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Ultrasound features of intussusception predicting outcome of air enema

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Abstract *Objective*. To examine features identified on US which predict success or failure of air-enema reduction of intussusception.
Materials and methods. A retrospective study of 117 consecutive episodes of intussusception, presenting for US over a 6-year period. The specific features examined were: free fluid within the peritoneum, small-bowel obstruction, colonic wall thickness, and fluid trapped between the colon and the intussusceptum.
Results. The overall reduction rate, irrespective of US features, over the 6-year period was 72 %. Reduction rates were significantly higher with the absence of free fluid, trapped fluid, or small-bowel obstruction (93 %). The presence of trapped fluid predicted an unfavourable outcome, with a significantly lower success rate (25 %). Colonic wall thickness did not predict outcome; in successful reductions, mean wall thickness was 7.2 mm and in failed reductions 7.6 mm.
Conclusions. Where free fluid, small-bowel obstruction, and trapped fluid are absent, almost 100 % success with air-enema reduction should be achievable. Where trapped fluid is present, air enema should be performed cautiously to avoid perforation caused by overvigorous attempts at pneumatic reduction of an incarcerated intussusception.

Introduction

Intussusception remains a significant cause of morbidity in childhood, due in part to the difficulties of clinical and plain-film diagnosis. The classic symptoms and signs of abdominal pain, palpable abdominal mass, and red-currant-jelly stool are present in only 50 % of cases [1]. The role of the plain abdominal radiograph in diagnosis is somewhat controversial with significant interobserver variability in identification and interpretation of 'classic' plain-film signs [2].

The role of US in the assessment of patients with suspected intussusception is indisputable [3–5]. Its wide availability, lack of ionising radiation, noninvasive nature, and accuracy approaching 100 % have established its place in the diagnosis of intussusception. US has also been used to monitor pressure reduction with saline [6] and air [7] and to establish complete reduction.

The aim of this study was to investigate the role of US in directing the management of intussusception once the diagnosis has been established. There is significant variation in reported reduction and perforation rates from various centres [8–10]. In striving to increase radiological reduction rates and avoid surgery with its attendant increased morbidity, a common association is increased perforation rate. We investigated the potential for US to direct the optimum mode of reduction. By selecting those intussusceptions that have the potential for pneumatic reduction it should be possible to increase the minimally invasive rate of reduction. Conversely, identifying those incarcerated intussusceptions in which persistent attempts at pneumatic reduction would result only in perforation would decrease

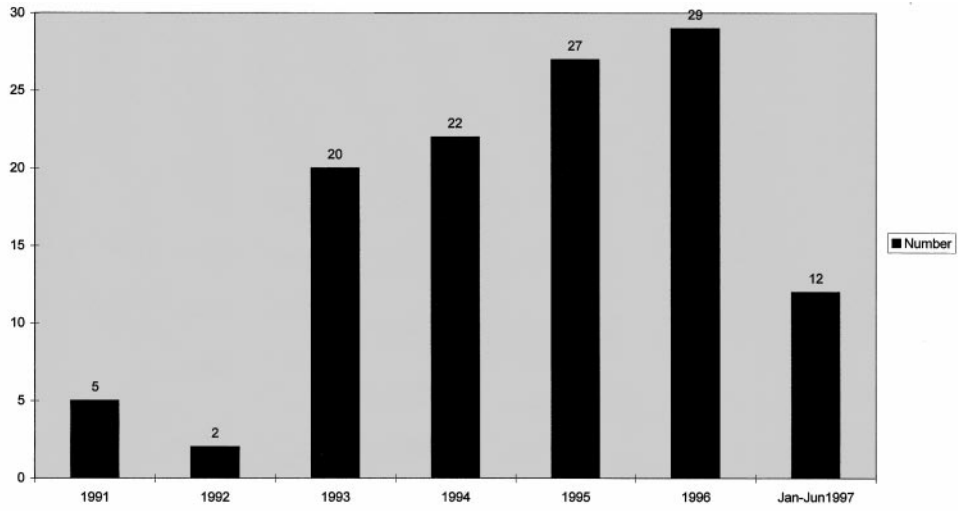

Fig. 1 Plot of number of attempted air reductions per year in patients who had undergone US examination

complication rates. The ability to stratify the US appearance into prognostic groups, with regard to outcome at pressure reduction, also has implications for direct comparison of reduction techniques.

Materials and methods

The imaging studies and clinical records of 125 patients with intussusception diagnosed or confirmed by US and managed by attempted air-enema reduction were retrospectively reviewed. Of the total, 12 patients were excluded. In 10, US was not performed as part of the initial assessment. In 2, air enema was not attempted, 1 by the surgeon's preference and the other because resuscitation was required. A total of 117 episodes in 113 patients were included in the study.

The patients presented over 6 years from 1991 to 1997. The mean age of the patients was 11 months (range 3 months to 8 years) and 74 % were under the age of 1 year. There were 47 girls and 66 boys.

From the imaging studies, presence or absence of the following were noted:

1. Free fluid within the peritoneum
2. Small-bowel obstruction
3. Colonic wall thickness in the region of the intussusception
4. Fluid trapped between the intussusceptum and the colonic wall

From the clinical records, duration of symptoms, success or failure of pneumatic reduction, outcome of laparotomy (if performed), and length of hospital stay were determined. The chi-square test was applied to noncontinuous variables to assess the statistical significance of the presence or absence of the US features.

Results

Over the 6-year period studied, the number of attempted air-enema reductions increased significantly (Fig. 1). With increasing numbers the reduction rate progressively increased (Fig. 2).

Table 1 Complications of intussusception detected on US with corresponding rate of successful reduction at air enema (– absent, + present)

Free fluid	Small-bowel obstruction	Lumen fluid	Number	Success
–	–	–	41	93 %
+	–	–	8	88 %
+	+	–	16	64 %
–	+	–	38	65 %
–	+	+	2	1 patient
–	–	+	2	1 patient
+	+	+	5	0
+	–	+	5	0

The overall success rate of pneumatic reductions was 72 %. There were seven perforations at air enema (5.9 %). A total of 32 patients required laparotomy, of whom 13 required resection. Of these, 4 had a lead point (Meckel's diverticulum in all cases), 3 had gangrenous segments, and 6 had serosal tears. Of the intussusceptions, 16 were reduced manually at laparotomy and 3 were found to have been successfully radiologically reduced at the time of surgery. Only 4 patients had recurrences but no lead point demonstrated. Mean hospital stay of those successfully reduced by air enema was 2.5 days compared to 6 days in those requiring surgery.

Of the US features predicting outcome of air-enema reduction, colonic wall thickness was irrelevant and in successful air-enema reductions was 7.2 mm and in failed pneumatic reduction 7.6 mm. Significant differences in success rates based on US appearance prior to attempted reduction were demonstrated (Table 1).

The commonest ultrasound appearance was the uncomplicated intussusception, with absence of free fluid or trapped fluid and no evidence of small-bowel ob-

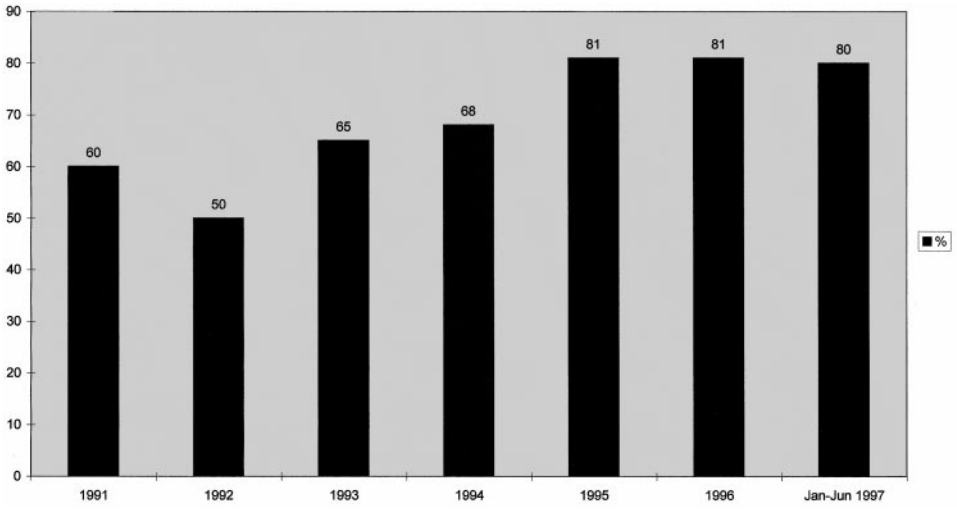

Fig. 2 Plot of reduction rate against year

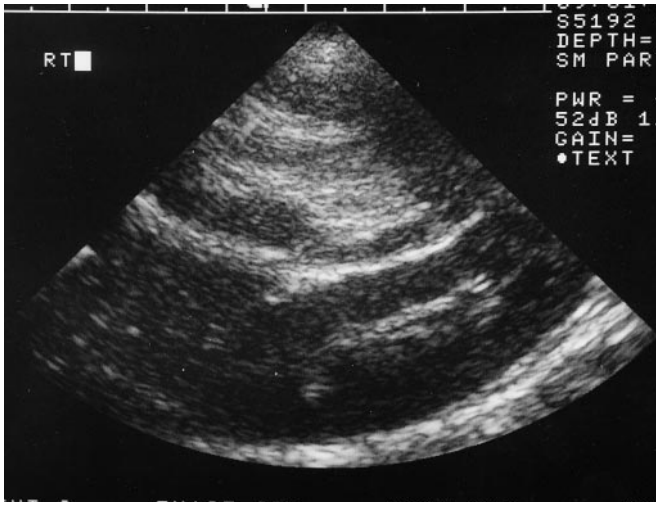

Fig. 3 US of uncomplicated intussusception showing pseudokidney appearance adjacent to right kidney

struction on US examination or plain film. This group constituted 41 of 117 patients (35%). Presence of small-bowel obstruction alone was the second-most-common appearance in 38 of 117 cases (32%).

Air-enema reduction was most successful in the sonographically uncomplicated intussusception where there was no evidence of free fluid, trapped fluid, or small-bowel obstruction (Fig. 3). Successful reduction was achieved in 93% (38/41) of this group compared with 60% (46/76) of those that had one or more complicating factors ($\chi^2 = 13.5$, $P < 0.001$)

In the presence of free fluid alone (Fig. 4), there was also a high reduction rate, 7 of 8 (88%). Patients having no complications other than free fluid underwent successful reduction in 92% (45/49 episodes), significantly higher than 54% (37/68) when small-bowel obstruction and/or lumen fluid was present ($\chi^2 = 19.0$, $P < 0.001$). The presence of small-bowel obstruction (Fig. 5) resulted in a lower success rate (25/38) than the uncomplicated intussusception (38/41) ($\chi^2 = 8.8$, $P < 0.001$)

A consistently poor prognostic feature for outcome of air-enema reduction was the presence of trapped fluid within the colon in the region of the intussusception (Fig. 6). In 14 presentations in which there was trapped fluid only, 2 were successfully reduced by air enema compared to 80/103 without trapped fluid ($\chi^2 = 23.6$, $P < 0.001$)

A potentially confounding variable is the changing rate of successful reduction by year (Fig. 1). Complex features tended to occur in a decreasing proportion of cases year by year (Fig. 7). This inverse relationship of decreasing incidence of complex features with increasing success rates supports rather than confounds the findings of the study.

Discussion

Our review of the literature yielded studies identifying clinical factors that influenced the likelihood of successful air reduction [11, 12], but few studies that related findings on US to the success of pressure reduction. This retrospective review confirms that US can identify good and poor prognostic features for the success of air-enema reduction.

The good prognostic constellation of US features was the uncomplicated intussusception with absence of free fluid, trapped fluid, or small-bowel obstruction. The relative mobility of the intussusceptum in these cases may prevent the accumulation of the more complex associated features. As any operator appreciates, a mobile intussusception, obvious from initiation of pneumatic reduction, is more readily reduced, sometimes so quick-

Fig. 4 US showing intussusception with free intraperitoneal fluid

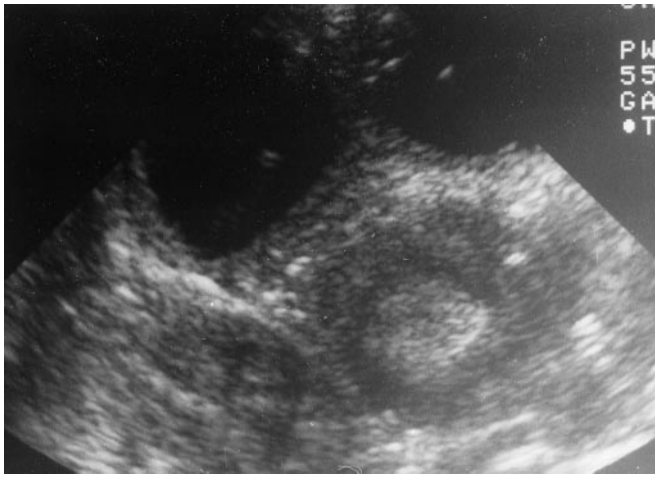

Fig. 5 US showing doughnut appearance of intussusception with dilated fluid-filled small-bowel loops indicating small-bowel obstruction

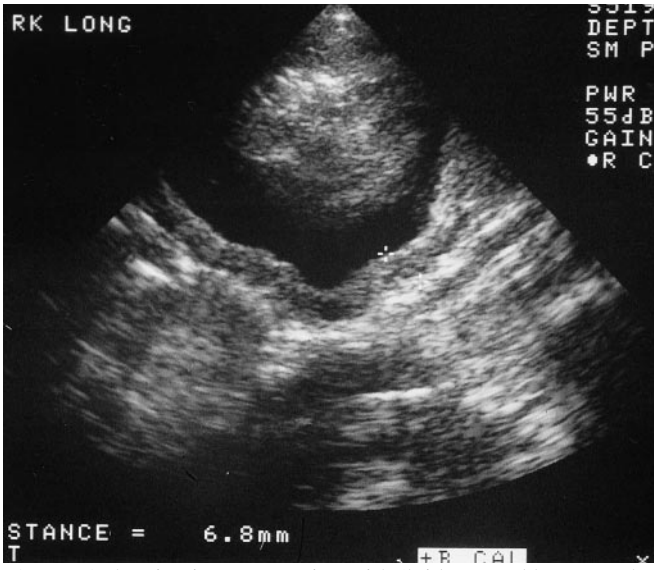

Fig. 6 US showing intussusception with fluid trapped between the intussusceptum and the colonic wall

ly that it may be difficult to know if an intussusception had been present [8].

With decreasing mobility of the intussusceptum because of oedema, local inflammatory factors, muscular spasm, or ischaemia [13] the accumulation of more complex features becomes more likely. An inevitable association of progressive incarceration is decreased likelihood of success at air-enema reduction. We found that although the presence of free fluid did not have an adverse effect on prognosis, small-bowel obstruction and trapped fluid were associated with decreased success rates at air enema.

It has previously been demonstrated that free intraperitoneal fluid is not a contraindication to pressure reduction [14] and our study supports this. More distal intussusceptions have been associated with lower rates of reduction [15], but we were unable to examine this factor because of incomplete recording of the relevant data.

Assuming that local oedema and decreased mobility of the intussusceptum are responsible for both the accumulation of more complex features and the decreasing likelihood of reduction, it is surprising that wall thickness was not a significant prognostic factor in determining outcome. Other studies have indicated that colonic wall thickness greater than 10 mm [16] or 16 mm [17] is associated with failure of pressure reduction. In our study the absolute measurement of wall thickness was not significant. However, in view of the multiple dynamic factors (osmotic pressure, muscular spasm, intraluminal and/or intra-abdominal pressure, arterial insufficiency, and venous engorgement) involved, absolute measurement may be a rather simplified assessment. The ratio of colonic wall thickness to bowel diameter may be a more integrated interpretation; however, we were unable to assess this retrospectively.

The phenomenon of fluid trapped within the intussusception has been examined by del-Pozo et al. [18], who demonstrated trapped fluid in 20 % of their cases and a reduction rate of only 26 % in this group. The influence of other US features was not examined in this study. It is not clear why there should be apparent

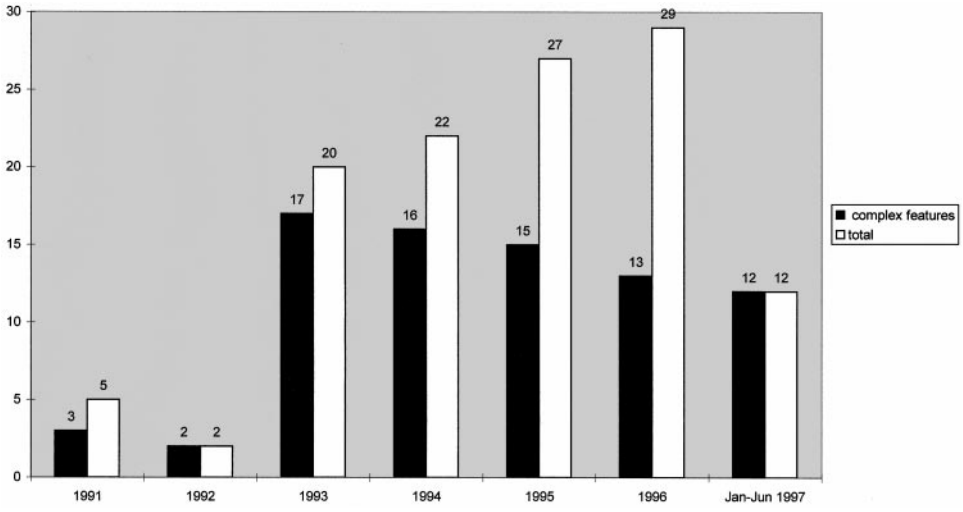

Fig. 7 Plot of incidence of complex features by year

wide variation in the proportion of patients with intussusception who have trapped fluid; the 20% reported by del-Pozo et al. is considerably higher than our 10% and the absence of previous reports of trapped fluid suggests that it may generally be uncommon. The variation may be explained by differing referral patterns, with patients with longer duration of symptoms being more likely to have accumulated fluid. An assessment of duration of symptoms was initially recorded in our study; however, the accuracy of this was questionable with inter-observer variation between parents and carers. In addition, the significance of any prodromal symptoms was subject to wide variation in opinion between junior and senior clinical staff. These data, difficult to collect prospectively, were deemed even more unreliable retrospectively and were therefore discarded. Whatever the aetiology of trapped fluid, it appears to be the most reliable factor in predicting incarceration in our study.

Colour Doppler studies were performed only in some of our patients, particularly those later in the series. This can assess the presence of blood flow within the wall of the colon and in the intussusceptum. It is likely that the presence of flow is a good prognostic factor, but numbers were too small for statistical analysis.

Identifying different prognostic groups by US has profound implications for other studies. Where comparison of reduction techniques is being made, results should be matched for separate prognostic groups. We are not aware of any studies in which the presentations are subdivided and stratified for the purposes of comparing outcomes. Ignoring the variable US appearances assumes that all intussusceptions can be viewed as a homogeneous group, which clearly they are not.

On the basis of the US features at diagnosis one can anticipate the likelihood of success of air-enema reduction, and it is possible to gauge the appropriate degree of persistence. With the uncomplicated appearance, 100% success should be anticipated, and it should be possible to avoid surgery in the great majority. Of the 41 intussusceptions with this appearance, all but 3 were radiologically reduced. These three failures were in the period 1991–1993, when experience was more limited, and therefore this may be a reflection of more tentative attempts rather than difficulty of reduction. It may be appropriate to attempt reduction of those uncomplicated intussusceptions in secondary referral centres or where experience is limited. More complicated cases should be referred to a tertiary centre where complications can be anticipated and dealt with.

In intussusceptions where small-bowel obstruction is present, one should proceed with caution, anticipating a lower probability of success. The presence of both trapped and free fluid universally predicted failure of radiological reduction in this study. However, numbers in this group were small in our study, and a cautious air enema should be attempted before resorting to surgery since a small proportion of this group may be reducible. Air enemas in this group should be performed only by the most experienced operators with surgical collaboration.

In conclusion, US can accurately confirm the diagnosis of intussusception and identify features that predict the likelihood of air reduction being successful. The air reduction can then be tailored to the individual patient, both maximising the potential for successful reduction and minimising the risk of complications.

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