Chapter 3

Modalities of Non-Surgical Reduction of Intussusception

Publication of short communication in this chapter is listed below.

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Treatment of intussusception

Resuscitation is the initial treatment for intussusception even in cases withsuspected intussusception. Fluid and electrolyte replacement should promptly be corrected after the diagnosis has been performed. A nasogastric tube should be inserted when bowel obstruction symptoms and signs are presented. Antibiotics should be given before the intervention as prophylaxis in case of bowel ischemia or perforation that might happen during treatment.[1]Many studies were conducted about the role of antibiotics after treatment. Zhang et al. stated that the use of antibiotics were only among children who had co-existing infection or other indications.[2] Al-Tokhais et al. found no difference in post-treatment outcome between patients who received and did not receive antibiotics.[3] The Japanese guidelines in 2011 stated that antibiotics were not routinely used in post-reduction enema.[4]

The treatments of intussusception include nonsurgical and surgical.Nonsurgical reduction refers to radiologic reduction which can be performed when no contraindications are observed including unstable patient, peritonitis and presence of free air in a plain abdominal radiograph. When at least one of the contraindications is present, the operative treatment will be performed. In addition, the operative treatment is also performed in cases of failed and developed complications after non-surgical reduction.

Modalities of non-surgical reduction of intussusception

After diagnosis of intussusception is performed and the contraindications are not present, nonsurgical reduction is performed. The techniques used for reduction are hydrostatic and pneumatic reduction under radiologic guidance. The radiologic guidanceduring the reduction comprised fluoroscopy or ultrasound. In 2004, Daneman et al. reviewed the method of reduction from various reports.[5]The reduction methods can be grouped in four categories.

1. Hydrostatic reduction under fluoroscopic guidance
2. Hydrostatic reduction under sonographic guidance
3. Pneumatic reduction under fluoroscopic guidance
4. Pneumatic reduction under sonographic guidance

Success and perforation rates in each method vary among study series which are uncomparable.

The history of intussusception treatment began in 1831. Surgery was the primary treatment option and the American Journal of the Medical Sciences reported the results of treatment were inconsistent.The reviewed data from many reported studies by Ravitch and McCune from 1903 to 1942 found that operation was the primary treatment and mortality rate was 8 to 52%.[6]Nonsurgical reduction was reported since 1836 by Samuel Mitchell.[7] In 1876, HaraldHirschsprung reported reduction of an intussusception by hydrostatic enema with transabdominal manipulation. In 1885, Treves reported the surgical treatment of intussusception had a high mortality rate of 70%.[8] In 1935, Hipsleyreported the technique of hydrostatic pressure and proposed two treatment methods for intussusception, i.e., operative treatment and injecting fluid into the rectum.[9] In 1986, Guo et al. reported the 95% success rate of pneumatic reduction in 6,396 intussusception cases over 13 years.[10] After that, nonsurgical treatment of intussusception was widely performed using various techniques depending on the experience of the surgeons, pediatricians and radiologists.

Hydrostatic reduction

Hydrostatic reduction can be performed using barium, saline or a water soluble contrast. The technique reported by Ravitch and McCune in 1948 involved barium reduction under fluoroscopic guidance.[6]They used a Foley catheter in the rectum. The balloon was inflated with air 20 to 40 milliliters depending on the size of patients. The tip was not lubricated to keep it in the rectum. The buttocks were squeezed together during the reduction to prevent barium leakage. The barium column height from the reduction table indicated **three** feet. Then the barium fills in the colon and reaches the intussusceptum, which is shown as a meniscus sign. The hydrostatic pressure pushed on the intussusceptum is the key process of reduction. When the reduction was not achieved, barium should be drawn out of the colon. **Three** attempts can be used. **Three** minutes for each reduction attempt is applied later to prevent the complication of reduction. Completeness of “the rule of three” with no further progression of the intussusceptum indicates a failed reduction. Surgical management is the next step. Therefore, adequate fluid resuscitation should be conducted before the reduction process. The pressure of barium while hanging three feet from the table is the optimumpressure sufficient to reduce

the viable intussusception with minimal complications and cannot reduce the gangrene bowel. The use of ultrasound guidance instead of fluoroscopic might be due to no radiation exposure but involves more difficulty to demonstrate the progression of reduction.[11]

Pneumatic reduction

Pneumatic reduction was introduced after the use of barium reduction. In 1959, Fiorito reported the use of air insufflation using the term, "control insufflator", with a success rate of 94%.[12] Later, in 1986 two large studies of air reduction under fluoroscopy for thousands of intussusception's patients in China were reported by Jinzhe[13] and Guo[10] with success rates of 91 to 94%. After discussing the advantages and disadvantages of the air enema, other optimum techniques of reduction were proposed. The pressure of air used for reduction started from 80 mmHg to a maximum of 120 mmHg.[14-16] Also, the same as in barium reduction, three attempts and three minutes for each attempt of reduction are used. The reduction is considered successful when the soft tissue of the intussusception disappeared; air flowed freely from the colon to the small bowel and postreduction ultrasound showed no intussusception.[17]

Comparison of "Hydrostatic reduction" vs. "Pneumatic reduction"

Many studies around the world have been conducted about these two modalities of reduction. The advantages and disadvantages of the hydrostatic and pneumatic reduction are listed in Table 3.1. The study of Sanchez, California in 2015 reported that the result of sonographic and fluoroscopic guidance non-surgical reduction of intussusception did not differ.[18]It depended on the experience of the operator.

Table 3.1 Advantages and disadvantages of hydrostatic and pneumatic reduction of intussusception[1, 5, 19, 20]

The advantages of hydrostatic reduction - Familiar technique of reduction - Clear visualization of intussusception - Good results
The disadvantages of hydrostatic reduction - Complicated equipment - If perforation • extensive colonic tear • severe contamination • rapid fluid shift
The advantages of pneumatic reduction - Simple equipment - Less radiation dose used because of rapid colon filling - Higher success rate in the majority of the comparative study series - If perforation • Less colonic tear • No chemical irritation in peritoneum
The disadvantages of pneumatic reduction - Leading points may be missed - The image of successful reduction not as clear as in barium reduction - The post reduction ultrasound should be performed to confirm - Pneumoperitoneum is a complication from perforation

In 2015, The meta-analysis by Sadigh showed that the success rate of pneumatic reduction and hydrostatic reduction were 82.7 and 69.6%, respectively.[20] Also our comparative study in two institutes of Thailand in 2015 showed a success rate of air reduction greater than that of barium reduction.[21] Our study was conducted among 190 patients with intussusception. The non-surgical reduction was performed among 170 patients while the remaining 20 patients underwent operation due to contraindications stated above. Hydrostatic reduction was performed with barium among 59 patients and pneumatic reduction was performed by air enema among 111 patients. The success rates were 61% regarding pneumatic reduction and 44% concerning barium reduction as shown in Table 3.2. We used propensity scores to control the confounders. The propensity score was constructed based on sex, age group of 36 months, weight group of 8 kg, duration of symptoms for 48 hours, vomiting, abdominal pain, rectal bleeding, diarrhea, abdominal distension, constipation, temperature of 37.8°C, palpable abdominal mass, location of the mass, white blood cell count of 10,000/mm3, plain abdominal radiography showing bowel obstruction and ultrasound showing poor prognostic signs by logistic regression.

Multivariable analysis comparing the success rate of hydrostatic and pneumatic reduction adjusted by propensity score revealed that the success rate of pneumatic reduction was 1.48 times greater than that of barium reduction (*P*-value =0.036, confidence interval [CI] =1.03–2.13). Complication after reduction was found in one case of pneumatic reduction, i.e., colonic perforation. The patient received a right hemicolectomy due to colonic gangrene and perforation.

Table 3.2 Outcome of children with intussusceptions who received non-surgical reduction by pneumatic reduction (n=111) and hydrostatic reduction (n=59)[21]

Characteristics	Success, n (%)	Fail, n (%)	P-value
Method of reduction			
Pneumatic reduction	68(61.26)	43(38.74)	0.036
Hydrostatic reduction	26(44.07)	33(55.93)	

Sources :TherClin Risk Manag. 2015;11:1837-42.

In conclusion, when no contraindication for no-operative reduction is observed, both methods can be performed safely. The modalities of non-surgical reduction of intussusception depended on the experience of the radiologist or pediatric surgeon and the hospital setting. Our two institutional studies did not receive a high success rate. These may due to the symptom duration before hospital admission constituting quite a long period of time. Some of the cases were referred from remote provincial hospitals and patients had to travel long distances to receive treatment. As a result, the prognostic factors of reduction failure should be studied.

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