An audit of paediatric intussusception radiological reduction at the Bloemfontein Academic Hospital Complex, Free State, South Africa

J A Venter,[1] MB ChB; **S M le Grange,**[2] MB ChB, MMed (Surg), Cert Paed Surg (SA);
S F Otto,[1] MB ChB, MMed (Diagn Rad), LLD, MPH; **G Joubert,**[3] BA, MSc

[1] *Department of Clinical Imaging Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa*
[2] *Department of Surgery, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa*
[3] *Department of Biostatistics, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa*

Corresponding author: *J Venter (jav@goadsl.co.za)*

Background. Intussusception remains the most common cause of bowel obstruction in infants and toddlers and can result in considerable morbidity and mortality if not properly treated. The aim of this study was to determine the success rate of air intussesception reduction (AIR), and to identify factors predicting an unsuccessful procedure, among paediatric patients diagnosed with idiopathic intussusception at the Bloemfontein Academic Hospital Complex, Free State, South Africa.
Methods. This retrospective analytic cohort study assessed data from the records of all paediatric patients with the diagnosis of idiopathic intussusception discharged from the Department of Paediatric Surgery between 1 January 2003 and 30 September 2011.
Results. Thirty-five children with intussusception were identified. AIR enemas were performed in 18 children (51.4%), with successful reduction in 2 (11.1%). Seventeen children (48.6%) were primarily treated surgically without attempting radiological reduction. Successful AIR was more likely if the duration of symptoms was <48 hours. Sixteen patients in whom AIR was attempted eventually required surgical intervention, either due to perforation during AIR or irreducibility. Approximately 94% of children required bowel resection at surgery. In 37.5% of cases AIR was complicated by perforation, making surgical treatment mandatory. Nine patients (56.3%) had unsuccessful AIR without perforation, but needed bowel resection at surgery. One patient (6.3 %) required manual reduction only, without the need for bowel resection at surgery. No deaths were recorded during the period covered by this audit.
Conclusions. Our institution's radiological reduction outcomes were not comparable to international standards. The only statistically significant predictor of poor outcome of AIR was time delay before attempted reduction.

S Afr J CH 2013;7(2):60-64. DOI:10.7196/SAJCH.531

Intussusception is the acquired protrusion of the bowel into itself and usually involves the ileum, the colon, or both. It is the most common cause of intestinal obstruction in young children between 3 months and 5 years of age, and may cause extensive morbidity and even mortality if not promptly treated. In contrast to the condition in adults, paediatric intussusception is usually idiopathic with no identifiable lead point.[1] The highest incidence of the disease is among infants younger than 1 year of age, with a male predominance reported in most studies.[2-7]

Retrospective evaluation of abdominal radiographs of patients with proven intussusception showed that plain films were diagnostic of intussusception in only 29% of cases. Completely normal gas patterns were seen in 24% of patients, which meant that further imaging was required, either by ultrasound or contrast enema.[8] Ultrasound examination by experienced operators using a high-frequency linear transducer has sensitivity of 97.9% and specificity of 97.8% in making the diagnosis. The positive predictive value of ultrasound was 86.6% and the negative predictive value 99.7%.[9,10] A study[11] in which paediatric emergency physicians performed bedside ultrasonography after a single focused training session on evaluation of the paediatric bowel showed good performance characteristics – the bedside ultrasonography had sensitivity of 85%, specificity of 97% and a negative predictive value of 97%. These doctors each had at least 1 month's clinical experience with bedside ultrasonography in adults.[11]

Enema reduction for ileocolic intussusception is less successful in general hospitals than in paediatric hospitals.[12] The main aim of enema therapy is to reduce the greatest number of intussusceptions without producing perforation. In developed countries, the overall perforation rate is 1% or less.[13,14] Perforation may precede enema therapy[15] or may be caused by the reduction process.[16,17] Perforation may occur during reduction in normal[18] or ischaemic[16,19] bowel segments, or in both types.[20,21] Air intussusception reduction (AIR) complicated by colonic perforation leads to none or only focal faecal peritoneal spillage, compared with diffuse faecal spillage when hydrostatic reduction is performed.[18]

The occurrence of perforations before enema therapy depends mainly on promptness of diagnosis and quality of patient treatment, so the frequency of perforations varies widely. Occurrence of perforations during the reduction process depends mainly on the pressure achieved and the duration of time over which pressure is applied, and partly on the dynamics and physical properties of the contrast material.[18,22] Barium, water-soluble contrast media, water, electrolyte solutions or air may be used with radiographic or ultrasound guidance. AIR is highly effective with successful reduction rates of up to 82%, compared with 68% with hydrostatic reduction techniques.[1] Other studies report rates between 82% and 89% for successful AIR.[3,4,14]

Symptoms associated with intussusception include abdominal colic, vomiting, rectal bleeding, dehydration and rectal prolapse. Only some patients present with the classic triad of pain, rectal bleeding and a mass.[4,14,23] One study found that 78% of infants presented with the combination of abdominal pain, lethargy and vomiting.[4] Clinical features that enable doctors to predict a higher risk of intussusception include bloody stool and lethargy at home.[24]

Late referral and delayed treatment may be due to nonspecific symptoms and signs, which may simulate gastroenteritis or other medical conditions. Parents may also treat these infants with traditional remedies in the belief that they will be effective.[2] An association exists between the duration of symptoms and the outcome of this condition.[3] The non-surgical reduction rate has been found to be very high (97.3%) when the duration of symptoms was less than 18 hours. The success rate decreased to 86.4% when symptoms were present for 18 - 24 hours, and further decreased to 33.3% if the duration of symptoms was more than 24 hours.[3] A long duration of symptoms decreases the success rate of air reductions.[3,5,23] Other factors that diminish the chances of successful enema reductions are significant dehydration, radiographic evidence of small-bowel obstruction, and patient age more than 5 years or less than 3 months.[10]

The aim of this study was to determine the success rate of radiological reduction of intussusception at the Bloemfontein Academic Hospital Complex, Free State, South Africa. An attempt was also made to identify common factors leading to poor radiological reduction outcome, including failure to reduce and colonic perforation.

Methods

A retrospective analytic cohort study was performed. All paediatric patients with the diagnosis of intussusception on discharge from the Department of Paediatric Surgery between 1 January 2003 and 30 September 2011 were included. Data were obtained from the hospital information system and review of patients' files for clinical notes and special investigations performed. Descriptive statistics, namely frequencies and percentages for categorical data and means and standard deviations or percentiles for continuous data, were calculated. Analysis of data was done by the Department of Biostatistics. Associations between variables were assessed using chi-square or Fisher's exact tests. Ethical approval to conduct the investigation was obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State.

Results

Thirty-five children with a diagnosis of intussusception during the period under investigation were identified. Their age distribution is summarised in Table 1; 28 of the patients (80.0%) were 12 months old or younger. Sixteen of the patients (45.7%) were male.

Despite a radiological service being available 24 hours a day, only 18 patients diagnosed with intussusception (51.4%) were referred for AIR, of whom only 2 had a successful outcome.

Table 2 sets out the type and duration of symptoms in all patients. The majority of patients were seen more than 72 hours after onset of symptoms. Rectal bleeding occurred in 85.3% of all patients and vomiting in 94.1%, including the 2 who underwent successful AIR, while 20.6% of all patients (none of the successful AIR patients) had colic; 58.8% presented with both rectal bleeding and vomiting, which also occurred simultaneously in the successful AIR group.

An increased pulse rate was found in 84.4% of all patients. One of the 2 patients who underwent successful AIR had a normal pulse rate. Two-thirds (66.7%) of all the patients had no peritonism, while 58.8% had no palpable abdominal mass, which was also the case in the 2 successful AIR patients. Most of the patients had a normal white blood cell count and normal urea and pH values, while one of the successful AIR patients had an elevated pH.

Table 4 summarises the outcomes of the 18 patients who underwent AIR. In 50.0% of these patients the intussusception was irreducible by AIR and bowel resection was required at subsequent surgery.

Table 1. Age distribution of children diagnosed with intussusception (*N*=35)

Age group	*n*	%
Birth - 6 months	16	45.7
>6 months - 12 months	12	34.3
>12 months - 18 months	3	8.6
>18 months - 24 months	–	–
>24 months - 10 years	4	11.4

Table 2. Duration and type of symptoms among children diagnosed with intussusception (*N*=35)

	n	%
Duration of symptoms (hours)		
<24	2	5.9
>24 - 48	5	14.7
>48 - 72	3	8.8
>72	24	70.6
Unknown	1	
Colic		
No	27	79.4
Yes	7	20.6
Unknown	1	
Rectal bleeding		
No	5	14.7
Yes	29	85.3
Unknown	1	
Vomiting		
No	2	5.9
Yes	32	94.1
Unknown	1	

Table 5 compares successful and unsuccessful AIR patients in order to identify factors associated with the outcome of the procedure.

Discussion

We only perform AIR when a paediatric surgeon can be in attendance during the procedure (in order to be prepared for needle decompression of tension pneumoperitoneum in the case of perforation) after proper resuscitation of the patient. After excluding free or intramural air on the plain abdominal radiograph, a thick Foley catheter is inserted into the rectum with balloon inflation to help create a tight seal, followed by three consecutive attempts of stepwise increased pneumatic pressure at 80, 100 and 120 mmHg, maintained for 3 minutes at each level. A device manufactured in-house consisting of a three-way valve and sphygmomanometer is used to monitor pressure during inflation of the colon. If successful reduction is not obtained or a perforation is detected, the procedure is terminated and the patient taken to theatre immediately for laparotomy. Surgery is the modality of treatment in patients presenting with shock, bowel perforation, generalised peritonitis, trans-anal prolapse of the intussusceptum, or failed enema reduction.

Table 3. Clinical and biochemical findings of children diagnosed with intussusception (*N*=35)

	n	%
Palpable abdominal mass		
Yes	14	41.2
No	20	58.8
Unknown	1	
Body temperature		
Increased	4	17.4
Normal	15	65.2
Decreased	4	17.4
Unknown	12	
Pulse rate		
Increased	27	84.4
Normal	5	15.6
Decreased	0	0
Unknown	3	
Signs of peritonism		
Yes	11	33.3
No	22	66.7
Unknown	2	
pH		
Increased	2	14.3
Normal	9	64.3
Decreased	3	21.4
Unknown	21	
White blood cell count		
Increased	10	31.3
Normal	21	65.6
Decreased	1	3.1
Unknown	3	
Urea		
Increased	11	34.4
Normal	15	46.9
Decreased	6	18.8
Unknown	3	

Table 4. Outcome of patients with attempted AIR (*N*=18)

Outcome of AIR	*n*	%
Successful radiological reduction	2	11.1
Unsuccessful radiological reduction		
Perforation during reduction	6	33.3
Irreducible intussusception requiring bowel resection surgery	9	50.0
Irreducible intussusception not requiring bowel resection surgery	1	5.6

Extended duration of symptoms seemed the most important predictor of poor AIR outcome. In this series, success rates for the period from onset of symptoms of <24 hours and 24 - 48 hours were similar, but declined after 48 hours. This may reflect inappropriate management at primary and secondary healthcare level, leading to late referral.

It has been suggested that bedside ultrasonography should be made available in settings with no comprehensive radiological service. The care of patients will be improved as a more timely diagnosis can be made and patients transferred rapidly to centres at which reduction can be performed.[11] No deaths occurred over the 8-year period of our audit. The classic triad of vomiting, abdominal mass and rectal bleeding was not present in all patients with intussusception.

According to Statistics South Africa, 50 678 live births were recorded in 2010 in the Free State.[25] On average, 4.4 paediatric patients with intussusception were admitted annually to our hospitals during the study period from 2003 to 2011. Taking into account that we see only the 80% of the population that depends on public healthcare services, the mean number of infants with intussusception per year can be estimated at 5.84. The mean annual incidence during 2010 was therefore 0.1152/1 000 live births. In comparison, the World Health Organization (WHO) report on acute intussusception in infants and children[2] stated that the incidence of intussusception was estimated to be between 0.5 and 2.3/1 000 live births in the USA. Furthermore, it is estimated from hospital-based studies in Europe[2] that the incidence of acute intussusception in infants was between 1.1 and 4.3/1 000 live births, or 0.66 - 1.2/1 000 infants aged younger than 1 year. In the UK, the rate of intussusception was calculated to be 0.66/1 000 population on the basis of mid-year age-specific population estimates. No published studies from Africa reporting the incidence of intussusception relative to the population of infants and children are available,[2] and no national co-ordinated study has been performed that could assist in estimating the incidence in any country in Africa.[2]

Most of the studies on intussusception are retrospective chart reviews of admissions for acute intussusception over a specific period in single hospitals.[3,4,14,23] The Bloemfontein Academic Hospital Complex is the only tertiary hospital with a paediatric surgery department in the Free State, and the only facility in the province that manages cases dependent on public health services. We also receive referrals from Kimberley Hospital in the Northern Cape Province (births not included in our incidence calculations) for further management. It can therefore be assumed that we manage most public health-dependent cases in the Free State with this diagnosis. The 35 cases referred to our institution represent a significantly lower incidence than that in the WHO report, and the reasons for this finding need to be identified.

Conclusion

Our institution's few successful radiological outcomes in the management of intussusception in children are not comparable with international standards. Primary- and secondary-level healthcare workers should have a high index of suspicion, and should always be aware of danger symptoms and signs in paediatric abdominal emergencies, as well as the importance of early referral when intussusception is considered in the differential diagnosis.

Owing to our low rate of successful AIR reductions, conclusions based on statistically significant differences regarding factors predicting successful and unsuccessful AIR could not be made. The situation requires further investigation.

Acknowledgements. We thank Dr Daleen Struwig, medical writer, Faculty of Health Sciences, University of the Free State, for technical and editorial preparation of the manuscript.

Table 5. Comparison of factors associated with successful v. unsuccessful AIR in children with intussusception (*N*=18)

	Outcome of attempted AIR				
	Successful (*N*=2)		Unsuccessful (*N*=16)		
Variable	***n***	**%**	***n***	**%**	***p*-value**
Age group					<0.05
Birth - 6 months	0	0	6	37.5	
>6 - 12 months	0	0	7	43.8	
>12 - 18 months	0	0	2	12.5	
>18 - 24 months	–	–	–	–	
>24 months - 10 years	2	100	1	6.3	
Gender					0.1830
Male	2	100	6	37.5	
Female	0	0	10	62.5	
Duration of symptoms (hours)					0.0515
<24	1	50.0	0	0	
> 4 - 48	1	50.0	3	20.0	
>48 - 72	0	0	2	13.3	
>72	0	0	10	66.7	
Unknown	0	0	1		
Colic					1.0
No	2	100	11	73.3	
Yes	0	0	4	26.7	
Unknown	0	0	1		
Rectal bleeding					1.0
No	0	0	2	13.3	
Yes	2	100	13	86.7	
Unknown	0	0	1		
Vomiting					1.0
No	0	0	1	6.7	
Yes	2	100	14	93.3	
Unknown	0	0	1		
Palpable abdominal mass					0.4771
Yes	0	0	8	50.0	
No	2	100	8	50.0	
Body temperature					1.0
Increased	0	0	2	16.7	
Normal	2	100	7	58.3	
Decreased	0	0	3	25.0	
Unknown	0	0	4		
Pulse rate					0.3309
Increased	1	50.0	13	86.7	
Normal	1	50.0	2	13.3	
Decreased	0	0	0	0	
Unknown	0	0	1		
Signs of peritonism					1.0
Yes	0	0	2	13.3	

continued...

Table 5. (...continued) Comparison of factors associated with successful v. unsuccessful AIR in children with intussusception (*N*=18)

	Outcome of attempted AIR				
	Successful (*N*=2)		Unsuccessful (*N*=16)		
Variable	*n*	%	*n*	%	*p*-value
No	2	100	13	86.7	
Unknown	0	0	1		
pH					0.2857
Increased	1	50.0	0	0	
Normal	1	50.0	16	100	
Decreased	0	0	0	0	
White blood cell count					1.0
Increased	0	0	3	21.4	
Normal	2	100	11	78.6	
Decreased	0	0	0	0	
Unknown	0	0	2		
Urea					0.6667
Increased	0	0	5	35.7	
Normal	2	100	6	42.9	
Decreased	0	0	3	21.4	
Unknown	0	0	2		
Radiologist experience					0.5882
0 - 18 months	2	100	5	31.3	
>18 - 36 months	0	0	2	12.5	
>36 months - 5 years	0	0	4	25.0	
Consultant	0	0	5	31.3	

References

1. Parashar UD, Holman RC, Cummings KC, et al. Trends in intussusception-associated hospitalizations and deaths among US infants. Pediatrics 2000;106(6):1413-1421. [http://dx.doi.org/10.1542/peds.106.6.1413]
2. Bines JE, Ivanoff B. Acute Intussusception in Infants and Children. Incidence, Clinical Presentation and Management: A Global Perspective. Geneva: World Health Organization, 2002. http:// www.who.int/vaccines-documents/DocsPDF02/www640.pdf (accessed 28 May 2012).
3. Shapkina AN, Shapkin W, Nelubov IV, Pryanishena LT. Intussusception in children: 11-year experience in Vladivostok. Pediatr Surg Int 2006;22(11):901-904. [http://dx.doi.org/10.1007/s00383-006-1764-y]
4. Justice FA, Auldist AW, Bines JE. Intussusception: Trends in clinical presentation and management. J Gastroenterol Hepatol 2006;21(5):842-846. [http://dx.doi.org/10.1111/j.1440-1746.2005.04031.x]
5. Fike FB, Mortellaro VE, Holcomb GW 3rd, St Peter SD. Predictors of failed enema reduction in childhood intussusception. J Pediatr Surg 2012;47(5):925-927. [http://dx.doi.org/10.1016/j.jpedsurg.2012.01.047]
6. Latipov R, Khudoyorov R, Flem E. Childhood intussusception in Uzbekistan: Analysis of retrospective surveillance data. BMC Pediatr 2011;11:22-27. [http://dx.doi.org/10.1186/1471-2431-11-22]
7. Mandeville K, Chien M, Willyerd FA, Mandell G, Hostetler MA, Bulloch B. Intussusception: Clinical presentation and imaging characteristics. Pediatr Emerg Care 2012;28(9):842-844. [http://dx.doi.org/10.1097/PEC.0b013e318267a75e]
8. Hernandez JA, Swischuk LE, Angel CA. Validity of plain films in intussusception. Emerg Radiol 2004;10(6):323-326. [http://dx.doi.org/10.1007/s10140-004-0354-3]
9. Hryhorczuk AL, Strouse PJ. Validation of US as a first-line diagnostic test for assessment of pediatric ileocolic intussusception. Pediatr Radiol 2009;39(10):1075-1079. [http://dx.doi.org/10.1007/s00247-009-1353-z]
10. Cogley JR, O'Connor SC, Houshyar R, Al Dulaimy K. Emergent pediatric US: What every radiologist should know. Radiographics 2012:32(3):651-655. [http://dx.doi.org/10.1148/rg.323115111]
11. Riera A, Hsiao AL, Langhan NL, Goodman TP, Chen L. Diagnosis of intussusception by physician novice sonographers in the emergency department. Ann Emerg Med 2012;60(3):264-268. [http://dx.doi.org/10.1016/j.annemergmed.2012.02.007]
12. Shekherdimian S, Lee SL. Management of pediatric intussusception in general hospitals: Diagnosis, treatment, and differences based on age. World J Pediatr 2011;7(1):70-73. [http://dx.doi.org/10.1007/s12519-011-0249-9]
13. Hiorns MP, Hall CM. The colon. In: Devos AS, Blickman JG, eds. Radiological Imaging of the Digestive Tract in Infants and Children. Berlin: Springer, 2008:201-202.
14. Ramachandran P, Gupta A, Vincent P, Sridharan S. Air enema for intussusception: Is predicting the outcome important? Pediatr Surg Int 2008;24(3):311-313. [http://dx.doi.org/10.1007/s00383-007-2101-9]
15. Mitra SK, Rao PLNG, Bhattacharyya NC, Pathak IC. Rupture of intussuscipiens. J Pediatr Surg 1982;17(3):300-301. [http://dx.doi.org/10.1016/S0022-3468(82)80017-1]
16. Gu L, Alton DJ, Daneman A, et al. Intussusception reduction in children by rectal insufflation of air. AJR Am J Roentgenol 1988;150(6):1345-1348. [http://dx.doi.org/10.2214/ajr.150.6.1345]
17. Kirks DR. Air intussesception reduction: 'The winds of change'. Pediatr Radiol 1995;25(2):89-91. [http://dx.doi.org/10.1007/BF02010312]
18. Shiels WE 2nd, Kirks DR, Keller GL, et al. Colonic perforation by air and liquid enemas: Comparison study in young pigs. AJR Am J Roentgenol 1993;160(5):931-935. [http://dx.doi.org/10.2214/ajr.160.5.8470606]
19. Humphry A, Ein SH, Mok PM. Perforation of the intussuscepted colon. AJR Am J Roentgenol 1981;137(6):1135-1138. [http://dx.doi.org/10.2214/ajr.137.6.1135]
20. Daneman A, Alton DJ, Ein S, Wesson D, Superina R, Thorner P. Perforation during attempted intussusception reduction in children: A comparison of perforation with barium and air. Pediatr Radiol 1995;25(2):81-88. [http://dx.doi.org/10.1007/BF02010311]
21. Stein M, Alton DJ, Daneman A. Pneumatic reduction of intussusception: 5-year experience. Radiology 1992;183(3):681-684.
22. Zambuto D, Bramson RT, Blickman JG. Intracolonic pressure measurements during hydrostatic and air contrast barium enema studies in children. Radiology 1995;196(1):55-58.
23. Kodikara H, Lynch A, Morreau P, Vogel S. Ten-year review of intussusception at Starship Hospital: 1998-2007. NZ Med J 2010;123(1324):32-40.
24. Weihmiller SN, Monuteaux MC, Bachur RG. Ability of pediatric physicians to judge the likelihood of intussusception. Pediatr Emerg Care 2012;28(2):136-140. [http://dx.doi.org/10.1097/PEC.0b013e3182442db1]
25. Statistics South Africa. Recorded live births 2010. http://www.statssa.gov.za/publications/P0305/P03052010.pdf (accessed 25 August 2012).