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ORIGINAL ARTICLE

Neonatal midgut volvulus: Spectrum of findings at color Doppler sonography

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KEYWORDS

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Abstract *Objective:* This study was conducted to evaluate the spectrum of findings of neonatal midgut volvulus by color Doppler sonography.
Patients and methods: From March 2010 to December 2013, fourteen neonates was retrospectively analyzed and diagnosed as midgut volvulus. The clinical and radiological data were evaluated with special concern about the color Doppler sonography findings. The radiological data were correlated with surgical diagnosis.
Results: Color Doppler sonography found proximal bowel dilatation in 8 cases, SMA/SMV inversion of relationships in 12 cases, whirlpool sign in 13 cases and SMV dilatation was found in 10 cases. US sensitivity was 92% to diagnose midgut volvulus.
Conclusion: Ultrasonography is an ideal examination for diagnosis of midgut volvulus and should be performed early in neonates with bilious vomiting.

1. Introduction

Midgut volvulus commonly occurs in neonates and may be infants and older children (1,2). It is also recorded in adult life (3,4). It is an important entity to be diagnosed urgently in neonates; especially with bilious vomiting (5). Midgut volvulus may lead to small intestinal ischemia and gangrene in neglected cases. So, early diagnosis is valuable to decrease morbidity and mortality (6). X-ray studies have some limitations and difficulties to neonates; such as; radiation and physical hazards. Furthermore; plain radiography usually rarely leads to direct diagnoses (7). However contrast studies were used before the era of sonography (8). On the other hand; ultrasonography is available, safe, and simple and becomes familial with all pediatric imaging. Also, ultrasonography with Doppler was reported as a unique modality for examination of neonates with bilious vomiting and clinical signs of intestinal obstruction and suspected cases of midgut volvulus (9–11). This study aims to evaluate the spectrum of color Doppler sonography findings in neonates with midgut volvulus and their correlation with surgical data.

Abbreviations: US, ultrasonography; SMA, superior mesenteric artery; SMV, superior mesenteric vein

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Table 1 Summary of clinical and US and surgical diagnosis.

Number	Age in days	Gender	Clinical symptoms	US diagnosis	Surgical diagnosis
1	5	Male	Bilious vomiting	Midgut volvulus	Midgut volvulus
2	2	Female	Bilious vomiting	Midgut volvulus	Midgut volvulus
3	28	Male	Bilious vomiting	Midgut volvulus	Midgut volvulus
4	4	Female	Vomiting	Midgut volvulus	Midgut volvulus
5	18	Female	Bilious vomiting	Midgut volvulus	Midgut volvulus
6	30	Male	Bilious vomiting	Midgut volvulus	Midgut volvulus
7	7	Male	Bilious vomiting	Midgut volvulus	Midgut volvulus
8	17	Female	Bilious vomiting	Midgut volvulus	Midgut volvulus
9	22	Male	Bilious vomiting	Midgut volvulus	Midgut volvulus
10	8	Female	Bilious vomiting	Midgut volvulus	Midgut volvulus
11	5	Male	Vomiting	Midgut volvulus	Midgut volvulus
12	21	Female	Bilious vomiting	Midgut volvulus	Midgut volvulus
13	25	Male	Vomiting	Midgut volvulus	Intussusception
14	27	Male	Bilious vomiting	Not conclusive	Midgut volvulus

Fig. 1 Contrast meal and follow through in a 5 days neonate with history of bilious vomiting. The image depicts malrotation with abnormal position of the duodeno-jejunal junction (to the right of mid line, arrow).

Fig. 2 Contrast study of a 18 days neonate with vomiting, the image shows dilatation of the distal duodenum (arrow) with little contrast passing through the jejunum.

2. Patients and methods

This study was made retrospectively. The clinical, radiological and surgical data were analyzed for neonates sonographically diagnosed as midgut volvulus and surgically proved as midgut volvulus (Table 1). It is included 14 neonates presented with bilious vomiting (8 boys, 6 girls). Their ages ranged between 1 and 30 days with a mean of 14 days were referred to Diagnostic Radiology Department at Sohag University Hospital and private sectors from March 2010 to December 2013 to investigate the surgical causes of vomiting. Oral and written informed consent was taken from the patients parents in accord with the ethical standards of the institutional committee.

For all patients, abdominal plain film was done as the first step, then abdominal ultrasound using linear high-frequency probe (7.5 MHz), Siemens G50 with Doppler examination. We started the US examination when the neonate is calm or during sleep while his/her abdominal wall is relaxed to guard against noise artifact. We use the compression technique from epigastric region down to the umbilicus. Examination is started from the pylorus to follow up the duodenum and evaluate its size. Then examination concentrated upon the SMA and SMV relation and orientation. Whirlpool sign was our main diagnostic tool to be evaluated. Wrapping of mesentery and SMV around the SMA in clockwise fashion with caudal movement of the transducer; is the main criteria of the whirlpool sign (9). We evaluate also the diameter of the SMV distally. Other US findings such as ascites are also reported.

Contrast imaging using water soluble contrast meal and follow through or enema were done to all patient to declare the anatomy. Standard pre-operative and post-operative neonatal care was considered at neonatal intensive care unit.

Fig. 3 Contrast study of 22 days neonate with vomiting. The image shows faintly opacified jejunal loops making spiraling course and partial filling defect (arrows).

All cases were managed surgically in Pediatric Surgery Unit at Sohag University Hospitals and private sectors. Definite diagnosis was established during laparotomy. Finally the radiographic diagnoses were compared with operative diagnoses.

The collected data were analyzed using the program Social Package of Scientific Statistics (SPSS) version 19. Initially, simple frequencies, means and standard deviations were described. To compare means, the Student *t* test and analysis of variance (ANOVA) test were used. In qualitative data, chi square test and Fischer exact test were used to detect significance. In all tests made, a level of significance of 0.05% was accepted.

3. Results

Our series included 14 neonates; 13 of them were proved to be midgut volvulus at surgery. As regards the plain films; they were not specific in all cases. Contrast examinations were done to all patients. The sites of duodeno-jejunal junctions were to the right of the vertebral column in 10 patients (10 out of 13; 78.9%; *P* value was significant <0.05) (Fig. 1), at the midline in 2 patients and to the left side in the other 2 patients. Also contrast study could show dilated proximal bowels in 8 cases (Fig. 2). Spiraling course of the proximal small intestine is seen in 2 cases (Fig. 3).

US could diagnose 12 of them (92%) and one false positive case which was early intussusception at surgery (Fig. 4). US was not conclusive in one case which proved at surgery to be midgut volvulus.

The spectrums of findings seen by sonography are evaluated as shown in Table 2. Dilatation of the duodenum was found in 8 patients (Fig. 5), one of them was not volvulus (7 out of 13; 53.8%, *P* value was not significant >0.05). SMA/SMV inversion of orientation was found in 12 patients (Fig. 6) (one of them was not volvulus 11 out of 13; 84.6%; *P* value was significant <0.05). Whirlpool sign was seen in 13 patients (Figs. 7–9), one of them was not volvulus; 12 out of 13; 92.3% *P* value was significant <0.05). SMV dilatation was noted in 10 patients (Fig. 10) (10 out of 13; 71.4%; *P* value was significant <0.05). We found ascites in 5 cases (38%).

4. Discussion

Neonatal midgut volvulus is not uncommon disease. Midgut volvulus is dangerous disease may lead to vascular compromise and bowel gangrene (12–14). It must be suspected in every neonate with bilious vomiting. X-ray and contrast examination are inconclusive in most of the cases. Our results revealed that plain

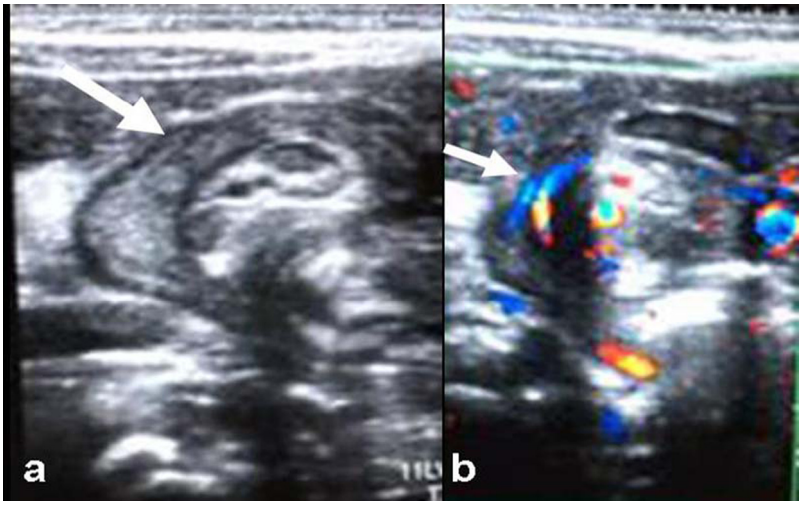

Fig. 4 (a and b) US images of 25 days neonate with vomiting. (a) Showing volvulus like mass (long arrow). (b) Revealed spiraling of mesenteric vasculature (short arrow). Intussusception was proved at surgery.

Table 2 US characteristics and other findings in 14 neonates.

Patient number	Proximal bowel dilatation	SMA/SMV inversion	Whirlpool sign	SMV dilatation	Other findings
1	Absent	Present	Present	Present	Ascites
2	Absent	Present	Present	Present	
3	Present	Present	Present	Absent	
4	Present	Absent	Present	Present	Ascites
5	Present	Present	Present	Present	
6	Absent	Present	Present	Present	Ascites
7	Absent	Present	Present	Present	Ascites
8	Present	Absent	Present	Present	
9	Absent	Present	Present	Absent	Ascites
10	Present	Present	Present	Present	
11	Absent	Present	Present	Present	
12	Present	Present	Present	Present	
13	Present	Present	Present	Absent	
14	Present	Present	Absent	Absent	
Total	8	12	13	10	5

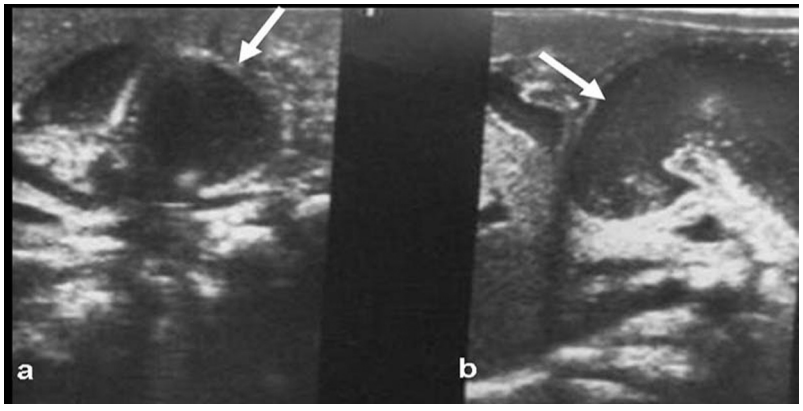

Fig. 5 (a and b) US images of 7 days neonate with bilious vomiting. The images are showing proximal bowel dilatation (arrows).

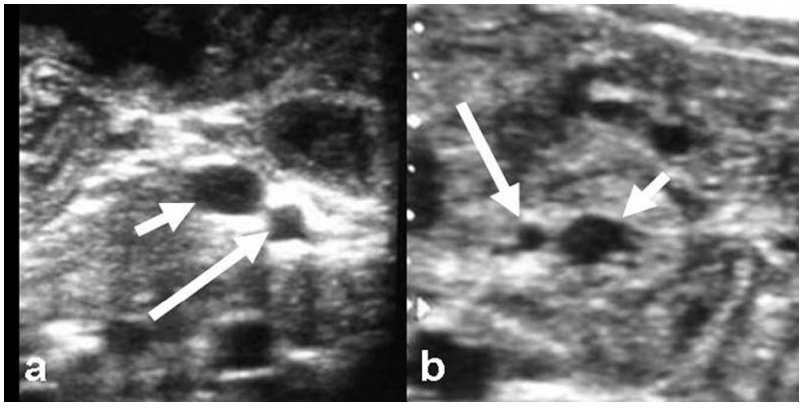

Fig. 6 (a) US image at the upper abdomen in a neonate with normal SMA/SMV orientation, the SMA (long arrow) has small size and hyperechoic collar and lies to the left to the SMV (short arrow). (b) US image of neonate with malrotation with reversed SMA/SMV orientation sign. SMA (long arrow) to the right of SMV (short arrow).

films were not specific. However; contrast examination confirmed the malrotation (8 out of 12) but not the midgut volvulus. Our results are corresponding with other studies (8,15,16).

Ultrasonography with color Doppler showed high performance in diagnosis of midgut volvulus. Our study included 14 neonates with bilious vomiting. Thirteen patients of them have midgut volvulus as proved by surgery. US could diagnose 12 of them (12 out of 13; 92%). One of the 13 patients with midgut volvulus; was inconclusive at ultrasonography. The last case (case number 14) was misdiagnosed at US as midgut

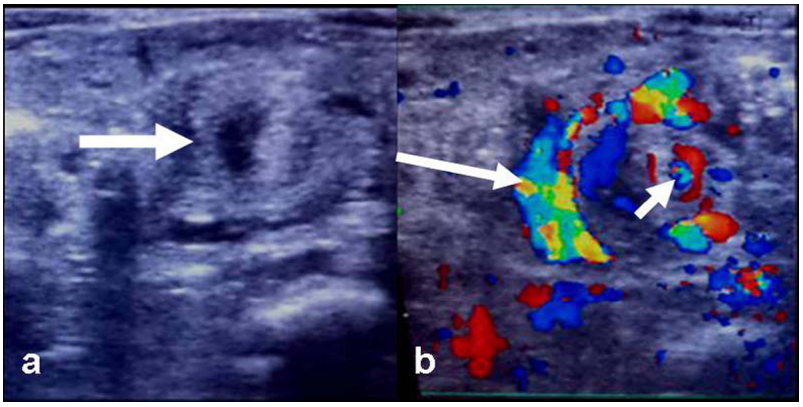

Fig. 7 (a and b) US images of 28 days neonate with vomiting. (a) Showing volvulus mass consisting of spiraling mesentery and mesenteric vessels. (b) Revealed winding of SMV (long arrow) around SMA (short arrow). Volvulus was confirmed at surgery.

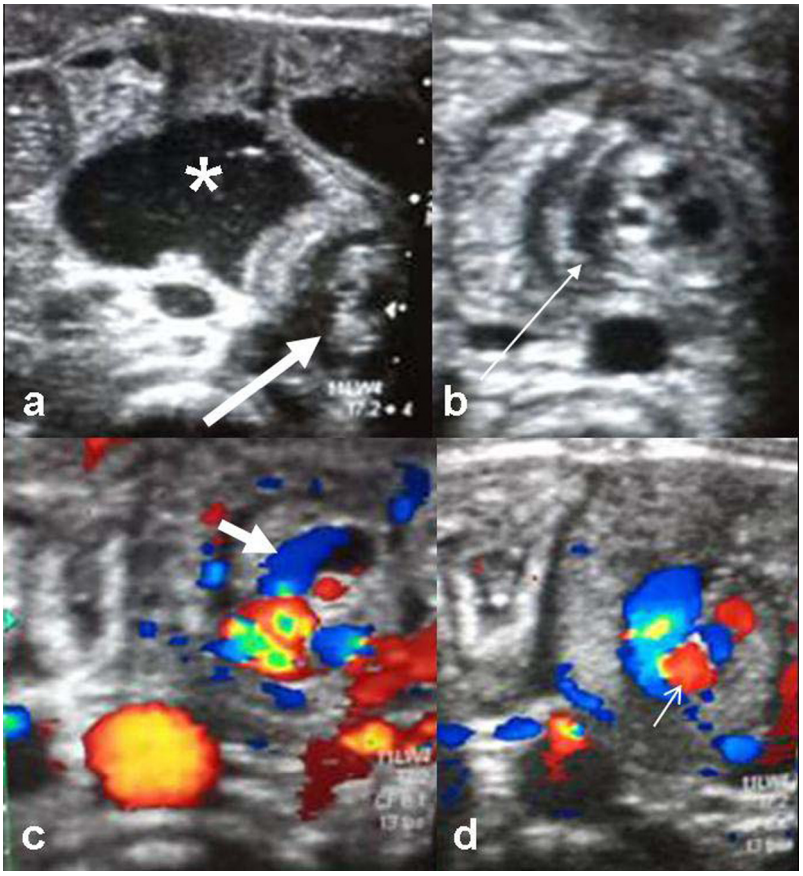

Fig. 8 Serial US images in a 17 days old neonate with bilious vomiting. (a) US image of dilated duodenum (*) with adjacent volvulus mass (long thick arrow). (b) US image of volvulus mass (Long thin arrow). (c) Color Doppler image showing the winding SMV (Short thick arrow). (d) Color Doppler image depicting the central site of SMA (short thin arrow).

volvulus but at surgery proved to be early intussusception. Previous studies confirmed our results (9,17–19). As regards the case which was inconclusive at sonography; the volvulus was masked by gases. The neonate who was misdiagnosed as volvulus and proved to be intussusception at surgery; probably due to early intussusception and presence of collar of vessels at transverse scan.

Many signs were reported in literatures (9,15,19–21). In our study we concentrated upon bowel dilatation, SM vessels orientation, whirlpool sign and proximal SMV dilatation.

Bowel dilatations due to partial obstruction of the distal bowel by volvulus were seen in 8 patients. Our results were comparable with another reported study results (17); were they found duodenal dilatation in 8 cases out of 9 cases proved at

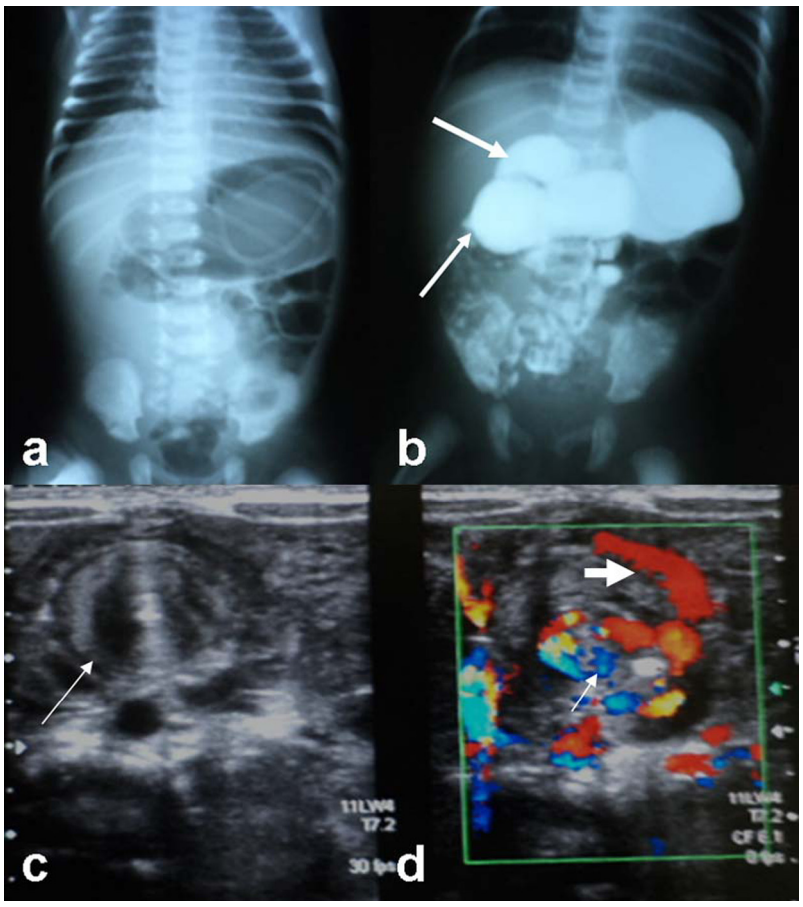

Fig. 9 A 8 days neonate with persistent vomiting (a) plain X-ray film with Ryle's tube showing distended stomach and duodenum by gases. (b) Contrast study revealing of dilated duodenum and proximal jejunum (long thick arrows). (c) US image of volvulus mass (Long thin arrow). (d) Color Doppler image showing the winding SMV (Short thick arrow) with the central site of SMA (short thin arrow).

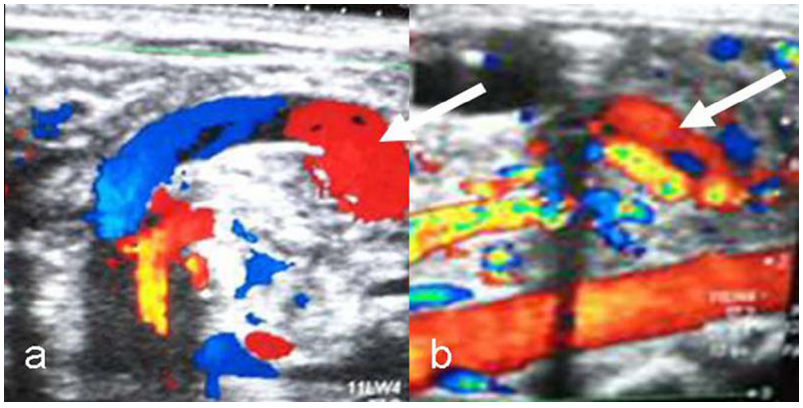

Fig. 10 (a and b) Color Doppler sonography images in 21 days neonate with midgut volvulus showing distal SMV dilatation (arrows).

surgery to be midgut volvulus. This study used instillation of distilled water to fill the proximal bowel; so they found more cases than ours. Also another study (22) found duodenal obstruction in their series with midgut volvulus. A more recent study (23) also used water instillation to delineate the duodenal anatomy to diagnose malrotation and volvulus in infants.

Normally SMV is to the right and slightly superior to the SMA. SMA/SMV inversion or disturbance of orientation is an important entity in midgut volvulus due to malrotation and wrapping of the SMV around the SMA (24,25). We found 12 cases of SMA/SMV inversion or disturbance of orientation. A previous study (17) found this finding in all of the studied cases. Another study (19) reported SMA/SMV inversion in 24 out of 27 cases with midgut volvulus.

Whirlpool sign is winding of mesentery and SMV around the SMA. Actually this sign is the gold standard of midgut volvulus at sonography. Compression technique was used to demonstrate this sign from cranial to caudal direction. By

using whirlpool sign we could diagnose 12 out of 13 cases of neonatal midgut volvulus. Shimanuki et al. (9) found whirlpool sign in most of their series. Patino and Munden (26) specify the utility of whirlpool sign in midgut volvulus in patients with atypical presentations and found this sign on sonography in all cases which were proved at surgery. Chao et al. (17) found whirlpool sign in 8 out of 9 cases proved to have midgut volvulus. Pracos et al. (27) utilize this sign to diagnose midgut volvulus in 15 out of 18 cases. Hennessey et al. (23) diagnose volvulus by whirlpool sign in 4 infants with midgut volvulus.

SMV dilatation or congestion is due to wrapping of SMV around SMA with partial obstruction of the SMV. SMV dilatations were reported in 10 cases out of the 13 cases of midgut volvulus. Chao et al. (17) reported this findings in 5 patients of the 9 patients of midgut volvulus.

Ascites is sympathetic effusion of peritoneum. It is usually minimal to small amount. We found peritoneal fluid in 33% of cases. This sign is not specific but reported in previous studies (17,28).

5. Conclusion

Ultrasonography with color Doppler is a valuable method for early diagnosis of midgut volvulus especially with the use of US criteria commonly seen in midgut volvulus namely; proximal bowel dilatation, SMA/SMV disturbance of orientation to each other; whirlpool sign and SMV dilatation.

Conflict of interest

We have no conflict of interest to declare.

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