



## Anticlockwise swirl of mesenteric vessels: A normal CT appearance, retrospective analysis of 200 pediatric patients



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### ABSTRACT

**Objective:** The counterclockwise rotation of the SMV on SMA is a normal and non-specific finding, which results in an incomplete swirl formation on CT scans. However, it has a potential to be misinterpreted as 'midgut volvulus' resulting in serious clinical implications. The study was done to determine the frequency and degree of counterclockwise rotation of the SMV on SMA on CT in normal otherwise asymptomatic pediatric patients undergoing CT scan.

**Methods:** In this IRB approved study, we retrospectively analyzed abdominal CT scan examinations of 200 consecutive pediatric patients (age range of 11 days to 18 years), which were performed for different clinical indications over a period of 10 months. They were evaluated for the absence or presence and degree of counterclockwise rotation of the mesenteric vessels.

**Results:** Of the 200 patients, 128 (64%) patients showed no clockwise or anticlockwise rotation of mesenteric vessels. Counterclockwise rotation of SMV on SMA was seen in 72 (36%) patients. Further, the degree of rotation of vessels was also calculated, based on the criteria proposed by the authors.

**Conclusions:** The counterclockwise rotation of SMV on SMA gives an appearance of mesenteric whirlpool in otherwise normal mesenteric vessels and can be misinterpreted as midgut volvulus. It is a normal CT appearance and is due to a variation in branching pattern of mesenteric vessels. Awareness of this normal branching pattern of mesenteric vessels is important to avoid an inadvertent laparotomy.

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### 1. Introduction

Midgut malrotation results from errors of rotation and fixation of bowel loops. It occurs in 1 in 500 live births and is one of the common causes of intestinal obstruction in neonates [1]. However, it can be seen even in adolescents and adults [1]. Midgut volvulus may result in fatal complications and sequelae in nearly 50% of cases. The initial symptoms seen in malrotation with acute volvulus usually include intractable abdominal pain and bilious vomiting. Associated complaints of fever, abdominal tenderness and leukocytosis may point toward the gangrenous changes. Bowel gangrene and perforation can occur due to prolonged volvulus and strangulation which is a life-threatening surgical emergency. Perforation

of the bowel can lead to peritonitis [1,2]. Hence, it is important to diagnose malrotation/volvulus at the earliest.

Imaging plays an important role in diagnosis of intestinal malrotation with volvulus. An upper gastrointestinal contrast study using a water-soluble contrast agent is the standard modality for diagnosing malrotation and volvulus, where oral contrast medium does not pass beyond the duodenum. Furthermore, a typical corkscrew appearance may be seen, however, it is seen in less than 50% of all cases. Computed tomography (CT) signs of midgut malrotation include inverted transposition of SMA and SMV, rotation of the superior mesenteric vein (SMV) around the SMA described as whirlpool or concentric circle sign, horizontal part of duodenum not reaching medioventral line or just reaching but encircled right down behind superior mesenteric artery (SMA), jejunal loops in right middle abdomen while ileum on the left side, and an ectopic ileocecal junction [3,4].

Normally, the SMV lies to the right of SMA and its tributaries course anteriorly to the SMA in a clockwise fashion on consecutive CT images seen from cranial to caudal direction. The counterclockwise rotation giving a whirlpool appearance is described in cases of midgut malrotation. However, counterclockwise rotation of SMV around SMA is a normal and non-specific finding, and can be seen in

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normal patients [5,6]. This finding should not be misinterpreted as a partial or incomplete midgut volvulus. The aim of this study was to determine the frequency and degree of counterclockwise rotation of SMV around SMA on abdominal CT scans in pediatric population and to highlight its occurrence in otherwise normal asymptomatic children.

## 2. Materials and methods

This study was approved by our institution's Internal Review Board. The requirement for informed consent was waived. Abdominal CTs of 200 pediatric patients between October 2012 and August 2013, done for the different clinical indications (trauma, tumors, infection and inflammatory pathologies) were retrospectively analyzed. None of the CT scans had been performed for a suspected malrotation or volvulus. All patients had also undergone abdominal ultrasound 1–10 days prior to CT scan, which did not show the presence of volvulus.

All the CT scans were performed on 64 detector Toshiba Aquilion 64 scanner. Of the 200 patients in the study group, there were 117 (58.5%) males and 83 (41.5%) females. The age range of the patients was 11 days to 18 years. The kVp ranged from 80 (in 11 days child) to 120 (in 18 years old patient). The milli-ampere (mA) was between 60 (in 11 days child) and 200 (in 18 years old patient). The pitch used was 0.828. 750–1500 ml of oral contrast was used followed by intravenous contrast @1.5–2 ml/kg body weight, as per our departmental protocol for CT abdomen in pediatric population. Use of oral contrast depends on the indication and age of the patient. The studies were evaluated on the work station (Aquarius intuition edition, version 4.3 from Tera Recon Inc.). The images were evaluated by two pediatric radiologists by consensus. Both the radiologists had more than 10 years of experience in pediatric radiology. Clockwise and counterclockwise rotation was used to describe the route of mesenteric vein during the evaluation of the consecutive images from cranial to caudal direction.

The patients in our study were divided into two groups as follows:

- Group I: Normal mesenteric vessels without any counterclockwise rotation.
- Group II: Counterclockwise rotation of SMV around SMA.

The group II studies were further evaluated for the degree of counterclockwise rotation of SMV around SMA and categorized as follows:

- Group A:  $>90^\circ$  to  $<180^\circ$  counterclockwise rotation of SMV around SMA (Fig. 1a).
- Group B:  $>180^\circ$  to  $<270^\circ$  counterclockwise rotation of SMV around SMA (Fig. 1b).
- Group C:  $>270^\circ$  counterclockwise rotation of SMV around SMA (Fig. 1c).

The group II studies were also evaluated for the presence of any abdominal pathologies which could potentially increase the probability or the degree of counterclockwise rotation of SMV around SMA. These included the intra-peritoneal or retroperitoneal solid/cystic lesions, mesenteric lesions and ascites. Unilateral lesions were further categorized as either right sided or left sided causing mass effect on the mesentery, thereby probably distorting the normal anatomical arrangement of vessels.

A descriptive analysis of the results was done and number of patients belonging to different groups and subgroups expressed in percentages.

**Table 1**

Categorization of the patients ( $n=200$ ) in different groups and subgroups based on rotation of rotation of mesenteric vessels.

Groups	Number of patients (%)
I <sup>a</sup>	128 (64%)
II <sup>b</sup>	72 (36%)
IIA <sup>c</sup>	24 (33.3%)
IIB <sup>d</sup>	24 (33.3%)
IIC <sup>e</sup>	24 (33.3%)

<sup>a</sup> Normal mesenteric vessels without any counterclockwise rotation.

<sup>b</sup> Counterclockwise rotation of SMV around SMA.

<sup>c</sup>  $>90^\circ$  to  $<180^\circ$  counterclockwise rotation of SMV around SMA.

<sup>d</sup>  $>180^\circ$  to  $<270^\circ$  counterclockwise rotation of SMV around SMA.

<sup>e</sup>  $>270^\circ$  counterclockwise rotation of SMV around SMA.

## 3. Results

### 3.1. CT findings

Table 1 summarizes the categorization of the patients in two different groups according to absence or presence of counterclockwise rotation. Further categorization of group II patients (Fig. 2) based on the degree of counterclockwise rotation is also summarized in Table 1.

Of the 72 patients belonging to group II, 16 (22%) patients were found to have associated intraabdominal pathologies which could possibly lead to an increase in the degree of counterclockwise rotation, thereby changing the group division. Table 2 summarizes the associated abdominal pathologies in patients ( $n=16$ ) belonging to group II which could have possibly lead to an increase in the degree of counterclockwise rotation.

## 4. Discussion

Midgut malrotation is a congenital anomaly which occurs due to errors in rotation of gastrointestinal tract around the SMA and fixation of the bowel during development. It occurs in 1 in 500 live births and is recognized as one of the common causes of intestinal obstruction in neonates with a male predominance [1,2]. Approximately 75% of all cases eventually develop volvulus, of which 75% present within the first month of life [1].

A  $270^\circ$  counterclockwise rotation of the midgut at the tenth week of life results in the normal adult position of duodenum behind SMA with the transverse colon seeing crossing anteriorly. The duodenum gets fixed to retroperitoneum at the ligament of Treitz, while cecum becomes fixed in the right lower quadrant [1,7,8]. In cases of mixed rotation, duodenum descends to the right of the spine, and the colon tends to lie below the antropyloric region. Ladd's bands, which are firm and fibrous adhesions fix the cecum and ascending colon to abdominal wall. These fibrous adhesions can lead to kinking or compression of the second part of duodenum. Furthermore, active peristalsis leads to twisting of the unfixed small bowel and ascending colon leading to volvulus [1].

An upper gastrointestinal contrast study series with a water-soluble contrast agent is the standard modality for diagnosing malrotation and volvulus [1,9]. When volvulus occurs, there may be partial or complete duodenal obstruction. A beaked tapering of

**Table 2**

Distribution of associated intraabdominal pathologies in Group II patients.

Pathologies	Groups		
	IIA	IIB	IIC
Left renal mass	–	–	5
Right renal mass	–	3	–
Ascites	1	2	2
Mesenteric cysts	–	3	–

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