Dynamic MRI in the Diagnosis and Post Surgical Evaluation of Wandering Spleen

James K. Clark[1], John Gorman[1], Mike H. Lee[1], Brian C. Barbick[2], Robert M. Marks[1*]

1. Department of Radiology, Naval Medical Center San Diego, San Diego, CA, USA

2. Department of General Surgery, Naval Medical Center San Diego, San Diego, CA, USA

* **Correspondence:** Robert M. Marks, Naval Medical Center, San Diego, Department of Radiology, 34800 Bob Wilson Drive, Suite 204, San Diego, CA, 92134-1204, USA
(*Robert.marks@med.navy.mil*)

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ABSTRACT

Wandering spleen is a rare but potentially clinically significant entity, and may be a cause for a patient presenting with acute abdomen. Because wandering spleen may present with non-specific symptoms and presentation, it can be a difficult diagnosis to make clinically. This paper describes a case report of the use of dynamic Magnetic Resonance Imaging (MRI) in a young woman to confirm the diagnosis of wandering spleen pre-operatively. The patient underwent a splenopexy and a post-operative MRI confirmed the successful surgical fixation of the patient's spleen.

CASE REPORT

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Imaging Findings

The patient is a 27-year-old female who presented to the emergency department (ED) with the chief complaint of left lower quadrant abdominal pain. A contrast-enhanced Computed Tomography (CT) of the abdomen and pelvis was ordered and demonstrated an abnormal configuration and location of the spleen, with the spleen lying more vertical than normal in the left flank and not in the expected location in the left upper quadrant of the abdomen. The spleen showed uniform enhancement without evidence of perfusion defect or infarct (Figure 1). Concern was raised for the diagnosis of a wandering spleen. The patient then underwent general surgery evaluation and outpatient follow-up was arranged.

To confirm the diagnosis of wandering spleen, the patient underwent a dynamic abdominal MRI on a General Electric (GE) Medical Systems Signa HDxt 1.5 Tesla magnet on an outpatient basis 3 months after her initial emergency room presentation. Using balanced steady-state free precession (bSSFP) sequences, the patient was imaged in the axial, coronal and sagittal planes in the supine, prone, left lateral decubitus and right lateral decubitus positions (Figures 2 and 3). Utilizing bSSFP sequences allowed for rapid acquisition times, decreased motion artifact, and provided a high signal to noise ratio to better define anatomic detail. This was important in this particular study due to having the patient in several "non-traditional" positions on the MRI gantry and the need to define anatomy rather than evaluate signal characteristics. The MRI confirmed a wandering spleen. As demonstrated in Figures 2 and 3, pre-operative MRI showed that the spleen changes position much more than expected with the patient changing positions from supine to prone to left lateral decubitus to right lateral decubitus. In a patient who does not have wandering spleen, much less, if any, movement of the spleen would be seen with the patient changing position. Also, the pre-operative MRI confirmed the initial CT findings of an abnormal lie of the spleen in a vertical orientation in the left flank rather than the left upper quadrant. Both findings are consistent with a diagnosis of wandering spleen.

Management

After general surgery evaluation, the patient underwent laparoscopic splenopexy approximately 7 months after her initial presentation and 4 months after her pre-operative MRI. Described in the surgical literature, splenopexy allows for the correction of wandering spleen while preserving splenic

function and avoiding post-splenectomy complications [1]. Both open and laparoscopic approaches have been described; some utilizing resorbable mesh and no mesh techniques [1].

Utilizing a laparoscopic approach, the spleen was visualized to be without its normal ligamentous attachments and to be hypermobile when adjusting patient positioning. Also, the splenic vascular pedicle was abnormally long and tortuous. This replicated the findings seen on pre-operative MRI. A vicryl mesh was then wrapped around the spleen as a purse with a central window for the hilum. The spleen was then repositioned in the left upper quadrant of the abdomen. The mesh was then tacked to the lateral abdominal wall and diaphragm and supported further with an omental sling around its inferior pole.

Follow-Up

Following an uneventful post-operative recovery, the patient underwent another MRI of the abdomen on a Siemens Verio 3 Tesla magnet one month after surgery. Utilizing bSSFP sequences, the patient again was positioned in the prone, supine, left lateral decubitus and right lateral decubitus positions and imaged in the axial, sagittal and coronal positions (Figures 4 and 5). This post-operative MRI demonstrated no significant splenic movement when the patient changed positions as was seen in the pre-operative MRI. The spleen had normal morphology without an adjacent fluid collection. Clinically, the patient had a good response to surgery with relief of her pain.

DISCUSSION

Etiology & Demographics

Wandering spleen is a rare entity and the exact incidence is difficult to quantify. In a large series of 3853 splenectomies performed for various reasons, the incidence was reported as 0.16% [2, 3]. As of 2012, fewer than 500 cases of wandering spleen have been reported in the literature and approximately 21 cases have been reported in the English literature over the last decade [4]. Demographically, wandering spleen is generally seen in women between the ages of 20 to 40 years old and in children. However, it may show a male predilection during childhood [5]. Both congenital and acquired forms have been described [6].

Congenital wandering spleen is thought to be secondary to underdevelopment of the normal ligamentous structures fixing the spleen in the left upper quadrant of the abdomen. The phrenosplenic and splenocolic ligaments fix the spleen to surrounding structures [6]. If these ligaments fail to develop, then an abnormally long splenic mesentery and hypermobile spleen may develop [7]. Abdominal wall laxity, splenomegaly, and the hormonal effects of pregnancy may increase splenic mobility and have been described as risk factors for the acquired form of wandering spleen [6].

Clinical & Imaging Findings

The clinical diagnosis of wandering spleen is difficult secondary to the often vague and non-specific symptoms. The patient may present with chronic abdominal pain, intermittent pain or even a painless left lower quadrant mass [8]. The feared complication is splenic torsion and subsequent infarction which can present with acute, severe abdominal pain. In addition to being located in an abnormal position, CT findings associated with splenic torsion include a circular, "whorled," appearance of splenic hilar vessels and no enhancement of the splenic vessels on post-contrast imaging [6]. Splenic torsion may go on to splenic infarction, which will show a heterogeneous spleen with wedge shaped, segmental areas of hypoenhancement on contrast enhanced CT with partial infarction. If it progresses to complete infarction, total lack of contrast enhancement of the spleen, with or without a cortical rim of enhancement, can be seen [9].

Given the abnormal position and lay of the spleen on initial CTs of the abdomen and pelvis obtained in the emergency department, there was a high clinical suspicion of wandering spleen before the MRI was obtained. However, the initial CT obtained during the emergency department evaluation was only a "snapshot in time," as it was only obtained with the patient in a single, supine position and not with the patient in different positions. Although CT could be repeated with the patient in different positions, MRI was used to avoid ionizing radiation in this female patient of reproductive age who would likely need multiple follow-up studies. Given that MRI was chosen for further evaluation and follow-up, utilizing bSSFP sequences allowed for rapid image acquisition and minimized relative motion sensitivity. In addition, it allowed for a more dynamic picture of the spleen's hypermobility to be obtained.

The MRI confirmed the abnormal position of the spleen and the abnormally long splenic vascular pedicle. Positioning the patient in various positions while imaging with bSSFP sequences definitively demonstrated that the spleen had an abnormal amount of motion with changes in patient position. It confidently demonstrated that the spleen was hypermobile pre-operatively and also demonstrated the good surgical result of the splenopexy.

Treatment & Prognosis

Due to the potential for splenic torsion and resulting splenic infarction, wandering spleen is generally treated surgically. Traditionally, an open or laparoscopic splenectomy has been performed. However, splenectomy is not an entirely benign procedure. In addition to the normal risks associated with surgery and general anesthesia, complications of a splenectomy include increased risk of sepsis from encapsulated organisms like Streptococcus pneumoniae, Haemophilus influenza and Neisseria meningitides. This risk may be mitigated by appropriate pre-operative vaccinations. Other risks include possible thrombocytosis and increased risk of thrombus formation.

Alternatively, both open and laparoscopic splenopexy without mesh and with mesh can be performed to affix the spleen while preserving the patient's splenic function [10]. Laparoscopic splenopexy offers the advantages of minimally invasive surgery but does demand a higher level of skill and training on the part of the surgeon. When the laparoscopic splenopexy is attempted without the use of mesh, native tissue

such as omentum, stomach or colon is used to create a pouch for the spleen and the created pouch is then used to affix the spleen to the lateral abdominal wall. When mesh is used in the splenopexy, absorbable mesh such as polyglactin (Vicryl) is generally used to form adhesions to hold the spleen in place [10]. This technique allows for less manipulation of intra-abdominal structures during splenopexy than without using mesh. A study by Schmidt et al. found that splenopexy with absorbable mesh demonstrated a good long term result with proper spleen fixation in the left upper quadrant [11].

Differential Diagnosis

Differential considerations include heterotaxia syndromes, sickle cell disease, lymphoma, and splenic trauma. Heterotaxia syndromes may be associated with asplenia or a malpositioned spleen, in which the spleen will not be in the left upper quadrant as seen with wandering spleen. Sickle cell disease can present with splenic infarction and splenic sequestration which can mimic a wandering spleen with torsion and infarction as they both can appear with a heterogeneous spleen on contrast enhanced imaging. An enlarged spleen with heterogeneous attenuation and enhancement with multiple low attenuation masses may be seen with lymphoma. This heterogeneous attenuation and enhancement seen in lymphoma may resemble the heterogeneity seen in an ischemic or infarcted wandering spleen. Splenic trauma can present with a devascularized, infarcted spleen, which can appear heterogeneous and mimic infarction from a wandering spleen.

TEACHING POINT

Wandering spleen is a rare entity that may present with non-specific and confounding clinical symptoms and may result in splenic infarction. Using dynamic MRI with bSSFP sequences to demonstrate splenic hypermobility with changes in patient positioning may allow for the more confident pre-operative diagnosis of wandering spleen.

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FIGURES

Figure 1: 27 year old female with wandering spleen. FINDINGS: Coronal contrast enhanced maximum intensity projection (MIP) CT of the abdomen shows the abnormal position of the spleen (*) along the left hemi-abdomen to left lower quadrant oriented vertically instead of the expected

position in the left upper quadrant. A long, tortuous splenic vascular pedicle (white arrow) is also seen.
TECHNIQUE: Maximum Intensity Projection (MIP) Coronal CT, 64 mAs, 100 kV, 3 mm slice thickness, 100 mL Isovue 370.

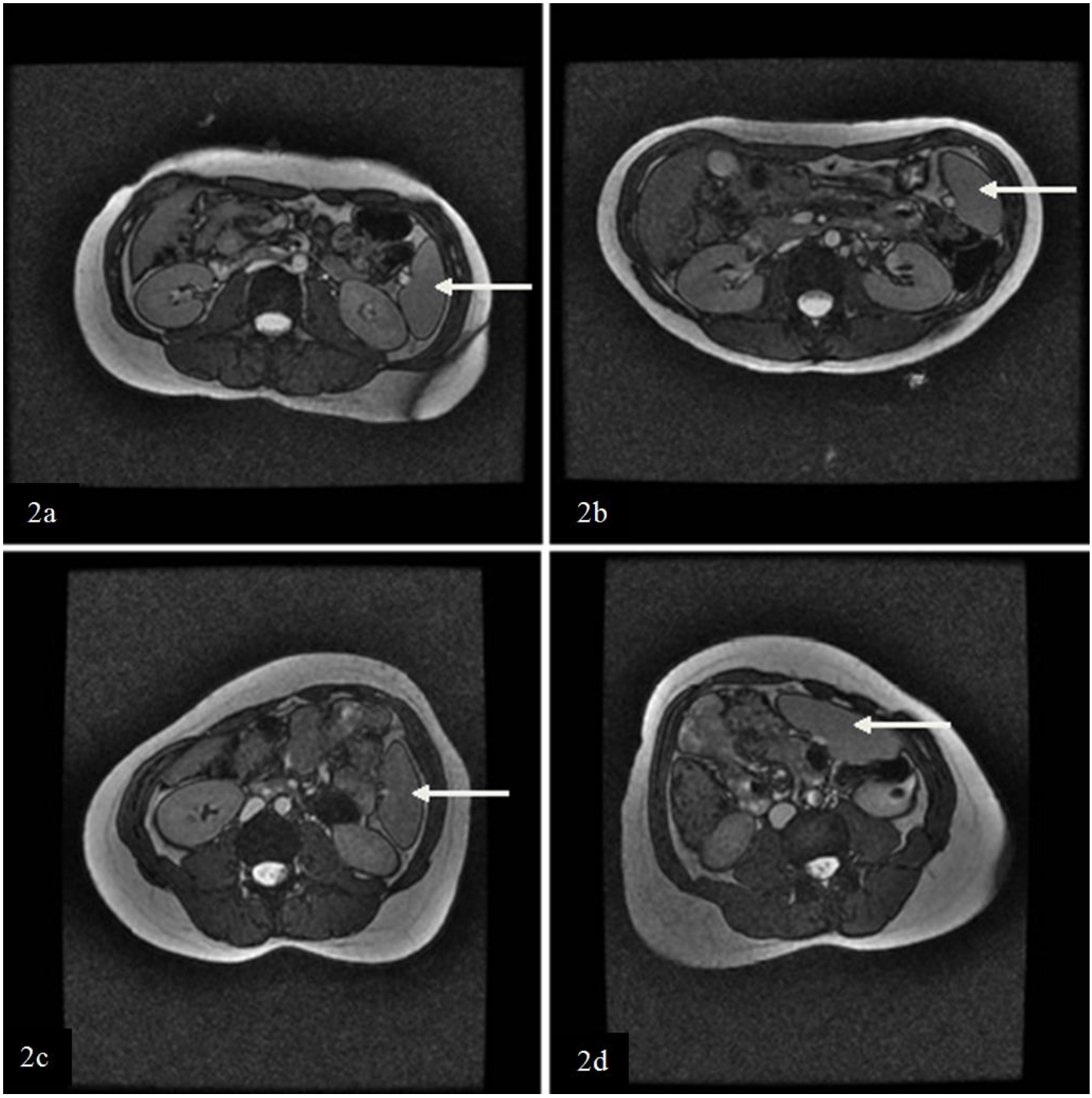

Figure 2: 27 year old female with wandering spleen.
FINDINGS: Axial bSSFP MRI of the abdomen obtained pre-operatively with the patient in supine (a), prone (b), left lateral decubitus (c) and right lateral decubitus (d) positions. The spleen (white arrows) is hypermobile and changes position substantially with changes in patient positioning.
TECHNIQUE: GE Medical Systems Signa HDxt 1.5 Tesla, Fast Imaging Employing Steady State Acquisition (FIESTA), TR 3.73 msec, TE 1.56 msec.

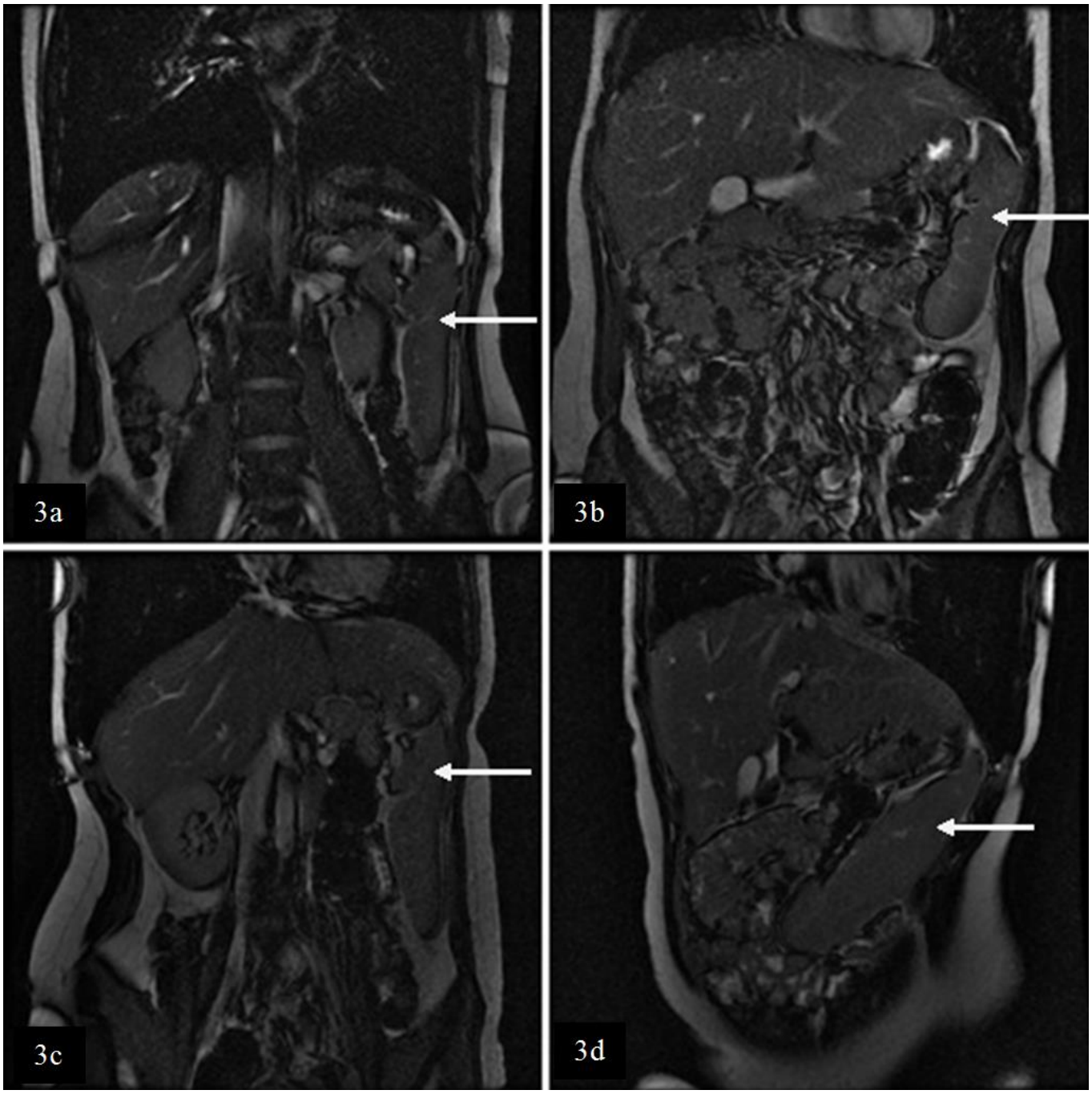

Figure 3: 27 year old female with wandering spleen.
FINDINGS: Pre-operative coronal bSSFP MRI of the abdomen with the patient in supine (a), prone (b), left lateral decubitus (c) and right lateral decubitus (d) positions again demonstrates the abnormally large amount of movement of the spleen (white arrows) with changes in patient positioning.
TECHNIQUE: GE Medical Systems Signa HDxt 1.5 Tesla, FIESTA, TR 3.73 msec, TE 1.56 msec.

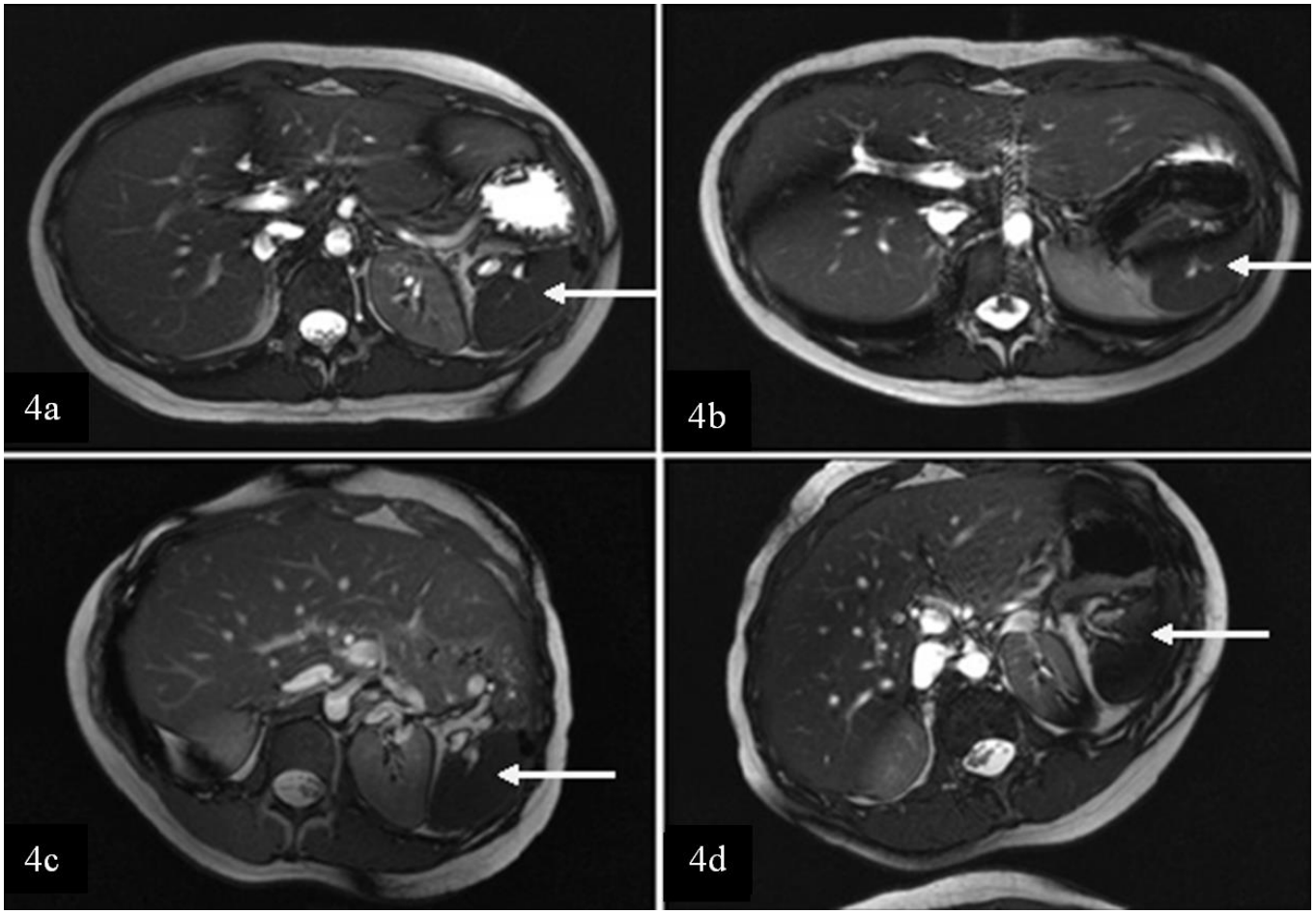

Figure 4: 27 year old female with wandering spleen.
FINDINGS: Post-operative axial bSSFP MRI of the abdomen demonstrates susceptibility artifact around the spleen, representing surgical sutures. The patient is in the supine (a), pone (b), left lateral decubitus (c) and right lateral decubitus (d) positions. The spleen (white arrows) does not change significantly with changes in patient positioning, consistent with successful splenopexy.
TECHNIQUE: Siemens Verio 3 Tesla, True Fast Imaging with Steady-state Precession (TrueFISP) TR 3.89 msec, TE 1.70 msec.

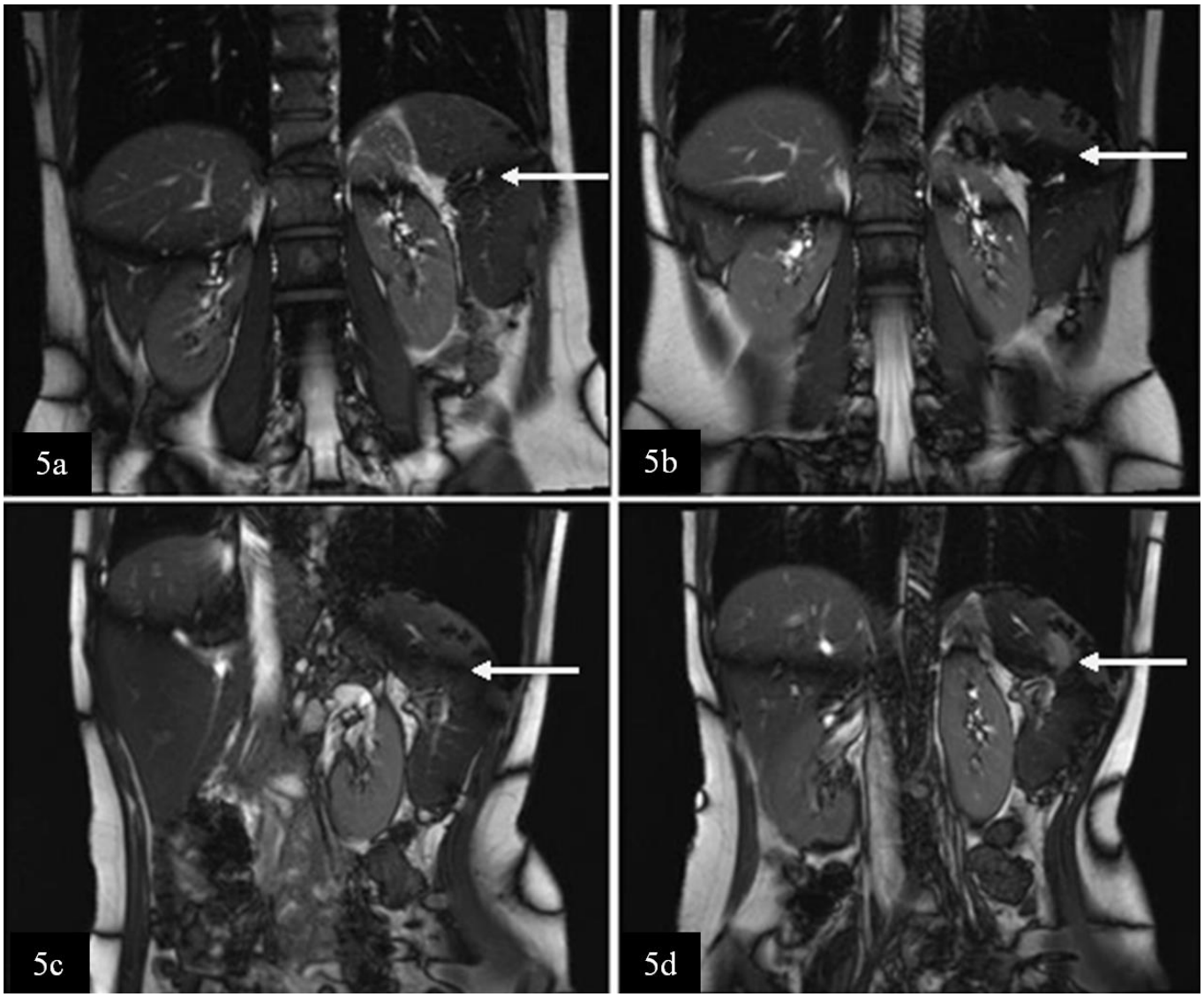

Figure 5: 27 year old female with wandering spleen.
FINDINGS: Post-operative coronal bSSFP MRI of the abdomen demonstrates susceptibility artifact around the spleen, representing surgical sutures. The patient is in the supine (a),prone (b), left lateral decubitus (c) and right lateral decubitus (d) positions. The spleen (white arrows) does not change significantly with changes in patient positioning, consistent with successful splenopexy.
TECHNIQUE: Siemens Verio 3 Tesla, TrueFISP TR 3.89 msec, TE 1.70 msec.

Etiology	Congenital underdevelopment of normal ligamentous structures fixing the spleen in the abdominal left upper quadrant.
Incidence	Hard to quantify, may be 0.16%. Fewer than 500 cases reported in the literature.
Gender Ratio	Affects women more than men during reproductive years. Affects men more than women during childhood.
Age Predilection	Typically seen between 20-40 years of age, may be seen in children.
Risk Factors	Abdominal wall laxity, splenomegaly, hormonal effects of pregnancy may increase splenic mobility.
Treatment	Laparoscopic or open surgery, to include splenectomy or mesh splenoplexy or splenopexy without mesh.
Prognosis	Good, unless complicated by splenic infarct.
Findings on Imaging	CT findings include abnormal position of spleen, splenic torsion with "whorled appearance" of vasculature, and differential enhancement of the spleen post-contrast. Dynamic MRI with changing patient positioning may directly demonstrate hypermobility of the spleen.

Table 1: Summary table for wandering spleen

Differential	CT	MRI
Wandering Spleen	Absence of spleen in normal left upper quadrant. May also show abnormal rotation. On non-contrast imaging, may be low in attenuation. Contrast enhancement may be heterogeneous from congestion or infarcts. May show "whorled vessels" if torsed. Elongated vascular pedicle.	Dynamic MRI with changes in patient positioning can directly demonstrate hypermobility of spleen. Absence of spleen in normal left upper quadrant position.
Heterotaxia Syndrome	Can show associated situs inversus. May show spleen in abnormal position or lack of spleen. Spleen may be in right upper quadrant if stomach on right.	May show abnormal position of spleen or lack of spleen. May also show associated situs inversus or congenital heart anomalies. Spleen should show normal T1 isointensity to liver and T2 hyperintensity to liver.
Sickle Cell Disease	Heterogeneous appearance of the spleen with infarction or sequestration.	Chronic splenic infarct with small appearing spleen that is hypointense on T1 and T2 weighted images. May show low signal on longer TE sequences due to iron deposition from blood transfusions.
Lymphoma	May be homogenously enlarged spleen without discrete mass. May also have a heterogeneous appearance with multiple hypoenhancing masses randomly distributed throughout the spleen.	MRI nonspecific in splenic lymphoma without contrast. Not reliable given similar T1 and T2 relaxation times of splenic tissue and lymphoma.
Splenic Trauma	"Sentinel clot" sign showing highest density blood adjacent to the spleen. Contrast enhanced CT showing heterogeneous spleen with parenchymal lacerations or splenic fracture or subcapsular hematoma.	Splenic hematoma with signal characteristics and evolution like blood products elsewhere in the body. Acute hematomas with T2 hyperintensity. Expected evolution of signal as progresses from oxyhemoglobin to deoxyhemoglobin to methemoglobin.

Table 2: Differential diagnosis table for wandering spleen

ABBREVIATIONS

bSSFP = balanced Steady-State Free Precession
CT = Computed Tomography
ED = Emergency Department
FIESTA = Fast Imaging Employing Steady State Acquisition
GE = General Electric
MIP = Maximum Intensity Projection
MRI = Magnetic Resonance Imaging
TrueFISP = True Fast Imaging with Steady-state Precession

KEYWORDS

wandering spleen; MRI; splenopexy; dynamic MRI