

Review Article

Air enema versus barium enema in intussusception: an overview

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ABSTRACT

Intussusception is a common cause of intestinal obstruction in paediatric population. It is a medical emergency that necessitates prompt reduction of intussuscepting bowel. If left untreated, intussusception can be fatal in a couple of days. The mainstay treatment of intussusception is enema reduction. Both barium and air enema reduction techniques are successful and acceptable strategies for management of intussusception in children. The use of air reduction is currently growing for its safety. Air reduction is associated with higher success rates, less risk for perforation, and less risk for peritoneal contamination than barium reduction. Air reduction generates higher intraluminal pressure during the reduction procedure thus making it faster and more effective. Barium reduction, on the other side, has a diagnostic potential and can better detect pseudo-reduction after management of intussusception. It is easier to perform and more familiar for most of the radiologists than air reduction. To date, both techniques are used, and the choice depends largely on clinical practice, institutional guidelines, and radiologists' preference. This article aims at differentiating between the two types of reduction regarding the technique, advantages, disadvantages, success rates, recurrence rates, and complications rates.

Keywords: Intussusception, Enema, Barium, Barium enema, Air enema

INTRODUCTION

Intussusception is a common cause of intestinal obstruction in pediatric population. It commonly affects infants between the age of 4 and 10 months, and it is considered the second most common cause of bowel obstruction after pyloric stenosis at this age.¹ Intussusception refers to the invagination of a loop of bowel within another more distal one. During the process of invagination, the intestinal loop pulls along its arterial supply making it vulnerable to ischemia and perforation.² Ileum is the most common loop to be affected in intussusception and it invaginates into the cecum through

the ileocecal valve. Intussusception is a medical emergency that necessitates prompt reduction of intussuscepting bowel. If left untreated, intussusception can be fatal in a couple of days. Mortality results from intestinal ischemia, perforation, septic peritonitis, and septic shock.³ Proper early management, however, decreases the mortality rate to less than 1%.⁴

Successful management of intussusception imposes early diagnosis, adequate fluid therapy, and early reduction of the invaginating intestinal loops.² The gold standard treatment of intussusception is enema reduction.⁵ Both air enema and barium enema are commonly utilized and

equally acceptable during the reduction process. This article aims at comparing the advantages, disadvantages, and outcomes of both enemas in intussusception reduction process.

EPIDEMIOLOGY

Typically, intussusception presents in infants and children between 6 months and 3 years, and it is the second most common cause of bowel obstruction in this age group after pyloric stenosis. The mean age of intussusception was reported to be 2.7 years in one study in Switzerland.⁶ It is estimated that more than two-thirds of the cases presents before the age of 12 months and up to 90% presents before the age of 24 months.⁷

The actual prevalence of intussusception is not known, and the incidence is variable among different countries and cities. In the United States (US), the incidence of intussusception is about 1 case per 2000 live births.⁸ In Switzerland, a population surveillance conducted from April 2003 to March 2006 reported the incidence of intussusception was 38 cases per 100,000 live births in the first year of life, 31 cases per 100,000 live births in the second year, and 26 cases per 100,000 live births in the third year of life. The incidence among older children was less than half of these values.⁶ In United Kingdom (UK), the reported incidences ranged from 1.6 to 4 cases per 1000 live births.⁹ Intussusception is more prevalent among males in children with a male to female ratio of 3:1. This difference is even more evident in older children i.e. male children above the age of 4 years are eight times more vulnerable to intestinal intussusception than females at this age.^{10,11} Despite being common in infants and young children, intussusception should be considered in children outside this age group. Some case studies reported intussusception during neonatal period, and many researchers reported the condition after 5 and even 10 years of age.^{6,7}

In children younger than 5 years, intussusception accounts for up to 25% of all cases of abdominal surgical emergencies.² Intussusception results in about 55 per 100,000 annual hospitalizations in the United States (U.S.).¹

DIAGNOSIS OF INTUSSUSCEPTION

Clinically, intussusception is considered in young infants, at typical age group of the disease, who experience signs of intestinal obstruction. Intussusception often follows upper respiratory tract infection, and thus a viral aetiology is highly suggestive specifically Rotavirus.^{12,13} Infants present initially with non-bilious reflexive vomiting that subsequently becomes bilious when intestinal obstruction takes place. Abdominal pain accompanies the vomiting and is usually colicky, intermittent, and severe in intensity. Diarrhoea is always an early sign of intussusception and is characterized by mucous bloody stools. As the condition progress, the

infant becomes lethargic, confused, and toxic. Palpable right hypochondrial sausage-like abdominal mass is the hallmark physical finding on examination. The right lower abdominal quadrant is often empty (Dance sign) and abdominal distension is encountered when bowel obstruction occurs.^{1,2,10,11}

Various imaging studies can be diagnostic for intestinal intussusception. Plain abdominal X-ray radiography can be diagnostic in 60% of the cases where it shows soft tissue density in right upper abdominal quadrant and air in right lower quadrant. Air-fluid level and dilatation of the small intestine occur later.¹⁴ Abdominal ultrasonography has a sensitivity of 97.9% and specificity of 97.8% in detecting intussusception. It reveals a characteristic target or pseudo-kidney sign.¹⁵ The most reliable method for making the diagnosis of intussusception in children is contrast enema, either barium or air.¹⁶ Contrast enema has the advantages of being quick, reliable, and potentially therapeutic for children with intussusception.¹⁶

BARIUM VERSUS AIR ENEMA FOR INTUSSUSCEPTION REDUCTION

Reduction is the mainstay treatment for intussusception in children. It can be performed non-operatively using enemas or operatively using open or laparoscopic surgery. Non-operative reduction is the role except in cases with any evidence of intestinal perforation and peritonitis. Other contraindications include small-bowel intussusception, intussusception in neonates, and intussusception in children with haemophilia, HSP, Peutz-Jegher syndrome, or malignancies. It can be performed under fluoroscopic or ultrasonographic guidance using hydrostatic enemas (e.g. water-soluble contrast or barium) or pneumatic (e.g. air insufflation).¹⁷ Reduction is considered successful when the air or barium is seen on ultrasound refluxing back into the ileum through the ileocecal junction. However, such reflux may not be visualized in cases of competent or oedematous ileocecal valve. Therefore, clinical improvement is a hallmark of successful reduction in those patients.¹⁶

Both air and barium reduction are used and equally acceptable in intussusception reduction. However, the use of air reduction is growing.¹⁸ The choice of the reduction strategy is highly subjective, variable and depends on regional practice, organisational protocols, and radiologists' preferences. To date, no clear guidelines are available to help this choice. Results from a recent comprehensive meta-analysis, including included 32451 patients who had enema reduction from 1966 to 2013, showed that air enema reduction had a higher success rates than barium enema.¹⁹ The mean success rate was 82.7% for air enema reduction and 69.6% for barium enema reduction. The recurrence rate 48 hours after enema reduction was not statistically significant between both approaches.¹⁹

Air enema reduction

Air reduction is one technique for management of intussusception in children. It is carried out through introducing CO₂, O₂, or air into the gastrointestinal tract through a rectal catheter. The pressure recommended for air insufflation in air-enema should be below 120 cm H₂O, pressures between 80-120 cm H₂O are commonly used. The main advantages of this technique are low radiation exposure and low risk of peritonitis if perforation occurred.²⁰ They are also faster, safer, and cheaper than liquid reduction techniques. Most of the air enema reduction strategies are closed-systems that use inflated balloon catheter to ensure reliable tight seal distally at the anus.²¹ This ensures maintained elevation of intra-luminal pressure and subsequently shorter time for the procedure. Using plastic catheters or manual squeezing of buttocks against catheters are not effective in prevention of air leakage. Air reduction is not preferred in cases of small bowel or prolapsing intussusception as it has low success rates in these conditions.²²

Barium enema reduction

Barium reduction is one of the non-operative methods for management of intussusception. Barium enema delivery system depends on hydrostatic pressure from a bag containing barium with elevated pressure. This system is subjected to bidirectional flow and thus generates a lower intraluminal pressure than that generated in air reduction systems. The pressure recommended for barium-enema

should not exceed 100 cm above the buttock level. Using an inflated balloon is also beneficial in this system to minimize air leakage and to direct the flow in a single direction from the delivery system to the intestine.¹⁸

One of the advantages of barium enemas over air enemas is that they are potentially diagnostic and can visualise the invaginating intestinal loops in cases with dilated gas-filled intestinal loops. Other advantages include the ability of the barium enemas to better identify the pathologic lead points of the intussusception than air-systems and to document pseudo-reduction.²¹ Most radiologists are more familiar with barium enema than air enema and thus prefer its use. On the other hand, barium enema delivery systems are associated with higher risk of septic peritonitis and electrolyte disturbance if intestinal perforation occurred.¹⁷ Success rate of barium reduction of intussusception varies widely from 40-90% among studies.¹⁰ This variability is attributed to many factors either related to the patient, the radiologist, or the institution.

Air versus barium enema reduction

Many studies have been conducted to differentiate between air and barium enema reduction as regards the success, recurrence, and complications rates. Table 1 summarizes the differences between the two techniques regarding advantages, disadvantages, techniques, success rates, recurrence rates, perforation rates, and peritonitis rates.

Table 1: Summary of the differences between barium and air reduction techniques.

	Barium Enema Reduction	Air Enema Reduction
Technique		
- Substance used	Barium	Air, CO ₂ , O ₂
- Pressure	<100 cm above buttock level	<120 cm H ₂ O
- Delivery system	Bidirectional – less sealed	Better seal
- Agent leakage	+++	+
Advantages	<ul style="list-style-type: none"> - Diagnostic and therapeutic - Better detection of lead points - Familiar among radiologists 	<ul style="list-style-type: none"> - Safer - Faster - Better seal, less air leakage - Less risk for peritoneal contamination if perforation occurred
Disadvantages	<ul style="list-style-type: none"> - Higher risk of peritoneal contamination if perforation occurred. - Lower seal and higher leakage 	<ul style="list-style-type: none"> - Therapeutic only (cannot be used for diagnosis) - Cannot detect lead points.
Success rate	Lower (69.6%)	Higher (82.7%)
Recurrence rate	Same	Same
Perforation rate	Slightly higher	Slightly lower
Risk of peritoneal contamination	+++	+
Current use	Declining	Growing

Success rates

Beres et al, in their meta-analysis studying the pneumatic versus barium reduction, reported higher success rates with air reduction.²² They stated that there was no

significant difference between both approaches as regards the perforation rate. In agreement with this, other studies reported that the higher success rate encountered among patients who underwent air reduction could be attributed to the higher pressures used in these delivery systems.²³

Other researchers stated that air enemas have higher success rates than barium enemas only if they were performed under fluoroscopic guidance. However, no statistically significant difference was found between air and barium enema when ultrasound guidance was used.²¹

Barium enemas were reported to have a significant advantage not found in air enemas. They were associated with higher rates of visualization of lead points during intussusception reduction than air enemas. Lead points were identified in 6.3% and 2.0% in barium reduction and air reduction, respectively.¹⁹

A recent meta-analysis published in 2015 revealed that the considerably higher success rates of air enema than barium enema for intussusception reduction was independent of any confounding factors including the hospital type, the country, the year of publication, the design of the study (retrospective or prospective).

Recurrence rates

Gray et al explored the recurrence rate after air and barium enema and they reported no significant difference between both techniques.⁵ Similarly, many studies including meta-analysis reviews and large randomised control studies agreed that the 48-hour recurrence rate was closely similar between air and barium enemas.^{19,23} Matthew et al, in their meta-analysis, stated that the recurrence rates after barium enema reduction are slightly higher than those after air reduction techniques.⁵ The overall recurrence was 12.7% and 7.5% among barium reduction and air reduction, respectively. The 24-hour reduction rate was 3.9% in patients who underwent barium reduction and 2% among those who had air reduction technique.⁵ Similarly, Narimis et al reported an overall recurrence rate of 15.8% after barium reduction and 11.4% after air reduction.²⁴ However, the difference between both approaches was insignificant ($p=0.08$).

Perforation rates

Results from literature studies are conflicting about the perforation rates of air and barium enemas. Some researchers reported no statistically significant difference in perforation rates among the two approaches.^{18,19,21,22} Others, however, stated that air enemas result in smaller perforations and less peritoneal contamination than barium studies.^{25,26} Perforation rate can be affected by multiple factors including the degree of intestinal ischemia, intestinal wall friability, the technique used, and the pressure generated during the reduction procedures. Most of these factors were not considered in the literature and thus the reliability of the results cannot be guaranteed.

CONCLUSION

Both barium and air reduction techniques are successful and acceptable strategies for management of intussusception in children. The use of air reduction is

currently growing for its safety. Air reduction is associated with higher success rates, less risk for perforation, and less risk for peritoneal contamination than barium reduction. Air reduction generates higher intraluminal pressure during the reduction procedure thus making it faster and more effective. Barium reduction, on the other side, has a diagnostic potential and can better detect pseudo-reduction after management of intussusception. It is easier to perform and more familiar for most of the radiologists than air reduction. To date, both techniques are used and the choice depends largely on clinical practice, institutional guidelines, and radiologists' preference.

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