

ROLE OF MRI IN EXEMPLIFYING THE SACRAL LESIONS

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Abstract

Background: A wide variety of disease processes can involve the sacrum either focally or as part of a systemic process. Plain radiographs, although limited in evaluation of the sacrum, should be carefully examined when abnormalities of the sacrum are suspected. Cross-sectional imaging, particularly magnetic resonance (MR) imaging, plays a crucial role in identification, localization, and characterization of sacral lesions. The aim and Objective is to interpret imaging evaluation of sacral lesions, to discuss radiological feature of different sacral tumor. **Materials and Methods:** Imaging was performed on 1.5 Tesla SEIMENS MRI with conventional T1 weighted, T2 weighted, FLAIR and T1W contrast imaging done for selected patients who were referred to Department of Radio diagnosis, Tirunelveli Medical College Hospital between August 2022 and January 2023 with history of sacral swelling, primary malignancy, developmental anomaly and pregnant women referred for fetal MR imaging with sacral abnormality seen at obstetric sonography were reviewed and about 22 cases were noted with sacral lesions. **Result:** This study stated that the secondary sacral lesions are more common than the others with equal gender predilection and occult disease will have a delayed presentation. **Conclusion:** The vast majority of primary sacral tumours are aggressive. The majority of tumours have nonspecific symptoms when they first appear, thus a high level of clinical suspicion and high-quality imaging are needed to make the diagnosis. While imaging the sacrum, MRI and CT play complimentary functions. These techniques are essential for preoperative planning, biopsies, and determining how the masses affect the surrounding structures.

INTRODUCTION

Bone, cartilage, marrow components, and notochord remains make up the sacrum. Any of these factors can lead to sacral tumours. The sacrum harbors hematopoietic bone marrow, making it a common place for lymphomas, multiple myelomas, and plasmacytomas to metastasize. In actuality, metastases are the most prevalent sacral malignancies. Primary malignant sacral tumours, such as chordomas, chondrosarcomas, osteosarcomas, and Ewing sarcomas, are less frequent. The best imaging modalities for assessing sacral masses are computed tomography (CT) and magnetic resonance imaging (MRI).

MATERIALS AND METHODS

Our study is a retrospective descriptive study. Imaging was performed on 1.5 Tesla SEIMENS MRI with conventional T1 weighted, T2 weighted

, FLAIR and T1W contrast imaging done for selected patients who were referred to Department of Radio diagnosis, Tirunelveli Medical College Hospital between August 2022 and January 2023 with history of sacral swelling, primary malignancy, developmental anomaly such as anorectal malformation, sacrococcygeal teratoma, pregnant women referred for fetal MR imaging with sacral abnormality seen at obstetric sonography were reviewed and about 22 cases were noted with sacral lesions. MRI findings were correlated to narrow the differential diagnosis, and this paper will offer a holistic approach to exemplifying the rare sacral lesions.

RESULTS

Age

In our study among 22 cases 3 cases were antenatal, 2 cases were belongs to the age group of 1-10 years, 4 cases were belongs to 31 - 40 years, 5 cases were

belongs to 41-50, 4 cases were belongs to 51-60 years and 4 cases were > 60 years. This study revealed the significant number of patient presenting with sacral lesions were between the age group of 41- 50 years [Chart 1].

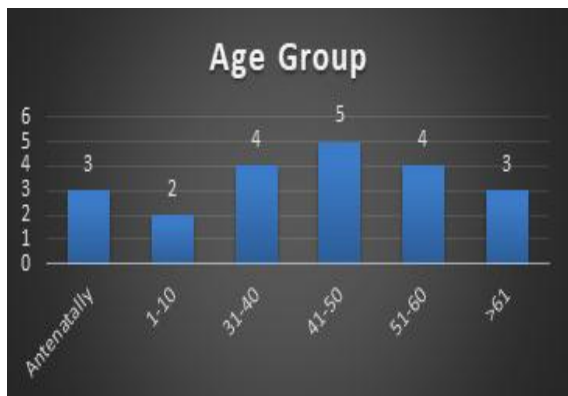


Chart 1: Age-wise distribution of sacral lesion

Sex

Our study evaluated a total of 22 cases among which 47.62% were males and 52.4% were females [Chart 2].

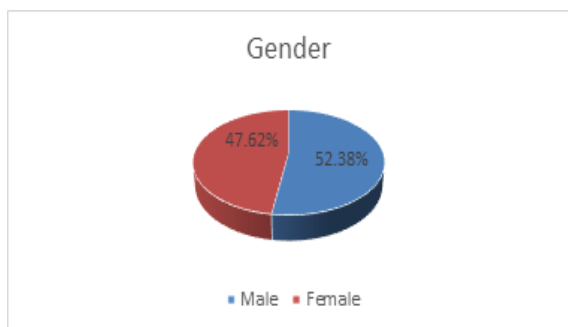


Chart 2: Sex-wise distribution of sacral lesions

Categorization of sacral lesions:

Of among 22 cases, developmental sacral lesions noted in 6 cases (28.5%), acquired lesion in 6 cases (28.5%), secondary lesion in 10 cases (47.6%). Hence it is noted that the primary sacral lesion is equally distributed between developmental and aquired lesions. Secondary sacral lesions were noted in major number of cases [Chart 3]

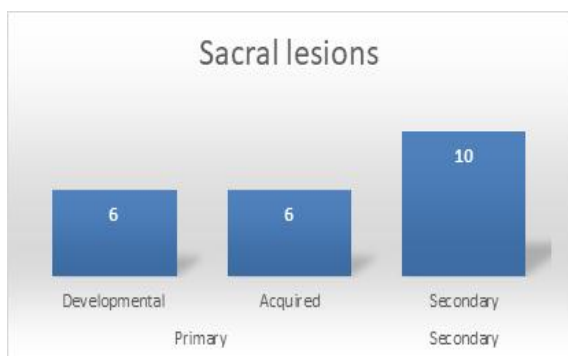


Chart 3: Categorization of sacral lesions

Clinical Presentation

Among 22 cases, about 52% were presented with numbness, 42.9% with weakness, 23.8% with swelling. [Chart 4]

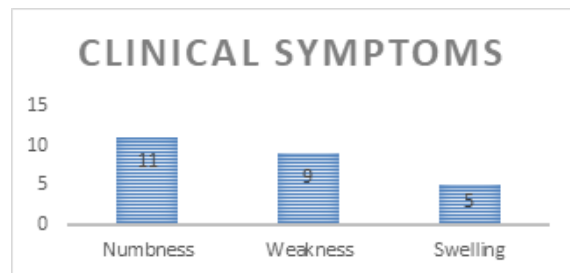


Chart 4: Clinical Presentation of sacral lesions

Research Ethics Standards Compliance

All procedures performed in studies involving human participants were in accordance with the ethical standards

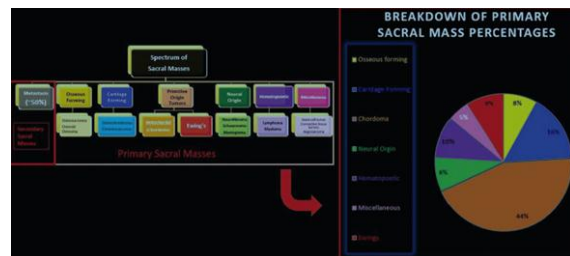


Figure 1: Pie chart showing the relative incidence of various types of sacral masses

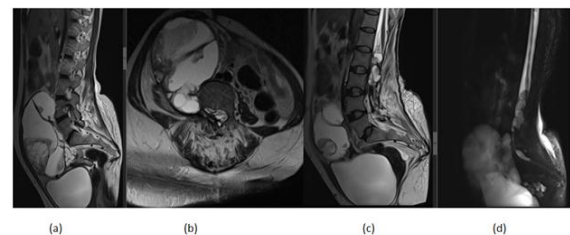


Figure 2: 32 year female with history of progressive distension of abdomen with right lower limb weakness. (a), (b), (c) T2 sagittal image showing multiloculated hyperintense lesion with multiple septations & soft tissue areas noted in the pelvis with extension into the neural foramen at L5-S1 level & to the intradural & extramedullary region. (d) Myelogram image showing the continuation with lesion in pelvis. Diagnosis : Nerve sheath tumor/ schwannoma

Acquired Sacral Masses

Nerve Sheath Tumor (Schwannoma and Neurofibroma)

Age and Sex: 20 - 40. No sexual preference.

Incidence: 6 to 30%. Nerve sheath tumours in the spine can be intramedullary extramedullary, extradural, or both. 8% of primary sacral tumours are neurogenic tumours.

Clinical Presentation: pain and radiculopathy are most typical signs and symptoms.

Imaging: The slow growth of these tumors causes remodeling and widening of the sacral neural foramina by exerting mass effect on the foramina. The presence of more than one nerve sheath tumor or tumor extension along the length of a nerve (a plexiform neurofibroma) should prompt investigation for syndromic association including neurofibromatosis or schwannomatosis. On MRI, masses are most commonly intradural and

extramedullary, T2 hyperintense, and often contain enhancing solid components (figure 2). A peripheral nerve sheath tumor containing both intra- and extradural components is often recognized by a “dumbbell sign”. The “target sign” (central T2 intermediate or hypodensity surrounded by T2 hyperintensity) due to a combination of fibrous and collagenous tissues.

Metastases

Lung, breast, prostate, kidney, head and neck, skin (melanoma) and gastro-intestinal cancers are the most common tumours that can produce sacral metastases. Most metastases are osteolytic except for prostate cancer, where metastases are mainly osteoblastic. Osteolytic lesions have a hypointense signal on T1-weighted sequences and iso- to hyperintense signal on T2-weighted sequences compared to normal bone marrow. On STIR sequences the signal is usually hyperintense [Figure 3]. Administration of gadolinium most often leads to intense uptake although moderate, heterogeneous and low uptake are not uncommon. In osteosclerotic metastases, the sclerotic areas appear hypointense on all sequences.

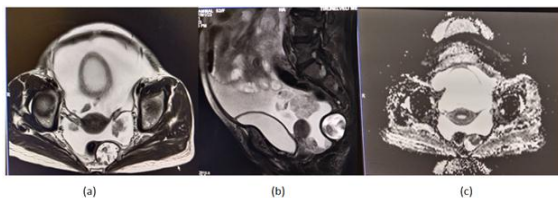


Figure 2: 52 years female, known case of ca ovary taken mri for staging. (a), (b) T2 axial & sagittal image showing gross ascites with bilateral T2 hypointense solid ovarian mass with well defined heterointense lesion noted in presacral region with bony erosion & low ADC value (c) in internal soft tissue areas. **Diagnosis: Sacral deposit/Metastasis**



Figure 3: 56 male with low back ache. (a), (c) T2 sagittal & T1 axial image showing well defined irregular lobulated T2, T1 hypointense lesion noted involving the entire sacrum with L5-S1 disc space extension. (b), the lesion demonstrating the low ADC value. (d) STIR image showing no suppression. **Diagnosis: solitary plasmocytoma**

Multiple Myeloma / Solitary Plasmocytoma

Age and Sex: 60 years and more, male predominance (2:1)

Incidence: Multiple myeloma accounts for 45% of vertebral tumors. Plasmacytoma (solitary lesion) often precedes the development of multicentric disease.

Imaging: On MRIs, plasmacytomas (figure 3) and myeloma [Figure 4] lesions are hypointense on T1-weighted images and hyperintense on T2-weighted images.

Developmental sacral masses

Sacroccygeal teratoma

Fetal sacroccygeal teratomas diagnosed in utero. Mortality rate of 15-35%, and a morbidity rate of 12-68%. Fetal hydrops, hemorrhage, or rupture of the sacroccygeal teratoma is the main

complication associated with a high mortality rate. There has been a rapid increase in the use of MR imaging for the assessment of the normal and abnormal anatomy of the fetus. MR imaging may provide additional information about tumor extent and content, both factors that affect the prognosis [Figure 6]. Because of fetal pelvic bone shadowing, the sonographer may be unable to assess precisely the extent of the mass; consequently, the type of the sacroccygeal teratoma may be underestimated. MR imaging also underestimated the intrapelvic and intraabdominal extension, diagnosing a type II instead of a type III tumor that was found at surgery. This error must be related to the delay between the time of prenatal MR imaging and surgery (6 weeks), during which the tumor continued to grow. This potential continuous growth of sacroccygeal teratoma renders postnatal MR imaging [Figure 5] mandatory to reassess the tumor, especially if time has elapsed between fetal MR imaging and delivery.

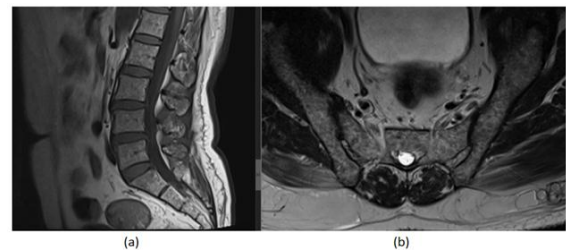


Figure 4: 65 male with low back ache & myalgia (a), (b) T1 sagittal & T2 axial image showing multifocal hypointense lesion with diffuse bone marrow involvement. **Diagnosis: Multiple Myeloma**

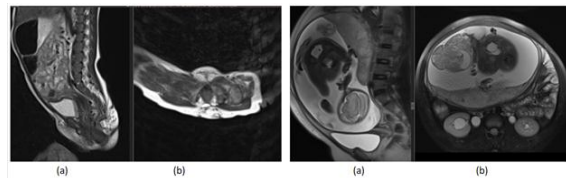


Figure 5: 7 days female child. (a), (b) T2 sagittal & axial image showing fat, fluid (cystic) components appear high signal, calcific bony components low signal with cystic area showing minimal extension into presacral region. **Diagnosis: Sacroccygeal teratoma Type- II**

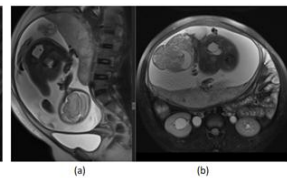


Figure 6: (a), (b) fetal mri T2 sagittal & axial image showing well defined irregular lobulated lesion with fat, fluid (cystic) components appear high signal, calcific bony components low signal with cystic component extending in to pelvis abutting the bladder. **Diagnosis: Sacroccygeal teratoma Type- II**

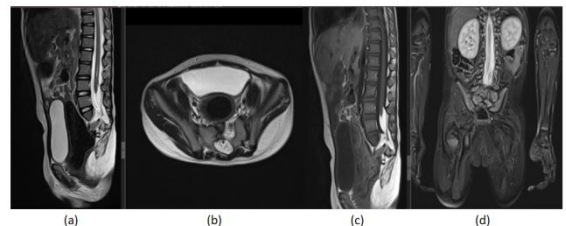
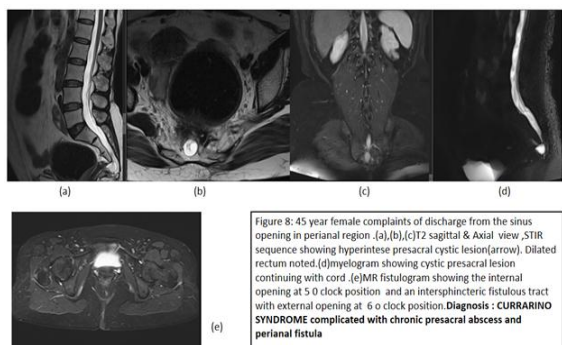


Figure 7: 5 Year male child known case perianal fistula operated with history of inability to walk (a), (b) T2 sagittal & axial view showing sacral dysgenesis with anterior defect showing extension of cord component into presacral region. (c) T1 sagittal image showing filum terminale lipoma extending to presacral region. subcutaneous fat & skin appears intact. (d) STIR image showing dural ectasia with sacral dysgenesis & fusion of residual sacrum. **Diagnosis: CURRARINO SYNDROME with perianal fistula treated & Type II sacral dysgenesis**



Curarino syndrome

Curarino syndrome was first described by Currarino et al, in 1981, as a triad of congenital anorectal stenosis, a defect in sacral bone, and a presacral mass.

Incidence: Less than 400 cases of this rare syndrome have been reported since then. Hereditary autosomal dominant disease with mutations in the homeobox gene HLXB9 located on chromosome 7q36, encoding the nuclear protein HB9. Adult patients may be asymptomatic or have gastrointestinal, urinary, or neurologic symptoms.

Clinical features: including constipation, abdominal distention, abdominal pain, nausea and vomiting, rectal fullness, low back pain, headaches, fever, arthralgia, recurrent meningitis, and urinary tract infection . The most common symptom is chronic constipation. Urinary malformations in Curarino syndrome include horseshoe or duplex kidney, duplex ureter, vesicoureteral reflux, secondary hydronephrosis, neurogenic bladder, recurrent urinary tract infections, and urinary incontinence.

Imaging techniques: such as ultrasonography, plain radiography, CT scan, and MRI are useful for diagnosing this condition. MRI is often the modality of choice specially when looking for the presence of a presacral mass, associated spinal cord anomalies, and evaluating abdominopelvic organs,

distinguishing the presacral mass and other abdominal structures, and other spinal cord related abnormality. Management of CS mainly depends on the presence of a presacral mass and/or anorectal malformations.

Sacral agenesis: (also considered as part of the caudal regression syndrome) is a rare and severe sacral developmental abnormality.

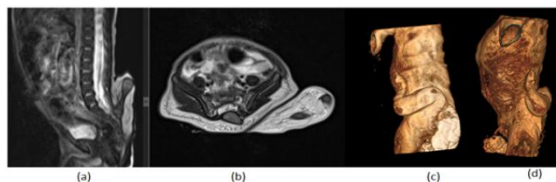


Figure 9: 5 days male baby with additional limb (a),(b)T2 sagittal & axial view showing extra parasitic lower limb duplication attached from sacral area with exophytic extension having bony component surrounded by subcutaneous fat and skin. (c), (d) volume rendered reconstructed image showing exophytic extra limb from sacral region. **Diagnosis: Tail-like Congenital Duplication of Lower Extremity (Extra Leg or Vestigial Parasitic Twin) from sacrum .**

Lipomyelomeningoceles

Lipomyelomeningoceles are one of the forms of closed spinal dysraphism. They usually present as a subcutaneous fatty mass just above the intergluteal cleft.

Imaging: On MRI typically seen as a spinal defect with lipomatous tissue, covered with skin. Neural placode-lipoma interface lies outside the spinal canal due to enlargement of subarachnoid space. Low-lying cord is usually present.

Tail-like Congenital Duplication of Lower Extremity (Extra Leg or Vestigial Parasitic Twin) from sacrum

Extra parasitic lower limb duplication attached from sacral area with extension to the presacral space unusual case with morphologically tail like soft tissue which consists of bony structure of lower limbs. The rare type of lower limb duplication with complete hemipelvis, femoral bone, patella, tibia and double fibula, tarsal, metatarsal, and toes.

Table 1: Classification of sacrococcygeal teratoma a location-based classification system according to the American Academy of Pediatric Surgery Section Survey is

Type I	Developing only outside the fetus (can have small pre-sacral component); accounts for the majority of cases, 47%
Type II	Extra-fetal with intrapelvic presacral extension
Type III	Extra-fetal with extension through the pelvis into the abdomen
Type IV	Tumor developing entirely in the fetal pelvis

Table 2: Classification: Sacral agenesis can be categorized into four types

Type I	Unilateral agenesis localized to sacrum or coccyx
Type II	Partial agenesis with bilateral defects; the iliac bone articulates with S1, but the distal sacral elements fail to develop
Type III	Total sacral agenesis; iliac bones articulate with the lowest lumbar element
Type IV	Total sacral agenesis; iliac bones fuse posteriorly

Table 3: Approach to sacral masses

Tumor	ML	EC	US	LS	Solitary	Multiple	Matrix	Remodeling	Soft tissue mass
GCT	-	+	+	-	++	-	-	-	+/-
NF	=	-	+	+	+	+	-	+++	++
Chordoma	+++	-	-	+++	++	-	-	-	+++
Chondrosarcoma	-	++ +	++	-	++	-	++Arcs and rings-Cartilage	-	+/-
Osteosarcoma	-	+	+	-	+	-	++ +Osseous	-	+/-
Metastasis	+	+	+	+	+	+++	-	-	+/-
Myeloma	+	+	+	+	+	+++	-	-	+/-

Abbreviations: EC, eccentric; LS, lower sacrum; ML, midline; US, upper sacrum.

DISCUSSION

The sacrum is a triangular-shaped structure composed of five fused vertebral bodies (S1–S5). The sacrum has a critical role in stabilizing the posterior portion of the pelvic ring.^[1,2] At its wider superior aspect, the sacrum forms the lumbosacral joint with the fifth lumbar vertebra above it. The sacrum narrows to a point at its inferior margin, where it forms the sacrococcygeal joint with the much smaller coccyx (tail bone).^[3,4] On each lateral margin, the sacrum articulates with the iliac bone at the sacroiliac (SI) joints. The SI joint is stabilized by several ligaments. The sciatic nerve, superior and inferior gluteal neurovascular bundles, posterior femoral cutaneous nerve, and internal pudendal vessels traverse the sciatic notch to enter/exit the pelvis. Sacral tumors represent only 5% of osseous tumors.^[5] Malignant lesions are the most frequent, leaded by metastasis and Chordoma. Different components that constitute the sacral bone may induce local tumors. Primary neoplasms of the sacrum are uncommon. Symptoms that may accompany sacral tumors, such as low back pain and pelvic pressure are nonspecific.^[6] A sacral tumor can be easily overlooked on standard radiographs, delaying diagnosis. The curved shape of the sacrum, its position in the pelvic girdle, and overlying bowel gas can obscure sacral tumors on radiographs. CT and MR imaging more readily permit detection, characterization, and staging of sacral tumors. The differential diagnosis of sacral tumors heavily relies on factors such as patient age, sex, and specific imaging findings. MRI allow the etiological diagnosis, the extension checkup; it helps the management of surgical treatment, guide biopsies and also allow the post-therapeutic supervision. However, because imaging findings among sacral tumors can overlap diagnosis may depends on biopsy and pathologic assessment.^[7,8]

CONCLUSION

The differential diagnosis of sacral tumours is extensive, and although metastases are the most common lesions, a broad spectrum of primary bone tumours can arise from sacral components. MR imaging allows us to detect bone marrow invasion, and changes in morphology and intensity will help to determine the most probable diagnosis. In addition, imaging has an important role in the staging of the tumour and further follow-up. The educational objectives for this study is to highlight key clinical, radiological features of various sacral masses and provide a concise yet comprehensive roadmap to approach these lesions.

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