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Review Article

A Review of Rectus Muscle Lesions Encountered in Clinical Practice: Review

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Abstract

Background: The rectus muscle is a major supporting muscle of the anterior abdominal wall. Lesions in the rectus muscle are rare in abdominal imaging. The commonest solid mass in the rectus muscle is the desmoid tumor. Usually, the lesions are manifestations of pre-existing conditions. Hence, thorough knowledge about the rectus muscle lesions is essential in modern-day practices.

Objectives: The objective of this article is (1) to provide a systematic way to approach rectus muscle lesions, (2) to classify based on their composition, and (3) to provide information about imaging characteristics of different rectus muscle lesions.

Methods: This is a retrospective study of rectus muscle lesions. It was done over a period of 1 year from September 2022 to August 2023. The study was done using a GE Revolution 128 computed tomography machine. At the end of our study, various rectus muscle lesions were identified. They are classified based on their imaging features.

Results: The following lesions were commonly observed in our study: (1) Rectus muscle hematoma, (2) abscess, (3) tropical myositis, (4) necrotizing fasciitis, (5) endometriosis, (6) desmoid tumor, (7) cysticercosis, and (8) hamartoma.

Conclusion and Contribution: The rectus muscle lesions are rare in daily practice. Our study helps to understand anatomy and provides information regarding various lesions which aids in early diagnosis and better treatment planning. Hence, multimodality imaging plays a key role in arriving at the diagnosis and altering the course of management.

Key words: Abscess, Arcuate line, Computed tomography, Hematoma, Rectus muscle

INTRODUCTION

Rectus muscle lesions are mostly incidentally detected finding in cross-sectional imaging. However, in certain cases, there can be an anterior abdominal wall mass pointing toward the rectus muscle lesion. The important point is to differentiate a rectus muscle lesion from the anterior wall hernias. The lesions can further be classified based on their composition, which will vary their appearance on imaging. The most common rectus muscle lesion is the desmoid tumor.

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Correlating proper histories with imaging findings helps to narrow the differentials. For example, cyclical abdominal pain every month drives the diagnosis in favor of rectus muscle endometriosis. The history of trauma points more toward a hematoma. The purpose of this article is to provide a systematic way to approach rectus muscle lesions, classify them according to their composition, and provide information about their imaging characteristics.

Anatomy: [Figure 1]

The anterior abdominal wall muscles are usually three layers, namely the external and the internal oblique, transverse abdominis, and the central rectus abdominis. The arcuate line is located midway between the umbilicus and the superior border of the pubic bone.[1] Above the level of the arcuate line, the rectus sheath encases the rectus abdominis muscle both anteriorly and posteriorly. Whereas below the level of the arcuate line, it presents only anteriorly. Hence, the lesions or collections above the arcuate line tend to be unilateral whereas below it, they tend to be bilateral.

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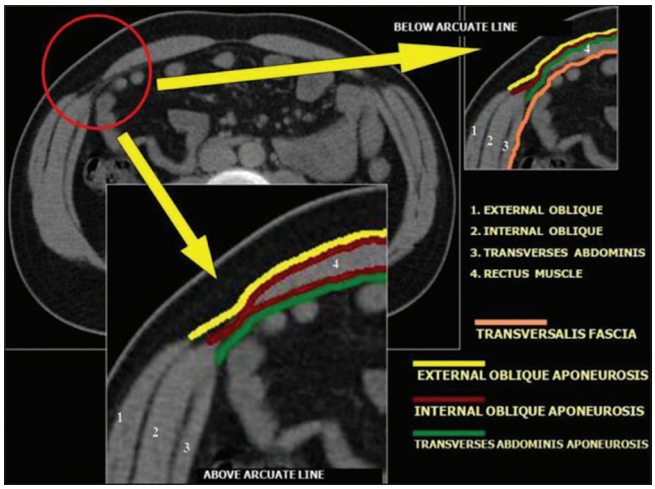

Figure 1: The axial section of the computed tomography abdomen showing the absence of rectus sheath posteriorly (Yellow arrow) below the level of arcuate line

RECTUS SHEATH HEMATOMA

It refers to the accumulation of blood within the rectus sheath. The cause can either be due to the rupture of superior or inferior epigastric artery. The rectus sheath hematomas are usually very rare causes of abdominal pain contributing only about 2–3%.

Classification based on location	
Above the level of arcuate line	Usually, it is spindle-shaped since it is confined by a circumferential sheath
Below the level of the arcuate line	Usually, less circumscribed since it can extend posteriorly into the peritoneum and prevesical space

Etiology

Trauma, which can either be a blunt or penetrating injury to the abdominal wall, tends to play a major role in the formation of rectus sheath hematoma. Exercise-related stretching and any surgery on the abdomen can also lead to contusions. Another iatrogenic cause could be repeated injections in the abdominal wall. Patients with coagulopathy and on anticoagulation medications can rarely develop hematomas.

Imaging Findings: [Figures 2-4]

On ultrasound imaging, rectus sheath hematoma appears as a predominantly hyperechoic mass. Over the course of time, as the hematoma ages, it becomes hypoechoic. At computed tomography (CT), it usually appears as a hyperdense mass lesion confined to the rectus sheath.[2] Upon contrast-enhanced CT, active extravasation of the contrast from either superior or inferior epigastric arteries can be visualized in cases of active bleeding. Lack of enhancement is noted in cases of organized hematomas.

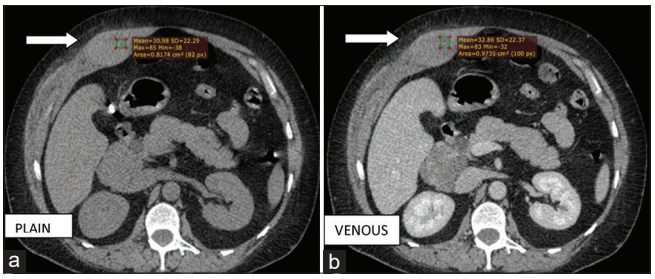

Figure 2: (a and b) Axial contrast-enhanced computed tomography sections showing a hyperdense hematoma in the right rectus sheath (White arrow) in a male presenting with abdominal trauma. No evidence of any enhancement was noted upon contrast administration

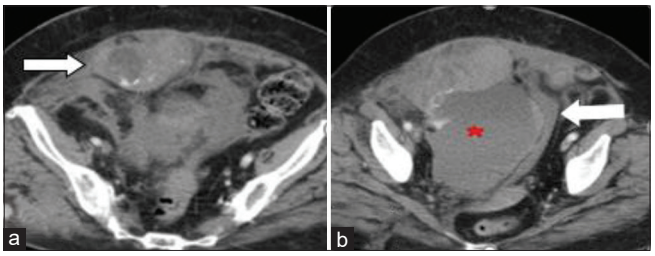

Figure 3: (a and b) Axial contrast-enhanced computed tomography sections showing rectus sheath hematoma, with active bleeding in the arterial phase (3a White arrow). Extension into the perivesical space and compression of the bladder are noted (3b White arrow)

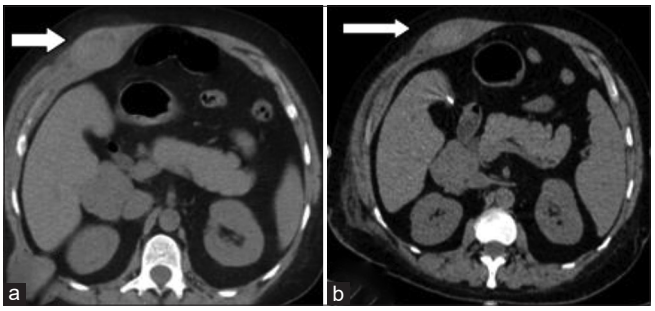

Figure 4: (a and b) Axial computed tomography (CT) section showing right rectus hematoma on the day of trauma (4a White arrow). Axial CT section showing a resoling hematoma over a span of 15 days (4a White arrow)

Over a period of time, as the hematoma breaks and starts to liquefy, the density of the hematoma in CT starts to decrease. The hematoma shows resolution in follow-up studies.

Histopathology: [Figure 5]

Analysis of the specimen from rectus sheath hematoma shows fibro adipose tissue with araes of inflammation and hemorrhage.

RECTUS MUSCLE ABSCESS

Rectus muscle abscess can be defined as a fluid collection in the rectus muscle with an over-added infection. It usually

occurs secondary to any of the intra-abdominal pathologies. Primary abscesses are rare and can be due to any of the immunocompromised states. The patient usually presents with a fever. Swelling and tenderness can be seen on the abdominal wall.

Etiology

The spread of infection and the formation of an abscess can occur in many ways. It can either be spontaneous or can occur following surgery or trauma. Abscesses following surgery were much more common earlier than now. It can also occur secondary to an intra-abdominal inflammatory pathology or extension of a nearby abscess.

Imaging Findings: [Figures 6 and 7]

Upon ultrasound, the rectus muscle abscess appears as a hypoechoic collection with internal septations.[3] Usually, it is a multilocular collection. In cases of gas formation within the abscess, internal echogenic reflections can be seen. Upon CT a well-defined fibrous capsule can be seen around the abscess. The capsule enhances contrast administration. The capsule usually is irregular and thick which helps to differentiate from other conditions. The abscess appears as a hypodense collection in the muscle with a central necrotic component. Inflammatory changes in the form of peritoneal fat stranding can be seen. In cases of active inflammation, the abscess starts to efface the adjacent structures.

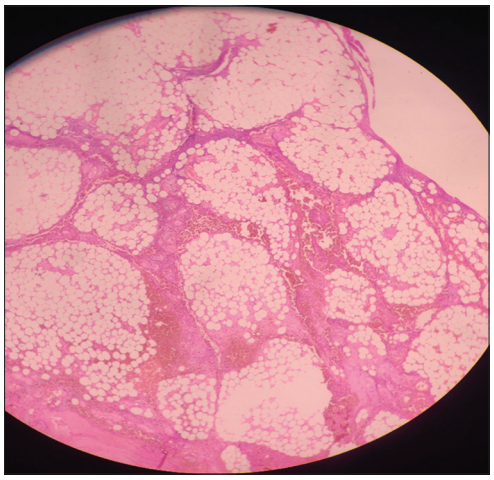

Figure 5: On biopsy, H and E-stained sample showing fibro-adipose tissue with large areas of hemorrhage and active inflammation

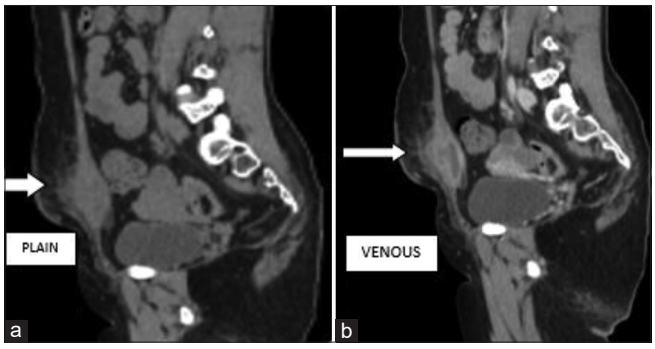

Figure 6: (a and b) Sagittal contrast-enhanced computed tomography sections showing an ill-defined heterodense collection in the rectus muscle (6a White arrow). Capsular ring enhancement is seen around the collection in the venous phase (6b White arrow)

Histopathology: [Figure 8]

Analysis of the specimen from the rectus muscle abscess shows infiltration of inflammatory cells. Disruption of the normal cell architecture with the formation of vacuoles can be seen.

TROPICAL MYOSITIS

Tropical myositis refers to the purulent inflammation of the rectus muscle. It is due to the hematogenous spread of

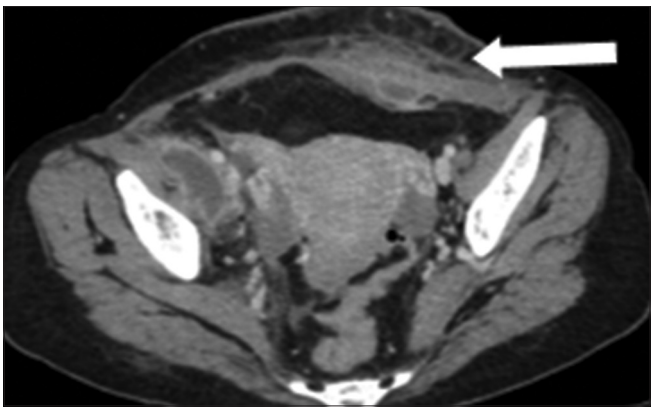

Figure 7: Axial contrast-enhanced computed tomography section showing a multilocular hypodense collection in the left rectus muscle with an enhancing capsule in the venous phase. Surrounding inflammatory changes could be appreciated

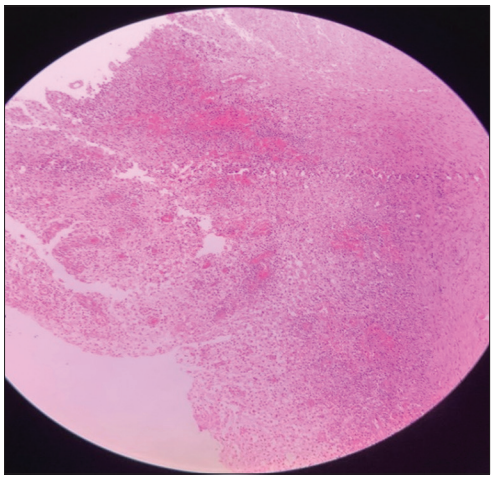

Figure 8: H and E-stained sample from the above rectus muscle abscess showing neutrophilic infiltration, suggesting an inflammatory pathology

the microorganism through the blood to the muscle, mostly bacteria. Almost 95% of cases are due to the staphylococcus aureus infection. The disease is prevalent mostly in the tropical areas. Nowadays, increased incidence of the disease is noted in the immunocompromised hosts. The patient here usually presents with fever and generalized body pain and weakness. Pus discharge can be seen from the abdomen.

Pathogenesis

Myositis usually starts with injury to the rectus muscle which can either be due to trauma or due to overuse, leading to the formation of intramuscular hematoma. Subsequent bacteremia over the hematoma results in the formation of rectus muscle myositis.

Imaging Findings: [Figure 9]

In cases of rectus muscle myositis, if abscess is present, on CT, it appears as a collection within the muscle with a peripheral rim enhancement.[4] The affected muscle usually appears enlarged and hypodense. Inflammatory fat stranding is seen surrounding the muscle. Upon contrast administration, it shows heterogeneous enhancement.

Histopathology: [Figure 10]

Degenerative changes in the muscle fibers along with interstitial inflammatory infiltrates can be seen. Changes in the myofiber size along with areas of necrotic myofibers can also be seen.

NECROTIZING FASCIITIS

Necrotizing fasciitis refers to the infection and inflammation of the rectus muscle and the fascia deep into the skin. Usually, it is a fatal disease with the mortality rate reaching up to 50–60%. The common cause of death includes sepsis and multi-organ system failure. The patient usually presents with vague symptoms, such as fever and malaise. Skin changes are often mistaken for cellulitis. The infection tends to spread rapidly, and the skin is usually warm and hard.

Etiology

The elderly and the immunocompromised are at major risk of developing rectus muscle fasciitis. However, healthy individuals are not completely spared. Intramuscular drug abusers, any skin trauma, and people with diabetes are at major risk. The presence of an underlying infection often predisposes to it. The disease is most commonly due to clostridium or Escherichia infection. As the mortality from it is very rapid, the need for radiological imaging for early diagnosis is growing nowadays.

Imaging Findings: [Figure 11]

The most specific feature in CT is the presence of fluid collection along with air in the deep fascia above the rectus muscle.[5] The presence of abscesses is seen clearly with CT. The infective etiology predisposing to necrotizing fasciitis can also be seen. Upon contrast administration and enhancement of the fascial layers can be seen. In aggressive cases, the underlying bone gets involved, which

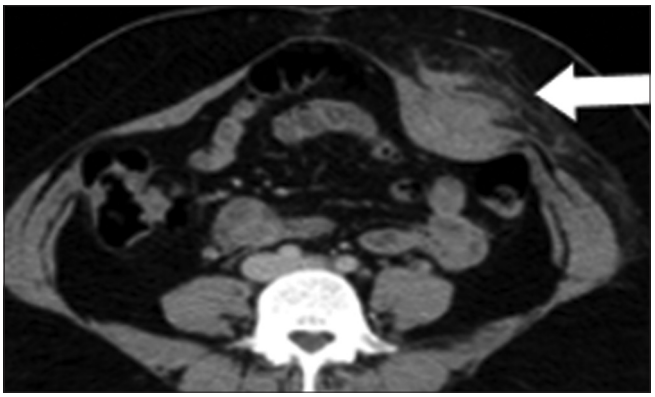

Figure 9: Axial contrast-enhanced computed tomography sections showing bulky and heterogeneous left rectus muscle with surrounding inflammatory changes

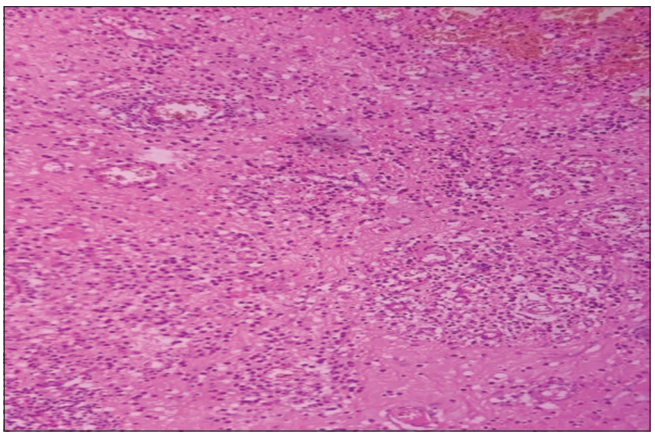

Figure 10: H and E-stained sample from the above rectus muscle showing areas of fibrosis with dense inflammatory granulation tissue

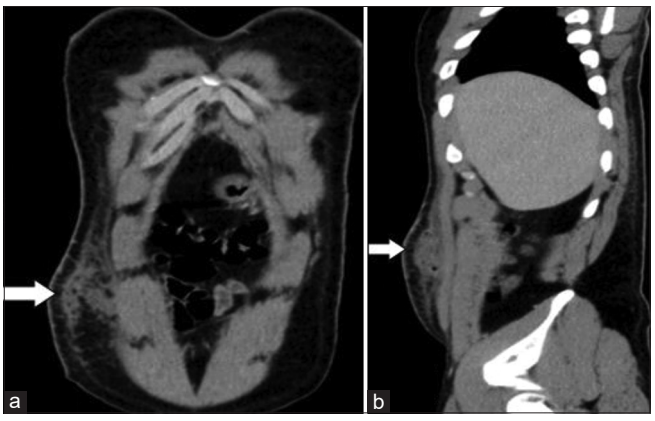

Figure 11: (a and b) Coronal and sagittal computed tomography sections in a case of necrotizing fasciitis showing edema of the right rectus muscle and the adjacent soft tissue. Deep muscular fascia is involved with the presence of air foci within (White arrow) and surrounding inflammatory fat stranding

can be seen as bony erosions in CT. The fat around the fascia gets affected and the presence of lymphadenopathy indicates the presence of inflammation.

Histopathology: [Figure 12]

The histopathological examination usually reveals areas of extensive tissue necrosis. Microthrombus can be seen within the vessel wall. The growth of microorganisms can sometimes be seen within the vessel wall. The involvement can either be superficial or deep.

ENDOMETRIOSIS

Endometriosis of the rectus sheath refers to the presence of endometrial tissue in the rectus sheath which is functional. Endometriosis is usually a disorder of the pelvic organs but can rarely occur in the rectus sheath also. It is usually associated with hysterectomy or cesarean section scars but can also be seen in patients without surgical history. The patient usually presents with cyclical abdominal pain, which is associated with menses and painful swelling usually adjacent to any scars on the abdominal wall.

Etiologies

Many theories have been proposed regarding the etiologies of endometriosis. Some say that it is due to the retrograde menstruation. While others say that it is due to venous/lymphatic metastasis or due to mechanical transplantation. Rectus sheath endometriosis occurs usually adjacent to the cesarean section/hysterectomy scars.[6]

Imaging Findings: [Figure 13]

On ultrasound examination, endometriosis of the rectus sheath usually appears as a nodular mass that is hypoechoic and is usually adjacent to the scar site. Internal vascularity can be seen since it is a functional tissue. Internal cystic areas can be seen due to repeated menstruation from the site. Upon CT, it usually appears as an enhancing nodular lesion on the rectus sheath.[7] A close differential is the desmoid tumor which also presents in menstruating women and has similar imaging findings, except that patients do not present with cyclical abdomen pain with menses.

Histopathology: [Figure 14]

Histopathological examination of the tissue from the rectus sheath endometriosis shows endometrial type glands/stroma. Areas of chronic hemorrhage can be seen within. Areas of necrosis with atypical cells can also be seen.

DESMOID TUMORS

Desmoid tumors refer to benign neoplasms that can occur in the abdominal wall in the rectus sheath or in the retroperitoneum. It is the most common abdominal wall mass. It is usually locally invasive and has a high rate of local recurrence. It rarely shows metastasis to a distant location. Patients usually present with painless abdominal swelling. Desmoid tumors can be seen in association with Gardner syndrome.[8]

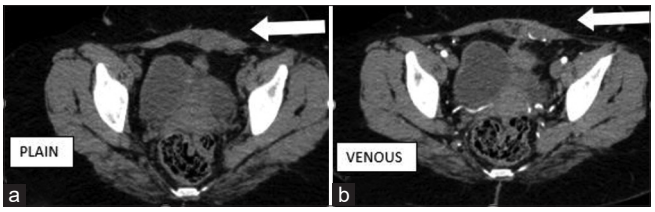

Figure 13: (a and b) Axial contrast-enhanced computed tomography section showing a hypodense enhancing nodular mass in the left rectus muscle in a patient presenting with cyclical abdominal pain

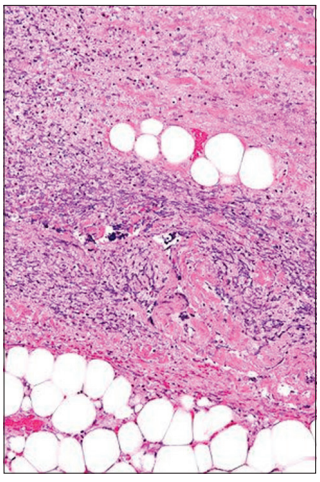

Figure 12: H and E-stained sample from the above rectus muscle showing areas of necrosis and neutrophilic infiltration

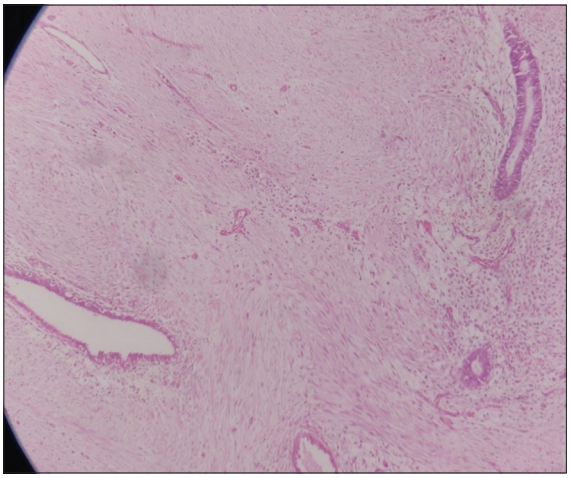

Figure 14: H and E-stained sample from the above-left rectus muscle showing fibrofatty tissue with scattered endometrial gland/stroma

Imaging Findings: [Figure 15]

Upon ultrasound, the rectus muscle desmoid tumor appears as a hypoechoic mass. It appears homogenous and shows internal vascularity on the color Doppler. Upon CT, most desmoid tumors appear as a well-defined mass. However, certain cases can be very aggressive and can be ill-defined. Upon plain CT imaging, they appear as homogeneously hyperdense masses. Enhancement of the mass can be seen on contrast administration. Patients presenting with Gardner syndrome usually present with multiple and large rectus sheaths desmoid tumors.[9]

Histopathology: [Figure 16]

Collagenous tissue can be seen with spindle-shaped cells. Mild-to-moderate cellularity with minimal atypical cells can be seen.

RECTUS MUSCLE CYSTICERCOSIS

Cysticercosis refers to the infection caused by the parasite Taenia solium. Man is the definite host here and the pigs are the intermediate host. Consumption of undercooked pork accounts for this infection to occur. Rectus muscle cysticercosis is a very rare entity and we can see cysts with scolex within the muscle. In later stages, the cysts may get calcified. Patients usually present with a history of travel to the endemic zone. Muscular system involvement alone is rare. Patients usually have myalgia or mass-like enlargement within the muscle.

Imaging Findings: [Figures 17 and 18]

Upon ultrasound, it usually occurs as an echogenic scolex which is located eccentrically.[10] Due to the death of the larva, an inflammatory mass can be seen around.

Upon CT, it is usually an incidental finding. It is usually seen as multiple seed-like calcifications within the rectus muscle. The calcifications are spread throughout the muscles giving the so-called starry sky appearance.

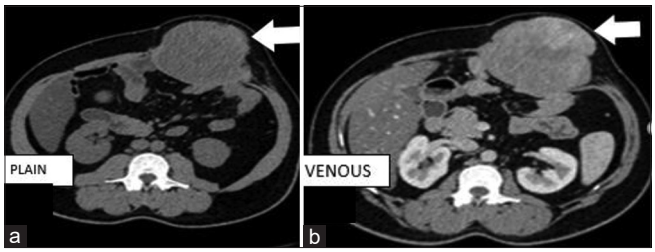

Figure 15: (a and b) Axial contrast-enhanced computed tomography section showing a desmoid tumor appearing as a well-defined lobulated hyperdense mass arising from the left rectus muscle (15a White arrow), showing heterogeneous contrast enhancement (15b White arrow)

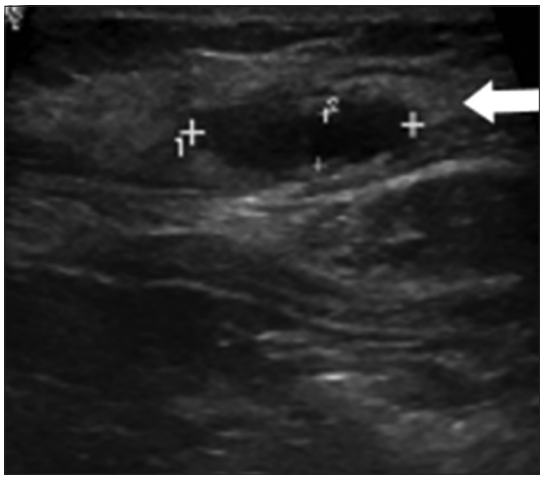

Figure 17: Ultrasound imaging of the rectus muscle showing eccentrically located echogenic scolex with surrounding inflammation (White arrow)

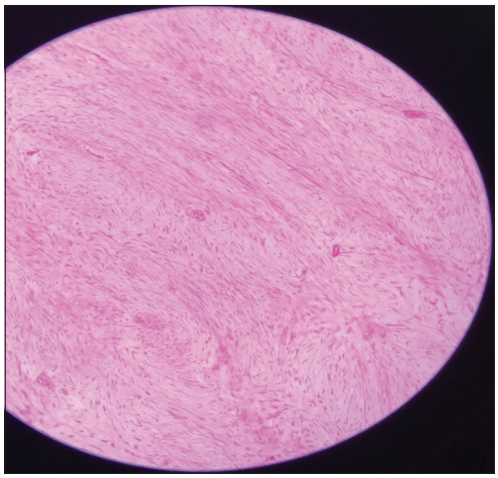

Figure 16: H and E-stained sample from the above-left rectus muscle showing fibrocollagenous tissue with areas of spindle cells within

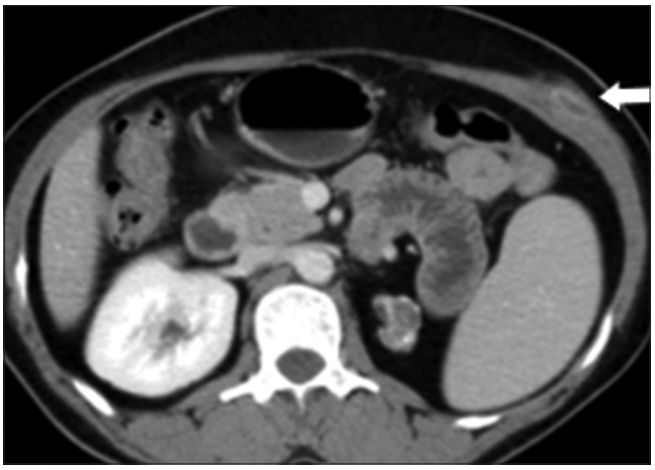

Figure 18: Axial contrast-enhanced computed tomography section showing bulky left rectus with a calcified cyst within (White arrow), suggestive of cysticercosis

Figure 19: Axial computed tomography section showing a rectus muscle hamartoma appearing as a relatively well-defined heterodense mass lesion in the right rectus muscle (White arrow)

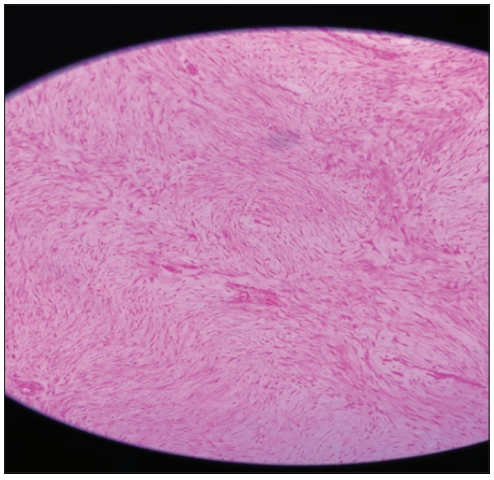

Figure 20: H and E-stained sample from the above right rectus muscle mass showing a mixture of blood vessels and collagenous tissue

Magnetic resonance imaging (MRI) is superior to CT and is the gold standard for diagnosing intramuscular cysticercosis. It can demonstrate both the live scolex and the degenerating cysts. The cysts usually appear hypointense on T1-weighted images and hyperintense on T2-weighted images. Scolices show low signal intensity on T2-weighted images. Surrounding edema can be seen in all cases.

RECTUS MUSCLE HAMARTOMA

Rectus muscle hamartomas are usually benign and are mostly known to arise from congenital cell rests. They usually contain a mixture of cartilage, fat, smooth muscles, and a rich collection of blood vessels. Proliferation of these mesenchymal elements results in the formation of the hamartoma. The architecture of the rectus muscle may be distorted by the hamartoma. The affected patients usually remain asymptomatic for a longer period.

Etiologies

Hamartomas can occur either sporadically or as part of certain syndromes. They can be seen as a part of the tuberous sclerosis complex or in the carneys triad. It is not localized only to muscles. It can occur in every organ system of our body. The usual presentation is of abdominal swelling which is mostly painless.

Imaging Findings: [Figure 19]

Rectus muscle hamartoma usually appears as a well-delineated mass and mostly contains a surrounding dense capsule. It usually shows heterogeneous density in a CT due to the presence of a mixture of components within it.[11] Dystrophic or punctate calcifications can be seen in 20% of the cases. Upon MRI imaging, the fat component within the hamartoma appears hyperintense on T1 and T2 and the rest of the components appear hypointense.

Histopathology: [Figure 20]

Upon histopathological examination, rectus sheath hamartoma usually shows a mixture of fat, blood vessels, and connective tissues. Fibrous septa can also be seen in certain cases.

CONCLUSION

With the advancements in medical imaging, the diagnosis of rectus muscle lesions has been made much easier. In addition, eliciting proper history and clinical examination aids in clinching the diagnosis. Upon identifying a rectus muscle mass, it can be classified based on the composition of the mass or its gross appearance on imaging. The rectus muscle masses can range from a traumatic hematoma to a metastatic lesion. Hence, the knowledge about these masses helps in the appropriate interpretation of them when detected incidentally.

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