hospital a month later it was noted that weight had been gained. The loss of his symptoms had changed him from a very miserable to a most cheery individual.

Comment

The cremaster muscle, which plays the active part in the syndrome, originates from the lower fibres of the internal oblique and transversus abdominis muscles. It forms an investment for the spermatic funiculus deep to the external spermatic fascia, and descends as a series of loops over the cord and testis; medially the fibres ascend to have insertion into the pubic tubercle. The nerve supply comes from L 1 and 2 through the external spermatic branch of the genito-femoral nerve; arising from the same lumbar segment is the ilio-inguinal nerve, the terminal cutaneous branches of which innervate the skin of the thigh over the proximal and medial part of the femoral triangle.

The function of the cremasteric reflex is protective. In the small boy it is well known that from this hyperactive reflex, on little provocation, the testes may temporarily disappear up into the inguinal canal or even into the abdominal cavity. As a protection from undue variations in temperature, which might prove harmful to the testis, the cremaster muscle is said to make appropriate adjustments. Whether this be true or not, it is perhaps significant that in natives of hot climates the cremasteric fascia is represented by no more than a few slender fibres hardly recognizable as muscle.

Reflex or defence movements in which there are sudden twitch-like co-ordinated involuntary movements are classified as tics. In the case described by McDonald and Mayo (1939) the cremasteric hypertrophy was associated with regular twitching and could truly be termed a tic. With the present series of cases the tonic rather than clonic nature of the spasms suggests that the malady is more allied to that group of disorders known as the cramps.

Cremasteric cramp with testicular retraction must be produced by some factor exciting the reflex either from the central nervous system or from within the arc itself. Spasms of the cremaster muscle have been reported in patients with central brain or spinal injuries; Hamburger is quoted as describing several cases of hyperactive cremasteric reflexes with spasm in which he thought the cause was psychogenic. Organic lesions of the central nervous system can be excluded as a possible cause in the above cases, and perhaps one of the half-dozen patients could be regarded as having any psychogenic instability. The remainder were hard-working men in whom the cause seems to lie within the reflex arc itself. Some local trauma has been the usual exciting factor; thereafter, the cremasteric reflex has become hypersensitive, and not infrequently the affliction has spread to involve both sides.

The fact that six cases have been personally dealt with by one surgeon supports the suggestion that the condition is a definite clinical entity which cannot be so very rare. A number of patients with undiagnosed groin pain might well belong to this category if its possibility were considered and the patient asked directly whether his testis was drawn up during the attacks. It is worthy of note that patients who have experienced the condition for any length of time develop anxiety not only from the continued discomfort but also from their inability to continue working because of it. The post-operative patient presents a marked contrast to the troubled individual he was before the operation.

The salient features of the syndrome may be summarized as follows: (1) the average age of onset was 32; (2) some form of local trauma usually precipitates the first attack, but thereafter lesser stimuli can initiate attacks; (3) once started, the condition is progressive and may eventually become bilateral; (4) hyperactive cremasteric reflexes may be elicited; (5) cremasteric cramp draws up the testis to near the external ring and intense groin discomfort is experienced until relaxation of the tonic spasm occurs; and (6) actual muscle hypertrophy is not always present, but it is likely to develop in the cases of longer duration.

Treatment

Drug therapy combined with psychotherapy, excision of the ilio-inguinal nerves, injection of an oestrogen, hot sitz baths, and diathermy have all been advocated by various authors. The results have been variable and uncertain. In both the cases reported in America (McDonald and Mayo, 1939; Muschat, 1941) removal of the hypertrophied cremaster muscle was completely effective, and similar treatment given to the above six cases was equally satisfactory.

Approach is made through an incision over the inguinal canal, which is opened from the external ring. The ilio-inguinal nerve is first removed. At the abdominal ring, a cuff of cremaster muscle is turned off the internal oblique and stripped down as far as the testis, removal of muscle being completed at this point. Any hernial sac is then excised. The mobilized conjoint tendon is sutured to the inguinal ligament deep to the cord with interrupted fine thread. The external oblique is then closed behind the cord medially.

The operation tackles the syndrome from three aspects: removal of the ilio-inguinal nerve renders anaesthetic the chief cutaneous trigger area for the cremasteric reflex; excision of the cremaster muscles leaves no muscle to develop cramp or draw up the testis; and, after the local readjustment, the external ring is no longer available for testicular impaction.

Summary

Six cases of cremasteric cramp with testicular retraction are described.

It is considered that the disorder, if it were recognized, would be found perhaps not so uncommon as the literature would suggest.

A minor operation is effective in giving complete relief.

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CLINICAL DIAGNOSIS OF PYLORIC OBSTRUCTION

THE SODA-WATER TEST

BY

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The clinical diagnosis of pyloric obstruction is not always easy. Early cases often present without copious and frequent vomiting. There is not much doubt if visible gastric peristalsis is present on examination, but this is rather infrequent (Parsons and Watkinson, 1954). Succussion splash is of doubtful diagnostic value. Most textbooks mention some adjuncts to simple inspection, including massage of the abdomen (Hurst, 1946) and tapping the stomach area with the fingers to stimulate peristalsis (Bockus, 1944). Bockus also states that visible gastric peristalsis is seen in only about 50% of the cases of pyloric obstruction and has to be carefully sought. For many years some physicians and surgeons have given a drink of water in the suspected case to stimulate peristalsis, because when the patient is examined his stomach is often empty or atonically dilated and inactive. Osler and Macrae (1920) recommended a dose of tartaric acid

followed by bicarbonate of soda in order to distend and stimulate the stomach in such cases. In this hospital soda water has been used for the same purpose for some years and has often given spectacular help in diagnosis (H. P. Brody, personal communication).

The present investigation was undertaken to assess the full diagnostic value of the test, and my interest was stimulated by the discovery of hypertrophic pyloric stenosis in a man who had visible peristalsis after drinking soda-water but in whom barium studies and other investigations showed nothing abnormal. One of the main objects was to determine whether normal stomachs might give a misleading "false-positive" result; I have seen only one of these. A very thin abdominal wall might allow normal gastric peristalsis to be seen, but I saw no such case in the series.

Method and Material

Soda-water provides a bulky and lively stimulus to gastric peristalsis. It is analogous to the less violent milk feeding of infants suspected of having hypertrophic pyloric stenosis. The stomach is rapidly distended with fluid and liberated gas. I have found that the amount required varies with the individual case. A general rule is that enough should be given to produce a stomach bulge. Usually this is 5 to 10 oz. (140 to 280 ml.), but may be more or less. Three or more tumblerfuls may be needed if the stomach is large. A stomach bulge was always seen in patients who were subsequently shown to have any degree of pyloro-duodenal occlusion.

The procedure is to examine the abdomen and then to let the patient sit up and drink a glass of soda-water. He then lies down again immediately. If no gastric bulge is seen more soda-water is given until one is produced. Observation is continued until one is quite satisfied about the presence or absence of visible peristalsis. I have found it convenient to refer to this as the soda-water test. If peristalsis is visible it is called "soda-water positive," and if not it is "soda-water negative." A big distended stomach without peristalsis is suspect, but is not a positive test.

I have reviewed 171 patients who were tested with soda-water before any radiological studies had been made, usually on the first attendance at the out-patient department or on admission to the wards. They are unselected apart from the fact that all were to have a barium meal. No case has been included in which peristalsis was visible before the test. At least two observers saw each positive case. The results of a follow-up have been analysed. The period of this has varied with individual cases, but it has allowed a diagnosis to be made in each. All the cases were seen from August, 1954, to February, 1955, and the results have been arranged under diagnostic headings for convenience.

Duodenal Ulcer

Forty-seven patients in whom the soda-water test was negative showed radiological evidence of duodenal ulcer. One had both gastric and duodenal ulcers. Vomiting was a quite frequent symptom, but commonly occurred only during acute exacerbations of the ulcer syndrome, and consisted of small amounts of acid fluid and bile. Vomiting of food was uncommon and copious vomiting of long-retained food was not a feature. On the other hand, six cases showed some residual gastric contents on radiological examination, but only two had any delay in emptying. Three of them had not vomited at all and the other three had had occasional bouts. Established pyloric stenosis did not develop in any "negative" case during the follow-up, so that no case of pyloric stenosis was actually missed by the test.

The position of the stomach bulge provides an excellent guide to the relative position of tender areas during the examination of patients with painful dyspeptic syndromes.

Eleven patients showed definite visible gastric peristalsis with soda-water and were found to have duodenal ulceration. These constitute the largest proportion of the positive cases. Four of them had established pyloric stenosis and two other operated cases had active duodenal ulcers without fibrotic stenosis. Four patients recovered on routine medical treatment and were presumed to be cases of pylorospasm, as the soda-water test became negative later.

The following remarks on a few of the positive cases indicate some of the conclusions which may be drawn from the results.

Case 1.—A man aged 63 complained on August 18, 1954, of periodic epigastric pain with food, and relief with alkali. Pain was first felt three years previously, and the most recent symptoms had continued for nine months with little respite. For one month he had vomited frequently after food, although day and night pain was still relieved by alkali. He was not dehydrated. The epigastrium was tender and soda-water revealed visible gastric peristalsis. With a dietary, alkali, and sedative therapy in bed symptoms abated and the soda-water test became negative after 12 days. Radiology at this stage showed a chronic duodenal ulcer with a diverticulum in the second part of the duodenum. There was no hold-up of barium. No further vomiting occurred. *Comment:* Positive test due to pylorospasm in the active phase of chronic duodenal ulceration.

Case 2.—A man aged 54 was first seen on November 15, 1954. He had suffered for 13 years with typical ulcer dyspepsia. For two years vomiting after meals had become frequent, and particularly in the last six months. The soda-water test was positive and remained so during the next two weeks. Operation then revealed a chronic duodenal ulcer with inflammatory and cicatricial stenosis. Radiological findings were limited to the observation of a large excess of gastric residue. Visible peristalsis was never seen apart from deliberate testing with soda-water. *Comment:* Positive test due to established pyloric stenosis. Absent peristalsis at other times presumed to be due to inadequate gastric filling or gastric atony.

Case 3.—A thin woman aged 45 complained of vomiting copiously for three weeks and some ill-defined abdominal pain. On examination the hypogastric region was tender, but no other abnormality was seen. Soda-water showed a long stomach outline with its lower limit just above the pubis. Visible peristalsis was soon obvious. Operation a few days later revealed a large stomach with pyloric narrowing and a large active duodenal ulcer. *Comment:* Abnormal stomach outline and position revealed by a positive test in a case of active duodenal ulceration.

Case 4.—A man aged 65 had been known to have a duodenal ulcer for 16 years when he attended on November 20, 1954. He had a classical history of pyloric stenosis. The soda-water test was positive and the morning gastric residue next day was 30 oz. (850 ml.). He settled down on a medical regime in the ward, but the soda-water test was positive on all five occasions in the following nine days. Operation was delayed because of severe cardiac disease. On November 29 the symptoms recurred with the addition of burning retrosternal pain and haematemesis. On December 6 the soda-water test was still positive although vomiting had again ceased. It remained positive until surgery, on December 13, revealed established pyloric stenosis due to a grossly fibrotic duodenal ulcer. *Comment:* The remarkable findings in this case were that at no time was peristalsis seen without the test and that the radiological report on November 25 (soda-water positive) stated: "Peristalsis and emptying began at once. The duodenal cap showed a constant gross deformity. No evidence of pyloric stenosis." This case shows the sensitivity of the test as compared with radiology in demonstrating relative obstruction to gastric outflow. *Conclusion:* Soda-water test necessary to show visible peristalsis in a case of pyloric stenosis due to duodenal ulceration. Test more reliable than radiology.

Case 5.—A man aged 59 had a negative test on first examination, but three weeks later the test was positive. Radiological examination showed a little residual gastric fluid but no delay in emptying. Surgery revealed the presence of a duodenal ulcer with surrounding oedema but no fibrotic stenosis. *Comment:* Change from soda-water negative to positive, indicating increased obstruction. Test valuable in following case progress.

Gastric Ulcers

There were 17 cases of benign gastric ulcer, proved by radiology or gastroscopy. Two cases had a positive soda-water test and are described below. The 15 negative cases showed no evidence whatever of pyloric obstruction. One had the sign of a little residual fluid, but stomach-emptying was normal and there was no vomiting. One had a pyloric ulcer without obstructive signs of any sort. Five had complained of occasional vomiting, but in none was it persistent. The ulcers in the negative cases were in various positions, including high, mid, and lower lesser curvature, posterior, and pyloric. Some were described as large and others as small. The positive cases indicate that gastric ulcers within a moderate distance of the pylorus can cause relative obstruction—that is, a positive soda-water test, and this may be a valuable diagnostic sign.

Case 6.—A mentally defective man aged 24 complained of upper abdominal pain and diarrhoea. He had not vomited and did not do so in the ward. The epigastric area was noticed to be rather distended, but peristalsis was not seen until soda-water was given. A barium-meal examination showed a large gastric ulcer in the pyloric antrum, which appeared rigid. There was some delay in emptying. He did well on medical treatment: the symptoms disappeared and so did the visible peristalsis. *Comment:* Active gastric ulcer, causing partial obstruction to gastric outflow. No vomiting.

Case 7.—A man aged 68 had dull postprandial pain in the epigastrium, radiating into the chest and back. Vomiting of bilious fluid once a day, anorexia, and weight loss were other features. There was no vomiting of food. Between October 23 and November 11, 1954, he was tested six times, and was positive in five of these even though at the time of the later tests he had no pain and was not vomiting at all. On October 29 a large tender gastric ulcer was demonstrated radiologically low down on the lesser curve. Increased residual fluid was present. A repeat radiological examination on January 25, 1955, showed a diminution in the size of the ulcer crater and the soda-water test had become negative. At this time he was free of symptoms; he recovered completely. *Comment:* A gastric ulcer on the lower lesser curve caused partial pyloric obstruction which gradually cleared up. Progress was mirrored by the test results.

Gastric Carcinoma

During the survey period 12 tested cases were subsequently shown to have carcinoma of the stomach, and from these I have been able to draw some interesting conclusions. In nine the soda-water test was positive, although one had only feeble and irregular waves. One had partial lower oesophageal obstruction and two had rigid infiltration, tests in these three being negative. A most remarkable feature is that 9 out of 12 cases had positive tests even in the absence of vomiting. In two with negative tests a mass could be felt, but in three of the positives there was no palpable mass and two had not vomited. One of the latter had a history unlike carcinoma. These observations are a fair indication of the screening value of the test.

Case 8.—A man aged 42 complained of dull epigastric pain for one year relieved by food. Hunger pain was present on fasting for a few hours. His appetite was good. He had no regurgitation or vomiting whatsoever. A small hard supra-umbilical mass and gastric peristalsis after soda-water were surprising findings in view of the history. A

barium-meal examination showed a neoplasm involving the distal part of the stomach, confirmed at operation. *Comment:* Early stage of pyloric obstruction before any vomiting in an atypical case of gastric cancer.

Case 9.—A man aged 52 had had remitting pain for five years. Five weeks before October 10, 1954, when he first attended, he had been vomiting copiously. The soda-water test revealed a very large stomach bulge, which had to be observed for fully five minutes after drinking about 15 oz. (425 ml.) of soda-water before large peristaltic waves appeared. He had a big inoperable gastric cancer involving the antrum. *Comment:* Prolonged inspection may be necessary if the stomach has become dilated.

Case 10.—A woman aged 47 had complete anorexia, weight loss, and nausea with occasional vomiting. An elongated mass could be felt in the upper abdomen, lying in an approximately transverse position. Carcinoma of the stomach was thought likely. I tried the soda-water test repeatedly, but only feeble and irregular peristaltic waves could be seen (classed as positive) although the patient vomited repeatedly after food or fluid. A barium-meal examination and gastroscopy confirmed the diagnosis of carcinoma of the stomach, but a narrow stream of barium passed through at once into the duodenum, which was normal. Gastric peristalsis was reported as "poorly marked." Operation showed diffuse infiltration in the distal third. *Comment:* Well-defined visible peristalsis was probably prevented by the rigidity of the stomach walls. The test helped to show that the mass was in fact the stomach. Overloading produced vomiting easily.

Miscellaneous Organic Disorders

Duodenal Obstruction

Case 11.—This case may conveniently be included here. The patient, a man aged 70, had been vomiting for six weeks. The soda-water test was positive. A barium-meal examination showed a hold-up but nothing else definite. At operation there was a large neoplastic mass stuck to the duodenum and obstructing it. The origin of the neoplasm was not established. *Comment:* Positive test due to obstruction of the duodenum.

Pin-hole Pylorus

This interesting case prompted a survey of the soda-water test because it had repeatedly been positive though the barium-meal examination showed no abnormality. The short summary of the history indicates the problem.

Case 12.—A man aged 55 was admitted to hospital on August 14, 1954, complaining of umbilical and left-sided abdominal pain, frequent borborygmi, and the vomiting of food and acid-tasting fluid in attacks during the last year. The symptoms had been worse recently. He had had a poor appetite for five months, and had lost 1 st. (6.4 kg.) in six months. He belched a lot. There were no urinary symptoms. He had been seen in the out-patient department on February 18, 1954, when he had complained of attacks of vomiting and severe flatulence; the latter had troubled him for two years. No definite diagnosis could be made at that time. Barium studies, fractional test meal, and other investigations gave normal results. Three days after admission a soda-water test was tried and, rather to our surprise, was positive, powerful gastric peristalsis being seen. Five days later a barium-meal examination was reported as normal; so was the follow-through study. A fractional test meal examination was again normal; no bile was present. The urine was normal, but the blood urea was 48 and 52 mg. per 100 ml. The alkali reserve was 22 mEq/l. The faeces contained no occult blood. As the vomiting attacks continued and the soda-water test remained strongly positive an operation was undertaken on September 26, no diagnosis having been made. A thick hypertrophied pylorus was felt on palpation at laparotomy, and gastrotomy showed a very small pyloric opening which admitted only the points

of the forceps. The pylorus was then dilated with a finger. Unfortunately a biopsy was not taken, so the exact nature of the pyloric hypertrophy remains obscure. The duodenum and other abdominal organs were apparently normal. *Comment:* Hypertrophic pyloric stenosis with a positive soda-water test and a negative barium-meal examination.

Carcinoma of Pancreas

Case 13.—This patient, a man aged 47, had escaped diagnosis elsewhere for many months and radiology had not revealed any abnormality. He was admitted with severe persistent vomiting, which had been getting worse for seven weeks. A positive soda-water test was the only physical sign. He was too ill for radiology and was obviously in need of surgery. This revealed complete stenosis of the duodenum just above the ampullary region. A hard mass was palpated in the underlying head of the pancreas. It proved to be a carcinoma of the pancreas infiltrating the duodenum and had produced an annular stricture of that organ.

Oesophageal Syndromes

Six patients (five females and one male) in whom the soda-water test was negative had oesophageal lesions. The symptoms were regurgitation of food or vomiting in two cases of hiatus hernia, haematemesis from a large hiatus hernia, and regurgitation of undigested food in a case of pharyngeal diverticulum. One patient with hernia had pain without vomiting. Another patient had oesophageal reflux without herniation and had been vomiting occasionally for three years. There were no gastro-duodenal lesions in any of these cases, apart from one who had a gastric ulcer in the herniated stomach wall. Soda-water tests were all negative. The ages of the patients ranged from 59 to 71 years.

Functional Dyspepsia

Forty-eight patients had a functional type of dyspeptic history; all had negative soda-water tests, and in each the barium-meal examination showed nothing abnormal. Symptoms were naturally very varied in this group. Ten had had acid reflux or vomiting at some time. None had symptoms or signs of pyloric obstruction. Other symptoms were abdominal pain, nausea, anorexia, dysphagia, heartburn, and diarrhoea. Other investigations showed no organic disease. Four patients had had two barium-meal examinations which showed nothing abnormal. The ages of the patients ranged from 20 to 72 years. No false positives were seen.

Patients without demonstrable lesions but with histories which suggest the presence of a peptic ulcer are familiar enough in the gastro-enterological clinic. Some of them would no doubt show a definite ulcer on later examination, but this is by no means always the case.

In the series there were 11 such patients. They were aged from 18 to 70 years. One had bled and three had vomited occasionally. None was suggestive of pyloric obstruction and all had "normal" barium-meal examinations. The important point is that they were all soda-water negative. No false positives were observed.

Functional symptoms that are more or less referred to the abdomen or alimentary tract are common. Gastro-intestinal radiology in these cases shows no important or relevant abnormality. Some cannot be diagnosed immediately, but show up in their true light later on. Similar cases are those which do have functional gastro-intestinal involvement; for instance, the gastric symptoms of pernicious anaemia or the vomiting in infections of the urinary tract. Also included here are those cases with a definite lesion, the effect of which is doubtful, an example being a duodenal diverticulum. Thirteen patients have been placed in this mixed bag. There was no sign of obstruction. All were soda-water negative. Each had a barium-meal examination. There were no false positives.

Diagnoses included the following: bronchitis and emphysema (1), pernicious anaemia (3), iron-deficiency anaemia (2), glandular tuberculosis (1), angina pectoris (1), recovered acute gastritis (1), biliary colic (1), depressive state (1), post-traumatic neurosis (1), urinary infection (1). One of the cases of pernicious anaemia had a duodenal diverticulum.

A False-positive Case

The following case is one of the most important because the patient had a persistently positive soda-water test yet no serious abnormality could be found, and she was in fairly good health without vomiting after eight months.

A woman aged 62 had been anaemic for many years and the menses had been terminated artificially 20 years previously. Her main trouble was abdominal pain before food radiating into the back with remissions and no night pain. Food produced no distinct relief of pain. She had a good appetite, had vomited three times in the past two weeks, felt weak and tired, had lost some weight, and suffered from occipital headaches. On first examination the soda-water test gave a positive result, showing also a low stomach bulge with its lesser curve at the level of the umbilicus. She was thin and asthenic. Mild iron-deficiency anaemia was evident. On October 30, 1954, a month after the first examination, the test was still positive. A fractional test meal gave normal results; free acid present. A barium-meal examination at this time showed nothing abnormal, the opaque material was in the colon in six hours, and the stomach was empty. Could visceroptosis be causing the visible peristalsis? Assumption of the Trendelenburg position did not affect the result of the test. The soda-water test was again positive on January 31, 1955. On readmission in March for further study she was still positive, with a low-lying stomach. A barium-meal examination was quite normal and there was no residual fluid in the stomach. Gastroscopy showed a long tubular-shaped stomach. The mucosa seemed to be somewhat atrophic and no peristalsis at all appeared in the antrum or pyloric region.

That was the position at the time of writing. I do not know the explanation. It may be some sort of functional disturbance of the stomach. There was no undue thinness of the abdominal wall. The patient had gastric symptoms. Laparotomy did not seem to be justified, as she was not really ill and her condition had remained static.

Conclusions and Summary

The soda-water test for pyloric obstruction is described. In this series of 171 cases the test has proved to be useful in the following ways: (1) the position, size, and shape of the stomach were often observed; (2) the positions of painful areas, lumps, and other structures relative to that of the stomach may be well shown; (3) pyloro-duodenal obstruction is revealed at an early stage, often before vomiting occurs, both in "organic" and in "functional" cases, including "pylorospasm"; (4) visible gastric peristalsis is often shown by the test when for various reasons it is not seen on simple inspection at the time; (5) valuable information may be given when radiological findings are inconclusive or incomplete; and (6) the false-positive result is uncommon.

I wish to thank Dr. H. P. Brody, under whose care the patients were observed, for his help and advice, and Dr. I. M. Baird, who saw many of the cases and confirmed the observations.

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