

Intravenous Atropine Treatment in Hypertrophic Pyloric Stenosis: Evaluation by Clinical Course and Imaging

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Abstract

Hypertrophic pyloric stenosis (HPS) is the principal disease to consider in neonates presenting with frequent projectile vomiting and poor weight gain. Ramstedt pyloromyotomy is commonly used for the surgical treatment of HPS. The present study investigated the efficacy of nonsurgical medical treatment using intravenous administration of atropine and the examined the clinical course and results of ultrasonography and a contrast upper gastrointestinal series. A 34-day-old girl was admitted with chief complaints of projectile vomiting and poor weight gain. HPS was diagnosed on the basis of the clinical course and results of imaging studies. After intravenous administration of atropine, projectile vomiting resolved and weight increased without complications. On imaging studies, barium introduced into the stomach by tube rapidly entered the duodenum after atropine administration. Ultrasonography initially showed no reductions in hypertrophic muscle in the pyloric region, but gradual reductions were identified in subsequent months.

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Key words: hypertrophic pyloric stenosis, atropine, contrast upper gastrointestinal series, ultrasonography

Introduction

Hypertrophic pyloric stenosis (HPS) is the first disease that should be considered when a neonate or infant has chief complaints of frequent nonbilious projectile vomiting and poor weight gain¹. Prospective studies have demonstrated that the pyloric muscle is not initially hypertrophied but appears to hypertrophy after birth, leading to gastric outlet obstruction². Some studies have

suggested pathogeneses for HPS^{3,4}, but the primary causes of the disorder remain unclear.

Medical treatment with *oral* antispasmodics, such as atropine and scopolamine, have been little used since the mid-1960s. Instead, surgical therapy with Ramstedt pyloromyotomy has been regarded as the optimal treatment for HPS⁵. However, medical treatment with *intravenous* atropine has recently been reappraised as an option for HPS^{6–8}. Atropine is absorbed from the small intestine but not from the stomach; therefore, it is speculated that efficacy of

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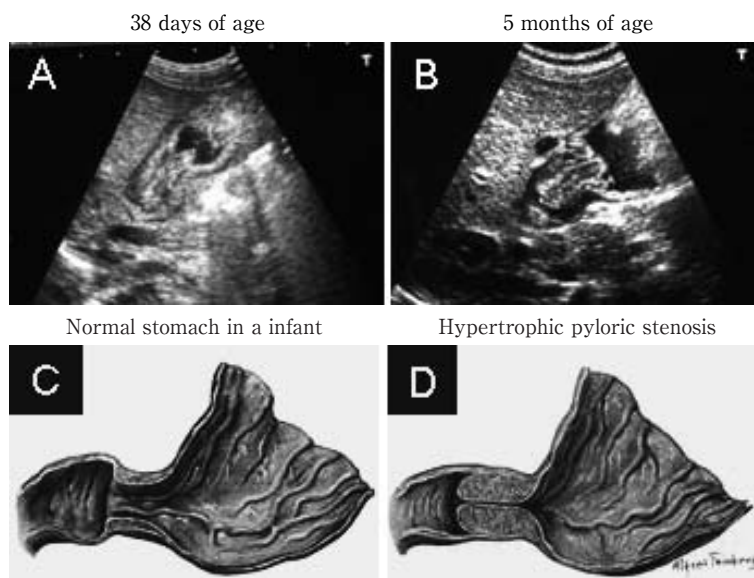


Fig. 1 Longitudinal scan of hypertrophic pyloric stenosis demonstrates thickening of the pyloric muscle. Pyloric canal length (L) and muscular layer thickness (T) decreased with atropine therapy. A) At 38-days-old, L=20.5 mm, T=5.6 mm. B) At 5-months-old, L=10.4 mm, T=3.5 mm. C, D) Schematic model of the stomach in normal infant and patient with HPS (taken from reference 11). C) A normal stomach in a 4-week-old infant. Note that the pyloric muscle is slightly thicker than that of the body of the stomach. D) Marked thickening of the pyloric muscle is noted in HPS. The pyloric canal is elongated and constricted.

intravenous atropine is greater than that of oral atropine. In addition, it is reported that tonic and phasic pyloric muscle contractions of HPS are transiently abolished by an intravenous atropine injection of 0.01 mg/kg⁹. These findings suggest that a certain blood level of atropine must be maintained to relax the contracted pyloric muscle.

Case Report

A 34-day-old girl was admitted with chief complaints of projectile vomiting and decrease of body weight. No abnormalities had been identified during gestation, and the patient had been delivered at 39 weeks weighing 2,655 g. Apgar score was 9 at 1 minute after birth. She was discharged from hospital weighing 2,650 g on day 5 and was breastfed thereafter. Repeated vomiting was seen from 22 days of age, and she was brought to our hospital at 27 days of age weighing 3,368 g. As weight gain had been satisfactory (27 g/day) to that time, the patient was observed while the mother

was provided with instructions on breastfeeding. However, vomiting continued, and body weight decreased from 3,368 g to 3,244 g over 7 days, despite the mother following our instructions. The patient was therefore admitted to our hospital for examination and treatment.

On admission at 34 days of age, no neurological abnormalities or external malformations were identified. Body weight was 3,244 g. Chest auscultation showed no abnormalities of the lungs or heart, and no masses were palpable in the abdomen. Blood examinations, including measurement of electrolytes, showed no abnormalities. Blood gas analysis was not done. Simple abdominal radiography showed intestinal gas and no dilatation of the stomach. Abdominal ultrasonography at 38 days of age indicated hypertrophy in the pyloric region (**Fig. 1A**). The criteria for the diagnosis of HPS include pyloric thickness greater than 4 mm or an overall pyloric length greater than 14 to 19 mm^{1,10}. In the present case, pyloric thickness was 5.6 mm and pyloric length was 20.5 mm. Furthermore, a

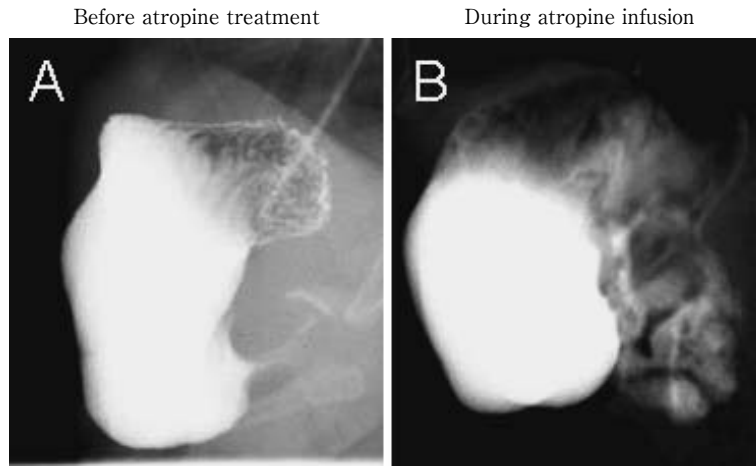


Fig. 2 Contrast upper gastrointestinal studies before and after intravenous atropine treatment. A) Before treatment, barium introduced into the stomach by tube stayed in the stomach and gradually passed into the antropyloric region. A narrowed pyloric channel (“string sign”) and the “shoulder sign” caused by bulging of pyloric muscle into the antrum are seen. B) After intravenous atropine transfusion, barium passes rapidly into the duodenum.

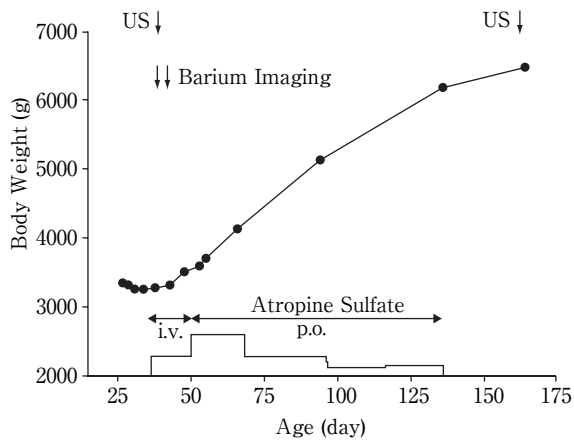


Fig. 3 Clinical course. Decreased body weight without atropine treatment turned to increase with atropine treatment. Atropine transfusion (0.1 mg/kg/day) continued for 10 days and was changed to oral treatment (0.2 mg/kg/day for 2 weeks, 0.1 mg/kg/day for 4 weeks and 0.05 mg/kg/day for 4 weeks) and was finally stopped at 4-months-old.

contrast upper gastrointestinal (UGI) series revealed narrowing of the pyloric canal (“string sign”) and the “shoulder sign” caused by the impression of the hypertrophic muscle on the barium-filled atrum at the juncture of the stomach wall and hypertrophic pyloric muscle (Fig. 2A)¹¹. on the basis of the history and imaging findings, a diagnosis of HPS was

confirmed.

We initially observed the patient with oral breastfeeding. However, projectile vomiting occurred every time she was fed more than 40 ml at once. Atropine treatment was started from day 4 after admission. Atropine was administered intravenously at a total dose of 0.1 mg/kg/day, which was divided equally by the number of oral feedings (i.e. 8 times) with each dose administered over 5 min. Doses were given 10 min before oral breastfeeding. Frequency of vomiting decreased, and no episodes occurred from 3 days after the start of atropine therapy. On day 6 of atropine treatment, a UGI series was performed. Barium was introduced into the stomach directly via tube 10 min after intravenous administration of atropine. Barium immediately entered the duodenum, without pooling in the stomach, suggesting that intravenous atropine administration was effective in this case (Fig. 2B). However, hypertrophic pyloric muscle remained unchanged on ultrasonography at this time (data not shown). As body weight started to increase, the dose and route of atropine administration were changed to 0.2 mg/kg/day orally. Vomiting remained absent, and body weight continued to increase. The time course of weight gain and atropine dose are shown

in **Figure 3**. As shown, body weight increased dramatically. Regression of the hypertrophic pyloric muscle was apparent on ultrasonography at the age of 5 months (**Fig. 1B**).

Discussion

Atropine is a cholinergic blocking agent with potent antimuscarinic activity that decreases peristaltic contractions by relaxing smooth muscle. The principal effect of atropine in the treatment of HPS can thus be considered the control of spasms¹². In early atropine treatment, pyloric hypertrophy has been shown to remain unchanged in infants for whom vomiting was controlled⁶. This finding suggests that muscular spasms rather than hypertrophic pyloric muscle accounts for the symptoms of HPS. Findings in the present case agree with this hypothesis, as symptoms resolved and contrast medium readily entered the duodenum after atropine was administered intravenously, yet hypertrophic pyloric muscle had not regressed on initial ultrasonography.

In most infants with HPS, vomiting develops about 3 weeks after birth. In contrast, symptoms in infants with nonobstructive pyloric hypertrophy resolve without treatment. Yamataka et al.¹³ have reported that normalization of pyloric muscle thickness was observed in patients after pyloromyotomy (3.8 ± 2.0 months) or atropine administration (3.4 ± 2.3 months). Such evidence suggests that HPS is a self-limiting and reversible disorder of muscarinic receptors in pyloric muscle.

We initially started atropine intravenously at a dose of 0.1 mg/kg/day for 10 days, and then changed the dose to 0.2 mg/kg/day orally. The dose was subsequently decreased in a stepwise manner. Nagita et al.⁶ reported that atropine was initially administered at a dose of 0.04 mg/kg/day intravenously was increased by 0.01 mg/kg/day until vomiting ceased. When vomiting ceased after administration of intravenous atropine, infants received oral atropine at twice the effective intravenous dose for 2 weeks. The mean dose of atropine actually given intravenously was 0.07 mg/kg/day (range, 0.04~0.11 mg/kg/day)⁶. Kawahara et

al.⁸ have reported that atropine was given intravenously at a dose of 0.06 mg/kg/day. When vomiting ceased and infants were able to ingest 150 ml/kg/day of formula after stepwise increases in feeding volume, oral atropine was administered at twice the intravenous dose with the dose decreased in a stepwise manner. The mean duration of treatment with atropine was 52 days (range, 28~136 days). The dose of atropine used in the present case was thus slightly higher than previously reported. The success rate was higher and the duration of intravenous atropine administration was shorter in the treatment protocol described by Nagita et al. than I that described by Kawahara et al. Therefore, we used the higher dose of atropine, 0.1 mg/kg/day, to ensure the success of treatment. However, no severe acute or delayed adverse reactions occurred with the effective doses of atropine used for this patient. During intravenous administration, mild facial flushing and sinus tachycardia (range, 160~180 beats/min) appeared and continued for about 30 min. No serious problems, such as ventricular or supraventricular tachycardia, were identified.

Before 1990, UGI study was the method of choice for diagnosing HPS. However, ultrasonography is now the modality of choice for diagnosis at most institutions¹⁴⁻¹⁶. UGI has some disadvantages, such as exposing the infant to a considerable dose of radiation and the risk of aspirating contrast medium. Conversely, ultrasonography is safe and allows repeated examination. Furthermore objective diagnosis can be made by direct measurement of the hypertrophic pyloric muscle. In this case, the classic method of UGI was used to observe the effects of intravenous atropine treatment, and ultrasonography was used to confirm the diagnosis and to observe regression of the hypertrophic pyloric muscle thereafter.

In conclusion, the efficacy of atropine treatment in HPS was clarified by examining the clinical course and the results of upper gastrointestinal imaging and ultrasonography. Although all cases of HPS might not be cured with atropine, this option should be investigated before surgical treatment.

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