Ultrasound guided reduction of intussusception with saline and comparison with operative treatment

Ultrasonografi eşliğinde serum fizyolojik ile invajinasyon redüksiyonu ve operatif tedavi ile karşılaştırma

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BACKGROUND

Reduction of intussusception under ultrasound guidance by saline has become popular in recent years. However, methods, duration of the procedure and causes of failure are not defined. In this study, we reviewed the patients who underwent ultrasound (US) guided saline reduction and compared them with those who were previously managed by operative intervention.

METHODS

Patients with severe peritonitis or perforation, those over 3 years or younger than 1 month were excluded. Saline was applied by anus. Entry of saline into the ileum was the main indicator for successful reduction. Dramatic improvement in the clinical findings was considered as an additional sign of successful reduction. No limit was imposed on duration of the procedure.

RESULTS

Hydrostatic reduction was successful in 41 out of 51 patients with intussusception. In three patients with partial resolution, hydrostatic reduction was attempted later and total reduction was achieved. No perforation or other complications were seen. In ten cases withreduction failure, one had an ileal lymphoma and another one had a duplication cyst as lead points.

CONCLUSION

US guided hydrostatic reduction for childhood ileocolic intussusception is safe and, painless, has a high success rate and avoids radiation exposure risk. Presence of ultrasonographic and clinical changes is the best indicator of a successful reduction. In some cases, a second attempt may be necessary for reduction.

Key Words: Invagination/diagnosis/therapy; saline enema reduction; ultrasonography; ultrasound guided intervention.

AMAÇ

Son yıllarda ultrasonografi (USG) eşliğinde invajinasyon redüksiyonu popüler bir yöntem olmuştur. Ancak, ayrıntılar, işlemin süresi, başarısızlık nedenleri irdelenmemiştir. Bu çalışmada, USG eşliğinde serum fizyolojik ile redüksiyon uygulanan invajinasyon olguları değerlendirildi ve operatif yaklaşım ile tedavi edilen önceki dönem olguları ile karşılaştırıldı.

GEREÇ VE YÖNTEM

Ciddi peritonit ya da perforasyonu olanlarla, 3 yaşından büyük ve 1 aydan küçük olanlar çalışma dışı bırakıldı. Anal kanala, ısıtılmış serum fizyolojik uygulandı. Başarılı redüksiyonun ana ölçütü olarak USG monitöründe serumun ileuma geçişi değerlendirildi. Bu sırada hastanın kliniğinde belirgin düzelme olması da başarılı redüksiyon açısından bir ölçüt olarak görüldü. İşleme bir zaman sınırlaması getirilmedi.

BULGULAR

Elli bir invajinasyonlu hastanın 41'inde işlem başarılı sonuçlandı. Redüksiyonu parsiyel olarak gerçekleşen üç hastada aynı işlem yinelendi ve bunlar da total olarak redükte oldular. Perforasyon ya da başka bir komplikasyon görülmedi. Redüksiyonun başarısız olduğu 10 hastanın birinde ileal lenfoma, birinde de duplikasyon kisti "lead point" nedeni olarak belirlendi.

SONUÇ

Çocukluk çağında USG eşliğinde hidrostatik ileokolik invajinasyon redüksiyonu güvenlidir, ağrısızdır ve başarı oranı yüksektir. Hasta ve ekip radyasyon ışınları ile de karşılaşmamaktadır. Başarılı redüksiyonu gösteren başlıca belirteçler arasında radyolojik ve klinik olarak düzelme bulguları vardır. Bazı olgularda, ikinci bir redüksiyon denemesi gerekebilir. İnvajinasyon için daha önce ameliyat öyküsünün bulunması hidrostatik redüksiyon için bir kontrendikasyon oluşturmaz.

Anahtar Sözcükler: İnvajinasyon/tanı/tedavi; salin lavmanlı redüksiyon; ultrasonografi; ultrason eşlikli girişim.

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In recent years, ultrasound guided saline reduction has gained great acceptance as the initial procedure both for the evaluation and nonoperative treatment of children with intussusception. The success rate of this modality varies at different centres, but it is not less than 80%.[1-3] There is no uniform technique accepted by all centres. Some of the centres use a Foley catheter and sedation[4] whilst others use no medication[1,2,5] and many authors describe the application of a time limit for the duration of the procedure.[1,6] Furthermore, the majority of cases in the literature have been reported by the radiologists and so the techniques are described from a radiologist's perspective.[1,4,7,8] However, the procedure itself is not a pure radiologic investigation. It has clinical and surgical standpoints. Besides the radiological changes, the child also shows many clinical changes during the reduction. With a collaboration of radiologists and clinicians, the diagnosis and the treatment of intussusception would be more favourable. Therefore, we aimed to study our method of reduction and demonstrate the clinical changes in the patient before, during and after the procedure and to evaluate the patients with lead points according to their ages. We also reviewed our former cases, in which we performed only operative treatment for intussusception and compared them with those with hydrostatic reduction.

MATERIALS AND METHODS

All patients with intussusception who were admitted before 1995 within a 7 year period have been treated operatively. The medical records of these cases were reviewed with special emphasis on presented lead points and the ratio of lead points was calculated. Ultrasonography (US) is being performed in all childhood cases, either for the diagnosis or for the treatment of intussusception since 1995. Sonographic criteria for intussusception are "target sign" in the transverse section and "pseudokidney sign" in the longitudinal section.[2,9-11] Patients, except those with signs and symptoms of severe peritonitis and/or perforation and those over 3 years of age or younger than 1 month of age are defined as candidates for sonographically guided hydrostatic reduction. Patients, who are over 3 years of age and younger than 1 month were excluded from the study, because they have a greater risk of having a lead point. The patients were prepared as if they are going to have an operation. Following rehydration with lactated Ringer's solution and insertion of a nasogastric tube, they were transferred to the radiology department. All reductions took place in the ultrasound room by a team consisting of radiologist(s) and pediatric surgeon(s). Sedation with diazepam or midazolam per rectum via the inserted Foley catheter was carried out if necessary. An ultrasound machine (Hitachi, EUB-415, 1990) with 3.5 MHz or 5 MHz linear transducer was used. A Foley catheter of the largest appropriate size was inserted into the rectum, the balloon was inflated with saline and the child was placed in supine position. Normal saline pre-warmed to 37°C was introduced under ultrasound guidance via the Foley catheter from 100 cm height.

Retrograde movement of the intussusceptum and instilled fluid were monitored sonographically. No additional pressure was exerted other than the fluid column.

The peritoneal cavity was observed for signs of perforation. Simultaneously the pediatric surgeon examined the abdominal distension, defence and tenderness at the abdomen and the general condition of the child, character of stool and presence of crying and pain. They all were examined during the procedure. If the distension has extended, abdominal tenderness or general condition became more severe, the procedure was terminated. Entry of saline from the cecum into the ileum was the main indicator for successful reduction and we did not wait for disappearance of the target sign.[12] No time limit was imposed on the duration of the procedure. If the retrograde movement of the intussusceptum has stopped anywhere in the large bowel and/or the flow of the saline stopped and/or leaked through the anus despite the catheter balloon, the process was being terminated and defined as failed reduction. However, before the final reduction, a temporary stop of the retrograde movement of the intussusceptum occurred at the ileocolic valve. At this point, we waited with patience for the complete release of intussusceptum. In some of recent cases, whose general condition was clinically stable, a second attempt of saline reduction was carried out, if a major part of intussuscepted bowel successfully reduced initially.

Immediately after the successful reduction, the bowel was being decompressed with digital help and an erect abdominal X-ray was taken in all patients. Successfully reduced patients were being transferred back to the ward and were monitored for the abdom-

inal distension, defence and tenderness at the abdomen and the general condition, character of stool and presence of crying and pain. They were not discharged until bowel motion returned to normal and oral feeding could be resumed without any problem. If reduction was unsuccessful, the patient was immediately transferred to the operating theatre.

RESULTS

Fifty-one patients (34 male, 17 female) aged between 1 month and 3 years (median 7 months) were treated with US guided hydrostatic reduction. In patients with US guided hydrostatic reduction, the procedure was successful in 41 children (80.39%). In almost all of these patients with successful reduction, the general condition showed a dramatic improvement, crying ceased, breathing was more stable, abdominal mass disappeared and the abdomen became soft. Distension was relieved after removing the Foley catheter and after discharging the saline with digital help. Some of the children fell asleep when reduction was successful. Improvement in these clinical signs indicated successful reduction. These were the early clinical signs. We observed nearly normal gas pattern on the erect abdominal X-ray subsequent to a successful procedure. After transferring the patients to the ward, we kept them under observation for a further 24 hours and we saw decreased amount of nasogastric drainage, less pain and tenderness at the abdomen and nearly normal stool, which were considered as late findings of successful reduction. In one child whose intussusception was previously managed by surgical manual reduction, a recurrence was reduced by US guided saline solution. In three patients with partial resolution, hydrostatic reduction was attempted immediately after stabilisation of the clinical status of the patient. Total reduction was successfully achieved in all of them. One of them had an ileocolocolic double intussusception. At the initial attempt, the colocolic part of it was easily reduced and afterwards, the ileocolic part was also reduced at the second attempt. One of our initial cases, which we initially regarded as a failed hydrostatic reduction was found to have spontaneous reduction at surgery. In two of our recent patients, the initial attempt of reduction was successful with good general condition and sufficient oral intake, but after 1 and 1 1/2 days respectively, the children developed typical clinical symptoms of intestinal obstruction which was considered as a re-intussusception, they underwent surgical intervention. At surgery, we found a mild ileocolic intussusception which was easily made a manual reduction in both of them and in one of them; multiple large mesenteric lymph nodes adjacent to cecum were present which had functioned as a lead point. No perforation or other complication was seen. Of the ten cases in which reduction was unsuccessful (Table 1), four had manual reduction, one patient had an ileal lymphoma and another one a duplication cyst as lead points. In three patients manual reduction could not be performed during the operation, thus the true failure rate was 8.8%. We did not find any evidence or risk factor for the failure of reduction (neither ultrasonographic nor clinical).

In 212 children admitted before 1995 and managed operatively, we found 18 lead points (8.5%), from these, there were 14 cases with Meckel's diverticulum, two with intestinal duplication cyst and the remaining two children had intestinal lymphoma. Four of 18 children with lead points, operated in this period were more than 3 years of age (22.22%). Only 9/194 cases with no lead point were more than 3 years of age (4.6%). Only 7.03% of children

Table 1. Characteristics of unsuccessful cases

Lead point	Operation	Age	n
Lymphoma	Bowel resection + Anastomosis	3 years	1
Duplication cyst	Bowel resection + Anastomosis	6 months	1
Multiple lymph nodes	Operative manuel reduction	21 months	1
No lead point	Operative manuel reduction	*	2
No lead point	Bowel resection + Anastomosis	**	5
Total			10

* One patient is 3 months of age, the other one is 7 months of age;
** Two patients were 3 months of age, each one patient was 7, 8 and 16 months of age.

(14/199) younger than 3 years of age had a lead point as the etiologic factor of the intussusception, whereas 4/13 children (30.77%) more than 3 years of age had a lead point as a cause of intussusception. The possibility having a lead point in patients more than 3 years of age is significantly higher than those, who are younger than that age ($p<0,05$). There is no significant difference of having a lead point between patients admitted before and after 1995 ($p>0.05$).

DISCUSSION

The classical nonsurgical reduction of intussusception is the barium enema reduction. More recently, air insufflation has become popular worldwide[8,9,13,14] However both techniques have the disadvantage of exposing the child and the "reduction team" to X-rays.[8,9,11] Daneman and Navarro extensively reviewed the hydrostatic reduction techniques of intussusception according to success rates, complication rates, advantages and disadvantages.[8] They also suggest that sonography assisted techniques are far more superior, in case of an experienced radiologist is available. Kim et al.[15] described reduction of intussusception by US guided saline enema in 1982. Later, many other investigators reported it as an alternative technique with a remarkable success rate and no radiation exposure.[3,4,15,16] Our study with 51 patients also supports this figure with a success rate of 80.39%.

The hydrostatic pressure exerted by fluid enema is less than that associated with air insufflation.[17] Thus, another advantage of this method is a lower incidence of perforation.[8,18] Intestinal perforation during the procedure of US guided saline reduction is exceedingly rare and only three cases of perforation have been reported in the literature.[2,3] Reported saline pressures exerted during the procedure range from 75 to 125 mmHg.[1,4,11,19] We employed a constant pressure of 100 cm H_2O (73.5 mmHg) and we wait until the intussuscepted bowel reduces or the flow of saline stops. We believe that the possibility of perforation is extremely low, because with saline the pressure exerted on the bowel wall is more evenly distributed.[17] However, if intestinal perforation does occur, it can immediately and accurately be recognized using sonography.[8] Moreover, if perforation should occur, the flow of the saline into the peritoneal cavity does not result in chemical peritonitis as is seen when perforation occurs with barium enema and does not cause tension pneumoperitoneum as in air enema.[1,8,11] We have chosen the pressure of 100 cm H_2O to lessen the risk of perforation during the reduction. Our success rate of reduction (80.4%) seems to be lower than those of the some other investigators,[3,20] but it is actually very similar to the many of the similar case studies.[1,2,4,11,16,19]

There are many reports considering the method of procedure, however, controversy still exists concerning the duration of the procedure and the definition of the method. The main ultrasonographical criterium of successful reduction is the flow of the fluid from cecum into the terminal ileum. Relief of the target sign is also a criterium for successful reduction, but we do not wait for disappearance of target sign.[12,19,20] Ein et al.[21] reported that 10% of radiologically unsuccessful cases had been found spontaneously reduced at surgery and therefore they suggested that clinical criteria for successful reduction should also be imposed for the final decision. We found that the early clinical criteria seen on the ultrasound table just after the reduction are the dramatic improvement in the general condition of the child, relief of crying, sleeping following the procedure, normal breath pattern, increasing abdominal distension during the procedure (which indicates filling of the small bowel with saline) and disappearance of the abdominal mass. Occurrence of near normal stool discharge and sucking, decrease in the amount of nasogastric drainage and relief of defense and pain during palpation after decompression of the bowel with digital help are the later clinical findings in patients with successful reduction. With the presence of these clinical and ultrasonographic findings, the procedure can be terminated. One of our initial cases was found to have spontaneously reduced at surgery; at this early stage we were not sufficiently experienced to recognize the clinical findings of a successful reduction. We therefore stress that the sonographic findings and the clinical signs should be evaluated together during the procedure. Thus, the procedure should be performed as teamwork of radiologists and pediatric surgeons, which in our belief is the best way of treating the patient.[11]

Ultrasound is an operator dependent modality. Chan et al.[11] therefore suggested that confirmation by a standard diagnostic technique such as a contrast enema is required. Riebel et al.[16] reported a US-

guided hydrostatic reduction with a mixture of saline and water soluble contrast material to check out the final outcome of intussusception by a short time fluoroscopic control. Nevertheless, as the authors mentioned, appropriate use and proper management of the technique can make an extra fluoroscopic control unnecessary. We think that successful reduction can accurately confirmed by clinical observation and clinical parameters mentioned above. An erect abdominal X-ray immediately after the saline reduction will show the disappearance of air and fluid levels.

We used in some children diazepam or midazolam for sedation through the Foley catheter per rectum, although some investigators are against sedation,[1,2] we think mild sedation is beneficial in some children for their comfort as well as for the success and increased image quality on the US-monitor.

Limiting the duration of the attempt at nonoperative reduction of intussusception has been proposed by some authors.[1,6] As some others, we do not limit the time of attempts at reduction.[3] The main indicators for terminating the procedure are the cessation of the retrograde bowel movement and the flow of the fluid.

Up to 60% of unsuccessful reductions by air can be reduced manually at surgery.[22] Therefore, many investigators recommended repeated attempts subsequent to an unsuccessful reduction, if the patient is medically stable.[1,2,8,11,19,20,23] We also share this opinion and we made a second attempt in three children after an initial attempt of procedure and we achieved successful reduction.

One of our patients with successful ultrasound guided saline reduction had a previous operative manual reduction. Therefore, we suggest that US guided reduction is also a safe method for recurrent cases. We think, even if the child had a history of previous surgery for intussusception, our method of hydrostatic reduction can be safely undertaken too.

Particular care should be exercised with patients older than 3 year of age because of the possibility of the presence of a lead point.[24] However this is not expressed as a contraindication.[11,25] We found 18 lead points in previous 212 operatively managed cases. Four of them were more than 3 years of age. Of the 194 patients, who were treated operatively and had no lead points, nine cases were more than 3 years of age (4.6%). Only 7.03% of children (14/199) younger than 3 years of age had a lead point as the etiologic factor of the intussusception. This figure suggests that it is rather unexpected, a small child with ileocolic intussusception to have a lead point. Nevertheless 4/13 children (30.77%) more than 3 years of age had a lead point as a cause of intussusception, which indicates that the older children with intussusception have significantly higher risk of having a lead point. As in three of our cases, patients with lead points are less likely to have a successful reduction by hydrostatic means,[12,24] especially in older children and in recurrent cases, however, the possibility of having a lead point should be kept in mind.[11] In multiple recurrences, the possibility of having a lead point is rather high.[26] Intestinal lymphoma as lead point must not be overlooked because of the unfavorable course of the disease. However, an intestinal lymphoma as lead point is fairly uncommon; successful reduction of such an intussusception by hydrostatic means is less likely than other causes of intussusception and the great majority of patients with intestinal lymphoma are more than 3 years of age. In case of radiologically successful reduction of an intussusception with lymphoma, a clinically obvious intestinal obstruction does persist and this is another evidence of the importance of clinical evaluation of the hydrostatically reduced cases.[27,28] We suggest therefore, hydrostatic reduction can be performed in patients older than 3 years, but success rate may be low. Care should be taken in these patients for the presence of a possible lead point. After the radiologic reduction, care also should be taken for the change in the clinical symptoms because intestinal obstructive symptoms still exist in patients with lead point. Moreover, detection of a pathologic lead point during a sonographic guided hydrostatic reduction was reported by Grant and Piotto recently.[25]

Furthermore, the two patients, in whom the re-intussusception after successful reduction was present, indicate that the family and surgeon should be careful about the risk for re-intussusception few days subsequent to a successful reduction.

In conclusion; ultrasound guided hydrostatic reduction is a reliable and radiation-free technique in childhood intussusception. The team should consist of radiologist and pediatric surgeon and the patient should be prepared as for a surgical intervention. In our opinion, one of the important factors affecting the success rate of the saline reduction is the famil-

iarity of the radiologist and surgeon with the procedure and in time, the rate of success can be expected to increase. Hydrostatic reduction should be the first line of the treatment in patients with intussusception aged between 1 month and 3 years old. In patients who are older than 3 years of age, this method can also be performed, the success rate should be expected to be low and great care should be taken for the presence of a possible lead point such as lymphoma in that group of older children. This procedure is also reliable for patients with prior intussusception surgery. In cases with failed initial reduction, a second attempt may provide successful reduction.

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