

Evaluation the Sonographic Appearance of Spectrum of Anterior Abdominal Wall Lesions and to Compare the Sonological Features with Pathological and Operative Diagnosis: A Cross-sectional Study

Mallikarjun M Devareddy¹, Shilpa Devakar², M Chetan¹

¹Assistant Professor, Department of Radiology, Navodaya Medical College Hospital and Research Centre, Raichur, Karnataka, India,

²Assistant Professor, Department of Radiology, Raichur Institute of Medical Sciences, Raichur, Karnataka, India

Abstract

Background: Based on physical examination alone, it is often difficult to diagnose the specific anterior abdominal wall pathologies. The aims of the study were to evaluate the accuracy of the high-resolution sonography in the diagnosis of anterior abdominal wall pathologies.

Materials and Methods: All patients with the clinical manifestations of various anterior abdominal lesions in a period of 2-year were included in the study. All patients included in the study underwent anterior abdominal wall ultrasonography using 7.0-12.0 MHz high-frequency linear array transducer coupled with Color Doppler equipment, followed by pelvic scan using 3.5-5.0 MHz transducer whenever required. Findings during surgery and histopathology reports were noted and compared with the sonographic features.

Results: Our study showed a high prevalence of anterior abdominal lesions in patients in the age group of 20-40 years which constituted 60% of all cases. Females were affected more (66%). Incisional hernia was the predominant anterior abdominal wall lesions followed by ventral hernias, lipomas, and hematomas cases. Least common was anterior abdominal wall sarcoma. In total diagnostic accuracy of high-resolution sonography was 97.6% in our study.

Conclusion: High-resolution sonography is an accurate diagnostic imaging modality in anterior abdominal wall lesions. The advantages of high-resolution sonography include noninvasiveness, high accuracy, lack of ionizing radiation, simplicity, wide availability, cost-effectiveness, and repeatability.

Key words: Anterior abdominal wall, Desmoids tumor, High resolution, Incisional hernia, Ultrasonography, Ventral hernia

INTRODUCTION

Abdominal wall lesions often mimic intra-abdominal conditions and frequently present as palpable masses. Pathologic processes that may involve the abdominal wall

occasionally raise diagnostic challenges because of the low specificity of physical findings. Sometimes a clinically suspected intra-abdominal mass proves to be in the wall, and sometimes an abdominal wall lesion is seen as an incidental finding on abdominal sonography performed for some other reason. Often patients with chronic abdominal pain need an examination of the abdominal wall, especially, when a positive Carnett's sign suggests the cause of pain to be in the abdominal wall.^{1,2}

The abdominal wall is a laminated structure. The different layers are skin, superficial fascia, subcutaneous fat, muscle layer, the transversalis fascia, and a layer of extraperitoneal

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Corresponding Author: Dr. Mallikarjun M Devareddy, Department of Radiology, Navodaya Medical College Hospital and Research Centre, Raichur, Karnataka, India. Phone: +91-8095135404. E-mail: mallikarjunclarity@gmail.com

fat. The skin is echogenic (Figure 1). The subcutaneous fat layer is variable in thickness and is usually hypoechoic. The muscles reveal medium-level echoes. A typical lamellar pattern of the muscle fibers usually can be recognized.³ A wide range of imaging modalities is available for the evaluation of abdominal wall pathology ranging from plain X-ray abdomen to high-resolution ultrasonography (USG), computed tomography scan, and magnetic resonance imaging.

With the introduction of high-frequency, high-resolution probes, detailed examination, and recognition of different layers of the abdominal wall are now possible on USG examinations. A high-resolution examination is capable of deciding whether an abnormality is in the abdominal wall or inside the abdominal cavity.⁴

There is wide range of pathology effecting the anterior abdominal wall which ranges from simple fluid collection to hernias to complex neoplasms of the abdominal wall, hence early detection of this pathology with use of high-resolution USG and another cross-sectional imaging has revolutionized the treatment options for the surgeons.²

There are very few studies in India regarding the diagnostic accuracy of ultrasound in diagnosing abdominal wall lesions. Hence, the study was taken up to find the diagnostic accuracy of high-resolution ultrasound.

Objectives

1. To evaluate the sonographic appearance of spectrum of anterior abdominal wall lesions
2. To compare the sonological features with pathological and operative diagnosis
3. To assess the accuracy of high-resolution sonography and Color Doppler in the diagnosis of anterior abdominal wall lesions.

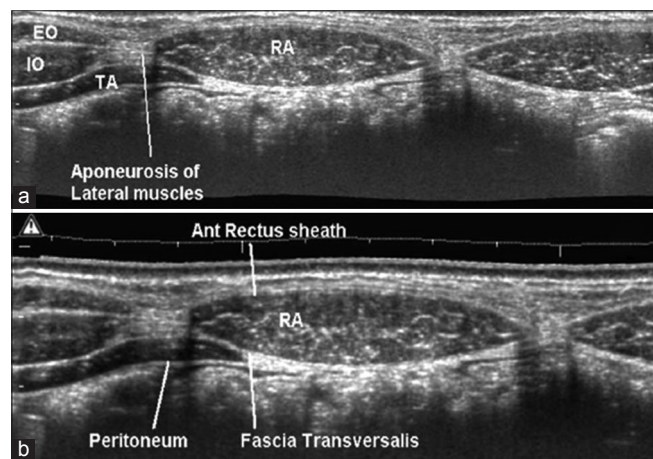


Figure 1: (a and b) Transverse sonography of the anterior abdominal wall. RA: Rectus abdominis, TA: Transverse abdominis, EO: External oblique, IO: Internal oblique

MATERIALS AND METHODS

This study is a study of 50 cases of anterior abdominal wall lesions that were seen consecutively in the Department of Radiology during a 2-year study period from September 2008 to September 2010, referred from two hospitals attached to J. J. M. Medical College, Davangere. Various patients with suspected anterior abdominal wall lesions and those anterior abdominal wall lesions which were picked up incidentally during routine sonography for some other cause were included in the study. These cases were evaluated using high-resolution USG with high-frequency linear array probe (7-12 MHz). All cases with clinical manifestations of anterior abdominal wall lesions of all age groups were included in the study. All cases with acute abdominal wall trauma were excluded from the study. All patients included in the study underwent anterior abdominal wall USG using 7.0-12.0 MHz high-frequency linear array transducer coupled with Color Doppler equipment (Philips Envisor CHD) followed by surgical or pathological confirmation whenever needed. This was followed by pelvic scan using 3.5-5.0 MHz transducer whenever required. Findings during surgery and histopathology reports were noted and compared with the sonographic features for assessing accuracy of high-resolution sonography. The purpose of the study was explained in local language (Kannada) or English, and the patients, who were willing to participate, were included in the study and a written consent was obtained. Ethical clearance was obtained from the Ethical Committee, J. J. M. Medical College, Davangere. Diagnostic accuracy of anterior abdominal wall lesion using high-resolution USG and Color Doppler was determined by comparing with operative and histopathological findings, by performing diagnostic validity tests such as sensitivity, specificity, and predictive values. Statistical analysis was performed using validity. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were determined.

RESULTS

Among 50 clinical suspected anterior abdominal wall lesions, the most common indication for high-resolution sonography was incisional hernia, followed by anterior abdominal wall lump which is relatively a nonspecific clinical diagnosis, which later turned out be different lesions on high-resolution sonography as well as histopathology.

Among 50 various clinically suspected anterior abdominal wall lesions which were subjected for high-resolution sonography most commonly and accurately detected lesions of anterior abdominal wall was incisional hernia, i.e., as many as 22 cases out of 50 cases (44%) followed by

ventral hernias, i.e., 7 case out of 50 cases (14%). We would like to emphasize another anterior abdominal wall lesions other than hernias which was common in our study was anterior abdominal wall lipomas, i.e., as many as 4 cases out of 50 cases (8%) were in all 4 cases correlated with histopathological findings (Tables 1 and 2).

Histopathological/post-operative findings were correlated in the majority of the cases, i.e., in 42 cases out of 50 cases whenever required. Cases diagnosed on USG which were subjected for histopathology/post-operative findings accurately with our sonographic diagnosis in all cases with 97.6% accuracy (Table 3).

- Sensitivity = 100%
- Specificity = 75%
- Positive predictive value (efficacy) = 97.4%
- Negative predictive value = 100%
- Diagnostic accuracy 97.6%.

DISCUSSION

Anterior abdominal wall lesions often mimic intra-abdominal conditions and frequently presents as

Table 1: Various high resolution sonographies of anterior abdominal wall lesions

| Ultrasound diagnosis | n (%) |
|-----------------------------------|---------|
| Incisional hernias | 22 (44) |
| Ventral hernias | 7 (14) |
| Anterior abdominal wall lipoma | 4 (8) |
| Anterior abdominal wall haematoma | 4 (8) |
| Desmoidtumour | 2 (4) |
| Dermoid cyst | 2 (4) |
| Postoperativeseroma | 1 (2) |
| External oblique pyomyositis | 1 (2) |
| Neurofibroma | 1 (2) |
| Metastatic melanoma | 1 (2) |
| Resolving abscess | 1 (2) |
| Abdominal wall sarcoma | 1 (2) |
| Others | 3 (6) |

Table 2: Various histopathological/post-operative diagnosis of anterior abdominal wall lesions

| Histopathology/post-operative findings | n (%) |
|--|----------|
| Bowel loops | 20 (40) |
| Not done | 8 (16) |
| Dermoid cyst | 2 (4) |
| Desmoidfibromatosis | 2 (4) |
| Linea alba defect | 2 (4) |
| Lipoma | 4 (8) |
| Metatatic melanoma | 1 (2) |
| Neurofibroma | 1 (2) |
| Omental fat/bowel loops noted | 5 (10) |
| Abscess | 1 (2) |
| Others | 4 (8) |
| Total | 50 (100) |

a palpable mass. This is a more common with patients who have thick anterior abdominal wall with a large layer of fat. Because of the introduction of newer scanning techniques with higher frequency probes and newer software like THI, it has lead to the better characterization and diagnosis of the lesion. Literature on this type of study is sparse in Indian literature and such studies have not been highlighted on incidence and the prevalence of anterior abdominal wall lesions.

Age

The time of onset of anterior abdominal wall lesions is well-known entity in congenital anterior abdominal wall lesions such as omphalocele, gastroschisis, cloacal exstrophy, and prune belly syndrome which can all be picked up during the second trimester antenatal sonography done during 18-24 weeks, hence age plays paramount importance in the diagnosis of anterior abdominal wall lesions. We categorized the age group of patients broadly into three groups (Table 4). Our study showed a high prevalence of anterior abdominal wall lesions in the age group of 20-40 years (60%), wherein the majority of cases were various types of incisional and ventral hernias. The higher prevalence of anterior abdominal wall lesions in the age group of 20-40 years probably explains the patients seeking medical/surgical attention more frequently than another age group due to various reasons.

Sex

Although there is no much significance of sex wise prevalence of anterior abdominal wall lesions, vast majority of studies in the literature have shown higher incidence of anterior abdominal wall lesions in females, majority being various kinds of incisional hernias, which probably explains the higher incidence of surgeries in females, e.g., Cesarean section which is the most commonly performed surgical procedure in the world literature (Table 5).

Table 3: Diagnostic validity of high resolution sonography

| Test | Positive | Negative | Total |
|----------|----------|----------|-------|
| Positive | 38 | 0 | 38 |
| Negative | 1 | 3 | 4 |
| | 39 | 3 | 42 |

Table 4: Age wise distribution of anterior abdominal wall lesions

| Age group | Number of cases | Total % |
|-------------|-----------------|---------|
| <20 years | 3 | 6 |
| 20-40 years | 30 | 60 |
| >40 years | 17 | 34 |

Diagnostic Accuracy of Clinical Findings

Among 50 clinical suspected anterior abdominal wall lesions the most common indication for high resolution sonography was incisional hernia, i.e., 28 cases (56%) out of 50 cases, followed by anterior abdominal lump, i.e., 11 cases (22%) out of 50 cases which is relatively a nonspecific clinical diagnosis, which later turned out be different lesions on high resolution sonography as well as histopathology which necessitates high resolution sonography with high frequency probe which helps in characterization, nature of the lesion with a very high specificity than clinical findings and equal to or slightly less than that of histopathological and surgical findings.

Diagnostic Accuracy of Ultrasonographic Findings

Among 50 various clinical suspected anterior abdominal wall lesions which were subjected for high resolution sonography, most commonly and accurately detected lesions of anterior abdominal wall were various types of incisional hernias, i.e., as many as 28 cases out of 50 cases (56%) followed by ventral hernias, i.e., 7 cases out of 50 cases (14%). We would like to emphasize another anterior abdominal wall lesion other than hernias which were common in our study was anterior abdominal wall lipomas, i.e., as many as 4 cases out of 50 cases (8%) were in all 4 cases correlated with histopathological findings.

Diagnosis of incisional hernias and ventral hernias on sonography is relatively simple because sonography can readily detect the anterior abdominal wall defect, contents of the hernias, as well as the reducibility of hernias due to the real-time imaging, with the application of color Doppler sonography differentiation between strangulated and nonstrangulated hernias can be made out. Anterior abdominal wall lipomas was the next common lesions detected in our study (4 cases), all 4 cases were accurately detected on sonography with 100% accuracy, all 4 cases of anterior abdominal wall lipomas showed similar sonographic findings, i.e., well defined round to ovoid, isoechoic to slightly hyperechoic echotexture as compared to the adjacent muscles along with a thin echogenic capsule.

Another common lesion was desmoids tumor and dermoid cyst, i.e., 2 cases each (6.66%). Sonographic diagnosis of both desmoids tumor and dermoid cyst was 100% accurate, wherein desmoids tumor appeared

as well defined hypoechoic lesions with increased vascularity on color Doppler at the site of previous laparotomy scar.

Anterior abdominal wall lesions which were diagnosed on USG was subjected for histopathology/post-operative findings which correlated accurately with our sonographic diagnosis in all cases with 97.6% accuracy. We have shown that sonographic diagnostic accuracy paralleled to histopathological/post-operative findings.

Some Common and Interesting Anterior Abdominal Wall Lesions in Our Study

Hernias

Hernias are the most common abdominal wall lesions seen in sonographic practice. Depending on their location and cause, they are divided into different categories. With a high-frequency transducer, the fascial defect can be visualized underlying the hernia. Herniated bowel loops have a variable appearance depending on their air-fluid content and degree of obstruction. During the real-time examination, induction and reduction of a hernia can be observed. The patient is asked to cough or perform a valsalva maneuver while scanning over the suspected sit is performed and with an increase in abdominal pressure, there will be better appreciation of hernia sac, site, and size of the defect and also contents of the hernia.

Ventral hernia

A ventral hernia occurs typically where there is no muscle support along the linea alba in the midline in the epigastrium (Figure 2) or periumbilical region (Figure 3). The defect can be easily made out in high-frequency probe, and the defect size can also be measured. The hernia very often contains only fatty tissue but at times may be large and contain bowel loops also.^{5,6}

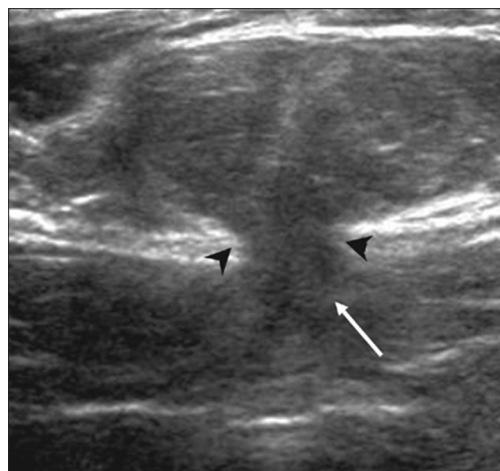


Figure 2: Ventral hernia. The omental fat is protruding through a defect in the rectus sheath

Table 5: Distribution of anterior abdominal wall lesions according to gender

| Sex | Number of cases | Total number of cases | Total % |
|--------|-----------------|-----------------------|---------|
| Male | 17 | 50 | 34 |
| Female | 13 | 50 | 66 |

Incisional hernia

An incisional hernia develops as a late complication of abdominal surgery. It also has been seen after laparoscopic procedures. Most incisional hernias will present within the first year; however, some go unnoticed by the patient and are incidentally detected on sonography or computed tomography. Sonography is very useful in ruling out a hernia at surgical sites and in monitoring the integrity of wire mesh implants⁷⁻⁹ (Figure 4).

Spigelian hernia

A spigelian hernia occurs because of a defect in the aponeurosis of the transverse abdominis muscle and the rectus sheath. The most common site is the point where the linea semilunaris crosses the arcuate line.^{10,11} The hernias may sometimes extend laterally and present as a flank lump before the use of high-resolution sonography, the diagnosis of spigelian hernia was missed in 50% of cases as per literature (Figure 5).

Inguinal hernia

An indirect inguinal hernia occurs as a result of protrusion of the peritoneal sac and contents through the internal inguinal ring into the inguinal canal and sometimes into the scrotum.¹² The internal inguinal ring is a defect in the transversalis fascia anterior to the femoral vessels, lateral to the inferior epigastric artery, and inguinal ring is a defect in

the external oblique aponeurosis. Direct inguinal hernias protrude through a weakened inguinal canal floor, medial to the inferior epigastric artery. Depending on the content, namely, fluid, air-containing bowel, or fluid-containing bowel, inguinal hernias will have different appearances on sonography. Distended, adynamic bowel indicates obstructed loops. The inferior epigastric artery can be visualized on color Doppler sonography, and then, differentiation of a direct or an indirect inguinal hernia is possible^{3,13} (Figure 6).

Femoral hernia

A femoral hernia protrudes through the femoral canal (Figure 7). Sonographic differentiation depends on demonstration of the hernia medial to the femoral vein.¹⁴ Most patients are elderly and obese and have abdominal or groin pain with or without a palpable mass.

Neoplasms

Lipomas

Lipomas are the most common abdominal wall neoplasm. They are well defined, ovoid or pad like masses (Figure 8)

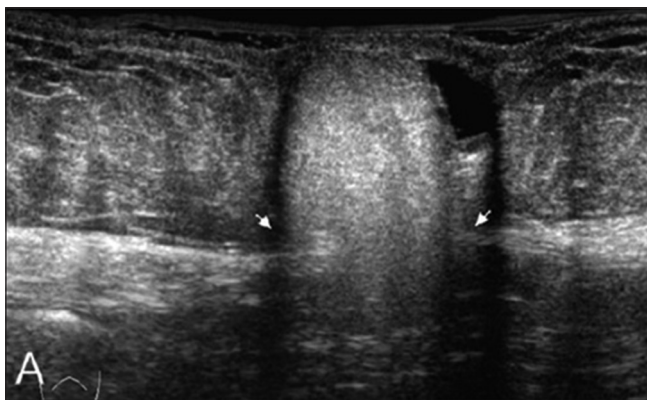


Figure 3: Peri-umbilical hernia. Fat is herniating through a defect in the rectus sheath



Figure 4: Incisional hernia. The image shows the hernial sac protruding through a scar defect (H: Hernial sac)

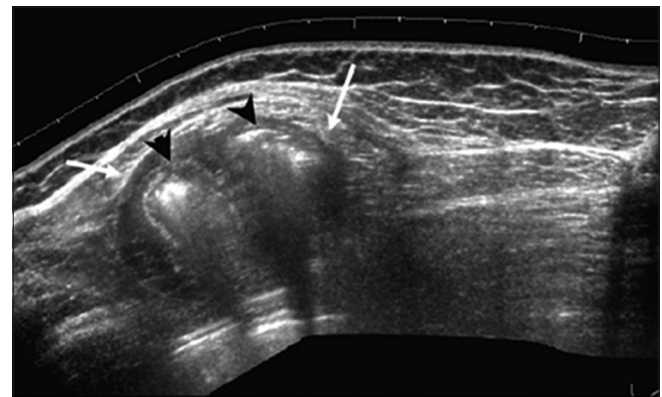


Figure 5: Spigelian hernia. The image shows the hernia containing bowel loops

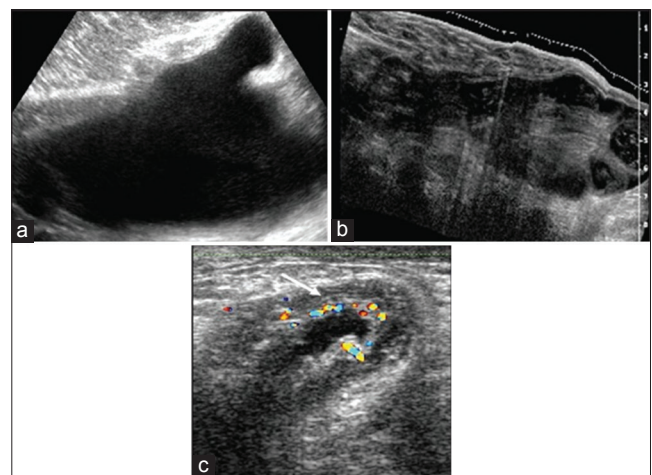


Figure 6: Inguinal herniae in different patients, (a) fluid containing and (b) non-obstructed, and (c) obstructed bowel loops

most of them reveal an iso to slightly hyperechoic texture as compared to the muscles, along with a thin echogenic capsule.²⁵

Desmoid tumor

Arises from the fascia or muscle aponeurosis. It often develops at the previous surgical scar and is more commonly in female patients than in male patients.^{6,7} Sonologically shows lobulated solid, well defined heterogeneous mass with moderate blood flow (Figure 9).

Metastatic melanoma

Is probably the most common metastatic malignant tumor to occur in the abdominal wall. Less commonly, metastases from lymphoma, lung, breast, ovary, and colon may be seen.

Fluid collections

Localized fluid collections in the abdominal wall may be due to seromas; abscesses or liquefying hematomas.

Seromas

These usually occur after surgical procedures. They usually appear as well-defined anechoic lesion with irregular

margins and internal echos with posterior acoustic enhancement on high-resolution sonography¹⁵ (Figure 10).

Abdominal wall abscess

May be due to various causes like - A cold abscess secondary to tuberculosis of the ribs may present as a lump. USG reveals pockets of fluid, along the costal margin, with internal echoes. Destruction of the corresponding rib may be seen.¹⁶⁻²⁰ Suture abscesses are seen as irregular collections within the layers of the abdominal wall, around infected sutures; fragments of suture materla may sometimes be seen within this collection (Figure 11).

Hematomas

Hematomas commonly occur in the rectus sheath, in patients who are on anticoagulant therapy or in those who suffer from some coagulation disorder, especially following violent muscle contraction, e.g, after a bout of coughing or seizures. The shape of the hematomas depends on their location and follows the limits of the rectus sheath. Above the arcuate line, hematomas are usually ovoid in shape, with a superoinferior long axis, typically seen on one side. Below the arcuate line, they can extend across the midline, as there is no midline aponeurosis²¹⁻²³ (Figure 12). In neonates, an abdominal wall hematoma may be limited to the subcutaneous layer and

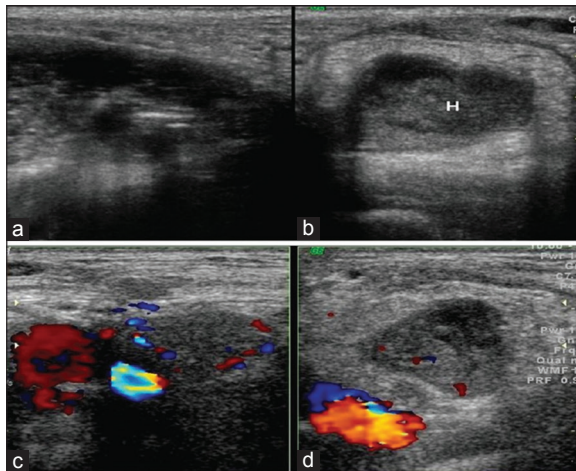


Figure 7: Femoral hernia - ultrasonography with color doppler.
 (a) Grayscale images show a femoral hernial sac at two different levels. (b) The color Doppler images show the sac lying medial to the femoral vessels

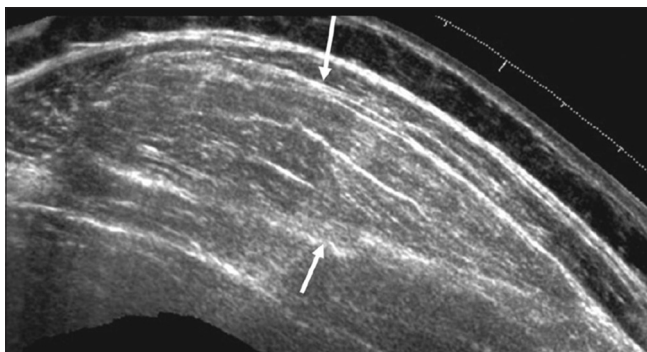


Figure 8: Lipoma. The image shows a well-defined mass with a capsule

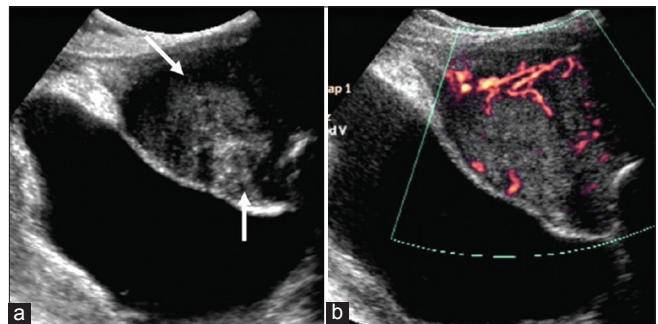


Figure 9: Desmoid. Grayscale (a) and color Doppler (b) images reveal a mass (arrows) at the site of a previous surgical scar, showing some vascularity within

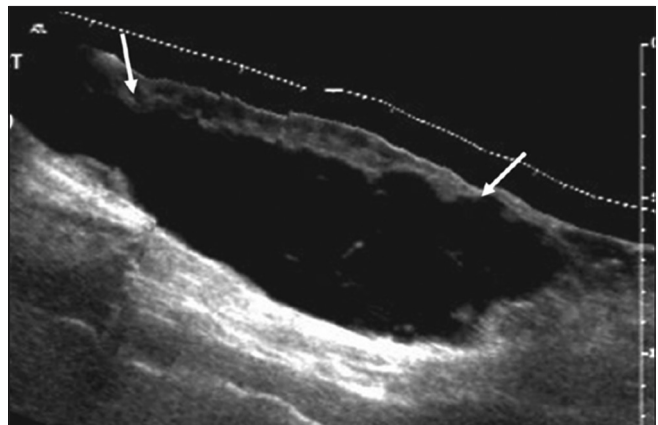


Figure 10: Seroma. Abdominal wall seroma, after splenectomy

may be spread transversely in the supraumbilical region. In post-operative patients, large hematomas may often be seen, in the vicinity of the surgical scar.

Miscellaneous

Urachal cyst

Aurachal cyst develops from urachal remnants. It is usually situated between the umbilicus and the urinary bladder. USG reveals fluid filled septated mass, with thickened wall and faintly echogenic fluid superior the bladder and attached to the lower mid anterior abdominal wall^{24,25} (Figure 13).

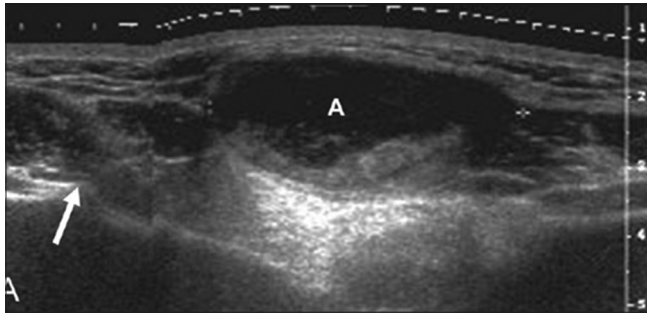


Figure 11: Complex abscess, inferior to the costal margin

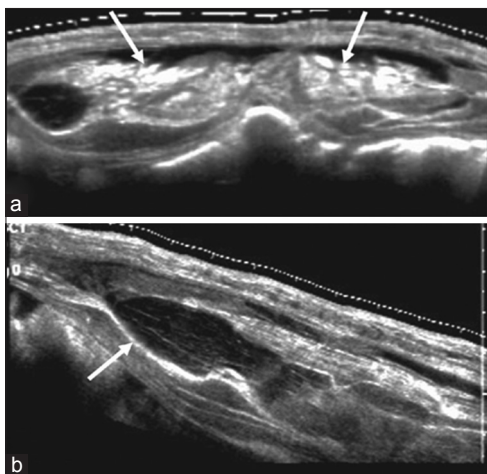


Figure 12: Rectus sheath hematoma. (a) Transverse and longitudinal (b) images show a hematoma following severe cough

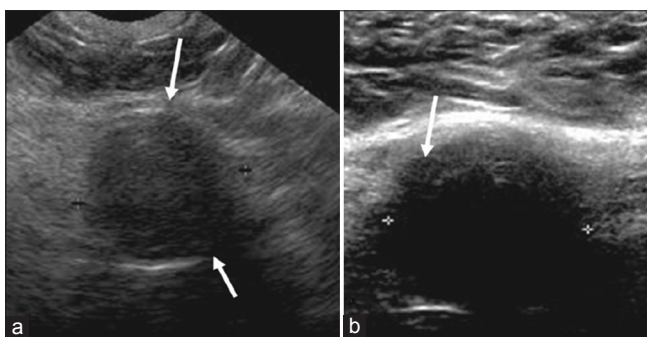


Figure 13: Urachal cyst. Transverse image shows an (a) infected urachal cyst (arrows), containing faintly echogenic fluid, the anterior wall of which produces (b) reverberation artifacts

Endometriosis

Endometriosis of the abdominal wall usually develops as complication of uterine surgery, due to seeding of endometrial tissue. Typically, it is seen as a focal mass at the scar of previous surgery. The size and the associated pain may vary cyclically.²⁶

CONCLUSION

The prevalence of anterior abdominal lesions was higher in the age group between 20 and 40 years. Ventral hernia was the most frequently encountered abdominal wall lesion. The most common indication for high-resolution sonography was palpable abdominal lump, which shows the low specificity of clinical examination in evaluation of anterior abdominal wall lesions. High-resolution sonography is an accurate tool in evaluation of various kinds of hernias (ventral, incisional, spigelian, and other types of hernias). We would like to emphasize on other anterior abdominal wall lesions other than hernias such as lipoma, desmoid, hematoma, dermoid cyst, metastatic melanoma, and resolving abscess, where sonography was an excellent complementary tool for the surgical management. Diagnostic accuracy of sonography was 97.6% in evaluation of hernias, lipomas, desmoid, dermoid, hematoma, and resolving abscess.

RECOMMENDATIONS

High-resolution USG is a very useful procedure which can be used for diagnosing the common abdominal wall lesions accurately.

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