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Doppler and High Resolution Ultrasound in Assessment of Complicated Anterior Abdominal Wall Hernias

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ABSTRACT

Anterior abdominal wall hernias are common diseases of the abdomen. Their types include groin hernias, followed by femoral and umbilical. Complications of abdominal hernias include obstruction, strangulation and incarceration. An incarcerated abdominal wall hernia was usually associated with a sonographic appearance that clearly differed from the sonographic appearance of a non-incarcerated hernia. **Aims:** The aim of this study was to investigate with sonography whether distinct cross-sectional imaging signs exist to differentiate incarcerated and non-incarcerated abdominal wall hernias **Patients and Methods:** This study included 30 cases, with suspected complicated anterior abdominal wall hernia, underwent ultrasound examination of the hernia as well as the abdomen with the help of color Doppler ultrasound, to determine the sonographic signs of complicated hernias. **Results:** We found that the most important signs of incarcerated hernial strangulation, of which is the absence of color flow within the bowel wall. More supporting criteria suggesting incarceration are herniated bowel wall thickening (with cut off value of 3 mm), free fluid in the hernial sac which suggests high incidence of complication, fluid within the herniated bowel loop, and dilated bowel loops in the abdomen which suggest high possibility of bowel obstruction.
Conclusion: Ultrasound examination is extremely helpful as an easy bed side examination in case of suspected abdominal wall hernial complication, helping to diagnose a hernia, its contents and if complicated especially strangulation which needs immediate surgery to treat this life threatening condition.

Keywords: Doppler, Ultrasound, Anterior Abdominal Wall Hernias

1. Introduction

Abdominal herniation is a protrusion of part of its content from the abdominal cavity through abdominal wall defect or from wall weakness (Mathieu and Luciani, 2004). Hernias may be congenital or acquired. The first appear prenatally or in infants and are caused by a congenital defect provoking an opening in the abdominal cavity. The second may be caused by conditions that increase the pressure in the abdominal cavity (obesity, coughing, straining), from previous surgical procedure (incisional hernia) or from trauma.

Abdominal wall hernias are common surgical emergency with a global incidence approximately 4%-5% (Digestive diseases in the United States, 1994). They represent one of the most common reasons for emergent surgery performed in patients over 50 years old (Aguirre *et al.,* 2004; Rutkow, 2003). In fact, they are the second most common indication for surgery after acute appendicitis in Europe and the United States (Madoz *et al.,* 2007).

Anterior defects consist of umbilical, paraumbilical, epigastric and hypogastric hernias (Rettenbacher *et al.,* 2001).

Umbilical hernias in adults are usually congenital and result from incomplete closure of the abdominal wall after ligation of the umbilical cord. This kind of hernia often remains asymptomatic. Incomplete herniation of the loop may occur and these are called Richter's hernias.

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Acquired umbilical hernias develop more often in obese and multiparous women and strangulation is common.

Epigastric hernias occur on the linea alba between the xiphoid process and umbilicus while hypogastric hernias take place on the midline below the umbilicus. Generally, properitoneal fat, vessels and sometimes solid viscera protrude through the hernial defect (Bendavid *et al.,* 2001). Strangulation (ischemia caused by a compromised blood supply) and incarceration (irreducible sac) are common in all midline hernias (Aguirre *et al.,* 2005).

Incisional hernia is one of the most common complications of abdominal surgery at sites of a previous laparotomy

Groin hernias are the most common with a prevalence of 75% followed by femoral (15%) and umbilical (8%) (Digestive diseases in the United States, 1994). Generally there is a higher prevalence in males (M:F, 8:1). However for anatomical reasons, women are more affected by femoral hernias [(3)]. The most common cause of hernia in the newborn is congenital malformation, in adults, wall stress and in the elderly, weakness of the abdominal wall.

There are many different types of hernias with a wide range of different clinical conditions. Symptoms of abdominal herniations may be absent or non-specific, consisting of mild abdominal discomfort alternating with episodes of intense periumbilical pain and nausea (Mathieu and Luciani, 2004). In some cases, however, they may develop acute complications (incarceration, bowel obstruction, volvulus and strangulation) that require rapid diagnosis and therapy (Aguirre *et al.,* 2004).

Diagnosis is usually made at physical examination and history. However, clinical diagnosis can be difficult, especially in patients with obesity, pain or abdominal wall scarring. In these cases, abdominal imaging may be the first clue to the correct diagnosis (Aguirre *et al.,* 2004) and to confirm suspected complications of hernias. Different modalities imaging are used: conventional radiographs or barium studies, ultrasonography (US) and computed tomography (CT). In addition, the cross-sectional imaging modalities, sonography and CT, can aid in the differential diagnosis of palpable abdominal wall masses and help to define hernial contents such as fatty tissue, bowel, other organs or fluid (Miller *et al.,* 1995).

US imaging, like CT, largely finds a mass in the abdominal wall corresponding to the contents of the hernia sac and distinguishes it from other masses such as cysts, hematomas, neoplasms or varicoceles (Ianora *et al.,* 2000). US may detect the presence of the hernia signs and is particularly useful in small midline hernias containing mesenteric fat or to study the pediatric population. US may detect the presence of hernias in the groin with a complete regional evaluation and hiatal hernias. A dynamic study of the gastro-esophageal junction is also possible. In a case of complications, US may provide information on the herniated organs and repercussions in the peritoneal cavity. Signs of mechanical ileus and of decompensation with the presence of peritoneal fluid, the presence or absence of color Doppler signals in the hernial contents and the presence or absence of peristalsis in the herniated bowel loop may be detected (Miller *et al.,* 1995). An important sign, with high specificity but limited sensitivity, of incarceration is fluid in the herniated bowel loop with bowel wall thickening and free fluid in the hernial sac and echogenic fat. In the evaluation of the groin area, US imaging has an advantage over CT in the ability to evaluate the standing patient, with alternate straining and relaxation (Ianora *et al.,* 2000) and no exposure to radiation as CT.

For these reasons, US is really helpful in patients with inconclusive or misleading clinical presentations (Miller *et al.,* 1995). High-resolution US have increased the accuracy of the diagnosis of hernias to over 97% (Deitch and Soncrant, 1981; van den Beg, 2002) [(11,12)]. Real-time US is accurate, non-invasive, relatively inexpensive, no radiation dose, and readily available.

US is non-invasive, allows for comparison with the asymptomatic side and can be performed in physiological positions with dynamic scanning; for these reasons it plays a fundamental role in evaluating the presence of complications such as strangulation or incarceration and, in some cases, US may detect further pathology in the hernial sac. Operator dependency and the relatively long learning curve are limiting factors. Furthermore, the presence of intestinal gas, often prominent in acute patients, limits the performance of US in emergency conditions.

US is performed with the 3.5 MHz convex probes usually adopted for abdominal examination and with high frequency 7.5 MHz probes to obtain better resolution of the nearest bowel loops. Color-Doppler analysis increases diagnostic power of the method by detecting circulatory alterations.

Dynamic study permits checking patency and reducibility of the involved organs (Miller *et al.,* 1995).

2. Patients and Methods

Patients Population

The study includes 30 patients (18 males and 12 females; 7 month to 75 years old) who underwent emergency diagnostic sonography between July 2020 and December 2021. These patients were referred by the surgery department for sonography of the abdominal wall and the abdomen when their clinical presentations were suggestive of obstructed abdominal wall hernia either progressed or not progressed to bowl obstruction, when their physical examinations were inconclusive or when the surgeon believed it was important to preoperatively determine the contents of a suspected hernia. Also included in our study patients in whom sonography revealed obstructed abdominal wall hernia clinically presented with acute inguinal lump.

Another patient was referred for sonography because of abdominal pain and vomiting of unclear origin.

Inclusion Criteria

- No gender predilection.
- Patients suspected to have complicated anterior abdominal wall hernia by physical examination.
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Exclusion Criteria

No exclusion criteria in such urgent cases.

All selected patients subjected to the following

- Full history taking from patients or parents including: patient name, age and sex.
- History of the current illness: onset, course and duration of any complaints as acute abdominal pain, vomiting and constipation.
- Family history of any congenital defect of the abdominal wall.
- Review of all previous investigations or radiological examination.
- Clinical examination was performed by surgeon at General surgery department.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** **(**Armonk, NY: IBM Corp**)**. Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR).

3. Results

Regarding the age: the age of studied patients ranged between 7months to 75 years old with a mean age of 50.6 years old. and according to the sex they were 18(60%) male and 12(40%) females (Table 1).

Table 1: Distribution of the studied cases according to demographic data (n = 30)

	No.	**%**
Sex		
Male	18	60.0
Female	12	40.0
Age (years)		
Min. – Max.	0.58 – 75.0	
Mean ± SD.	50.6 ± 17.50	
Median (IQR)	54.50 (40.0 – 61.25)	

IQR: Inter quartile range SD: Standard deviation

Regarding the site of hernia: 7(23.3%) right inguinal region, 4(13.3%) left inguinal, 8(26.7%) paraumblical, 5(16.7%) umblical, 4(13.3%) incisional, 2(6.7%) epigastric (Table 2).

Table 2: Distribution of the studied cases according to the site of the hernia (n = 30)

Site	No.	%
Right inguinal	7	23.3
Left inguinal	4	13.3
Para umbilical	8	26.7
Umbilical	5	16.7
Incisional	4	13.3
Epigastric	2	6.7

Regarding the viability of bowel loops: 24 (80%) of studied cases the bowel loops were preserved, 6(20%) the bowel loops were non viable (Table 3).

Table 3: Distribution of the studied cases according to viability of bowel loops (n = 30)

Viability of bowel loops	No.	%
Non-viable	6	20.0
Preserved	24	80.0

Our data suggest that the absence of blood flow in the contents of a hernia is the most important sign of strangulation because almost all strangulated hernias in our series (20%) had no detectable blood flow on color Doppler sonography, with high sensitivity (100%) & specificity (100%).

Wall thickening of herniated bowel is an important sonographic sign of incarceration in our patients, yet it does not help to distinguish obstructed from strangulated hernias, wall thickening indicated incarceration of the hernias containing bowel with sensitivity (100%) & specificity (37.5%). Absence of peristaltic activity is important sign of strangulation with sensitivity (100%) & specificity (91.7%) (Table 4).

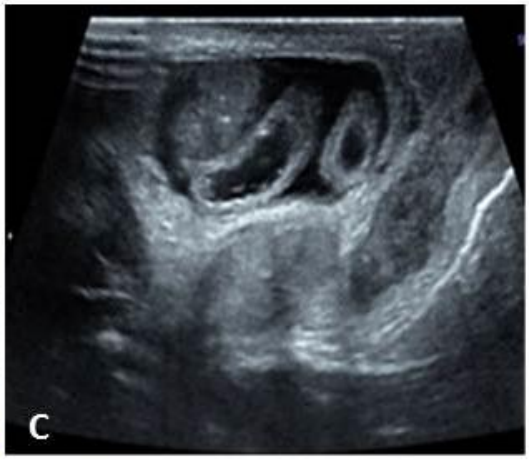
Table 4: Distribution of the studied cases according to intra-abdominal bowel (n = 30)

	No.	%
Caliber		
Normal	20	66.7
Dilated	10	33.3
Thick wall		
Normal	24	80.0
Dilated	6	20.0
Dilated Fluid filled	6	20.0

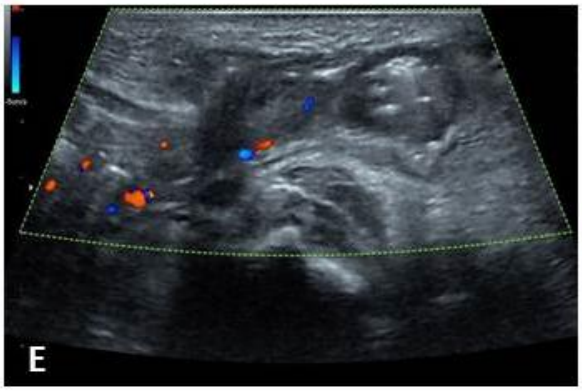
Case 1:

7-month infant came to emergency room with right inguinal painful irreducible swelling.

(A) Defect 1 cm



(B& C) Hernial sac



(D) Preserved vascularity with color Doppler

(E) The patient underwent reduction and herniotomy

Fig. 1: Ultrasound examination revealed right irreducible inguinal hernia containing appendix, bowel loops, caecum, and free fluid (Amyand's hernia), with defect about 1 cm.

Case 2:

Male patient 51 years old came to emergency room with vomiting, constipation on clinical examination. Irreducible right inguinal hernia was revealed by us. The patient underwent reduction and herniotomy.

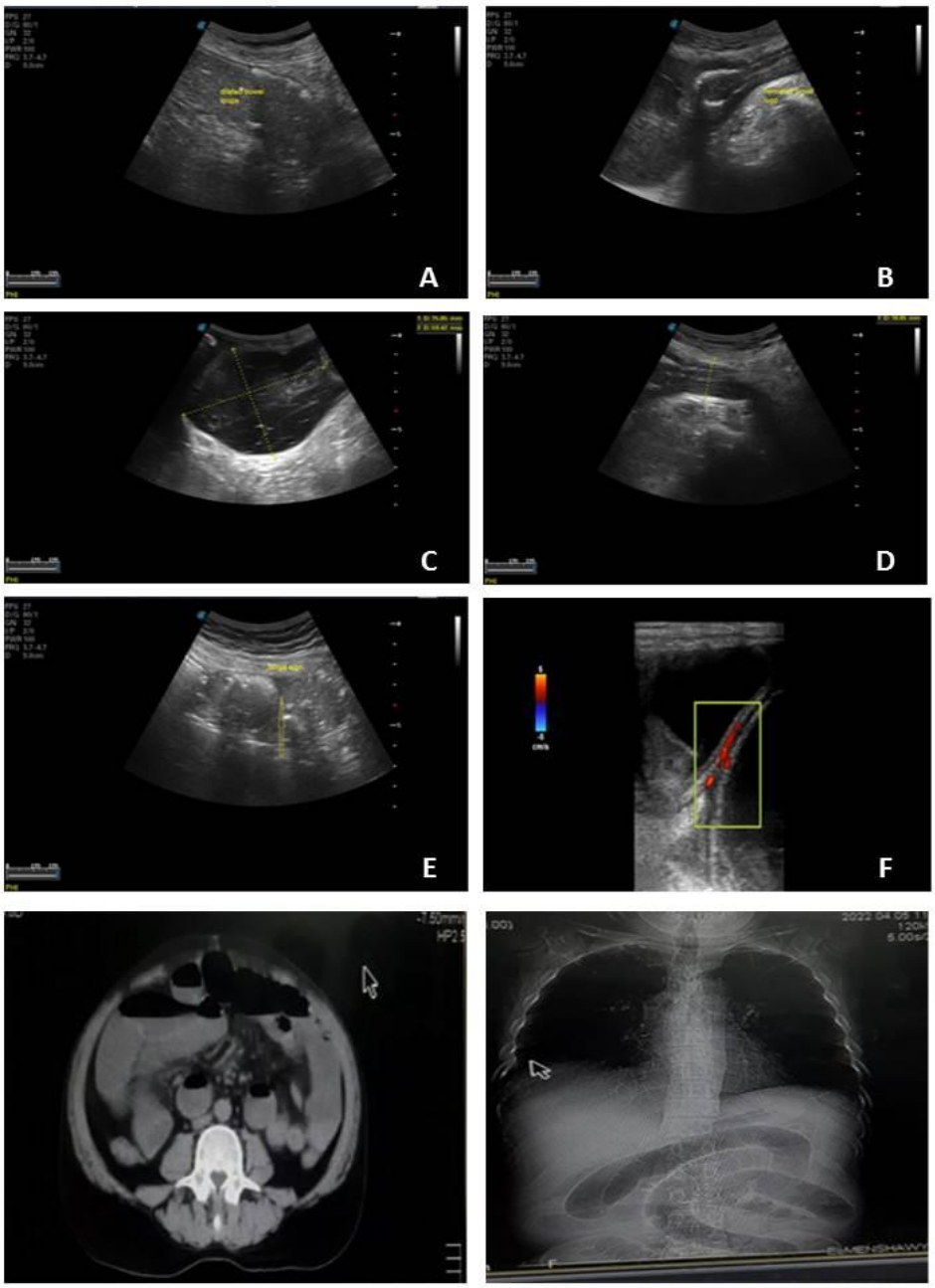


Fig. 2: (A&B) On superficial ultrasound examination of right inguinal region revealed thick edematous irreducible non peristalting bowel loops seen herniating through dilated right inguinal canal into right hemi-scrotum. **(C)** The hernia sac contains septated turbid fluid measuring (6x7.5cm). **(D)** The inguinal canal diameter (18mm) with thickened wall (5.7 mm). **(E)** Triangular shaped free fluid seen between bowel loops (Tanga sign). **(F)** Color Doppler shows preserved vascular flow in the bowel loops. **(G)** CT shows multiple air fluid levels, dilated bowel loops.

Case 3:

54 years old female patient presented with history of paraumblical hernia repaired with mesh application, presented with irreducible painful lump at the lateral end of the incisional scar, vomiting and absolute constipation.

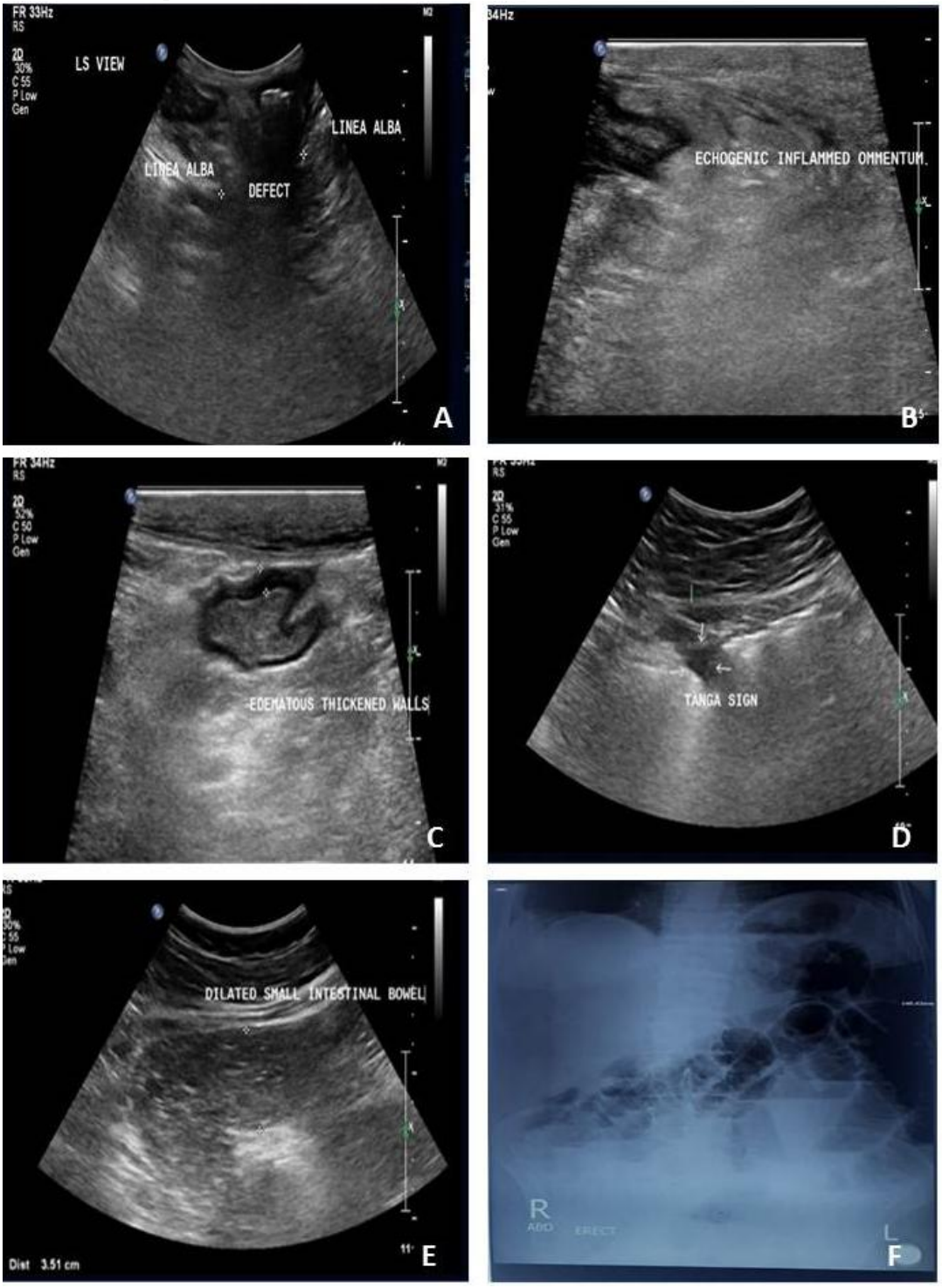


Fig. 3: Superficial Ultrasound on the medial end of the scar revealed**: (A, B & C)** Hernial sac containing oedmatous dilated bowel loops and omentum with defect about (3 cm). **(D)** Free fluid between the bowel loops (Tanga sign). **(E)** dilated bowel loops in the abdomen measures about (3.5 cm). **(F)** Plain X-ray abdomen erect position showed air fluid levels.

Case 4:

60 years female patient presented with vomiting, abdominal pain, and umbilical swelling.

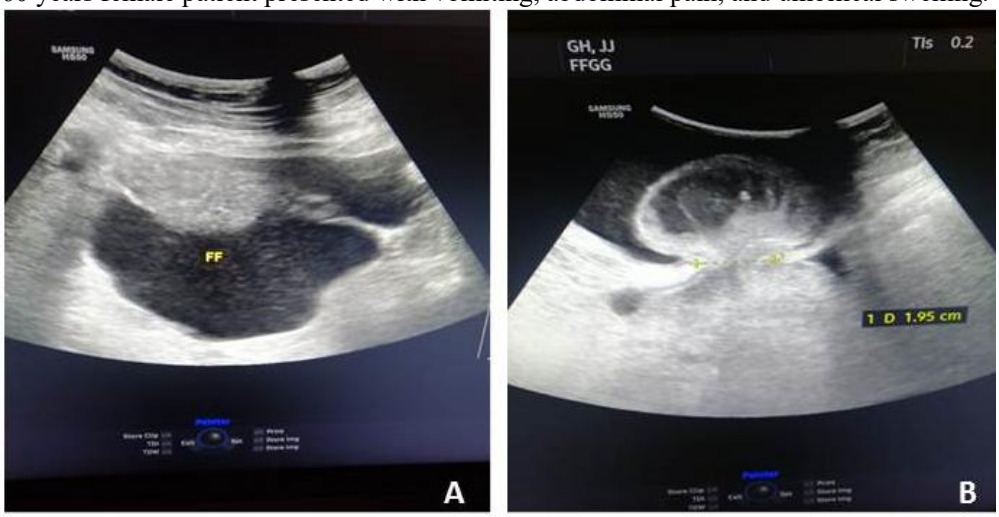


Fig. 4: Superficial ultrasound revealed: **(A)** Hernial sac contains viable bowel loop (with visualized peristalsis), omentum, and free fluid. **(B)** Dilated bowel loops (I.O), with defect (1.9 cm)**.**

4. Discussion

The present study showed that Complicated Anterior Abdominal Wall Hernias are more common in males than females and the age of studied patients ranged between 7 months to 75 years old with a mean age of 50.6 years old.

This could be explained by the age-related deterioration and weakness of the abdominal boundaries. The mean age ± SD in our study was 50.6 ± 17.50 years similar to a recent study by Jayaram *et al.* (2018).

In line with our findings, Slater *et al.* (2014) showed that the male gender is a main risk factor for complicated anterior wall hernia mostly inguinal hernia. Also, male gender is a risk factor for recurrence after surgery.

On the other hand, Surek *et al.* (2021) showed that regarding the sex of 426 patients included in the study 217 (50.93%) were female and 209 (49.1%) were male. Male patients were more likely to have an inguinal hernia, whereas female patients were more likely to have other hernia subgroups ($p<0.001$).

The same study showed 234 patients (55.16%) were under 65 years, and 192 (44.8%) were over 65 years with a mean age of 61.47 years old.

In line with our findings, Young *et al.* (2007) reported most male patients in their study, which may be due to a large sample size and different study design.

In contrast with our finding Zafar *et al.* (2006) revealed the number of females suffering from anterior abdominal wall hernia was more than males. This could be explained by the higher incidence of surgeries in females, e.g., Cesarean section which is the most performed surgical procedure in the world literature.

The present study showed regarding the site of hernia: 7(23.3%) right inguinal region, 4(13.3%) left inguinal, 8(26.7%) paraumbilical, 5(16.7%) umbilical, 4(13.3%) incisional, 2(6.7%) epigastric.

In line with our findings, Dabbas *et al.* (2011) studied the most common type of hernia is Inguinal hernias account for more than 70% of abdominal wall hernias; femoral (10–15%), umbilical, epigastric, and incisional hernias account for most of the other types.

In contrast with our findings Murphy *et al.* (2014) studied the most prevalent non-groin anterior abdominal wall hernias are incisional and umbilical hernias.

Balamaddaiah and Reddy *et al.* (2016) studied the prevalence of inguinal hernia among 212 patients and showed 101 cases (47.6%) of hernias, the right side was the most common, followed by the left side with 71 patients (33.5%). Bilateral inguinal hernias affected 40 patients (18.9%).

Baz *et al.* (2019) who had documented that the ventral hernia was the most frequent one (48.3%) followed by the inguinal type (38.7%). Devareddy *et al.* (2016) reported that incisional hernia (44%) was the most frequent one followed by ventral hernias (14%) and this could be explained by the small sample size in both studies.

Our study showed regarding the viability of bowel loops: in 24 (80%) of studied cases the bowel loops were preserved, and in 6(20%) the bowel loops were non-viable.

In line with our finding's studies by Seya *et al.* (2010) and Catalano *et al.* (2004) revealed that most of the bowel loop in the hernia sac was viable predicted by peristalsis and color Doppler ultrasound, While Catalano *et al.* (2004) revealed that most of the bowel loop in the hernia sac were non-viable.

Zaki *et al.* (2021) studied where the hernial sac contains viable intestinal loops. Examining intestinal loops close to the obstructed hernial ring can help keep non-viable bowel from returning to the abdomen while the surgery is being done.

Our data suggest that the absence of blood flow in the contents of a hernia is the most important sign of strangulation because almost all strangulated hernias in our series (20%) had no detectable blood flow on color Doppler sonography, with high sensitivity (100%) & specificity (100%).

Wall thickening of herniated bowel is an important sonographic sign of incarceration in our patients, yet it does not help to distinguish obstructed from strangulated hernias, Wall thickening indicated incarceration of the hernias containing bowel with sensitivity (100%) & specificity (37.5%). The absence of peristaltic activity is an important sign of strangulation with sensitivity (100%) & specificity (91.7%).

In line with our findings Abdel Hamid *et al.* (2021) the most crucial indicator of strangulation is the absence of blood flow within the hernia's contents, as nearly all the strangulated hernias in his study (27%) showed no blood flow at all on color Doppler sonography. Patients with an established surgical diagnosis of incarcerated hernia and intestinal necrosis were those in whom color Doppler sonography failed to show blood flow in the imprisoned bowel loop.

This was in line with research by Devareddy *et al.* (2016), who discovered that color Doppler sonography was useful in differentiating between hernias that were strangulated and those that weren't, as well as research by Liang *et al.,* (2006) who discovered that color Doppler was useful in assessing the vascular state of hernias.

Abdel Hamid *et al.* (2021) discussed the preservation of a viable colon, surgical bowel resection was performed as soon as the color Doppler revealed missing flow, which indicates ischemia and necrosis. These results are in line with those of Young *et al.* (2007) who claimed that the US helps plan abdominal hernia surgical operations, especially when there are big or numerous recurring hernias.

In line with our findings Abdel Hamid *et al.* (2021) showed Comparing the ultrasound findings with the operative data revealed that ultrasound had 100% sensitivity.

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