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PREDICTIVE ACCURACY OF ABSENT COLOR FLOW ON DOPPLER ULTRASOUND IN THE OPERATIVE FINDING OF INTUSSUSCEPTION AT TIKUR ANBESSA HOSPITAL , ETHIOPIA

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DECLARATION

This is to certify that the thesis entitled “PREDICTIVE ACCURACY OF ABSENT COLOR FLOW ON DOPPLER ULTRASOUND IN THE OPERATIVE FINDING OF INTUSSUSCEPTION AT TIKUR ANBESSA HOSPITAL , ETHIOPIA”; submitted as partial fulfilment of specialty in Pediatrics Surgery, Addis Ababa University, is a record of my original work and has not been submitted to any other institution for any purpose. The references used for this thesis proposal are properly cited and the assistance I received has been duly acknowledged.

_____ _____

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APPROVAL OF THESIS FOR DEFENSE

I hereby certify that I have supervised, read and evaluated this thesis titled “PREDICTIVE ACCURACY OF ABSENT COLOR FLOW ON DOPPLER ULTRASOUND IN THE OPERATIVE FINDING OF INTUSSUSCEPTION AT TIKUR ANBESSA HOSPITAL, ETHIOPIA” by Dr. Freselam Brhanu under my guidance I recommended the thesis for oral defence.

Advisor’s name	Signature	Date
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SUMMARY

Background: Intussusception is a common paediatric surgical emergency condition which has contributed a significant burden on morbidity, mortality, and emergency surgical health care. Despite ultrasound serving a great deal as an accurate tool in diagnosing intussusception, evidences on the diagnostic accuracy of absent colour flow with the intraoperative finding are limited. The aim of the study was to assess the diagnostic accuracy of absent flow on colour Doppler Ultrasound study with intraoperative findings of Intussusception

Methods: Hospital based retrospective crossectional study was used. The medical record number of patients operated in the past 5 years, from September 2017-December 2022, with the preoperative diagnosis of intussusception, was traced and their charts were retrieved. The data was collected with standardised questionnaire. The data was cleaned, entered and analyzed using SPSS version 25. Diagnostic accuracy of absent color flow to predict gangrenous and viable bowel was measured using Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Uni-variate analysis was performed to test factors associated with gangrenous intussusception. A binary logistic regression mode was used to identify independent risk factors. Results of logistic regression reported as adjusted odds rations (OR) with 90% confidence intervals.

Results: During this crossectional study, data from 121 patients were collected. The median age was 9 months (±IQR 9) with male predominance (70.2%). The most common complaints were vomiting (93.4%), non-bloody Diarrhea (78.5%), abdominal pain (89.3%), fever (29.7%), abdominal distension (14%) and, bloody diarrhea (8.3%). while the commonest physical findings were currant jelly stool detected at the time of DRE (62.8%), palpable abdominal mass (45.5%), abdominal distension (41.3%). Classic triads were present in 35.5% of the patients. The postoperative complication rate was 20.7% and mortality rate was 2.5%.

Conclusion: In our setting Color Doppler US had Sensitivity of 46.8%, Specificity of 84.3%, PPV of 66.67% and NPV of 70.2% in predicting whether or not an intussuscepted bowel is gangrenous.

Keywords: Paediatric gangrenous Intussusception, Outcome, Doppler US

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Contents

ABBREVIATIONS AND ACRONYMS

CDUS: Color Doppler ultrasonography

DHN: Dehydration

Dx: Diagnosis

HAI: Hospital acquired infection

IQR: Interquartile range

NEC: Necrotizing Enterocolitis

NPV: Negative Predictive Value

PLP: Pathologic lead point

PPV: Positive Predictive Value

Pre-op: preoperative

TASH: Tikur Anbessa Specialized Hospital

US: Ultrasound

USGHR: Ultrasound guided hydrostatic reduction

CHAPTER ONE

1 INTRODUCTION

1.1 Background

Intussusception is one of the leading causes of pediatric surgical emergencies which have played a significant role in mortality, morbidity and surgical care load. The pathogenesis of intussusception is in approximately 90 % of cases idiopathic and is assumed to be secondary to uncoordinated peristalsis of the gut or to lymphoid hyperplasia, which may be due to a recent GI infection(1–6). However, approximately 5–6 % of intussusceptions in children have pathologic lead points (PLP) which are due to either focal masses or diffuse bowel wall abnormality such as Meckel's diverticulum, duplication cyst, polyp, and lymphoma. The diagnosis of intussusception mainly depends on clinical presentations and ultrasound findings. Even though intussusception is one of the most common causes of an 'acute abdomen' in infants and young children, it often poses a diagnostic challenge for the clinician at the time of first presentation because the symptoms are frequently non-specific and can be quite variable. The main problem for the clinician is that the classical triad of symptoms of intussusception (abdominal colic, abdominal mass and red currant stools) only occurs in about 1:5 children with the condition. The main clinical sign and symptoms which suggestive of intussusception are abdominal pain, vomiting, pallor and lethargy and as time goes beyond 3-4 days (7) with the key abdominal finding in intussusception is the palpation of a 'sausage-shaped' mass in the abdomen, but once the symptoms have progressed beyond about 24 h (7).

Ultrasound is the most important investigation modality for intussusception. Evidences such as leading point and type of intussusceptions can be obtained from ultrasound. Doppler color flow also one of the important parameter to suspect the viability of the bowel. Evidences from different diagnostic accuracy test has suggested that absent of Doppler of color flow has indicated the gangrenous the bowel. However, there have no available evidences in our country on the accuracy rate of absent Doppler color flow with intraoperative findings of intussusception.

Intussusception is a leading pediatrics surgical condition which had varied geographical distributions. Evidences obtained from 82 epidemiological observational studies from Asia, North America, European, Africa, Eastern Meditranean , central and South America revealed

that the mean incidence rate of intussusception was 74 per 100,000 cases among children(10). It also has varied with age. Intussusception occurs mainly 3-9months with peaking of 6-9months. A large review which consisted 44,454 intussusception cases reported that the peak incidence was 5-7months(10).

The diagnosis of intussusception depends on the clinical presentation and diagnostic imaging. US is the primary imaging modality for initial diagnosis of intussusceptions and also plays a role in the evaluation of reducibility, presence of a lead point mass, potential incomplete reduction after enema and for depicting other pathology unrelated to intussusception (7,22). In addition to conventional real time ultrasonography, Color Doppler has been recently employed in the study of children with suspected intussusception. The use of this technique was aimed at obtaining information about the viability of intussuscepted loops and, therefore, about the possibility to indicate the need for direct surgical intervention in children with ischemic bowel(11). The diagnostic accuracy rate of ultrasound is not questionable. Evidence obtained from different observational analytic studies suggests the diagnostic capability of ultrasound is nearly 100% even though strong evidences on the reliability of color Doppler ultrasound are still lacking.

A Korean study involving 176 patients' detected intussusceptions in 65 patients with 100% sensitivity with prevalence of absent color Doppler was 5% and all of absent color flow had underwent surgical resection (12). The decision on patients with absent color flow is one of the controversial issues in clinical practice.

Blood flow to the intussusceptum was assessed in 290 patients in South Africa, with color flow Doppler on a study published on 2021. Color flow was confirmed in 132 (46%) and reported as absent in 78 (30%) patients. Some patients with reported absent flow underwent a successful enema reduction while those with reported preserved flow had a necrotic bowel. So, they stated that they couldn't correlate the absence of color flow with failed enema reduction or bowel viability. Thus they mentioned basing their management option on clinical ground and not on the color Doppler result outcomes (8).

A study conducted in Italy noted that 18% of the included patients had absent color flow and all had necrosis during surgery and resection was made while 82% of the patients with preserved vascular flow had no evidence of bowel necrosis, all except one were successfully managed with

hydrostatic reduction and one had to receive surgery for failed hydrostatic reduction (13). Another large study conducted in China which involving 260 patients reported that group of patients with absent Doppler color flow during evaluation with intussusceptions had lower rate of success in air reduction compared to those with normal color flow study, 91% versus 30% for normal color flow and absent color flow respectively (9).

Fifteen cases of intussusception were studied by the radiology department at Australia. The cases were grouped in to two, 7 cases were put under group I and these were cases that were managed by barium enema. 8 cases were grouped at II and these were patients who underwent surgical management due to failed barium enema reduction.3 of the 8 patients at group II had an absent color Doppler flow and they required resection of a gangrenous intussusception(11).

Eighteen pediatric patients with acute abdominal pain, of whom 16 had US diagnosed intussusception were studied retrospectively in Italy. The blood flow signal appeared on color Doppler Ultrasound showed presence of vascular flow in 75% of patients while 25% had absent flow. 100% of the patients with lack of vascular flow underwent surgical resection of a necrotic bowel(14).

In a 20 years retrospective study from a single center at France, one patient was treated with saline enema although the initial Doppler sonography has showed a lower blood flow. A perforation was diagnosed 24 hours after successful reduction. They stated that saline enema is only a safe procedure if there were no alarming signs both clinically and on the diagnostic imaging(15).

A study conducted in Ethiopia found that 75% of patients who had decreased or absent color Doppler ultrasound had gangrenous bowel intraoperatively and 25% became viable in spite of absent Doppler flow (16)

1.2 Statement of the problem

Many comparative studies have been done on the accuracy rate of ultrasound for the diagnosis of intussusception. Ultrasound is the primary imaging modality for initial diagnosis of intussusceptions and also plays a role in the evaluation of reducibility, presence of a lead point mass, potential incomplete reduction after enema and for depicting other pathology unrelated to intussusception (7,22). Absent Doppler flow in intussusception accounts approximately 25-30%

in all case (8). However, there were no evidences on diagnostic capability of absent Doppler flow with viable and gangrenous bowel after intussusception. Evidences obtained from hospital based observational studies noted that there were no correlation between bowel viability and absent Doppler flow(8). Many studies have failed to generate high level evidences and recommendations on whether to go ahead with surgery or non-operative reduction for absent color flow on the bowel wall(8,9).

Comprehensive systemic review of studies done so far noted that there were no evidences which stated the diagnostic accuracy of absent color flow on the intraoperative finding of a viable or gangrenous intussuscepted bowel. Therefore, this study will provide the sensitivity, specificity, positive and negative predictive capability of absent Doppler ultrasound for assessing bowel vitality.

1.3 Significance of the study

The study is important provided that the findings prove the presence of association between absent color flow Doppler signal and gangrenous intussusceptions. This will potentially decrease the time delay to definitive intervention that would have been spent on nonsurgical interventions. Additionally, this decrease in delay to attaining definitive care can help reduce the mortality from peritonitis that eventually results from gangrenous intussusceptions.

1.4 **Research Question**

- What is the predictive accuracy of color Doppler US in determining bowel viability?

2 Objectives

2.1 General Objectives

- To assess the diagnostic accuracy of absence of flow on color Doppler US with intraoperative finings of intussusception

2.2 Specific Objectives

- To provide the socio-demographic characteristics
- To identify contributing factors for bowel gangrenes
- To predict the diagnostic accuracy of absence of flow on color Doppler with intraoperative finings of gangrenous intussusception

CHAPTER FOUR

3 Method and Materials

3.1 Study area

The study was conducted in TASH, Addis Ababa town, region 14, Ethiopia. TASH is a tertiary teaching referral hospital for the whole of the nation with a population of 100 million of which 43.47 % are under 15 years old. It has 40 pediatric surgery beds and neonatal unit annually it operates around 1000 pediatric surgery cases. The unit is served by 7 pediatric surgeons, 2 pediatric surgery fellows, pediatrics & pediatric surgery residents on training, nurses, interns and other supportive staff.

3.2 Study design and period

Hospital based retrospective cohort study design was employed from Sep 2017-Dec 2022.

3.3 Populations

3.3.1 Source populations

All patients who had pediatrics surgical intervention at TASH hospital from Sep 2017-Dec 2022.

3.3.2 Study populations

All children who were operated with the diagnosis of intussusception regardless of the intra-op finding

3.4 Eligibility criteria

3.4.1 Inclusion criteria

All children who were operated with the diagnosis of intussusception regardless of the intra-op finding

3.4.2 Exclusion criteria

Lost charts and incomplete information

3.5 Sample size determinations

All patients who were operated during the study period with the pre-op diagnosis of intussusception fulfilling the inclusion criteria were included in the study.

3.6 Sampling procedure

All patients who meet the inclusion criteria during study period will be included in the study.

3.7 Study variables

3.7.1 Dependent variables

- Bowel viability
- Color flow

3.7.2 Independent variables

- Age
- Sex
- Duration of presentation
- Type of intussusception
- Presence of leading point

3.8 Data Collection Procedure

Data was collected using a structured questionnaire using the medical record number (MRN) of those had demographic information, preoperative information, intraoperative findings, and postoperative courses. The data was collected by the primary investigator. Each filled questionnaire was checked for completeness and consistency.

3.9 Statistical analysis

The data was presented with tables and charts. SPSS version 25 was used for analysis. Categorical variables described as proportions, and chi-square or Fisher's exact tests used to compare them. Uni-variate analysis performed to test factors associated with 30-day mortality and 30- postoperative morbidity. Variables with p-value 0.05 and less in the bivariate analysis

entered into the multivariable binary logistic model. A multiple logistic regression model will be used to identify independent risk factors. Multicollinearity test performed for categorical, continuous and binary variables. Multicollinearity measured by variance inflation factor (VIF) and tolerance. When a VIF was below five and tolerance was above 0.1, variables were forwarded to multivariable logistic regression analysis. Variables with a VIF score of ≥ 5 to 10 and tolerance below 0.1 were excluded from the final model

A stepwise approach will be used to enter new terms into the logistic regression model where $p<0.05$ was set as the limit for inclusion of new terms. A logistic regression model will be performed to assess independent association between prognostic factors and outcomes. Results of logistic regression will be reported as adjusted odds rations (OR) with 95% confidence intervals. P-value < 0.05 are considered statistically significant.

Diagnostic accuracy test such as sensitivity, specificity, positive predictive value and negative predictive value of absent Doppler flow for gangrenous and viability of bowel was calculated using 2*2 table.

3.10 Ethical approval

Ethics approval obtained from IRB of Department of surgery Collage of Health Science Addis Ababa University. Principal investigators was responsible for clarifying the need for ethics approval and applying for this where appropriate

4 CHAPTER FIVE:

Results

4.1 Socio-demographic Characteristics

Data from 121 patient charts were obtained as part of this retrospective hospital based cohort study. 70.2 % of them were male, while 29.8% were female. The study's participants had a median age of 9 months (IQR: 9). Significant proportion of the patient population was less than 24 months of age accounting about 81.8% of the study population. The majority (72.7%) of individuals in the study were from urban area while 27.3% are from rural sites (Table 1).

4.2 Clinical Presentation

The most common complaints were vomiting (93.4%), non-bloody Diarrhea (78.5%), abdominal pain (89.3%), fever (29.7%), abdominal distension (14%) and, bloody diarrhea (8.3%).

79.3% of them had tachycardia while 32.2% had tachypnea and 28.9% had fever. The commonest physical findings were currant jelly stool detected at the time of DRE (62.8%), palpable abdominal mass (45.5%), abdominal distension(41.3%)and mass palpable per rectum (35.5%). Classic triads of colicky abdominal pain, passage of currant jelly stool and palpable abdominal mass were found in 35.5% of the patients. Three patients had a prolapsed mass per rectum (2.5%) . one of them had presented with peritonitis and a gangrenous bowel intraoperatively and required REEA but the other two had a viable bowel which was reduced manually.

21.5% of the patients presented with peritonitis and 37.3% of them had leukocytosis.

Table 1 : Socio-demographic data and Clinical Presentation

Variables	Response	Frequency	Percentage
Age	Median	9 months	
Age class (N=121)	<24 months	99	81.8%
	24-60 months	13	10.7%
	>60 months	9	7.4%
Sex(N=121)	Male	85	70.2

	Female	36	29.8
Duration of complaints	≤3days	73	60.3
	above 3	48	39.7
Clinical presentation	Vomiting	113	93.4
	Abdominal pain	108	89.3
	Non bloody Diarrhea	95	78.5
	Fever	36	29.7
	Abdominal distension	17	14
	Bloody mixed diarrhea	10	8.3
	Failure to pass faces/Flatus	10	8.3
	Protrude mass per rectum	3	2.5
Physical Examination N=121	Tachycardia	96	79.3
	Tachypnea	39	32.2
	Fever	35	28.9
	Localized tenderness	12	9.9
	Generalized tenderness	25	20.7
	Rebound Tenderness	26	21.5
	Abdominal distension	50	41.3
	Palpable abdominal mass	55	45.5
	Currant jelly stool	76	62.8
	Palpable mass per rectum	43	35.5
Peritonitis (N=121)	Yes	26	21.5
	No	95	78.5
Mentation (N=121)	Alert	87	71.9%

	Drowsy	3	2.5%
	Lethargy	31	25.6%
Leukocytosis (N=118)	Yes	44	37.3
	No	74	62.7
Left shift (N=118)	Yes	37	31.4
	No	81	68.6

4.3 **Imaging**

The most common anatomical type of intussusception detected by US was ileocolic intussusception (81.5 %). However, intraoperatively, only 64.7% of the patients had ileocolic. The second most common type was a colo-colic intussusception of approximately 10% picked by US, and 10.9% was found intraoperatively. One anatomic type that was shown to be the least frequent type with US was Ileo-ileo colic intussusception, which was detected in about 0.1% of the patients preoperatively but had an approximately 11.8% prevalence intraoperative. Among the operated patients, 84 of them (71.8%) were reported to have a preserved color flow. While the 33 (28.2%) were regarded as having an absent color flow on Doppler US. Among the 121 patients operated during the study period at TASH, 58.7 % of them were found to have a viable bowel, while the rest (41.3%) tuned out to have gangrenous bowel. Among patients who had a viable bowel , 80.2% were manually reduced, 11.3 % required enbloc resection and anastomosis due to difficulty in reduction. The remaining 8.5% were spontaneously reduced intraoperatively. Ninety% of those with gangrenous bowel were managed with REEA, while the remaining 10% underwent resection of the gangrenous segment and stoma. 71.8 % of patients were proven to have preserved flow on color Doppler US. Pathologic lead points were detected in 2.6 % of the children by preoperative US, while 14.05% of them were found to have a PLP, identified intraoperatively. Of the preoperatively picked PLPs were duplication cysts, lymphomas, and polyps, each accounting for approximately 33%. Meckel's diverticulum was found in 50% of the patients intraoperatively, followed by polyps, which accounted for approximately 22.2% of the cases, and 11.1% of the cases were duplication cysts and lymphoma each.

Table 2: Imaging

Variables	Response	Frequency		Percentage	
Type of intussusception by US (N=119)		US Finding	Intraoperatively found	US	Intraoperatively found
	Ileocolic intussusception	97	77	81.5%	64.7%
	Colo-colic intussusception	12	13	10%	10.9%
	Ileo-colocolic intussusception	6	11	5%	9.2%
PLP detected by US (N=116)	Yes	3	17	2.6%	14.05%
Color Flow (N=117)	Preserved	84		71.8%	
	Absent	33		28.2%	
Bowel Viability	Viable	71		58.7%	
	Gangrenous	50		41.3%	
Intraoperative Finding and procedure (N=121)	Viable and manually reduced	57		47.1%	
	Viable but underwent enbloc resection	8		6.6%	
	Gangrenous and REEA	45		37.2%	
	Gangrenous and	5		4.1%	

	Resection & Stoma		
	Spontaneously Reduced	6	5.0%

4.4 Trial of hydrostatic reduction

Among the 121 patients included in this study, information regarding whether hydrostatic reduction was tried couldn't be found for 1 patient. Among the 120 patients, hydrostatic reduction was tried for 62.5% of them while the rest were taken directly to the operating room with the pre-operative diagnosis of possible gangrenous intussusception. Among them, 33.3% received hydrostatic reduction once, 44% had trial of twice, 21.3% of them had trial three times and and the last 1.3% had a 4 time trial.

4.5 Surgical outcome

The postoperative complication rate was 20.7% and mortality rate was 2.5%. The most common complications were electrolyte disturbance 6.6%, surgical site infection 4.1% and postoperative adhesive SBO 3.3%. Other complications encountered include Post op intussusception (Ileo-ileoal, and jujeno-jujenal)(2.5%), bowel perforation(2.5%) ,wound dehiscence(1.7%), postop septic shock(1.7%), anastomosis Leak(0.8%) and HAI(1.7%) The median hospital length of stay was 5 days (IQR-3), with the shortest stay being 2 days and the longest stay was 116 days.

Table 3 : surgical outcome

Variables	**Response**	**Frequency**	**Percentage**
Surgical outcome (N=121)	Postoperative complication	25	20.7
	Mortality	3	2.5
Types of	Electrolyte disturbance	8	6.6

complications (N=121)	Surgical site infection	5	4.1
	Postop adhesive SBO	4	3.3
	Post op intussusception (Ileo-ileoal, and jujeno-jujenal	3	2.5
	Bowel perforation	3	2.5
Length of hospital stay (Days)	Median ±IQR	5±3	
	Range	114(2-116)	

4.6 Diagnostic accuracy

This study compared the accuracy rate of absent Doppler color flow to indicate postoperative gangrenous bowel. The sensitivity of absent Doppler color follow to indicate gangrenous bowel was 46.8 % and specificity was 84.3%. The positive and negative predictive values of absent Doppler color flow to indicate gangrenous bowel were 66.67 % and 70.2% respectively. The sensitivity of preserved Doppler color follow to indicate viable bowel was 84.3%% and specificity was 46.8% %. The positive and negative predictive values of preserved Doppler color flow to indicate viable bowel were 70.2 % and 66.7% respectively.

Table 4: Diagnostic accuracy

		Doppler color flow (Gold standard)		
Screening test		Gangrenous	Viable	Total
	Absent	22	11	33
	Preserved	25	59	84
	Total	47	70	117

There was no statistically significant correlation between age, duration of presentation, type of intussusception, presence of leading point and absent color flow on color doppler US.

5 Discussion

Till this research was conducted, there was no single study on the sensitivity, specificity, positive and negative predictive accuracy of color Doppler US on the viability of intussuscepted bowel. The invagination of one segment of the intestine within a more distal segment is known as intussusception. Between the ages of 4 and 10 months, it is the most frequent cause of intestinal blockage in newborns. The intussuceptum invaginates in to the intussuscipiens and pulls its blood supply along with it. Intussusception may become more difficult to treat, which could weaken the bowel's blood supply and lead to intestinal ischemia and even perforation. It can be lethal if left untreated(10).

The mean incidence rate of intussusception was 74 per 100,000 cases among children(10). The median age at symptom onset was 6 months with only 12 (7%) of cases occurring in the first 3 months of life(17).The median age of the patients included in this study was 9 months close to a median age of 6 months on a study done where this study was done same hospital(17). A large review which consisted 44,454 intussusception cases reported that the peak incidence was 5-7months(10).

There is a male predominance as seen in almost all previous studies on intussusception and was about 70.2% in this study.

Only about 20% of cases have the traditional trio of symptoms present at the time of presentation(11) (18).In this study the commonest complaints were vomiting, non-bloody Diarrhea , abdominal pain, fever, abdominal distension and, bloody diarrhea while the most common complaints were vomiting, non-bloody Diarrhea , abdominal pain, fever, abdominal distension and, bloody diarrhea while the commonest physical findings were currant jelly stool detected at the time of DRE , palpable abdominal mass , abdominal distension.

A lead point can occur anywhere from 1.5% and 12% of the time, and its prevalence rises proportionately with aging with increasing incidence above 5 years of age(19).In this study the incidence of ak PLP detected by US was 2.6%. Intraoperatively 14.05% of the cases had a PLP with 47.8% of the cases having meckel’s diverticulum as a PLP while polyps and duplication cysts had incidence of 23.5 and 11.8% respectively. Unlike what has been said in most previous

studies, a significant majority (82.35%) of the cases with a PLP fall under the age class of <60 months in this study.

US is the primary imaging modality for initial diagnosis of intussusceptions and also plays a role in the evaluation of reducibility, presence of a lead point mass, potential incomplete reduction after enema and for depicting other pathology unrelated to intussusception (7,22). Doppler has been recently employed in the study of children with suspected intussusception. The use of this technique was aimed at obtaining information about the viability of intussuscepted loops and, therefore, about the possibility to indicate the need for direct surgical intervention in children with ischemic bowel(11). The diagnostic accuracy rate of ultrasound is not questionable. It has a strong negative predictive value (99.7%), high sensitivity and specificity for the identification of intussusception (97.9% and 97.8%, respectively)(18).

Ileocolic intussusception is the most commonly encountered anatomic type(18). 81.5% of the patients had an ileocolic intussusception in this study as well. It was also the most common type found intraoperatively (64.7%) but lower than the pre-op US report.

Blood flow to the intussusceptum was assessed in 290 patients in South Africa, with color flow Doppler on a study published on 2021. Color flow was confirmed in 132 (46%) and reported as absent in 78 (30%) patients. Some patients with reported absent flow underwent a successful enema reduction while those with reported preserved flow had a necrotic bowel. So, they stated that they couldn't correlate the absence of color flow with failed enema reduction or bowel viability. Thus they mentioned basing their management option on clinical ground and not on the color Doppler result outcomes (8).

In this study 121 patients were operated during the study period but complete US reports could only be found for 117 patients, among these patients, 70 of them were found to have a viable bowel and 47 patients were gangrenous. Among the 70 patients, 59 patients had a preserved flow while 11 0f them were stated to have an absent color flow on color Doppler US done prior to the procedure. Among the 47 patients who had a gangrenous bowel intraoperatively, 25 of them had a Doppler US done which showed a preserved flow while the Doppler US in 22 of them had absent flow.

A study conducted in Italy noted that 18% of the included patients had absent color flow and all had necrosis during surgery and resection was made while 82% of the patients with preserved vascular flow had no evidence of bowel necrosis, all except one were successfully managed with hydrostatic reduction and one had to receive surgery for failed hydrostatic reduction (13). Eighteen pediatric patients with acute abdominal pain, of whom 16 had US diagnosed intussusception were studied retrospectively in Italy. The blood flow signal appeared on color Doppler Ultrasound showed presence of vascular flow in 75% of patients while 25% had absent flow. 100% of the patients with lack of vascular flow underwent surgical resection of a necrotic bowel(14).In this study 72.3% of the patients whose Doppler US report was preserved had a viable bowel while 75% of the patients whose initial Doppler US has shown absent flow were found to have a gangrenous bowel intraoperatively.15.7% of the patients who were told to have an absent flow had a viable bowel while 46.8% of patients with preserved flow had a gangrenous bowel intra-op.

In a prospective study conducted at this hospital between July 2014 and august 2015, there were 4 patients who were excluded from the study since their doppler study has showed decrease to absence of flow, 3 of the 4 patients had a gangrenous bowel intra-operatively and needed resection while 1 of them didn't need resection(16).

Blood flow to the intussusceptum was assessed in 290 patients in South Africa, on 2021. Color flow was confirmed in 132 (46%) and reported as absent in 78 (30%) patients. Some patients with reported absent flow underwent a successful enema reduction while those with reported preserved flow had a necrotic bowel. So, they stated that they couldn't correlate the absence of color flow with failed enema reduction or bowel viability(8).

In a study posted on American journal of roentgenology, Blood flow was detected in all 53 children with the use of DUS but had a gangrenous bowel in 7 patients(20).

There was no statistically significant correlation between age, duration of symptoms and presence of PLP with bowel Viability in this study. We could not find similar studies to compare the final sensitivity, specificity, NPV and PPV of doppler US.

It was a retrospective study which might make it weak for a recommendation. Considering the fact that there were no similar studies on this area, this study will serve as a stepping stone and will inspire other researchers and clinicians to study this further.

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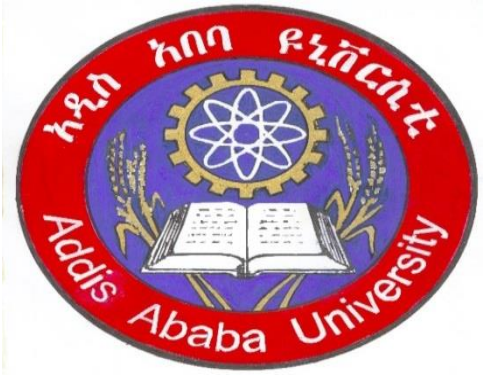

ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE, DEPARTMENTS OF SURGERY,

PEDIATRICSURGERY UNIT

ADDIS ABABA, ETHIOPIA.

A Research PROPOSAL ON

PREDICTIVE ACCURACY OF ABSENT COLOR FLOW ON DOPPLER ULTRASOUND IN THE OPERATIVE FINDING OF INTUSSUSCEPTION AT TIKUR ANBESSA HOSPITAL , ETHIOPIA

I kindly request your willingness to perform these reviews. The information gathered will be used confidentially

General Information

- Code----------
- Date----------
- MRN ----------

BY

PRINCIPAL INVESTIGATOR: Freselam Birhanu (PSR)

Phone no +251989228239, Email: freselambrh123@gmail.com

Appendix I: Questionnaire

Annex 1: Data collection Checklist, on color flow of intussusception cases at TASH

Sex	M ☐ F ☐
Age	☐
Age of Patient_____	☐

Residency	Rural ☐ urban ☐ Region ☐
Pre-op clinical data (Presenting Symptom (more than one symptom is possible)	Vomiting ☐
	Diarrhea ☐ -Blood mixed -Non-Blood mixed ☐
	Abdominal Pain (Intermittent Irritability) ☐
	Fever ☐
	Lethargy ☐
	Abdominal Distension ☐
	Other(Specify) ☐
	other medical illness Specify _____
Duration Of Symptoms	< 72 hours ☐ >72 hours ☐

Physical Findings	
1. Derangement in vital signs	❖ Abdominal Examination Findings
Tachycardia (according to the age) ☐	Gross Distension ☐
Tachypnea(Distress) ☐	Movement with respiration ☐
Fever ☐	Bowel sounds

	✓ Active ☐ ✓ Hypoactive ☐ ✓ Absent ☐
Signs of Peritonitis Yes ☐ No ☐ If Yes, please mention what were the evidences……..	Palpable abdominal mass ✓ Yes ☐ ✓ No ☐
	Abdominal wall erythema,edema or shinny appearance ✓ Yes ☐ ✓ No ☐
Did the child respond to resuscitative measures ✓ Yes ☐ ✓ No ☐	Tenderness…….localized or general ✓ Yes ☐ ✓ No ☐ Mass palpable per rectum ✓ Yes ☐ ✓ No ☐
How soon was the response? Mention the time? ☐	Currant jelly stool appreciated ✓ Yes ☐ ✓ No ☐
	Mentation if the child ✓ Irritable ☐ ✓ Active ☐ ✓ Lethargic ☐ ✓ comatous ☐
	Others ☐ Specify_____

Investigations	CBC 1. WBC 2. Hgb/Hct 3. Plt 4. Neut/Lymp
	Serum Electrolytes 1. Na+ 2. K+ 3. Cl- 4. Ca2+ 5. Mg2+
	RFT ❖ BUN ❖ Cr
Imaging Modalties	Ultrasound Finding • Ileo-colic or ✓ Yes ✓ No ✓ Others (Specify) • Length and diameter of the intussusceptions ➢ Length ➢ diameter • Free peritoneal fluid and presence of echodebris

	➢ Yes ☐ ➢ No ☐ • Entrapped fluid (if specified) ➢ Yes ☐ ➢ No ☐ • Location of the apex of the intussusceptions ☐ • Color flow of the intussusceptions ➢ Questionable ☐ ➢ Decreased ☐ ➢ Absent ☐
	• Probe tenderness ➢ Yes ☐ ➢ No ☐
	• PLP? ➢ Yes ☐ ➢ No ☐ ➢ If yes…please specify----------
Management outcome	• Was hydrostatic reduction tried? ➢ Yes ☐ ➢ No ☐ If yes, How many attempts? ☐ • What was the intra-operative finding? ➢ Viable ☐ ➢ Gangrenous ☐ ➢ Viable but irreducible ☐ ➢ Spontaneously reduced and ischemic segments identified ☐

	➢ Spontaneously reduced and no ischemic segments identified ☐

- PLP identified
  - Yes ☐
  - No ☐
- What was the PLP and how was it managed?

_____

_____

- How was the post-operative course of the child?
  - Smooth and discharged uneventfully
  - Post-op ileus that responded shortly
  - Prolonged post-op ileus
  - Required Re-laparatomy
  - Succumbed
- What was the total length of stay with in the hospital
  - ☐

Is there any postoperative complication?

Yes ☐

No ☐

If yes, please specify……

Did the child succumb

Yes ☐

No ☐

If yes , What was the possible cause of death and on how many post-op days did it happen?

Annex 2: ASSURANCE OF INVESTIGATOR

I the undersigned resident declare that this thesis is my original work, in partial fulfillment of the requirement for certificate of specialty in pediatrics surgery. I also declare that it has never been presented in this or any other higher institution and all the resources and materials used in the research have been duly acknowledged.

Name of the Resident: _____

Signature: _____

Date: _____

Approval of Advisor

Name of the Advisor: _____

Signature: _____

Date: _____