cardinal features of tabes. In five out of forty-two cases in the Friedenwald and Leitz series crises were the first manifestation, and in three cases recorded by Mills⁴⁶ there were no signs in the central nervous system to suggest tabes, although the Wassermann reaction was positive in the blood. In other cases, again, where pupillary signs and hypotonia point to a neurosyphilis, severe gastric crises may be the outstanding feature of the symptomatology and yet the cerebrospinal fluid and blood may be completely negative in their reactions, not only respecting cytology and protein content, but also with regard to the Lange and Wassermann tests. This has been exemplified in several cases lately under observation at Queen Square.

A consideration of the symptomatology may be of assistance. The patient is usually attacked with sudden severe pain in the pit of the stomach, which, although described as stabbing in character, does not

tend to spread to other parts of the abdomen or thorax. Vomiting follows, but affords no relief to the pain; there is a variable degree of accompanying nausea, and frequently copious eructations of gas occur. Hæmatemeses, though unusual, are by no means unknown. Dysphagia may be present; constipation is the rule, but diarrhœa has been described. There is frequently an intense hyperalgesia of the skin of the epigastrium, but the abdominal wall itself remains flaccid throughout the attack. The patient's face shows intense pallor and the pulse becomes feeble and frequently irregular. The crises last from a few hours to several days and usually cease with startling suddenness. In certain instances the crisis is followed by a severe bout of hiccough. Gastro-analysis reveals no constant departure from the normal. In about 18 per cent. of cases the acid content is normal, when estimated during attack, and in the intervals between the bouts the proportion of normal gastric juices is 39 per cent. In the others there may be either an achlorhydria or a hyperchlorhydria. The condition of the reflexes during an attack is an important point; in many cases there is an exaggeration of the abdominal reflexes. In certain instances, also, there is a temporary aggravation of the pupillary signs during a crisis, viz. an increase in the myosis, and the pupils, which formerly gave a sluggish response to light, now become immobile.

Skiagraphy of the stomach reveals, in many cases, intensely active peristalsis, with a degree of pylorospasm.

In spite of the striking clinical features of the crises, the mechanism responsible still remains uncertain. The attacks are regarded by some as sympathetic in origin (Laignel-Lavastine, Roux); by others they are assigned to a recurring attack of acute posterior radiculo-ganglionitis in the lower dorsal segments of the cord; others hold the vagus nerves or the vomiting centre in the fourth ventricle responsible for the symptoms. Gowers pointed out many years ago that the cases of tabes in which crises are prominent are those in which the morbid process is more marked in the upper cervical segments. The occurrence of obstinate vomiting after high cervical cord lesions is probably another instance of medullary interference. Eppinger and Hess regarded visceral crises as the expression of irritation and later paralysis of the autonomic nervous system, and laid greater stress on motor than on sensory irritation.

Head and Fearnside³² maintained that one form of crisis is "obviously associated with irritation of the posterior nerve roots in the thoracic region of the spinal cord, which tends to set up reflex attacks of vomiting accompanied with violent root pains round the trunk, due to the coincident irritation of the somatic afferent fibres of the posterior roots." It is difficult to understand this reasoning: in no other type of posterior root irritation do we meet with vomiting. The radiculitis

of Pott's disease, of extramedullary tumour, of chronic spinal meningitis, undoubtedly gives rise to root pains and girdle sensations, but intractable vomiting, sudden in onset and termination, is practically unknown. Neither does herpes zoster, even in those rare cases where both sides of the chest are affected, give rise to vomiting.

Is it possible that more than one agent is at fault in the causation of gastric crises? Or are there different types of gastric crises, which are clinically distinguishable, of differing pathology, and each requiring its own particular form of treatment? The latter is a view which is supported by considerable evidence and which is seriously considered by Förster, Cotte, Jean and others. Thus it is postulated that there are two chief types of crises, depending upon whether they are of vagal or sympathetic origin. Förster expressed his opinion as to the nature of the attacks in these words: "crises are due to the irritation of the sensory sympathetic fibres of the stomach, which, after entering the coeliac plexus in the splanchnic major nerve, pass to the spinal cord through certain posterior dorsal roots." Later, in 1917, he added: "We must, however, bear in mind that gastric crises may possibly arise from irritation of the vagus and perhaps even of the vomiting centre in the medulla."

Vagal crises are characterized by intense nausea and vomiting. Pain is conspicuously absent, but it may be replaced by a peculiar gnawing feeling in the epigastrium which causes the patient the most profound distress. There may be a grossly disordered action of the heart beat and dysphagia may be pronounced. There is no accompanying hyperalgesia of the abdominal wall. Gastro-analysis reveals a hyperchlorhydria.

In the sympathetic crises, on the other hand, pain constitutes the predominant symptom and vomiting may even be absent. There is intense hyperæsthesia of the skin of the abdomen, and the epigastric reflexes are exaggerated. Such crises are characterized by a low HCl content in the gastric juice.

This theory of a dual type of attack is one of great ingenuity and would repay systematic research. It would explain the benefit occurring in some cases of rhizotomy and vagotomy, and the complete failure in others. Differentiation would therefore become necessary between the two types before advising surgical measures. Thomsen⁶³ compares the effects of vagotomy with the administration of atropin; in the vagal crises he states that temporary relief can be afforded by atropin, which, moreover, produces a transient achylia. Heile advocates the epidermal injection of adrenalin for the purpose of differential diagnosis; relief of symptoms after this measure suggests a sympathetic origin.

In cases where the symptomatology points to a sympathetic origin, division of the anterior and posterior spinal roots would theoretically alleviate the symptoms by interrupting the circuit. Such benefit does

not invariably follow, however, as exemplified by Cases 6 and 7. In such instances it is probable that the painful impulses originate in the celiac ganglion or in one of the many extraspinal sympathetic arcs, and so are short-circuited. The path by which these stimuli reach consciousness is not clear; division of the anterolateral bundle, although producing absolute analgesia and thermanesthesia, does not prevent pain being felt in the anæsthetic regions. Extensive transection of the anterior and posterior roots on both sides frequently produces a similar dissociation between objective and subjective sensation. The pathway, therefore, appears to lie in some cases outside the spinal cord. In this connection the vagus nerve must be considered as a probable conduction path; its fibres are known to comprise not only motor and secretory elements but also afferent sensory twigs, which may well convey some of the stimuli originating in the stomach wall.

No one will deny the insecurity of the present status of surgery in the treatment of visceral crises. The large proportion of failures after extensive ablation of the afferent systems necessitates a revision of our whole conception as to the pathogenesis of visceral pain in tabes. In future it would appear necessary by clinical and pathological investigation, biochemistry and skiagraphy, carefully to differentiate between the crises of vagal origin, those of sympathetic origin, and those in which both systems are involved. Treatment is still on an uncertain basis; vagal crises are capable of relief by atropin medication, but this measure is purely palliative. It is possible that section of the gastric branches of the vagus, combined with gastrojejunostomy, will afford the maximum relief when performed upon the proper type of patient. Alcohol injection of one vagus has been suggested as an operative measure in these cases (J. M. Wolfsohn).

Certainly a proportion of the sympathetic crises are amenable to surgical treatment directed towards the afferent sensory systems. Of these operations, chordotomy appears to be the least dangerous, and the most rapid of performance. The resulting heterolateral analgesia is not a grave drawback to the operation. The pain which persists after many operations on cases of sympathicogenic crises is explicable by regarding it as originating in the short sympathetic neurones situated in the gastric musculature, and conducted probably *viâ* the vagus. The correct line of treatment here is not known; possibly section of the vagus will effect a cure; more probably the future therapeutic measure will be found in some sympathetic-paralysing drug of the nicotine class—as suggested by Kinnier Wilson.

CONCLUSION.

The question of the pathogenesis and treatment of visceral crises would appear, therefore, to remain a problem. This present paper is a

plea for a thorough and systematic investigation into the nature of these crises by means of modern laboratory methods.

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