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Fortuitous Discovery of a Case of Situs Inversus Totalis on Acute Intestinal Occlusion at the Fousseyni Daou Hospital in Kayes

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Abstract

Situs inversus is a rare congenital anomaly referring to the mirror image of the abdominal and thoracic viscera. It can be discovered routinely or on the occasion of a complication related or not to situs inversus. We report a case of Situs inversus discovered incidentally during surgery for acute intestinal obstruction caused by an iatrogenic uterine perforation.

Keywords

Situs Inversus, Incidental Finding, Intestinal Obstruction, Iatrogenic Uterine Perforation

1. Introduction

Situs inversus is a rare anatomical anomaly referring to the mirror image of the abdominal and thoracic viscera. Growing evidence suggests that interference with normal genetic pathways and mechanisms for establishing the left-right axis during embryogenesis may be responsible for most cases of this anomaly [1]. Humans establish a left-right anatomical asymmetry before and during gastrulation during the embryonic period. A variation of this normal arrangement (situs solitus) results in heterotaxy, expressed either by randomization (situs

ambigus) or by complete inversion (situs inversus) of the normal organ position. Complete situs inversus is a rare syndrome, with an estimated overall frequency of 1/10,000 births [2]. Situs inversus is also classified into situs inversus with levocardia and situs inversus with dextrocardia. In levocardia, the base-apex axis of the heart points to the left, whereas in dextrocardia, the axis is reversed. Situs inversus is more common in dextrocardia than in levocardia. Situs inversus totalis. Situs inversus with levocardia is rare (1 in 2,000,000 of the general population), also called "incomplete situs inversus" [3]. Isolated dextrocardia is also called situs solitus with dextrocardia. Dextrocardia was first drawn by Leonardo da Vinci in 1452-1519 and recognized by Marco Severino in 1643. However, Mathew Baillie described the complete mirror inversion of thoracic and abdominal organs in situs inversus after more than a century [4].

A 3% to 5% incidence of congenital heart disease is seen in situs inversus with dextrocardia. It is usually associated with transposition of the great vessels and right aortic arch, atrial and ventricular septal defects, tetralogy of Fallot [3]. The literature provides evidence that situs inversus is associated with multiple congenital anomalies, namely Kartagener syndrome, duodenal atresia, biliary atresia, gastroschisis as well as vascular anomalies [5] [6] [7] [8].

Situs inversus is usually diagnosed incidentally during diagnostic imaging of other pathologies. It may be recognized first by radiographic examinations or ultrasound. Electrocardiography reveals a reversal of electrical waves from the heart and is the diagnostic measure of choice for dextrocardia. Computed tomography is the examination of choice for the definitive diagnosis of situs inversus with dextrocardia [5]. This condition is of clinical importance for the physician to be aware of the possibility of situs inversus, as more common conditions will present uncharacteristically in this condition (appendicitis, for example, will present as pain in the left lower quadrant) [9].

2. Observation

This was a 26-year-old female patient with a low socioeconomic level, referred from the gyneco-obstetrics department to the general surgery department on June 24, 2022 for generalized abdominal pain, incoercible vomiting without frank cessation of matter and gas.

The interrogation revealed a notion of uterine curettage following a retention of placental debris after an euto-cic delivery for 12 days. She was at her third parity with all children alive and well.

There was no history of diabetes, ischemic heart disease, peripheral vascular disease, skin pathology, HIV/AIDS, or psychiatric illness. She also had no history of surgery. She was not an alcoholic or smoker.

On examination, the patient had an altered general condition and the patient was classified score 2 according to the WHO index, clear consciousness. Her temperature was 38.4˚C. Her blood pressure was 106/72 mmHg, pulse was 115 beats/minute and regular, and respiratory rate was 16 cycles per minute.

The examination revealed a sabral tongue, distension with generalized abdo-

minal defense, there was no palpable mass, no organomegaly, absence of pain on pressure of the umbilicus absence of pain on rectal touch, absence of An emergency workup was performed: at the CBC, hemoglobin was 10.9 g/dl, hematocrit was 37.3%, white blood cells were 5.2 × 10^9/l, red blood cells were 3.67 × 10^{12}/l, fasting blood glucose was 1.02 g/dl, creatinine was 83 mml/l, Group A Rhesus +.

The radiography of the abdomen without preparation had allowed us to objectify central hydro-aeric levels wider than high.

Note that we did not notice dextrocardia, the position of the gastric air sac, or other images on this radiograph that could suggest a situs inversus.

During our laparotomy, it was an occlusion without necrosis following the incarceration of an ileal loop through the uterine perforation orifice (**Figure 1**). After intestinal reintegration, we proceeded to the uterine suture with vicryl 1/0.

The decision was made to perform a principled appendectomy, during which we found the appendix on the left side, hence the decision to check the anatomical position of the other organs, namely the liver, the small curvature of the stomach, the heart, etc., all of which were inverted (**Figure 2(a)** and **Figure 2(b)**).

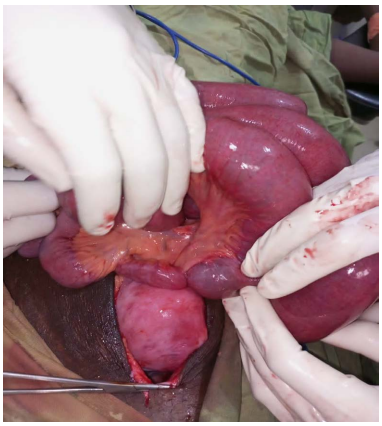
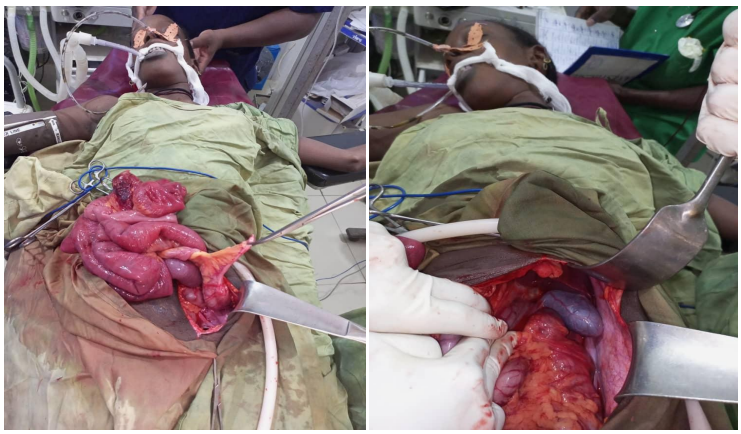


Figure 1. Intestinal occlusion on uterine.



(a) (b)

Figure 2. (a) Coecum and appendix; (b) Liver and small gastric curvature.

Subsequently, other examinations were requested such as: A frontal chest X-ray (Figure 3); A cardiac echography (Figure 4) and An electrocardiogram (Figure 5) which all concluded to a situs inversus totalitis.

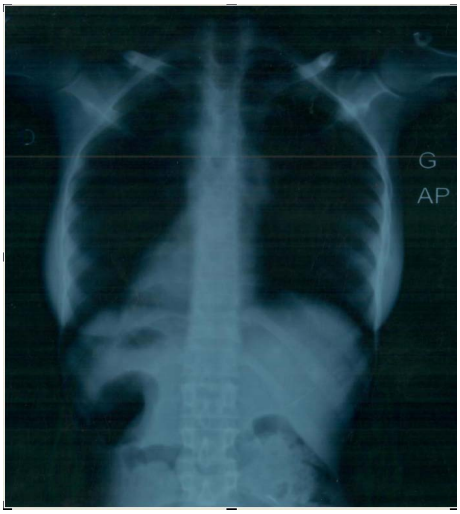


Figure 3. Frontal radiograph of the thorax.

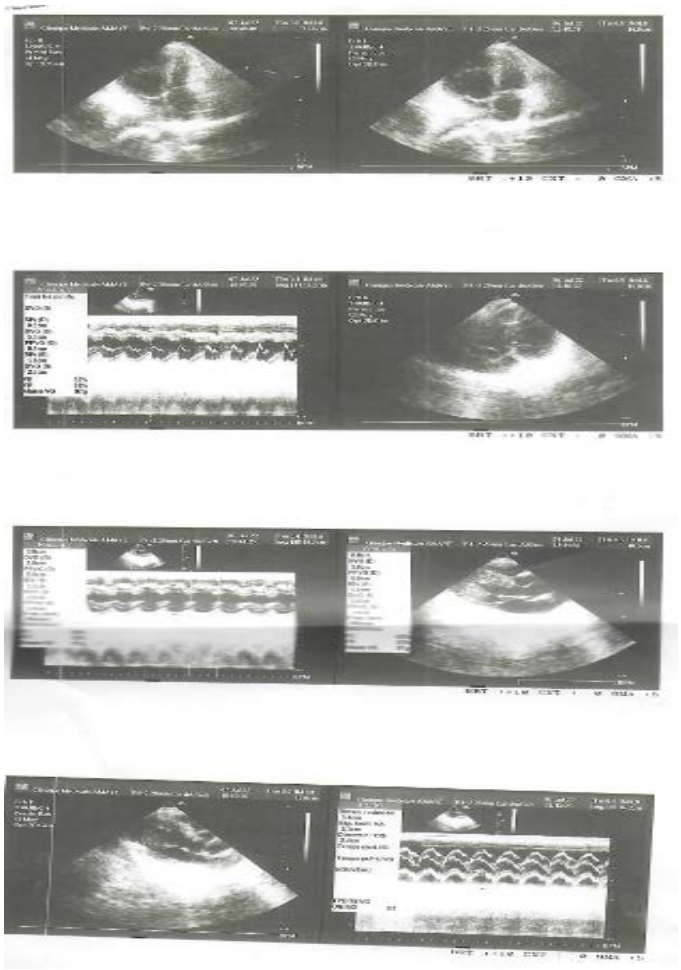


Figure 4. Cardiac ultrasound.

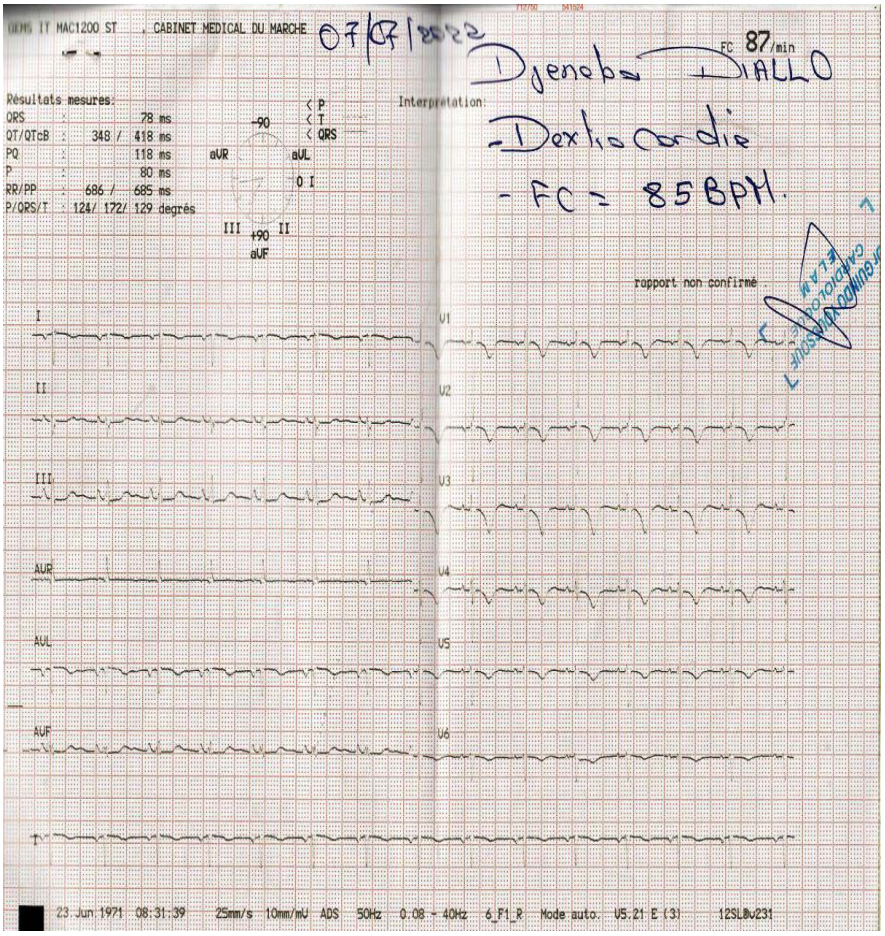


Figure 5. Electrocardiogram.

In the postoperative period, analgesic treatment with paracetamol 1000 mg every 6 hours, antibiotic prophylaxis with 2 G of Amoxicillin + Clavulanic acid and a dressing.

The postoperative course was simple and the patient was discharged from the hospital on July 4, 2022.

In order to search for possible familial cases we performed a simple physical examination based on cardiopulmonary auscultation of the patient's family members.

During this examination, we did not note any suspected case of situs inversus in the family.

3. Discussion

Situs inversus with dextrocardia is also called situs inversus totalis because the heart and abdominal viscera are present as a mirror image of the normal anatomy [3]. Situs inversus totalis has an equal distribution in both sexes [2] [10]). Situs inversus is usually inherited as an autosomal recessive condition, but it can be inherited as an X-linked disorder or can be found in mirror-image identical twins [11] [12]. Monozygotic twinning can be associated with mirror twins that

result from the division of the fertilized egg later in the embryonic stage than the normal time, around day 9 - 12. The mirror image, as a reflection of a biological polarization, can result in an anatomical, functional, medical or psychological mirror image. Mirror twins have an inverted asymmetry. They may be opposite each other in terms of dominant hand, dental structure, asymmetrical features, and/or cerebral hemisphere dominance. Even facial and dermatoglyphic analysis reveals mirror smiles as well as fingerprint patterns. Heterotaxy, or situs inversus with nearly identical mirror-image abdominal and thoracic viscera, has been reported in mirror-image twins. Situs inversus can be discordant when only one individual of a pair of twins has it, in which case it is called situs inversus specularis.

When the left-right anatomical axis in the body is neither normal nor completely mirror-inverted, the phenotype is called ambiguous situs or heterotaxy. Ambiguous situs describes a global anatomical arrangement in which any structure with left-right asymmetry can be normal, completely inverted, or neither. Situs ambiguus is classified into two main subtypes: 1) right isomerism and 2) left isomerism, or left isomerism polysplenia syndrome, or bilateral left polysplenia [13]. In making the diagnosis of situs inversus totalis, the possibility of family history, mirror effect, and other similar conditions such as situs ambiguus and situs inversus incomplete should be kept in mind, which requires further investigation.

Recent studies on positional cloning have shown that a tightly regulated genetic cascade plays a crucial role in establishing the three orthogonal body axes, anterior-posterior (AP), dorso-ventral (DV), and left-right (LR), before and during the gastrulation period [13], prior to the onset of morphologic asymmetry. Conceptually, LR patterning is divided into three phases. In the first phase of LR patterning, a yet unknown mechanism must orient the LR axis relative to the other two axes. The LR axis is probably specified after the AP and DV axes, and is determined relative to them. Asymmetric gene expression cascades are the intermediate phase of LR axis formation. By inducing or repressing transcription of downstream asymmetric targets, they propagate signals among subpopulations of cells (such as the mesoderm of nodes and lateral plates), which ultimately dictate the lateral character of organs undergoing asymmetric morphogenesis. In the final phase, individual organs use cell migration, differential proliferation, cytoskeletal organization, and other mechanisms to achieve asymmetries in their location or morphogenesis [14].

When the primitive streak appears, fibroblast growth factor 8 (FGF8) is secreted from the node and primitive streak cells, which induces Nodal expression. Later, when the neural plate is established, FGF8 maintains Nodal expression in the lateral plate mesoderm, along with left-right determination factor 2 (LEFTY-2), and these two genes upregulate the homeo-domain transcription factor Paired-like 2 (PITX2), a glovebox and left-handedness master gene [13] [14] [15]. Its expression is repeated on the left side of the heart, stomach and primordial gut when these organs assume their normal asymmetric position. If the gene is ex-

pressed ectopically, for example on the right side, this abnormal expression leads to laterality defects, including situs inversus and dextrocardia. Simultaneously, left-right determining factors (LEFTYs) are expressed on the left side of the neural tube floor plate and may act as a barrier to prevent left-sided signals from crossing. Sonic hedgehog (SHH) may also play this role of repressing left-side gene expression on the right. The Brachyury T gene, encoding a transcription factor secreted by the notochord, is also essential for the expression of Nodal, LEFTY-1 and LEFTY2 [13] [14] [15] [16].

Nodal is located on human chromosome 10q21-q23, where a de novo interstitial deletion has been detected in the human left-right axis defect. Analysis of polymorphic microsatellites flanking human NODAL in the affected individual and his or her parents indicates that this gene is included in the deleted region. In addition, cloning was effective in identifying mutations in ZIC3, an X-linked zinc finger transcription factor, as a molecular genetic cause of human left-right axis defects. Zic genes are involved in hedgehog (sonic) signaling that is implicated in human left-right axis specification [17]. Importantly, the neurotransmitter serotonin (5HT) also plays a critical role in this signaling cascade that establishes laterality. 5HT is concentrated on the left side, probably because it is degraded by its enzyme, monoamine oxidase (MAO), on the right side. Mothers who take selective serotonin reuptake inhibitors as antidepressants may give birth to children with laterality defects [13].

Interestingly, the cilia normally present on the ventral surface of the primitive node beat and create a leftward Nodal gradient, which may initiate the cascade or a signal gradient established by gap junctions and small ion transport (proton-potassium −H+/K+-ATPase pump) may also have some role [13] [18]. It has been reported that approximately 20% of patients with situs inversus have Kartagener's syndrome, an abnormality affecting the respiratory cilia and often accompanied by infertility [8] [16] [17]. Affected individuals suffer from chronic respiratory tract infections and a variable combination of infertility (in males), chronic ear infections and a reduced or absent sense of smell. These problems result from a deficiency of the cilia and flagella, hence the diagnosis of real estate ciliary syndrome (RCS). The cilia are functionally abnormal and electron microscopy usually reveals absent or abnormal dynein arms connecting the nine pairs of microtubules [19]. A mutation in all 82 exons of the DNAH11 (axonemal heavy chain dynein type 11) gene found on chromosome 7p21 has been considered an underlying cause of IBS in patients with Kartagener syndrome with situs inversus [20]. In addition to kinesin and dynein, other proteins such as inversin, polaris, polycysteine 2 have also been linked to asymmetry which has been interpreted as resulting from impaired ciliary function [14].

Insights into the mechanisms of asymmetry have been provided by a variety of drugs that cause defects in an asymmetric LR manner or that render asymmetry random. These drugs include cadmium (heavy metal), phenyl ephedrine (adrenergic agonist), retinoic acid (teratogen) and many others [14].

Thus, many genes, namely LEFTY, NODAL, HAND, ZIC3, SHH, ACVR2B,

PITXZ [2] are suspected to orchestrate the proper positioning and shaping of organs in the body. Because a cascade of many genetic steps is required to produce situs inversus, its incidence is rare. However, a specific genetic cause of dextrocardia with situs inversus has not been identified.

In our case, the patient's age was 26 years and the discovery of situs inversus totalis was made following a laparotomy for acute bowel obstruction. It has been stated that situs inversus totalis is not associated with physiological difficulties and that the life expectancy of individuals with situs inversus totalis is not affected [2] [14]. In the present case, we found dextrocardia, *i.e.* the heart was located in the right hemi thorax with the base-apex axis pointing to the right. The rightward coiling of the heart tube is the first embryological manifestation of left-right asymmetric development. The cardiac situs is determined by the location of the atria. The ventricles exhibit the L-loop pattern where the right ventricle is located behind and to the left of the left ventricle. Therefore, individuals with situs inversus usually have dextrocardia [1] [2] [3]. 5% - 10% of dextrocardia cases with situs inversus have congenital heart disease [2]. In this case, we found a transposition of the great vessels and a right aortic arch. The interatrial septum and interventricular septum were normal.

Complete situs inversus can be part of multiple malformative syndromes and is usually associated with polysplenia and splenic malformations [7] [21]. In the present case, the spleen was of normal morphology and located in the right hypochondrium.

Because mirror image inversion of all asymmetric structures was evident in the patient, the diagnosis of situs inversus totalis was made.

Congenital polycystic kidney is inherited as an autosomal recessive or autosomal dominant disease and is related to mutations in genes that code for cilia-related proteins [13]. The mutation (embryonic turn reversal) can cause situs inversus and cyst formation in the kidneys [22].

In our case, both kidneys were lobulated and did not show any morphological abnormality. Therefore, lobulated kidneys in a situs inversus case can be explained by the mutation of related genes.

The ureters and urinary bladder were normal.

Gastrointestinal malrotation, specifically "intestinal rotation and attachment abnormalities" (IRFA), is also a manifestation of SRA malformations [23].

In our patient, the ascending colon, cecum, and appendix were present on the left side and the descending colon and sigmoid colon were housed on the right side. It is reported that the direction of rotation of the bowel is under the influence of the forces exerted by the adjacent organs on the bowel and its mesentery [5].

Thus, the liver located on the left, while the stomach and spleen are located on the right, could be the possible link to the gastrointestinal inversion in this case. This case also had a higher risk of developing acute volvulus because, in this case, the malrotation of the bowel and the abnormal location of the cecum produce a narrow superior mesenteric vascular pedicle, as opposed to the normally

wide small bowel mesentery, predisposing to a subsequent midgut volvulus. The literature recommends treating this condition prophylactically with the laparoscopic Ladd procedure [23], which requires mobilization of the right colon and cecum by dividing the Ladd bands, mobilization of the duodenum, division of adhesions around the superior mesenteric artery to widen the mesenteric base, and an appendectomy.

In our case, only the appendectomy of principle was carried out because we were in an emergency situation imposed by the acute intestinal occlusion.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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