Congenital Pyloric Obstruction

II. Etiology, Prophylaxis and Treatment

A CLINICAL STUDY

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The first description of pyloric obstruction in an infant was made by George Armstrong[1] in England in 1777. His case was the third death from that cause in the same family. For years, however, Hezekiah Beardsley[2] of Connecticut, whose report was published in 1787, has been given credit for publishing the first case. After these reports nothing appeared in the literature for a half century. In 1841 Williamson[3] and the next year Dawosky[4] each reported a case with autopsy findings. Modern interest in pyloric obstruction began with Hirschprung's presentation[5] of two cases before the German Pediatric Society in 1888. This stimulated sufficient interest to make it possible for Ibrahim[6] to collect over 400 cases some 20 years later. Hertz[7], in 1916, reported that 2.7 per cent. of children under one year show this condition. One may well ask whether this rapid increase is due entirely to improvement in diagnosis, or whether our altered habits of living are factors. Walls[8] compares appendicitis with pyloric obstruction and says that in a clinic totaling 5,000 cases every year, he found, during a five year period, less than five cases of acute appendicitis compared with 30 cases of pyloric stenosis.

The condition is now so common that at this time it is necessary only to mention the cardinal symptoms: projectile vomiting, loss of weight, visible gastric peristalsis, with or without palpable tumor, constipation and x-ray evidence of obstruction. Since early treatment may prevent a serious outcome, every vomiting baby should be examined with this disease in mind.

The underlying pathology considered responsible for these symptoms is spasm of the pylorus with or without an accompanying hypertrophy. Arguments have waged for years as to whether the hypertrophy preceded the spasm or the spasm caused the hypertrophy. Among the inadequate explanations offered for

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the spasm theory and carried through the literature are: (a) that the spasm, with resultant hypertrophy, took place in utero as an attempt to rid the stomach of swallowed amniotic fluid[9]; (b) that hyperadrenalism of the mother causes the spasm, and retention gastritis or other reflex irritation completes the obstruction[10]; (c) that phimosis[10] causes irritation and accounts for the condition being found so much more commonly in males.

In 1897 Thomson[9] wrote that pyloric stenosis is not a muscular affection but a functional disturbance of the nerves of the stomach and pylorus. Haas[11] believes that "a careful consideration of the possible etiological factors would seem to point to a disturbance of physiological function of the vegetative nervous system. Under this hypothesis, hypertrophic pyloric stenosis is considered simply as an advanced degree of pylorospasm. Pylorospasm and pyloric stenosis are the dominant features of a general state of hypertonicity." Elsesser[12] produced partial stenosis in the pylorus of dogs and increased the tonicity and motility of the empty stomach.

The adherents of the tumor theory believe that it is due to faulty embryonic development which results in an actual stenosis of the pyloric orifice. This, they state, leads to a definite hypertrophy caused by the increased effort necessary to force the food through the smaller orifice. However, the idea of Sauer[13] seems more tenable: "In the fetus there is no pyloric valve as in the adult, and closure occurs by a contraction of the entire pyloric segment, known as the canalis pylori." Wachenbein[14] showed that the diameter of the pyloric musculature of the fetus is often greater than that in infants a few weeks old. In his opinion this furnishes an "anlage" for subsequent pyloric growth. A persistence of this transient, normal condition gives a primary anatomic basis for the origin of stenosis. In addition, the infolding of the mucosa may contribute appreciably to the obstruction by producing a valve-like closure.

The persistence of hypertrophy months after spontaneous recovery or years after posterior gastroenterostomy proves, according to Sauer[15], that the hypertrophy is not dependent on the spasm. The clinical picture on the other hand is dependent on the spasm, whether accompanied by hypertrophy or not. The numerous autopsies, performed on infants who died of other causes months after symptoms of stenosis had spontaneously dis-

appeared, showed a persistent hypertrophy, which proves that hypertrophy alone need not elicit symptoms. Koplik[16] reported never having seen a case of hypertrophic stenosis with palpable tumor in which there was no spasm. The spasm as well as the hypertrophy affects not only the pyloric ring, but Balan[17] holds that it may involve the entire pyloric portion of the stomach, while Pehu and Pinel[18] report in their exhaustive studies that there is hypertrophy of the whole stomach. Heubner[19] believes the spasm to have its seat not in the pylorus but in the entire stomach wall. He states that this gastrospasm occurs in predisposed infants whose entire gastric muscularis is hypertrophied.

The autopsy findings upon which these tumor and hypertrophy theories are based is rather variable. In general the stomach is dilated, often to twice its normal size, and its wall is thickened or not according to the degree of distention. Histopathological studies of the pylorus have shown that the circular muscle fibers are chiefly involved. Strange to relate no such study has included the nerves controlling this portion of the gastrointestinal tract. In spite of this lack of neurological study, Elterich[20] states that "the majority of writers attribute the disorder to an imbalance of the autonomic or involuntary nervous system, which, of course, consists of two divisions, the parasympathetics and the sympathetics, the functions of which are opposing."

EXPERIMENTAL

Although pyloric obstruction has been known for 150 years, no one has presented a cause for this "disturbance of the physiological function of the vegetative nervous system," nor have attempts to produce it experimentally heretofore been successful. Our research work at the University of Oregon Medical School is concerned primarily with the causes of pre-natal and neo-natal deaths. While studying the various effects of a lack of the vitamin B complex on albino rats, we were surprised to find, especially on the young of the second generation, a clinical picture characterised by an enlarged and very firm abdomen accompanied by extreme emaciation. At autopsy the stomach was found to be enlarged to several times its normal size and to be so packed with milk curd that on extrusion the curd made a perfect cast of the mucosa. As rodents cannot vomit, there had been repeated pack-

ing of each day's nursing into the distended stomach. An examination of the vagus nerves of these animals showed myelin degeneration, a finding typical of beriberi. In cases in which the gastric distention was mild or was cured by atropin, the animals later developed polyneuritis.

Pyloric obstruction appears therefore to be one manifestation of a vitamin B deficiency with resulting defective myelinogeny. In a previous paper[21], we have discussed its association with hemorrhage and polyneuritis. Pyloric obstruction was obtained in 1.2 per cent. of the young of the first generation, and in 22 per cent. of the young of the second generation raised on this diet. The details of this experimental work have been published by one of us (J. L. B.) as the first paper of this series[22].

ETIOLOGY

Several interesting but, up to this time, unexplained etiological facts have been brought out by the students of this subject. It is noteworthy that the case described by Armstrong in 1777 was the third fatal one in that family.

Sauer[15] reports two families in each of which three cases of stenosis occurred and twin boys in whom the diagnosis was confirmed by autopsy. Finkelstein[23] noted four cases in one family, and he speaks of two other families in each of which there were three cases. Two cases in successive generations were reported by Caulfield[24].

Koplik[16] believed this condition to be a distinctly neurotic one and in some cases actually hereditary. Two of his cases occurred in sisters, both of whose husbands (brothers) were neurotic and confirmed dyspeptics. One of these sisters had two babies who suffered from pyloric spasm and stenosis. Another patient was the child of the other sister. All three babies recovered. One infant was breast-fed throughout; its cousin was artificially fed from birth, so the mode of feeding per se seems to have little to do with starting the symptoms.

In view of the above recent experimental work, a different interpretation may be put upon the hereditary factor in this disease. May it not depend upon the well-known fact that food habits are carried through several generations? There is also the possibility that a varying demand for the antineuritic vitamin may be the hereditary factor.

Many authors have noted that this condition is much more common in males than females, the proportion generally being three or four to one. Alexander[25] reports 90 per cent. of 107 cases as boys. Richter[26] reports that three to four boys are affected to every girl. Davison[27] reports twice as many boys. Goldbloom and Spence[28] claim four times as many cases in males but only two times the mortality. Heusch[29] finds 75 per cent. of his 446 cases to be in males.

Clinical beriberi, a vitamin B deficiency disease in man, and polyneuritis, the corresponding condition in animals, are known to affect males much oftener than females. The explanation usually offered for this difference is the greater metabolic requirement of the male. In our pyloric obstruction cases in nursing albino rats, 87 per cent. were found in males, thus corresponding to the findings in man.

Davison[27] made the interesting observation that pyloric stenosis is very much more frequent in the winter months than from March to September. During the summer months, diets in the north temperate zone contain the largest amount of vitamin B containing foods. Richter[26] notes that pyloric obstruction is found to be widely distributed, but occurs only rarely in eastern Europe. If his report is correct, it would be interesting to check the dietary customs of that portion of the world with those parts in which the disease is more common.

TREATMENT

With so much confusion as to the etiology of pyloric stenosis, the treatment has of necessity been purely symptomatic. We may well profit by a consideration of the manner in which the prevailing methods of treatment corroborate our experimental findings. The two outstanding forms of treatment have been medical and surgical. In the latter field, gastroenterostomy, pyloroplasty, and the Fredet-Rammstedt operation have all had their day of development and favor.

After gastroenterostomy the vomiting may persist for days, in spite of the fact that a new opening has been made in the stomach and some food passes through, as evidenced by the fecal movements. Although the pyloric valve has been sidetracked, the spasm still involves a greater or less amount of the stomach muscu-

lature. The mortality with this operation was at least 50 per cent. The pyloroplasty operation, the molding of a new pylorus, also had an exceedingly high mortality. In 1908, Fredet[30] suggested the longitudinal incision of the serous and muscular coats of the pylorus and the conversion of the longitudinal incision to a transverse one by sutures. The Rammstedt[31] modification, now in common use, allows the longitudinal incision to gape. This Fredet-Rammstedt operation has brought the mortality down to 13 per cent.

Strauss[32] claims that pyloroplasty is successful because it separates Auerbach's and Meissner's plexuses and breaks the arc for the stimulus. Haas[33] says: "The reason the Rammstedt operation is superior to any other operation that has been attempted is that it does the same thing as medical treatment by severing the nerves through which the reflexes are produced. If the nerves are not severed, the results are incomplete after resection of the tumor."

The medical treatment recommended by Knopfelmacher, Meyerhofer, and Bokay[34] is papaverin, which is believed to act by decreasing the tone of smooth muscle and thereby make it less susceptible to impulses. Carlson and Ginsberg[35] report either a hypertonicity or a hypermotility of the empty stomach of infants with congenital pyloric stenosis, pylorospasm, and chronic vomiting. Workers on the nervous control of the pylorus agree that the vagi and splanchnics may be either motor or inhibitory to this region, depending upon the existing tone of the pylorus. So, when once started, we may easily have a vicious circle. The early degenerative change along these nerve pathways, either the splanchnic or vagus or both, lead to an increased nerve stimulus to the pyloric antrum with hypermotility and partial obstruction. Papaverin interrupts this circle.

The commonly used treatment in this country is atropin, with or without thick cereal feedings. The accepted pharmacological action of atropin is paralysis of the nerve endings of the parasympathetics, which includes the vagus, and thus cuts off abnormal impulses coming to the pylorus by this route. The thick cereal pastes have been used in an attempt to lessen gastric irritation and make the vomiting more difficult. It is interesting to note that Birk[36] in 1914 claimed very beneficial results from using corn

meal mush, which is known to be a good source of the antineuritic vitamin. The excellent results reported with blood transfusions, either intravenous[37], intraperitoneal[38], or subcutaneous[39], may also be due in part to the vitamin content of the whole blood. Parsons and Barling[40] report that if a child can be kept alive until six months old improvement will occur and after that age set-backs are rarely seen. Is this possibly due to the more varied diet given to children at this age with its consequent richer proportion of antineuritic factor, or does the demand for this factor decrease after myelination is completed?

Experimental work on animals[41] repeatedly has shown that in order to protect the young against deficiencies of the vitamin B complex there must be in the diet of the mother during pregnancy and lactation three to four times the amount of vitamin B necessary for her own well-being. Macy and associates[42] find that the antineuritic potency of the mixed milk of a group of wet nurses receiving the average American dietary is very slight. An experiment reported from our laboratory[21] tells of a female albino rat on a low vitamin B diet being allowed to nurse three of her own young and three from the litter of a stock mother. It shows that the young with deficient pre-natal development, plus the same deficiency during the nursing period, developed polyneuritis and died earlier than did those with an optimum prenatal development but a vitamin B deficiency during the nursing period only. Although the time necessary for pre-natal development, infancy, and total span of life is very different in rodents and man, it has been repeatedly demonstrated that their vitamin requirements are comparable.

Knowing then that mothers require three to four times the amount of vitamin B during pregnancy and lactation, and that normally their diets are too low in this factor, prophylactic treatment is most clearly indicated. We therefore advise giving every pregnant or lactating woman six tablets (three grams) daily of desiccated yeast (Northwestern Yeast Co.) This product we have been using for several years in our animal experiments as well as clinical practice and find its potency very high and constant. Attention must be called to the fact that the ordinary live, moist yeast on sale is very low in vitamin B potency and is likely to produce an undesirable fermentative action in the intestinal tract.

Mothers whom it has been our privilege to diet in this manner throughout pregnancy report that they have felt much better than during previous pregnancies. Morning nausea was minimal. Confinement was without hemorrhage and recovery was rapid. One mother states that one month after delivery, her fourth, she feels as though she had just returned from her first invigorating vacation in 12 years of married life.

Many cases of pyloric obstruction are not brought to the doctor until the projectile vomiting and other symptoms are well established. The plan followed at present is to treat these cases by thick cereal feeding and re-feeding with the addition of one-quarter yeast tablet to each feeding. Atropin is given in the usual dosage, one to three minims of 1/1000 solution, 15 minutes before each feeding. Thus we are shutting off the abnormal impulses and by adding vitamin B at the same time are repairing the nerves. Of course, breast milk is continued throughout the treatment. It is expressed and fed by gavage, if the baby cannot retain it when nursed. In critical cases, where the loss of weight is over 25 per cent., or the baby is premature, subcutaneous blood, 25-50 c.c. per kilo., is given and repeated ten days later if necessary. Blood increases food tolerance and resistance to bacterial infection. Its added food value, as well as its vitamin content, often give just the stimulus needed to make the patient more responsive to the other forms of treatment.

A series of pyloric obstruction case reports is now being prepared. The following ones illustrate typical responses obtained by the types of medical treatment outlined above.

CASE REPORTS

1. Blood Transfusion. Baby U, male, with a birth weight of seven pounds (3,175 grams), weighed five pounds four ounces (2,480 grams) when seen at ten weeks of age, thus having lost 25 per cent. of its weight. The mother reported that since one month of age the child, her fifth, had vomited practically all the food taken. She stated that her family physician had advised her to discontinue breast feeding and had given her a list of infant foods to try according to the directions on the can until she found one that would agree. The baby presented so extreme a degree of emaciation that even the buccal sucking pads were gone. The

temperature was subnormal, and the hands and feet were cold. The fontanel was sunken, the skin was dry and hung in folds from the bony framework. His condition was so poor that the surgeon called in consultation refused to consider even a Fredet-Rammstedt operation. The only chance of saving this life lay in immediate blood transfusion. Previous experience had taught us that paternal blood is superior to puerperal maternal blood in the vitamin B complex. Hence 200 c.c. of the father's blood was withdrawn and injected subcutaneously into two places on the

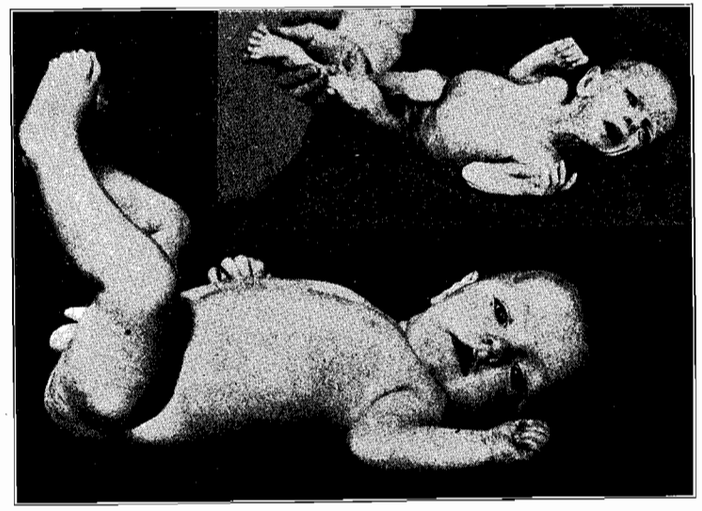

Fig. 1. Baby U. Congenital hypertrophic pyloric stenosis, photographed at ten weeks of age (weight 25 per cent. less than at birth) and three months later. Treatment: subcutaneous blood transfusion and re-establishment of breast milk.

sides of the baby's abdomen. Thick cereal feeding, preceded by three drops of atropin solution (1/1000), was begun at once. The mother was taught manual breast expression and instructed to save every drop for the baby. One week later, another subcutaneous blood transfusion of a similar amount was made. When discharged from the hospital at the end of the month the child had regained his birth weight. Manual expression had caused the mother's milk to increase so much that the baby was able to obtain three and one half ounces of milk from her breasts at the

first nursing, although a period of ten weeks had elapsed since the last previous nursing. As the breast milk increased, the complemental feeding was gradually discontinued. As the baby improved, the projectile vomiting ceased and gastric peristalsis became normal. Eleven weeks after the first transfusion the infant's weight had increased 100 per cent. and its general condition had correspondingly improved (Fig. 1).

2. Blood Transfusion to Baby and Vitamin B to Mother. Baby Mary L. was a seven months premature child, weighing three pounds nine ounces (1,615 grams) at birth. Projectile vomiting began with the first feedings. When seen at the age of three days she had lost over seven ounces (210 grams) in weight and was an undernourished, hypertonic infant with a dry, wrinkled skin. She also had the subnormal temperature and cold extremities typical of beriberi in the new-born. The next day, 80 c.c. of maternal blood and two weeks later a like amount of paternal blood was given subcutaneously. The mother was given two and later six yeast tablets daily. Frequent feedings and re-feedings of expressed breast milk were given by gavage. At the age of ten weeks she was dismissed, the vomiting having entirely ceased and the birth weight having more than doubled.

3. Blood Transfusion and Vitamins to the Baby. Baby L, a boy, had weighed seven and one-half pounds (3,400 grams) at birth. Vomiting began while still in the hospital, and for this reason, at the age of two weeks, the infant was weaned and various infant foods were tried. On our first examination at seven weeks he was found to weigh eight pounds eleven ounces (5,480 grams), was nervous, restless in sleep, and, after feeding, gastric peristaltic waves were visible. Vomitus, occasionally blood streaked, was projected a distance of four feet. Re-establishment of breast milk was begun and one-quarter yeast tablet given the baby four times a day. This was later increased to three tablets daily. A few days later the child was removed to the hospital, where 160 c.c. of paternal blood was injected subcutaneously. After one week in the hospital, there was no more vomiting, and the child gained two pounds ten ounces during the first month of treatment. Visible peristalsis was still present, however, and the infant still unusually nervous. There were associated with the vitamin B deficiency symptoms such as craniotabes and inspiratory

stridor, pointing to a lack of vitamin D, and a pulse rate of 210, indicating insufficient vitamin C. In addition to the yeast therefore orange juice, cod liver oil, and later acterol (Mead Johnson Co.) were added to the baby's diet. Within the next few weeks all signs of the general avitaminosis disappeared. The food was retained, sleep was normal, and the general condition improved.

DISCUSSION

In the light of these clinical and laboratory findings we may now add to the cardinal symptoms of pyloric obstruction two newer prodromal symptoms: subnormal temperature and cold extremities. These usually appear before the baby is two weeks old.

The object of this paper is not to present case histories but to harmonize human experience with the latest biological research. We realize that the therapy suggested needs application to a large series of cases before definite and final conclusions can be drawn. It seems almost too good to be true that so simple a procedure as giving sterilized yeast to pregnant mothers would prevent any considerable proportion of the present pre-natal and neo-natal morbidity and mortality. However, all of our own cases to date have been so monotonously uniform as to suggest such a possibility. No pregnant woman so far who has taken the yeast as prescribed has had a baby that showed any signs of either idiopathic hemorrhage or pyloric obstruction.

For over two years the mothers attending our Infant Welfare Clinics, as well as our private clinic, have received daily six tablets (three grams) of yeast, and their infants one or more tablets with uniformly excellent results. Hoobler[43] well says: "Just as regularly as orange juice and cod liver oil are prescribed, one should also prescribe a substance rich in vitamin B for the infant dietary." Let us add this substance to our maternal dietary also and note the improvement in mother's energy and outlook.

SUMMARY AND CONCLUSIONS

1. Congenital pyloric obstruction has shown an exceedingly rapid increase during the last 40 years; statistics indicate that 2.7 per cent. of all infants under one year of age suffer from this malady.

2. Dietary habits may be responsible for this increase as well as its occurrence in several members of the same family and in twins. Variations in diet may also explain the seasonal incidence and geographic distribution of this disease.

3. The diet of the average American mother is normally very low in vitamin B, although she needs during pregnancy and lactation for the protection of her infant three to four times the amount of this factor necessary for her own well-being.

4. In our laboratory a deficiency of the vitamin B complex in the maternal diet of rats has produced pyloric obstruction in the young. Other phases of the deficiency found in the same individuals or littermates are hemorrhage and polyneuritis.

5. In the animals thus affected the motor nerves to the pyloric region show myelin degeneration, the typical pathology of a vitamin B deficiency.

6. This experimental work offers a basis for the prevailing theory that pylorospasm results from an unbalance in the autonomic nervous system.

7. Vitamin B deficiency as produced experimentally and found clinically in beriberi occurs most commonly in males. In clinical pyloric obstruction cases, 75 per cent. to 90 per cent. are found in boys, and our series of experimental cases shows 87.5 per cent. in males.

8. Clinical experience bears out the experimental evidence of the association of pyloric obstruction with hypertonicity and hemorrhage. A subnormal temperature and cold extremities in premature or malnourished infants are often the first signs of a vitamin B deficiency.

9. As a prophylactic for pyloric obstruction and other manifestations of a dietary deficient in the vitamin B complex, every woman should receive dessicated yeast throughout pregnancy and lactation. Likewise the baby should receive it from the beginning.

10. After symptoms of pyloric obstruction have become manifest, treatment should include the usual atropin and thick cereal and in addition desiccated yeast. In serious cases blood transfusion is also indicated.

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