

HYDROSTATIC REDUCTION OF INTUSSUSCEPTION IN CHILDREN: PROGNOSTIC MATHEMATICAL SCALE BASED ON INDEPENDENT RISK FACTORS FOR FAILURE OF CONSERVATIVE REDUCTION: A SINGLE CENTER STUDY FROM SYRIA.

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ABSTRACT

Objective: The aim of this study is to design prognostic scale for predicting the probability of failed conservative reduction of intussusception in children. **Patient and Methods:** Four independent risk factors of failure reduction have been retrospectively defined, we have made of them a scale of 7 grades as following: Bloody defecation:1, free peritoneal fluid:1, length>5 cm:1, and duration of symptoms:0-4grades. and divided it into two areas: low risk <4, and high risk when the grade ≥ 4 . Then we applied it on the prior sample off 99 patients, and by a prospectively study on a sample of 15 patients, to evaluate its accuracy. **Results:** According to the ROC curve, patient with chance of failure more than 60% will be a real failure in 94% of cases. On the other hand, patient with chance less than 19% will be a real success in 89% of cases, We have retrospectively applied our scoring system on patients excluded from our earlier sample and treated with primary surgery to evaluate its accuracy and found that 5/7: 71.4% of them are considered as high risk of failure. When we prospectively applied this scoring on the 15 patients intussusception prepared to hydrostatic reduction, we found that it had a high degree of sensitivity and specificity, that 80% Of high risk group was a real failure. **Conclusions:** These scores can be used as a guide to promote the referral of the cases to tertiary centers with facilities for conservative reduction if possible.

KEYWORDS: Intussusception, Risk factors, Prognostic, Scale, Hydrostatic Reduction.

Prognostic Study (Case- control study) Level of Evidence III

INTRODUCTION

Once the diagnoses of intussusception is confirmed, conservative reduction is the first treatment of choice unless any contraindication is found.^[1]

There were multiple studies trying to reveal factors influencing the rate of successful conservative reduction of intussusception in literature.

Some of these factors achieved a wide acceptance among the previous studies as an independent risk factor of failed reduction, (such as the period from onset^[2,3], radiological signs of intestinal obstruction^[3-5] and the location of the intussusception beyond the splenic angle^[4])

On the other hand, still the effect, sensitivity and the independence of some other factors such as the presence of free peritoneal fluid , length of intussusception or even the age of patients controversial.

But there have been few studies in which attempt has been made to design predictive scales which varied in sensitivity and specificity.^[3,4,6,7], some of these scales depended on factors recognized as independent risk factors of failed conservative reduction of intussusception in the literature, however most scales were based on multivariate logistic regression analyses performed during the study, and here we will try to design our predictive scale based on multivariate analyses to 14 presumed risk factors.

METHODS AND PATIENTS

We previously have studied prognostic factors of failed hydrostatic reduction of the intussusception in children

less than the age of 3 years. The demographic, clinical, radiological, and laboratory data of patients were reviewed.

Data were extracted from patient charts, and were assessed by single senior pediatric surgeon and a single senior radiologist. We used multivariate analysis on a primary sample of 99 children who were admitted to our institute with the diagnoses of intussusception confirmed with ultrasound screening between January 2015 and January 2020, with a success rate of 60.6%.

Exclusion criteria included children aged more than 3 years, who had acute peritonitis, hemodynamic instability, Intestinal perforation, incomplete data and intussusception secondary to a confirmed pathologic lead point (PLP).

The statistically significant variables were entered into the logistic regression equation to assess the independence of the variables. We found that : the duration of symptoms, length of intussusception, presence of free peritoneal fluids and the presence of bloody defecation are four independent risk factors associated with the failure of hydrostatic reduction of ileocolic intussusception in children as shown in table.^[1]

Table 1: Determination of the independent factors for unsuccessful hydrostatic reduction using multivariate Analysis.

Variables	EXP	P value
Age	1.2	0.1
Weight	0.8	0.7
Duration	2.9	0.001
Vomiting	1.8	0.5
Distention	0.6	0.6
Bloody Defecation	3.2	0.02
Left Position	1.6	0.7
Length	2.2	0.004
Free peritoneal fluid	2.1	0.02
Gas liquid levels	0.9	0.9

We concluded in our last study that we can use these criteria in a later study to design a predictive mathematical model to predict the failure of a hydrostatic reduction of intussusception.

We designed a scale of 7 grades (shown in table 2) depending on these criteria and applied it on the 99 patients to investigate its sensitivity and specificity, then we expanded our sample(a complementary prospective study) by applying this scale on patients admitted to our institute and treated with hydrostatic reduction from February 2020 until 1st October 2020 (n=15), and investigated also the sensitivity and specificity of it.

Table 2: Our Predictive Scale of Possibility of Failure of Conservative Reduction.

Variable		Grade
Duration of Symptoms(H)	≤12	0
	13-24	1
	25-36	2
	37-48	3
	>48	4
Bloody Defecation	Yes	1
	No	0
Free Peritoneal Fluid	Yes	1
	No	0
Length of Intussusception	≤5cm	0
	>5cm	1

RESULTS

The differences between the success and failure groups were analyzed using Mann-Whitney test, as shown in table.^[3]

Table 3: The differences between the success and failure groups.

Group	Grades	P value
Success	1.3 ± 1.07	0.0001
Failure	4.2 ± 1.06	

We performed a receiver operating characteristic curve (ROC curve) to evaluate the accuracy of the prediction Figure.^[1]

Sensitivity measures the proportion of failed reductions that are correctly identified as such. Specificity measures the proportion of successful reductions that are correctly identified as such.

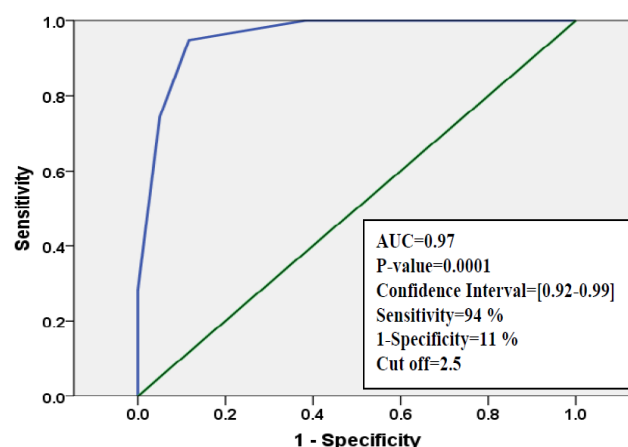


Figure (1): (ROC Curve) for evaluating the accuracy of the prediction.

According to this curve, patient with chance of failure more than 60% will be a real failure in 94% of cases.

On the other hand, patient with chance less than 19% will be a real success in 89% of cases, We have retrospectively applied our scoring system on patients

excluded from our earlier sample and treated with primary surgery to evaluate its accuracy and found that

5/7: 71.4% of them are considered as high risk of failure as shown in table.^{[4],[5]}

Table 4: Patients that underwent primary surgery without attempting hydrostatic reduction. Characteristics and calculated chance of failure.

Patient	Age(month)	DOS*	BD**	FF***	Length(cm)	Contraindication	Grade
1	9	60	Yes	Yes	4.5	Intestinal perforation	6
2	48	24	No	Yes	8	Age>3year	3
3	96	18	No	No	7.5	Age>3year	2
4	12	38	Yes	No	18	Peritonitis	5
5	18	48	No	Yes	5.5	Intestinal perforation	5
6	36	32	Yes	Yes	15.5	Lymphoma	5
7	6	18	Yes	Yes	12	Unstable hemodynamic state	4

*: Duration of symptoms(hours), **: Bloody defecation, ***: Free peritoneal fluid

Table 5: Distribution of risk of failed conservative reduction of intussusceptions in the primary sample of 99 patients.

Risk level	Failed, n (%)	Successful, n (%)	P-value
Low (score <4)	8(12)	58 (88)	<0.001
High (score ≥4)	31 (94)	2(6)	<0.001

We have collected the data of patients of hydrostatic reduction between January- 1st October 2020 prospectively as shown in table.^[6]

Table 6: data of patients who underwent hydrostatic reduction between January- 1st October 2020.

Patient	Age (month)	DOS	BD	FF	Length(cm)	Grade	Result
1	5	12	Yes	Yes	4.5	2	Success
2	24	24	No	No	3	1	Success
3	9	30	Yes	Yes	12.5	5	Failure
4	18	27	No	Yes	6	4	Success
5	30	38	Yes	Yes	15	6	Failure
6	8	8	No	Yes	2.5	1	Success
7	12	18	No	No	9.5	2	Failure
8	6	6	No	No	4	0	Success
9	24	33	Yes	No	18	3	Failure
10	36	4	No	Yes	5.5	2	Success
11	7	40	Yes	Yes	10	6	Failure
12	5	18	No	No	2.5	1	Success
13	8	14	No	Yes	6	3	Success
14	11	32	Yes	Yes	22.2	5	Failure
15	7	18	Yes	No	3.5	2	Success

When we prospectively applied this scoring on the 15 patients intussusception prepared to hydrostatic

reduction, we found that it had a high degree of sensitivity and specificity as shown in table.^[7]

Table 7: Distribution of risk of failed conservative reduction of intussusceptions in the secondary sample of 15 patients.

Risk level	Failed, n (%)	Successful, n (%)	P-value
Low (score <4)	2(20)	8(80)	<0.001
High (score ≥4)	4(80)	1(20)	<0.001

DISCUSSION

Intussusception is the most common cause of intestinal obstruction in infants and children under 2 year old around the world.^[8,9] The method of diagnosis and management of intussusception have developed over time.^[10-12] The management also developed from primary surgery to conservative reduction unless any contraindication is found.^[13-16]

The decision for the method of treatment was dependent on patient characteristics, experience of patient care team (surgeons, radiologists, and pediatricians), facilities, and equipment.

In our study, nonsurgical reduction was attempted if there were no contraindications with a success rate of 9/15=60%, 60/99=60.6% respectively. We studied the prognostic indicators for failed reduction and found four independent parameters in our earlier study.

There were a few earlier reports about predictors in the literature.

In 2014, He et al^[17] found that the presence of bloody stool, free peritoneal fluid, trapped fluid in the intussusception, and location in the left side of the abdomen were associated with a lower success rate.

Our study found that the predictors included the clinical signs and symptoms (bloody defecation, duration of symptoms) along with the ultrasound findings (free peritoneal fluid and length of intussusception).

From the earlier reviews, there were some scoring systems.

In 1986, Guo et al^[6] reported a large series of intussusception treated with air pressure enema. In that study, he proposed a clinical criteria scoring system as a guide in the determination of initial treatment. The parameters in that scoring system were the clinical signs and symptoms. In 2011, Weihmiller et al^[7] set up the clinical criteria for the diagnosis of intussusception with a decision tree. His criteria, however, did not indicate a clinical prediction for failed reduction.

In 2016, Khorana et al^[3] made a prognostic scale of 0-16 grades divided into 2 slices: low and high risk, depending on logistic regression multivariate analysis of demographic, clinical, radiological and technical characteristics.

In 2017, Soria et al^[4] designed complicated mathematical prognostic scoring system depending on risk factors recognized in literature, he found contrary to what we and most studies found, that the time of onset did not influence the result of conservative reduction.

In our study, we set up clinical and radiological prediction rules for predicting the failure of conservative

reduction of intussusception. We used the parameters depending on our earlier study including duration of symptoms, the presence of free peritoneal fluid, the length of intussusception over 5cm and rectal bleeding to calculate the scores.

Because the period from onset was the most confirmed risk factor playing the most important role influencing the reduction rate (2.3.5.18) as we statistically found, we have divided it into 5 ranges and give a score in ascending order for every range.

The prediction of the nonsurgical reduction results might help the physician to communicate with the parents about the importance of attempting a nonsurgical reduction and prognosis of the patient. In some areas with no facilities for reduction, surgery was the treatment. The prediction scores may be used to facilitate the referral of cases to the center in which nonsurgical reduction could be performed. However, this study was a retrospective study that was one of our limitations. The validation of this prediction score should be performed before its actual use.

We think this model proved to be a reliable tool for prediction based on the ROC curve results. The retrospective study based on it identifying of risk factors and the small sized samples of our two studies are the most important limitations of our research.

CONCLUSIONS

A mathematical predictive scale based on hours from onset, presence of free peritoneal fluid, presence of bloody defecation and intussusception length, allows for predicting the chance of conservative reduction success for each patient. The usefulness of these prediction scores was to inform the parents before the reduction. These scores can be used as a guide to promote the referral of the cases to tertiary centers with facilities for conservative reduction if possible. Depending on our results, we found that: under 61% calculated chance of conservative reduction success, further diagnostic workup or referral to a more conveniently equipped medical center should be considered.

Declarations

Conflict of Interest

The authors declare that they have not any Conflict of Interest.

Informed Consent

Informed consent have been obtained from all individual parents.

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