Trichiniasis[1]

A REVIEW OF THE CLINICAL PICTURE AND LABORATORY DIAGNOSIS OF THE DISEASE, WITH AN ANALYSIS OF SEVERAL CASES

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TRICHINIASIS is a disease caused by the nematode, *Trichinella spiralis*, and claimed as the only metazoan infection in humans accompanied by fever. It is acquired by the ingestion of uncooked or insufficiently cooked meat infested with the parasite. When such meat reaches the stomach, the trichina cysts are acted upon by the digestive juices, and the larvae, previously contained in these cysts, are liberated into the small intestine. The larvae then penetrate the intestinal mucosa and sexual differentiation takes place at that site. Copulation occurs forty-eight hours after the ingestion of the infested meat and each pregnant female may give birth to as many as one thousand embryos that enter the lymphatics of the intestine at around the fifth day and, through them, pass into the venous circulation. By the sixth to eighth day after the intake of the meat, the embryos reach their most predominant localization—the skeletal musculature. It has been stated that an ounce of infested pork may contain as many as fifty thousand larvae, thus insuring infection even if the intake is very small.[2]

Pigs and rats are the usual hosts of this parasite, the rat being considered only a casual reservoir. Ham, both smoked and pickled, pig's feet, salami, liverwurst, bratwurst, and all other kinds of sausage meat are some of the many pork products that may be infective. Walker[3] reported an epidemic of trichiniasis in the United States resulting from the ingestion of bear meat; Weitz[4] mentioned a similar one in Germany. Dog meat, if improperly cooked, has been responsible for the disease in some countries.

It is believed that current inspection of pork for trichina has proved too difficult and expensive to be carried out routinely with success; in addition, many families raise and butcher their own animals. Microscopic examination is necessary but this is impracticable, of course.[5] The only solution to the problem would be the

1. Received for publication April 3, 1944.

2. O. H. P. Pepper, Trichiniasis, in *Oxford Medicine*, 1928, Vol. V, Chap. 41, p. 996.

3. A. T. Walker, Trichiniasis; report of outbreak caused by eating trichinous bear meat in form of "jerky," J.A.M.A., 98:2051–2053, 1932.

4. W. Weitz, Zur Klinik der Trichinose, Klin.Wchnschr., 10:938–941, 1936.

5. O. H. P. Pepper, Trichiniasis, South.Med.& Surg., 94:415–420, 1932.

prevention of the disease among swine. Wright[6] concludes that the rat is only partly responsible for porcine trichiniasis, therefore food for swine assumes importance in its control. If the latter were well cooked, the problem would be solved for man. It has been demonstrated that corn-fed hogs are less liable to develop trichiniasis than those receiving other forms of dietary.

Thorough cooking of pork and pork products will kill the trichina, hence these should be cooked at a temperature of 58.3° C until the natural color of the meat disappears or "until the whole meat turns white."[7]

Trichiniasis is now somewhat prevalent in the United States, as reports of several observers show.[8] In fact, the disease is more common than is suspected by the clinician. For this reason many cases remain undiagnosed[9] due, perhaps, to the protean clinical manifestations and characteristic mildness of the disease in many instances. Its incidence in the United States has been calculated as high as 10 to 25 percent, estimated upon efficient post mortem examinations in which consistent search for the parasite was made.

An analysis of the literature, both in English and Spanish, has impressed the authors by the tremendously high incidence of trichiniasis in certain countries of the temperate zones as contrasted with its relatively infrequent occurrence in the tropics. It seems possible to them, however, that this difference may be due to the fact that more numerous and more accurate surveys have been effected in the United States. Another factor responsible for this difference may be the dietary habits of the inhabitants of these two regions. The bulk of the population, because of its extreme poverty, consumes less meat and more carbohydrates than the inhabitants of the temperate zones; then, too, the inhabitants of the

6. W. H. Wright, Studies on trichinosis; epidemiology of *Trichinella spiralis* infestation and measures indicated for control of trichinosis, Am.J.Pub.Health, **29**:119–127, 1939.

7. O. H. P. Pepper, *op. cit.*

8. J. B. McNaught and E. V. Anderson, Incidence of trichinosis in San Francisco, J.A.M.A., **107**:1446–1448, 1936.

W. A. Riley and C. H. Scheifley, Trichinosis of man—a common infection, J.A.M.A., **102**:1217–1218, 1934.

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T. B. Pote, Present incidence of *Trichinella spiralis* in man as determined by study of 1060 unselected autopsies in St. Louis hospital, Am.J.Med.Sc., **197**:47–52, 1939.

F. B. Queen, The prevalence of human infection with *Trichinella spiralis*, J.Parasitol., **18**:128, 1931.

9. M. C. Hall, Studies on trichinosis; complex clinical picture of trichinosis and diagnosis of disease, Pub.Health Rep., **52**:539–551, 1937.

M. C. Hall and B. J. Collins, Studies on trichinosis; incidence of trichinosis as indicated by post mortem examination of 300 diaphragms, Pub.Health Rep., **52**:468–490, 1937.

T. B. Magath, Encysted trichinae; their incidence in private practice and bearing of this on interpretation of diagnostic tests, J.A.M.A., **108**:1964–1967, 1937.

tropics—especially those of Spanish ancestry—cook their food quite thoroughly. It is also possible that cases presenting diarrhea and eosinophilia—so commonly appearing together in the tropics—may be often diagnosed as intestinal parasitism and are not investigated further for possible trichinal infestation.

Trichiniasis has never been reported from Puerto Rico. Oliver González,[10] states that "the disease is either rare or absent in Puerto Rico but no thorough surveys have been made in this country to prove my assertion." We cannot very easily explain the absence of trichiniasis in Puerto Rico, a place where pork products are consumed in such large quantities. Furthermore, the greater portion of these products is imported from the United States where, in one survey, 10 percent of the pork sausage picked at random in the meat markets of one of its largest cities was found infested with *Trichinella spiralis*.[11] Perhaps thorough cooking, as practiced in Puerto Rico, may be contributory to the very low incidence there.

CLINICAL PICTURE

Depending upon the number of parasites ingested, the individual develops mild to severe gastrointestinal symptoms, which present themselves from two to twenty-seven days after ingestion of the infested meat. This period varies from two to three days in sporadic cases. Nausea, vomiting, and abdominal pains are the most characteristic symptoms at this stage. Two or three days later, the period of invasion begins and the patient suffers from anorexia, nausea and vomiting, and diarrhea; pain in the abdomen intensifies. Diarrhea, which is quite severe in some cases, may produce signs of dehydration, loss of weight, and acidosis.

As soon as the parasites are embedded in the skeletal musculature, a myositis sets in involving the gastrocnemii, deltoids, biceps, especially the muscles of the eye. The musculature of the diaphragm and the muscles of the abdominal and thoracic walls are affected with less frequency. This happens occasionally to the muscles of mastication, deglutition, and speech but rarely to the cardiac muscle. At the time that the muscles of the eye become involved, the patient complains of pain and burning as well as lacrymation. There may be conjunctival hemorrhages, conjunctivitis, photophobia, and diplopia. Edema of the eyelids is one of the most constant manifestations of the disease. According to Carter,[12]

10. J. Oliver González, Personal communication.

11. A. Dickman, Trichinosis: distribution of *Trichinella spiralis* in pork products sold in Philadelphia, J.Lab.& Clin.Med. **23**:671–680, 1938.

12. L. F. Carter, Trichinosis and its ocular manifestations, J.A.M.A., **95**:1420–1423, 1930.

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chemosis of the bulbar conjunctiva is the most common ocular sign. Papilledema suggesting intracranial pressure is not a rarity of the disease.

The abdominal pain may simulate an acute abdomen and frequently the patient consults a surgeon before seeing a clinician. The severe pain of the muscles—as a rule accompanied by edema—is sometimes suggestive of poliomyelitis.

Painful breathing and dyspnea may come from involvement of the intercostal and diaphragmatic musculature. Paralysis of the respiratory muscles may result in death. Affection of the pharyngeal and laryngeal muscles may bring on asphyxia because of obstruction secondary to edema.[13] If the muscles of mastication are affected, the condition may simulate mumps or tetanus. If the lungs, bronchi, trachea, and pleura are invaded, cough and expectoration, cyanosis, dyspnea and signs of consolidation may be present simulating actual pneumonia.[14] Goldwater *et al.*[15] have reported hemoptysis in these cases; pleurisy with effusion may also occur.

Diplopia, paralysis of the eye muscles, and certain reflex changes may be purely secondary to the existing myositis. Signs of meningeal irritations, such as a positive Kernig and Brudzinski sign, headache, blurred vision, and stiffness of the neck have been reported by Stoll.[16] Cases of hemiplegia with larvae in the spinal fluid have been mentioned by Blumer[17] and by Meyer.[18] Kaufman[19] reported a case with absence of knee jerks and biceps reflexes, stiffness of the neck, positive Kernig and Brudzinski signs, carpopedal spasms, paralysis of the left side of the face and unequal pupils, as well as a terminal temperature of 109°. Therefore, possible diagnoses of meningitis, polyneuritis, encephalitis, poliomyelitis, dermatomyositis, periarteritis nodosa, and tetanus should first be discarded before establishing a diagnosis of trichiniasis.

Rashes simulating typhoid fever, scarlet fever, German measles, or erythema multiforme may be found in some instances, thus bringing up another problem in establishing a differential diagnosis.

13. J. E. Mackenty, Trichinosis of the upper respiratory passages, with report of cases, Am.Med., 3:69–71, 1908.

14. G. R. Minot and F. M Rackemann, Respiratory signs and symptoms in trichinosis, Am.J.Med.Sc., **150**:571–582, 1915.

15. L. J. Goldwater, I. Steinberg, H. Most, and J. E. Connery, Hemoptysis in trichiniasis, New England J.Med., **213**:849–851, 1935.

16. H. F. Stoll, Trichinosis: report of 2 cases presenting diplopia and one, polyserositis, J.A.M.A., **92**:791–793, 1929.

17. G. Blumer, Trichinosis, with special reference to changed conceptions of pathology and their bearing on symptomatology (Shattuck lecture), New England J.Med., **214**:1229–1235, 1936.

18. J. Meyer, Trichinosis, J.A.M.A., **70**:588, 1918.

19. R. E. Kaufman, Trichiniasis; clinical considerations, Ann.Int.Med., **13**:1431–1460, 1940.

The disease is of importance both for its morbidity and its mortality. In epidemics, the mortality rate varies from 1 to 30 percent. In its sporadic form the death rate is less than 5 percent, but the severity of the disease depends upon the number of parasites ingested and the resistance of the individual affected.

LABORATORY DIAGNOSIS

Trichinella spiralis may be demonstrated in the blood or in the spinal fluid during the period of invasion by diluting 5 to 10 cc. of venous blood in a 2 percent acetic acid solution and then examining the sediment. The spinal fluid can be centrifuged and the sediment will show up the parasite. Cell counts of 20 to 240 in the spinal fluid, with a predominance of lymphocytes, is suggestive of trichiniasis.

As a rule, moderate or appreciable leukocytosis accompanies the disease with a usual count average of 12,000 to 18,000 per cu. mm. Leukopenia is frequently seen in children. Eosinophilia is the most important finding on differential counts in which levels of 80 percent have been reported, nonetheless, this is not a measure of the severity of the condition since the more acute cases tend to show very low eosinophil counts.

Bachman's[20] intradermal test consists in injecting .01 to 0.5 cc. of 1:10,000 solution of dessicated trichina powder intradermally, the results being read within fifteen to thirty minutes. A positive reaction shows a wheal with a surrounding zone of erythema accompanied by local warmth and, sometimes, itching. An aid in the diagnosis of the disease is a negative reaction during its early stage which becomes positive as the disease progresses. A further aid is a negative reaction 14 to 20 days after the onset of a condition simulating trichiniasis. A positive reaction cannot establish a diagnosis definitely, since this test yields positive reactions in cases of infestation acquired many years previous to the performance of the same. Furthermore, it may yield false positive results in other parasitic diseases or in perfectly normal individuals. In some occasions, a case of proved trichiniasis may never react positively to the test; in others, it may be considerably delayed. The authors therefore depend on the demonstration of the parasite in the blood, in the spinal fluid, or in the skeletal muscle. The eosinophilia accompanying the disease is of great value in the clinical diagnosis of the condition.

20. G. W. Bachman, Intradermal reaction in experimental trichiniasis. Preliminary report, J.Prev.Med., 2:169–173, 1928.

One of the drawbacks of the precipitin test is the delay which it involves since it does not become positive until the fourth week after the onset of symptoms. Demonstration of the parasite by muscle biopsy confirms a diagnosis in at least 90 percent of the cases.[21] The only difficulty is the inconvenience that this minor surgical intervention may cause the patient and the inability of such a procedure to be of diagnostic aid during the earliest phase of the disease.

TREATMENT

There are no specific measures in the treatment of trichiniasis. Purgation with calomel has been recommended during the early stages to free the intestine of as many adult worms as possible. It has been suggested, further, that purgation should be instituted at any time up to six weeks after infection.[22] After involvement of the skeletal musculature has taken place, the treatment of the disease is symptomatic. Numerous drugs like rivanol, antimony, arsenicals, gentian violet, metaphen, Lugol's solution, and sulfa drugs have been tried without success. Immune serum has also failed in the treatment of this condition. However, rest and a good diet are essential during convalescence.

The purpose of the present communication is to show the great variability of symptoms and the difficulties encountered in establishing a clinical diagnosis of this condition. The authors are therefore presenting eight of the most interesting cases of trichiniasis diagnosed at the Hospital of the University of Pennsylvania on the basis of the demonstration of *Trichinella spiralis* in the blood, spinal fluid, or in the muscles.

CASES

CASE 1 (No. 37–26, 217). D. C., a 48-year-old Italian shoemaker, married, complaining of diarrhea and pain in the mid-abdomen, was admitted to the hospital on February 8, 1937. Two weeks previous, he had eaten some pork and a few days later had developed pain in the abdomen around the umbilical region with nausea, but no vomiting. Still a few days later, diarrhea appeared; he vomited profusely, noticing severe pains in the muscles of his legs. The pain in the abdomen intensified, the patient stating that it has been so severe

21. O. R. McCoy, J. J. Miller, Jr., and R. D. Friedlander, Use of intradermal test in diagnosis of trichiniasis, J.Immunol., 24:1–23, 1933.
W. W. Spink and D. L. Augustine, Trichinosis in Boston, New England J.Med., 213:527–531, 1935.

22. O. H. P. Pepper, *op. cit.*

that "he rolled on the floor in agony." This symptom suggested a perforated viscus to his physician who sent him to the hospital for treatment.

On the day of admission, the patient developed swelling of the eyelids, face and hands, as well as photophobia, lacrymation, and a choking sensation in his throat. There was coughing and dyspnea and, on examination, signs of bronchitis were found present. His temperature was 101° F and he had a palpable spleen. A WBC count averaged 12,750 with a 48 percent eosinophilia. A biopsy of the muscle was positive for trichiniasis twenty days after onset of the condition. The patient improved under supportive therapy and was discharged after nineteen days of hospitalization.

CASE 2 (No. 35–20, 592). R. H., a 39-year-old white woman, married, was admitted to the hospital on August 9, 1935, stating that on July 16 she had ingested some pork meat. On the 18th, she had felt weak and had prespired profusely; the next day "her eyes felt funny." On the 21st, her eyelids became swollen and, on the 23rd, she developed a fever of 103° F. A physician made a diagnosis of nephritis yet her urine was negative. With the onset of fever, the patient related that she had developed pain in the muscles of her legs, arms, shoulders and neck, as well as pain on mastication. Swallowing became very difficult so her physician thought she had tetanus. On August 6 the patient had a 35 percent eosinophilia, at which time she complained of a dry, irritating cough, and a severe headache.

Physical examination on admission disclosed considerable swelling of the eyelids and face, extreme tenderness on pressure over the eyeballs, tender muscles of the calves and of mastication. On August 12 a WBC count gave a reading of 12,400 with a 33 percent eosinophilia. Twenty-eight days after onset of the disease, trichinae were found in a muscle biopsy. The patient was treated symptomatically and discharged five days after admission.

Note: The patient's sister was also taken ill after partaking of the same meal of pork. Her symptoms were identical but less severe.

CASE 3 (P & P DIS. OBC. Class. 107). R. E., a 30-year-old waitress was admitted to the hospital on September 8, 1923. She stated that four days previous to admission she had noticed "shooting pains in the bridge of her nose and forehead," together with blurring of vision. Next day her eyes were swollen and she went to an ophthalmologist who referred her to the hospital for further study.

On admission, the patient presented edema and brownish pigmentation of the eyelids, chemosis of the conjunctivae, and edema

of the bulbar conjunctivae. There was paralysis of the external recti, superior recti, and inferior oblique muscles of the eye. The levator palpebrae superioris was partially paralyzed. There was considerable tenderness of the eyeballs on pressure, photophobia and lacrymation, a two plus exophthalmos and tenderness over the bridge of the nose and over the frontal sinuses. The muscles of the abdomen, thighs, and calves were also tender. A WBC count was 9,000 with a 16 percent eosinophilia. Twenty-five days after onset a muscle biopsy was performed and proved positive for trichiniasis. The patient was treated symptomatically and discharged as improved.

Case 4 (No. 30–2, 648). A. D., a 22-year-old white dental student, male, admitted to the hospital on February 28, 1930, stated that five days previously he had awakened and noticed swelling and redness of his eyes with blurring of vision. The next day the right malar region was swollen and he felt sick and feverish. He also developed a dry cough, was quite anorexic and constipated.

On admission to the hospital, the patient had a temperature of 102° F; his eyes were swollen and the palpebral conjunctivae congested. He presented tender calf and thigh muscles. Ten days after onset, he developed severe pain in the back, chest, and arms; the muscles at these sites were exquisitely tender. The WBC count on admission showed an eosinophilia of 48 percent; a muscle biopsy, twenty-six days after onset of illness, was positive for trichiniasis. The patient was treated symptomatically and discharged as improved.

Note: Three other youths, who lived in the same boarding-house, came down with the disease. It was found that they, too, had ingested pork bought in a neighborhood grocery. The pork was found to contain trichinae.

Case 5 (No. 30–326). A. H., a 28-year-old white sheet-metal worker, married, was admitted to the hospital on July 17, 1929, complaining of fever, diarrhea and weakness, and stating that on July 5 he had developed pains in the calves of his legs and up his arms, as well, and had a watery diarrhea. Next day he had a fever of 101° F, when he noticed a swelling of his eyelids. On July 9 he felt a severe headache, nausea and vomiting, and anorexia.

On admission, the patient's temperature was 104° F, blood pressure, 90 systolic, 52 diastolic. His eyelids were still swollen, and pressure over the frontal and malar bones caused him pain. There was a right facial weakness; mastication was painful, and he had appreciable pharyngeal and tonsillar injection. The spleen was palpable and the muscles of his thighs and arms were tender. Three days after admission (July 20), *Trichinella spiralis* larvae were seen in the spinal fluid; a WBC count averaged 23,600 with a 28 percent eosinophilia. An electrocardiographic tracing showed abnormality of the T waves, suggestive of trichinal involvement of the myocardium. During his hospital stay, the patient developed a general furunculosis which delayed his discharge for thirty-eight days.

Note: On July 2, the patient and his wife had eaten some bologna sausage. Both of them developed the same symptoms though the wife was not as ill.

Case 6 (Obc. No. 2983). L. B., a 24-year-old Hungarian laborer, white, was admitted to the hospital on May 31, 1940. This individual stated that ten days before he had been taken with severe pain in his limbs—so excruciating that "nobody could touch him"—and that he had had to go to bed because he felt so weak; that his eyes had become swollen, and that he had suffered from photophobia and lacrymation from the second day after onset of the illness.

On admission, the patient's eyelids were still swollen; the conjunctivae were congested; the spleen was palpable, and the calf muscles, as well as those of his back and shoulders, were tender. Biceps tendon reflexes and jerks were absent. A WBC count of 15,000 was accompanied by an eosinophilia of 43 percent. About ten days after admission, the patient developed painful and difficult deglutition. A muscle biopsy twenty-seven days after onset of the symptoms showed encysted trichinae and interstitial myositis. The patient was treated symptomatically and discharged as improved.

Case 7 (Obc. No. 3046). C. P., a 47-year-old Italian laborer was admitted to the hospital on November 22, 1910, complaining of edema of the limbs, face, and other areas of his body. He gave a history of an "angioneurotic type of edema" that had occurred periodically during the previous six months. These attacks were accompanied by fever and, while they lasted, he was dyspneic because the glottis was also affected. During the last few days previous to admission, he had had considerable difficulty in deglutition.

On examination, the patient presented swelling of the eyelids and cheeks as well as of his arms and hands. He had a two plus exophthalmos, conjunctival injection, and a temperature of 104° F. A WBC count revealed 15,400 per cu. mm. with 50 percent eosinophilia. During his hospitalization, attacks of the "angioneurotic type of edema" occurred repeatedly, so on December 4 a muscle biopsy was performed and demonstrated encysted trichinae in tremendous numbers. The patient's temperature oscillated between 99° and

103° F for twenty-one days. He was then discharged as improved but, unfortunately, he never returned for a follow-up.

CASE 8 (No. 34–18, 662). C. J., a 9-year-old colored girl was admitted to the hospital on March 20, 1939 with the following history: she had suffered from asthma from the age of four. On February 15th a temperature of 102° F had developed, at which time her mother noticed that the child's eyelids were swollen. The little girl complained of pain in the muscles of her calves, in the muscles of her neck and shoulder as well as in those of her thighs.

On admission, her eyelids were still swollen; on pressure there was tenderness of the calf muscles. A WBC count of 5,000 was accompanied by a 33 percent eosinophilia. The diagnosis was confirmed by the Bachman test and by muscle biopsy; the patient was treated symptomatically and was discharged in fourteen days, somewhat improved.

SUMMARY

Case 1 illustrates the similarity of trichiniasis to an acute abdominal emergency. Case 2 demonstrates how nephritis and trichiniasis bear many similarities to each other and how the latter may be mistaken for tetanus. In Case 3 trichiniasis suggests a pathology of the central nervous system. Case 4 illustrates the method of multiple infections when ingesting the same dish; Case 5 gives evidence of myocardial damage due possibly to trichinal infection. Case 6 shows the extreme myositis that may accompany the disease. Case 7 shows the possible association of trichiniasis with "allergic-like reactions" in the form of an angioneurotic edema, and Case 8 demonstrates the appearance of trichiniasis in conjunction with asthma.

Because of the complexity of symptoms and the difficulty involved in arriving at a diagnosis, the authors feel that a more thorough study of conditions in tropical areas should be made. The high incidence of the disease in certain regions of the temperate zones and its relatively low incidence in the tropics may not be due alone to the fact that more accurate surveys have been carried out in the former place or that the dietary of the people of these two regions is so different. The problem warrants further investigation.