# AIM OF THE WORK

The aim of this work is to assess the role of Magnetic Resonance Imaging in assessment of pediatric pelvic masses.

# PATIENTS

The study was conducted on 20 children (2 -17 years) presenting with known or suspected pelvic mass referred to the Radiodiagnosis Department at Alexandria University Hospitals for MRI evaluation in the period from June 2013 till June 2014.

The patients were referred from the Pediatric Surgery Department, the Pediatric Unit of the Oncology Department and the Obstetrics and Gynecology department in Alexandria university Hospitals.

# METHODS

All the studied patients were subjected to the following:

1. Full history taking (from parents and referring physician)
2. Thorough clinical examination and laboratory investigations.
3. Review of available previous imaging studies (US in 7 cases and CT in 6 cases)
4. The medical ethics were considered: The parents were aware of the aim of examination, of the risks of contrast injection and anesthesia (whenever it was indicated). The parents' agreement was obtained. The child had to get benefit from the examination.
5. The MR Study.

- **Anesthesia**

It was used in the very young uncooperative patients (7 patients who were less than 7 years old). Thiopental Sodium was given by intravenous route in a dose of 3-5mg /kg. This was performed by an anesthesiologist.

- **Machine:**

MRI studies were done on 1.5 Tesla closed magnets including:

- Achieva ( Phillips Medical systems, Netherlands)
- MAGNETOM Avanto (Siemens, Erlangen, Germany).

- Fasting was only needed (for 4-6 hours) in the very young patients who were planned to have the examination under anesthesia.
- The patients were placed in the supine position.
- The urinary bladder was preferred to be of moderate repletion at time of examination whenever possible.
- Phased array pelvic coils were used**.**

- **The following MRI parameters were used:**
  - Slice thickness 3 mm
  - Gap between slices: 3.3 mm
  - Flip Angle 90
  - Number of signal averages 3
  - Matrix 320x320

- **The following MRI sequences were used:**
  - Sagittal T2-weighted fast turbo -spin-echo sequence from one femoral head to the other(TR 3000, TE 75)
  - Axial T2-weighted fast turbo-spin-echo sequence from the umbilicus to the groin(TR 6150, TE 100)
  - Sagittal T1-weighted fast spin-echo sequence from one femoral head to the other(TR 517, TE 15)
  - Axial T1-weighted fast spin-echo sequence from the umbilicus to the groin (TR 640, TE 10)
  - Axial T1-Weighted spin-echo sequence with fat suppression (TR 760, TE 12).
  - Coronal STIR covering the whole abdomen and pelvis (TR 5240, TE 60, and TI 140).
  - Diffusion weighted MR images were obtained in the axial plane by using a single-shot echo- planar sequence. The b values corresponding to the diffusion-sensitizing gradient were 0, 400, and 800 sec/ $mm^2$.
- Post contrast axial, sagittal and coronal T1- weighted spin-echo sequences with fat saturation were acquired after gadolinium injection. This was done in 16 cases using Omniscan (Gadodiamide 0.5 mmol/ml). Contrast amount was calculated according to the body weight (0.1mmol/Kg). Contrast was injected manually
- Images were transferred to a post processing workstation (Phillips extended MR workspace 2.6.3.5).

6. Feedback of the surgical and histopathological data was obtained.

# RESULTS

This study was conducted on 20 children admitted to the outpatient clinic of the Pediatric surgery, Oncology and Obstetrics and Gynecology departments of Alexandria university hospitals presented clinically with known or suspected pelvic mass. The age of studied patients ranged between 2 and 17 years old. The study included five males (25%) and 15 females (75%). Table 1

**Table 1: Distribution of patients according to age and sex**

| Age in years | Males | Females | Total | |
|---|---|---|---|---|
| | | | Number | Percentage |
| 2~7 | 2 | 5 | 7 | 35% |
| 7~12 | 2 | 2 | 4 | 20% |
| 12-17 | 1 | 8 | 9 | 45% |
| **Total** | 5 | 15 | 20 | 100% |

All the studied patients complained of pelvic pain either as the main or associated complaint. The pain was communicated to the parents in children < 5 years by indirect signs as irritability during sitting position, defecation and urination. Other complaints included evident pelvi-abdominal distension ( in 4 patients), visible masses noticed by the parents (one case with yolk sac tumor had large bilateral inguinal nodes, one case with cervical rhabdomyosarcoma had protruding mass in introitus and one case with presacral dermoid cyst had visible bulge in the lower back), primary amenorrhea (in 3 patients), abnormal vaginal bleeding (in one patient), dysuria and urine retention (in one patient) and limited movements of the hip( in one patient) .Table 2

**Table 2: Distribution of patients according to the presenting symptoms**

| Symptoms | No. of patients | percentage |
|---|---|---|
| Pelvic pain | 20 | 100% |
| Evident pelvi- abdominal distension | 4 | 20% |
| Visible bulging masses noticed by parents | 3 | 15% |
| Primary amenorrhea | 3 | 15% |
| Vaginal bleeding | 1 | 5% |
| Dysuria and urine retention | 1 | 5% |
| Unilateral limited hip movements | 1 | 5% |

N.B: some patients had more than one complaint

The final diagnosis of the examined pelvic masses was confirmed in all cases by surgical and/or pathological evaluation.

The examined pelvic masses included masses arising from anterior, middle and posterior pelvic compartments. Table 3

- *Anterior compartment masses(2 cases):*
  - Prostatic rhabdomyosarcoma (1 case)
  - Yolk sac tumor in the perineum surrounding the urethra(1 case)
- *Middle compartment masses(9 cases):*

I. Uterine and/or vaginal masses

  - Haemato(metro)colpos(4 cases)
  - Cervical rhabdomyosarcoma(1 case)

II. Ovarian masses:

  - Ovarian germ cell tumors( one case with mature teratoma, one with yolk sac tumor)
  - Complicated ovarian cyst(one case)
  - Ovarian torsion with secondary necrosis(one case)

- *Posterior compartment masses(4 cases)*
  - Presacral chordoma (one case).
  - Presacral Ganglioneuroma (one case).
  - Presacral dermoid cyst (one case).
  - Recurrent neuroblastoma (one case).
- *Others(5 cases):*
  - Multifocal (3 cases):
    - Yolk sac tumor(two cases presenting by multiple pelvic nodules)
    - Burkitt's lymphoma (one case presented by multiple pelvic masses including infiltrated bilateral adnexa)
  - Trans-spatial (1 case)
    - Lymphangioma (one case presented by huge pelvi-abdominal cystic mass filling the whole pelvic region)
  - Lateral pelvic region (1 case):
    - Spindle cell sarcoma(one case with huge mass involving left pelvic bones with protrusion in the lateral pelvic compartment)

**Table 3: Distribution of examined pelvic masses according to anatomical location and final pathological/surgical diagnosis**

| Anatomical region | Pathological/surgical diagnosis | No. of patients | Percentage |
|---|---|---|---|
| **Anterior compartment** | | **2** | 10% |
| | *Prostatic rhabdomyosarcoma* | 1 | |
| | *Yolk sac tumor* | 1 | |
| **Middle compartment** | | **9** | 45% |
| | *Hemato(metro)colpos* | 4 | |
| | *Cervical rhabdomyosarcoma* | 1 | |
| | *Ovarian yolk sac tumor* | 1 | |
| | *Ovarian teratoma* | 1 | |
| | *Ovarian complicated cyst* | 1 | |
| | *Ovarian torsion with secondary necrosis* | 1 | |
| **Posterior compartment** | | **4** | 20% |
| | *Dermoid cyst* | 1 | |
| | *Ganglioneuroma* | 1 | |
| | *Chordoma* | 1 | |
| | *Recurrent neuroblastoma* | 1 | |
| **Multifocal** | | **3** | 15% |
| | *Yolk sac tumor* | 2 | |
| | *Burkitt's lymphoma* | 1 | |
| **Trans-spatial** | Lymphangioma | **1** | 5% |
| **Lateral pelvic region** | Spindle cell sarcoma | **1** | 5% |
| **Total** | | **20** | **100%** |

The examined pelvic masses included both neoplastic and non neoplastic masses of different origins which were confirmed by surgical and/or pathological assessment. Tables 4-6

The cases with neoplastic pelvic masses included: Table 4

- 5 cases were diagnosed as Germ cell tumor (2 cases with unilateral adnexal mass, 2 cases with multiple pelvic nodules and one case with infiltrating perineal mass).
- 2 cases were diagnosed as rhabdomyosarcoma (one prostatic and one cervical).
- 2 cases were diagnosed as malignant mesenchymal tumor (one with presacral chordoma and one with spindle cell sarcoma of the pelvis).
- One case with presacral Ganglioneuroma.
- One case with Burkitt's lymphoma.
- Once case with small recurrent pelvic neuroblastoma.

The examined neoplastic masses included both benign and malignant tumors. Table 5

Benign tumors were found in two cases:

- Ovarian mature teratoma
- Presacral Ganglioneuroma

Malignant tumors were found in 10 cases:

- Four yolk sac tumors
- Two rhabdomyosarcomas (one cervical and one prostatic)
- Burkitt's lymphoma
- Presacral chordoma
- Spindle cell sarcoma of pelvic bones.
- Recurrent neuroblastoma

**Table 4: Distribution of the examined neoplastic pelvic masses according to the specific final pathological diagnosis**

| Pelvic mass nature | No. of patients | percentage |
|---|---|---|
| Germ cell tumor | 5 | 41.5% |
| Rhabdomyosarcoma | 2 | 16.6% |
| Ganglioneuroma | 1 | 8.3% |
| Presacral chordoma | 1 | 8.3% |
| Spindle cell sarcoma (of left pelvic bone and muscles) | 1 | 8.3% |
| Burkitt's lymphoma | 1 | 8.3% |
| Recurrent neuroblastoma | 1 | 8.3% |
| **Total** | **12** | **100%** |

**Table 5: Distribution of the examined neoplastic pelvic masses according to benign and malignant nature**

| **Nature of the mass** | | **No. of patients** | **Percentage** |
|---|---|---|---|
| **Benign** | | **2** | **16.6%** |
| | *Ovarian mature teratoma* | 1 | |
| | *Presacral Ganglioneuroma* | 1 | |
| **Malignant** | | **10** | **83.3%** |
| | *Yolk sac* | 4 | |
| | *Rhabdomyosarcoma* | 2 | |
| | *Presacral chordoma* | 1 | |
| | *Burkitt's lymphoma* | 1 | |
| | *Spindle cell sarcoma* | 1 | |
| | *Recurrent pelvic neuroblastoma* | 1 | |
| **Total** | | **12** | **100%** |

The cases with non neoplastic pelvic masses included: Table 6

- 4 cases were diagnosed as distended vagina and/or uterus due to vaginal obstruction (secondary to imperforate hymen in 2 cases, atresia/hypoplasia of the cervix and upper vagina "Mullerian anomaly type I b" in one case and unilateral transverse vaginal septum in a case of didelphys uterus in one case).
- One case was diagnosed with chronic ovarian torsion with secondary hemorrhagic necrosis.
- One case was diagnosed with sizable pelvi-abdominal lymphangioma.
- One case with benign complicated ovarian cyst.
- One case with presacral dermoid cyst.

**Table 6: Distribution of the examined non-neoplastic pelvic masses according to the final surgical and/or pathological diagnosis**

| **Surgical/pathological diagnosis** | **No. of patients** | **Percentage** |
|---|---|---|
| Distended vagina and/or uterus due to vaginal obstruction | 4 | 50%% |
| Chronic ovarian torsion with hemorrhagic necrosis | 1 | 12.5% |
| Lymphangioma | 1 | 12.5% |
| Benign complicated ovarian cyst | 1 | 12.5% |
| Presacral dermoid cyst | 1 | 12.5% |
| **Total** | **8** | **100%** |

Most of the examined patients had one pelvic mass while only five cases had multiple masses and these were all of neoplastic origin. These included:

- One case with prostatic rhabdomyosarcoma who had few pelvic nodules besides the prostatic mass
- Two cases with pelvic yolk sac tumor who had multiple pelvic nodules
- One case with perineal yolk sac tumor who had few bilateral inguinal nodal deposits
- One case with Burkitt's lymphoma who presented by multiple pelvic and abdominal masses. Table 7

**Table 7: Distribution of patients according to the number of pelvic masses**

| **No. of masses** | | **No of patients** | **percentage** |
|---|---|---|---|
| Single | | **15** | **75%** |
| Multiple | | **5** | **25%** |
| | *yolk sac tumor* | 3 | |
| | *Burkitt's lymphoma* | 1 | |
| | *Prostatic rhabdomyosarcoma* | 1 | |
| **Total** | | **20** | **100%** |

# MRI diagnosis

## I) Neoplastic masses (12 cases): Table 8

- **Five cases were diagnosed with germ cell tumors (one with mature ovarian teratoma and four with yolk sac tumor)**

  ✓ **One case with mature teratoma:**

  - A 12 year old girl diagnosed with mature teratoma had a well defined left adnexal mass lesion with mixed cystic and solid components having heterogenous signal intensity in both T1 and T2 images. Fine streaks of hyperintense signal in both sequences showed signal suppression in fat saturated images. It showed heterogenous contrast enhancement and diffusion restriction Two small contiguous peritoneal nodules had the same MR appearance.(figure 48)

  ✓ **Four cases with yolk sac tumor: (Figures 49-52)**

  - A 4 year old boy had 2 well defined para rectal and presacral masses showing hyperintense signal in both T1 and T2 signal, intense marginal enhancement and restricted diffusion.
  - A 2 year old girl had large infiltrative perineal soft tissue mass showing hypointense signal in T1, hyperintense signal in T2, intense contrast enhancement and restricted diffusion. She also had few bilateral enlarged inguinal nodes with similar MRI appearance in addition to a single lumbar vertebral bony deposit.
  - An 11 year old girl had multiple, discrete and amalgamated, pelvic nodules in peri rectal and presacral regions. These showed hypointense signal in T1, hyperintense signal in T2, mild contrast enhancement and restricted diffusion.
  - A 13 year old girl had right adnexal mass with small extra ovarian extension. It showed cystic and solid components with mixed signal in T1 and T2 images, mild contrast enhancement and restricted diffusion. Mild ascites and stranding of related peritoneum was also noted.

- **Two cases were diagnosed with rhabdomyosarcoma (Figures 53 and 54)**

  - A 4 year old girl diagnosed with uterine cervical rhabdomyosarcoma had a large solid mass totally filling and expanding the vagina and uterus showing mainly hypointense signal in T1, hyperintense signal in T2, intense heterogenous contrast enhancement and restricted diffusion.
  - An 11 year old boy diagnosed with prostatic rhabdomyosarcoma had a heterogenous lesion at the prostate and bladder base with hypointense signal in T1, hypo to intermediate signal in T2 .It showed moderate heterogenous contrast enhancement and restricted diffusion. Other few small pelvic nodules were noted showing same MR features.

- **One case was diagnosed with presacral chordoma: (Figure 55)**

  A 7 year old boy presented by a sizable presacral mass lesion with small intra-osseous, intra-thecal and retro-sacral components. It showed isointense signal in T1, hyper intense signal in T2, moderate contrast enhancement and restricted diffusion.

- **One case was diagnosed with spindle cell sarcoma: (Figure 56)**

  A 17 year old girl had a sizable heterogenous destructive soft tissue mass involving the left iliac bone with infiltration of the related muscles and forming a large pelvic soft tissue component. It showed heterogenous MR signal mainly hypointense in T1 and hyperintense in T2 with moderate peripheral contrast enhancement with a large central necrotic area. It also showed diffusion restriction.

- **One case was diagnosed with presacral Ganglioneuroma: (Figures 57)**

  A 2 year old girl had a sizable presacral mass lesion with homogenous low signal in T1 and mildly hyperintense signal in T1. It showed homogenous intense contrast enhancement and mild restricted diffusion. It had smooth borders with clear surrounding fat planes, closely abutting the sacrum yet with no bone or foraminal involvement.

- **One case was diagnosed with Burkitt's lymphoma (Figures 58 and 59)**

  A 15-year-old girl had multiple pelvic and abdominal masses with hypointense signal in both T1 and T2, mild contrast enhancement and restricted diffusion. The largest of these were the two hugely enlarged ovaries showing peripheral T2 hyperintense follicles. This was associated with mild ascites and enlarged lymph nodes. Imaging features suggested aggressive neoplastic lesion of peritoneum as DSRCT or other sarcoma or adenocarcinoma. However, pathological examination of biopsy revealed Burkitt's lymphoma.

- **One case was diagnosed with small recurrent neuroblastoma: (Figure 60)**

  A 2 year old boy with known history of treated neuroblastoma had a denovo small presacral mass at follow up showing hyper intense signal in T1, intermediate signal in T2 with mild contrast enhancement.

**Table 8: MRI findings of examined neoplastic pelvic masses**

| Pathology | Site and number of masses | T1 | T2 | Contrast enhancement | Diffusion Restriction | Associated findings. |
|---|---|---|---|---|---|---|
| Ovarian teratoma | left adnexal mass | mixed | mixed | heterogenous | + | ○ Marked ascites<br>○ Two peritoneal nodules. |
| Yolk sac | Two Presacral and para rectal masses | hyper | hyper | Intense marginal | + | Subcutaneous sinus tract connected to one of the nodules |
| | Infiltrative perineal mass | hypo | hyper | Intense | + | ○ Bilateral inguinal nodes<br>○ Single vertebral deposit |
| | Multiple Amalgamated presacral and para rectal nodules | hypo | hyper | Mild | + | - |
| | Ovarian mixed solid and cystic mass | hypo | hyper | Mild | + | ○ Mild ascites<br>○ Regional peritoneal stranding |
| Cervical RMS | Large mass filling vagina, cervix and uterus | hypo | hyper | Intense | + | |
| Prostatic RMS | Mass at prostate and bladder base | hypo | hypo to inter-mediate | Mild heterogenous | + | ○ Few small scattered pelvic nodules. |
| Presacral chordoma | Large infiltrative mass with osseous and intrathecal extension | iso | hyper | Moderate | + | - |
| Spindle cell sarcoma | Large infiltrative mass of left iliac bone and related muscles, pelvic soft tissue component. | hypo | hyper | Moderate peripheral with central necrosis | + | - |
| Ganglio-neuroma | Sizable presacral mass | hypo | mildly hyper | Intense homogenous | Mild | - |
| Burkitt's lymphoma | Multiple variable sized pelvic and abdominal masses | hypo | hypo with periph-eral cysts | Mild | + | ○ Mild ascites<br>○ Multiple enlarged nodes. |
| Recurrent Neuro-blastoma | Single small presacral lesion | hyper | inter-mediate | Mild | Mild restriction | - |

## II) Non-Neoplastic masses (8 cases).

- **Four cases were diagnosed with vaginal and /or uterine distension due to vaginal obstruction: (Figures 61-64)**

  Four adolescent girls (age 13-15 years) with pelvic pain, associated with primary amenorrhea in three of them, were found on MRI to have vaginal and/or uterine distension due to vaginal obstruction. The vagina and /or uterus were distended by accumulated menstrual blood which had variable signal intensities among the cases, likely due to different chronicity of retained blood products. No intravenous contrast was used in these cases. MRI findings are summarized in Table 9

**Table 9: MRI findings in cases presenting with vaginal and/or uterine distension due to vaginal obstruction**

| Age | T1 | T2 | DWI | Cause of obstruction | Associated findings |
|---|---|---|---|---|---|
| 14 | hyper | hypo | restricted | Cervical and upper vaginal atresia/hypoplasia(Mullerian anomaly type Ib) | o Bilateral hemato-salpinges<br>o Minimal ascites<br>o Overdistended UB ,bilateral mega ureters |
| 14 | hyper | hyper | restricted | Imperforate hymen | - |
| 13 | hyper | hypo | restricted | Imperforate hymen | - |
| 15 | hypo | hyper | - | Unilateral transverse vaginal septum | o Didelphys uterus with longitudinal vaginal septum.<br>o Absent kidney on same side of obstruction |

- **One case was diagnosed with hemorrhagic ovarian necrosis secondary to torsion: (Figure 65)**

  A 5 year old girl had an enlarged right ovary with abnormal persistent hyper intensity in both T1 and T2 weighted images with hypointense rim. No contrast enhancement was noted after GAD injection and it showed evident diffusion restriction

- **One case was diagnosed with lymphangioma (Figure 66)**

  A 15 year old boy had a huge pelvi-abdominal multilocular cystic lesion containing locules of variable signal intensities predominantly hyper intense in T1 and hypo intense in T2 with multiple fluid levels. No enhancing soft tissue could be detected and no diffusion restriction.

- **One case was diagnosed with a benign complicated ovarian cyst: (Figure 67)**

  A 7 year old girl had a right ovarian cystic lesion showing thin wall( < 3 mm) with homogenous T1 hypo and T2 hyperintense fluid content together with few thin

hypointense septa (not exceeding 3 mm). No soft tissue or abnormal enhancement was detected after GAD injection and no diffusion restriction.

- **One case with presacral dermoid cyst(Figure 68)**

  A 2 year old girl had a large well defined presacral mass with mixed signal intensities in both T1 and T2 matching with mixed fat and fluid components. Partial suppression of signal was noted on the fat saturated sequence. No contrast enhancement was seen and no restricted diffusion

# ILLUSTRATIVE CASES

**Case 1:** A 13 year old female patient presented by gradually developing pelvi abdominal pain and distension.

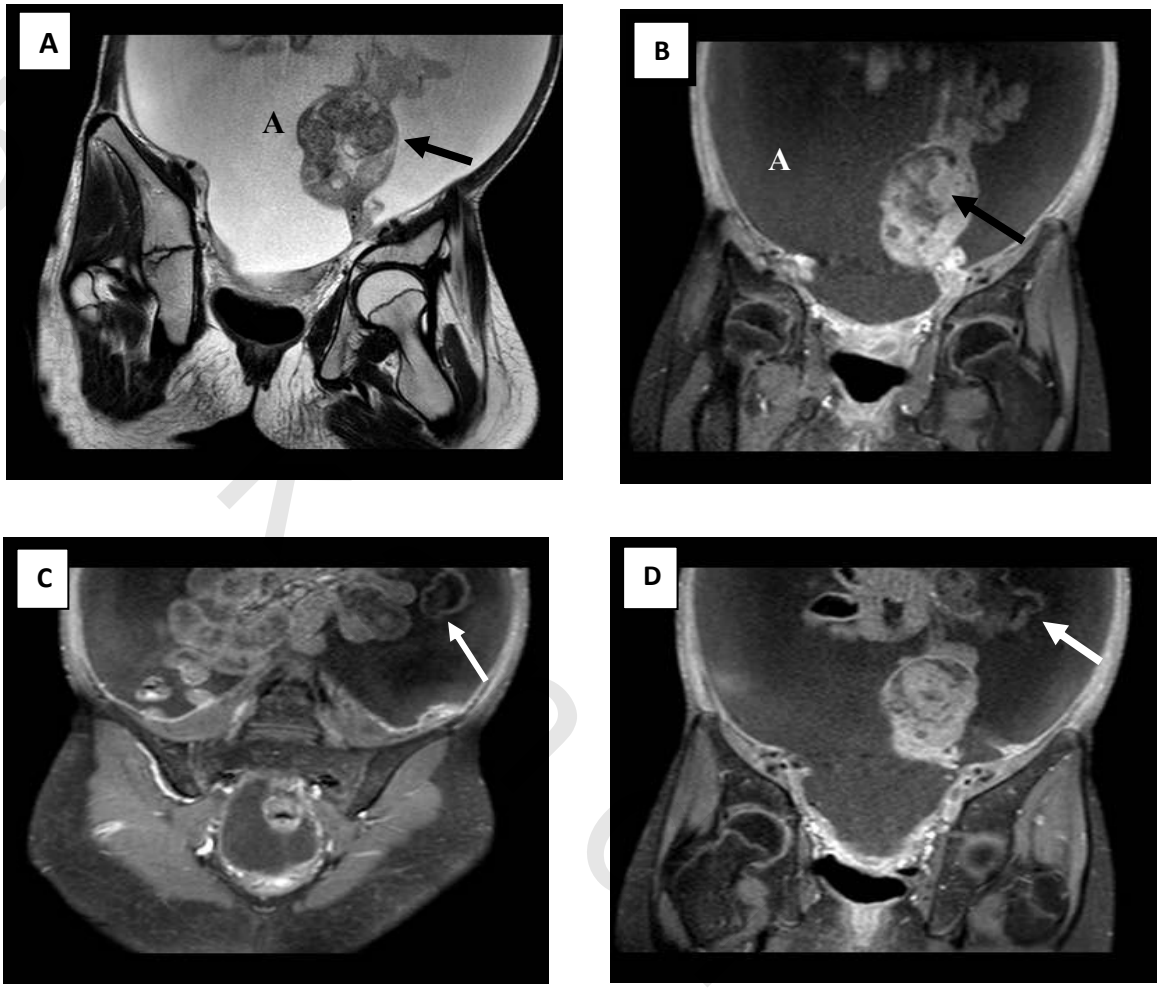



**Figure (48):** **Case 1:** (A) coronal T2, (B, C, D) coronal T1 Fat-Sat after GAD injection. The left ovary is enlarged with heterogenous mass lesion (black arrow) showing inhomogeneous intensity in both T1 and T2 with tiny hyperintense streaks that were suppressed in fat saturated images. Also was noted heterogenous contrast enhancement and restricted diffusion. Two cystic peritoneal nodules are seen (white arrow in C&D) with marked amount of ascites"A". Small few calcific spots were found on review of CT images (not shown). **Pathology of the adnexal mass and peritoneal nodules revealed mature teratoma with predominance of mature neural elements.**

**Case 2:** A 4 year old boy presenting by pelvic pain and irritability during defecation.

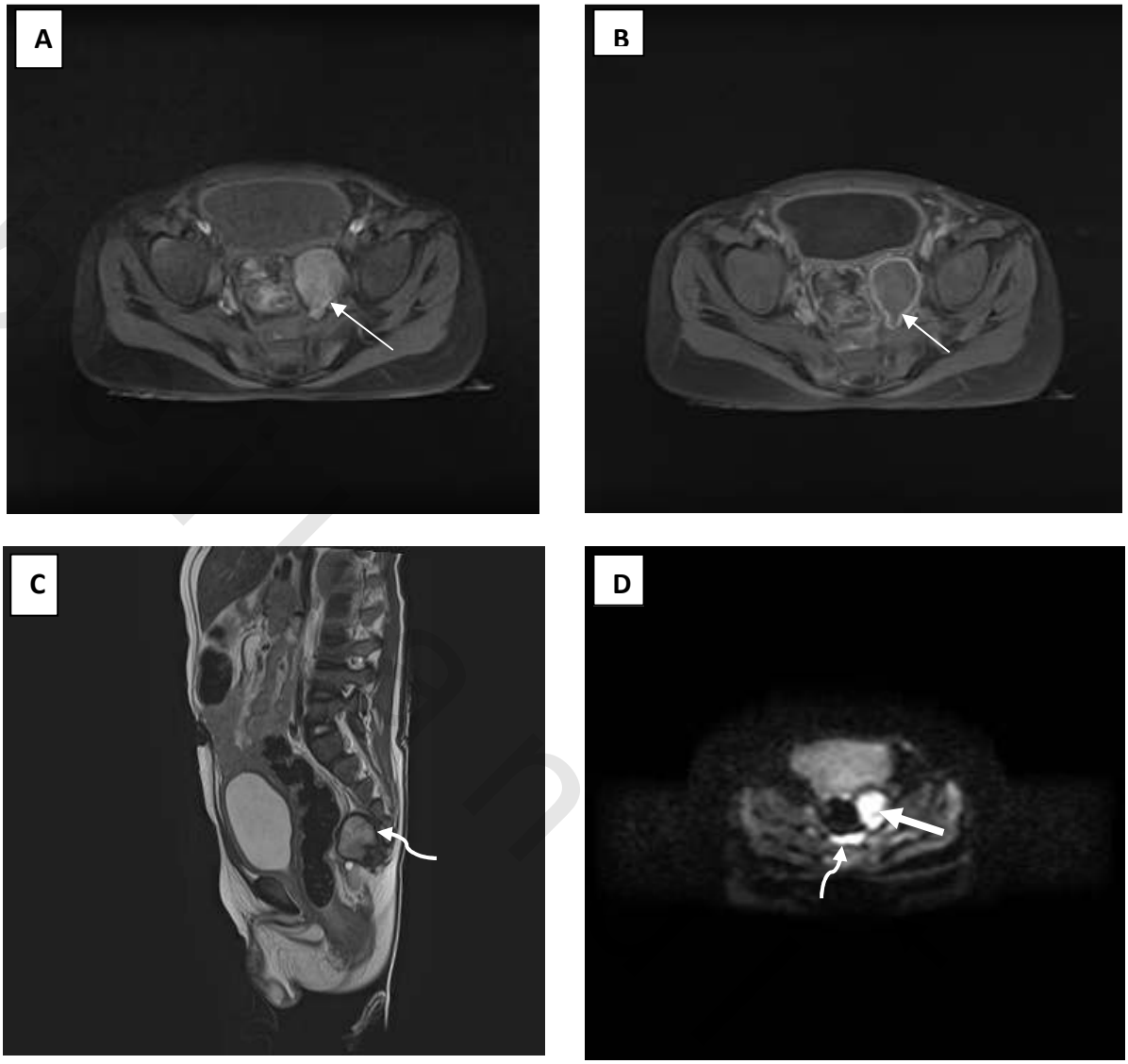



**Figure 49**: **Case 2:** (A&B) axial T1 with fat suppression before and after GAD, (C) sagittal T2, (D) DWI. MRI showed 2 well defined para rectal (straight white arrow) and presacral masses (curved white arrow) showing hyperintense signal in both T1 and T2, intense marginal enhancement and restricted diffusion. The presacral lesion (curved white arrow) is noted on T2 to be infiltrating the coccyx. **Pathology revealed yolk sac tumor.**

**Case 3:** A 2 year old girl presented by bilateral inguinal masses felt accidentally by her parents. MR revealed infiltrating perineal masses with metastatic bilateral inguinal nodes together with a single lumbar vertebral deposit

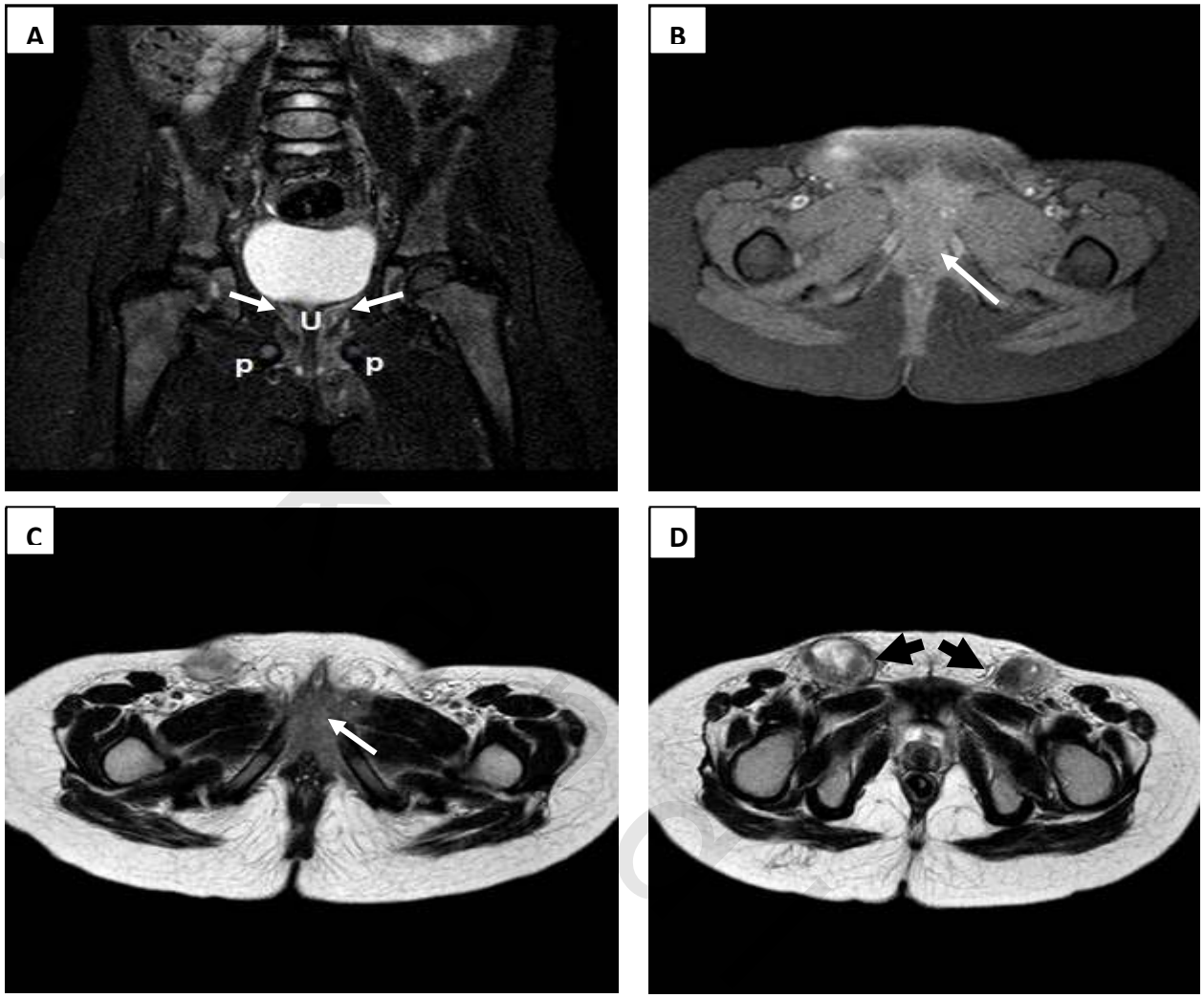



**Figure 50:** **Case 3:** (A) coronal STIR, (B) axial T1 Fat-Sat after GAD injection, (C&D) axial T2. The perineal mass (white arrow) is seen clearly on coronal view to be surrounding the urethra (U) and abutting both pubic rami (P). It showed hypointense signal in T1, slightly hyperintense signal in T2, mild contrast enhancement and diffusion restriction. Bilateral large inguinal nodal deposits are seen also seen (black arrows in D). **Pathology revealed yolk sac tumor.**

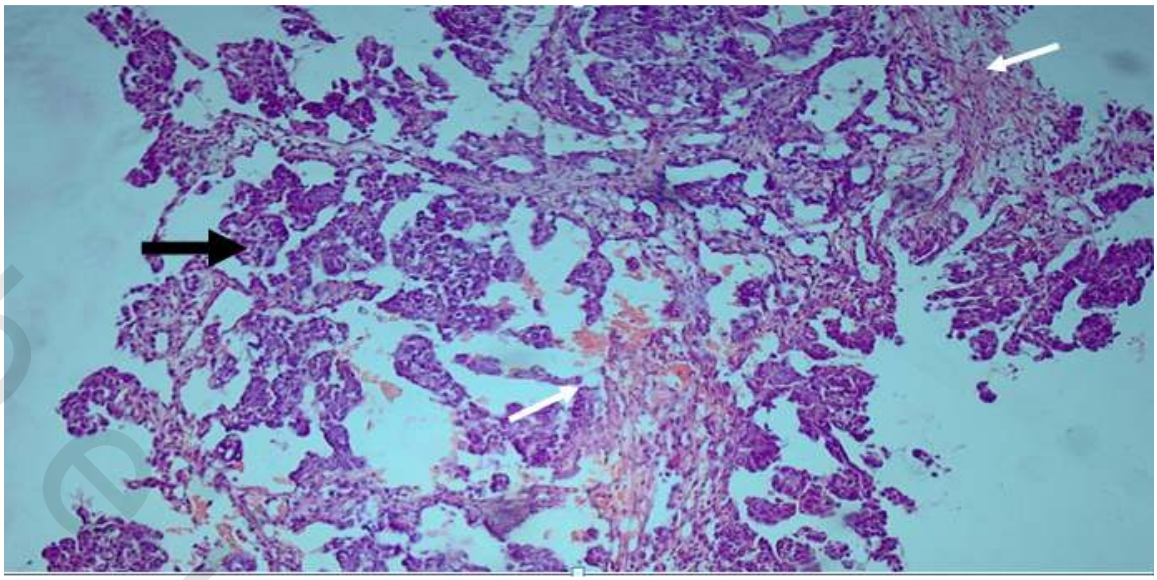


**Figure (50): Continued: Case 3:** Histopathological image of core biopsy of the yolk sac tumor showing reticular background forming microcystic spaces (black arrow) which are lined by flattened to polygonal cells with minimal surrounding stroma (white arrows) having scattered spindle cells and myxoid areas.(H&E X 100) showing typical features of yolk sac tumor.

**Case 4:** An 11 year old girl presented by chronic pelvic pain and sense of heaviness

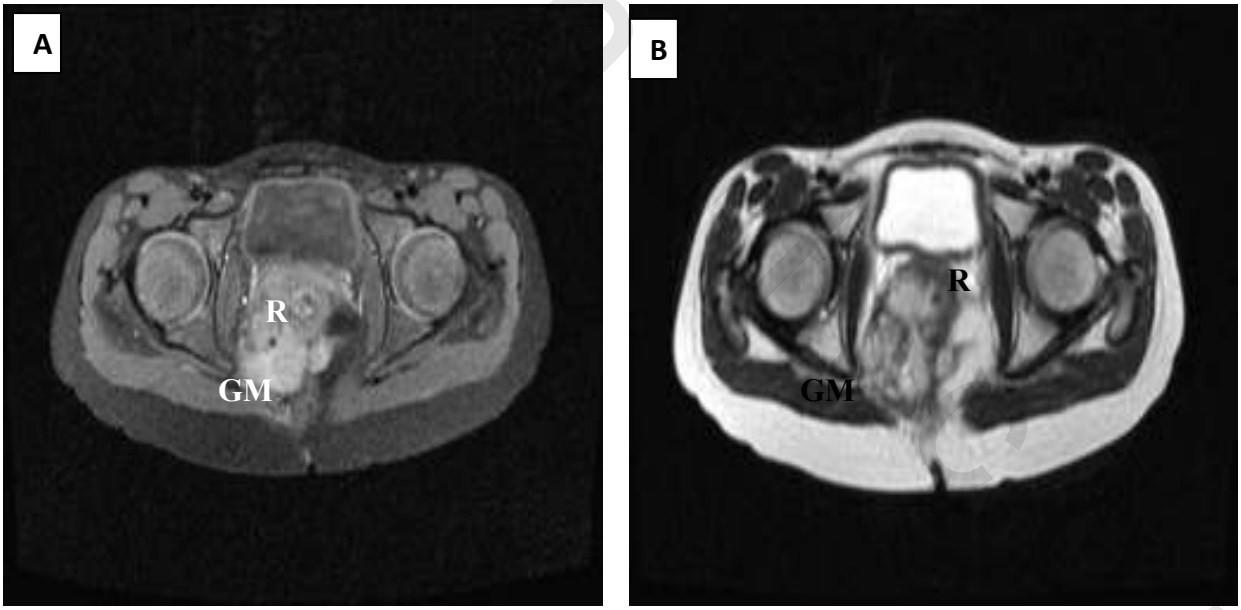



**Figure (51): Case 4:** (A) axial T1 Fat-Sat after GAD injection, (B) axial T2. Multiple amalgamated nodules are seen in peri rectal and presacral regions. These showed hypointense signal in T1, hyperintense signal in T2, mild contrast enhancement and restricted diffusion. The nodules are partially encasing the rectum (R) mainly on its right side and inseparable from the medial end of the gluteus maximus muscle (GM). **Pathology revealed a yolk sac tumor**

**Case 5:** A 13 year old girl presented by right sided pelvic pain

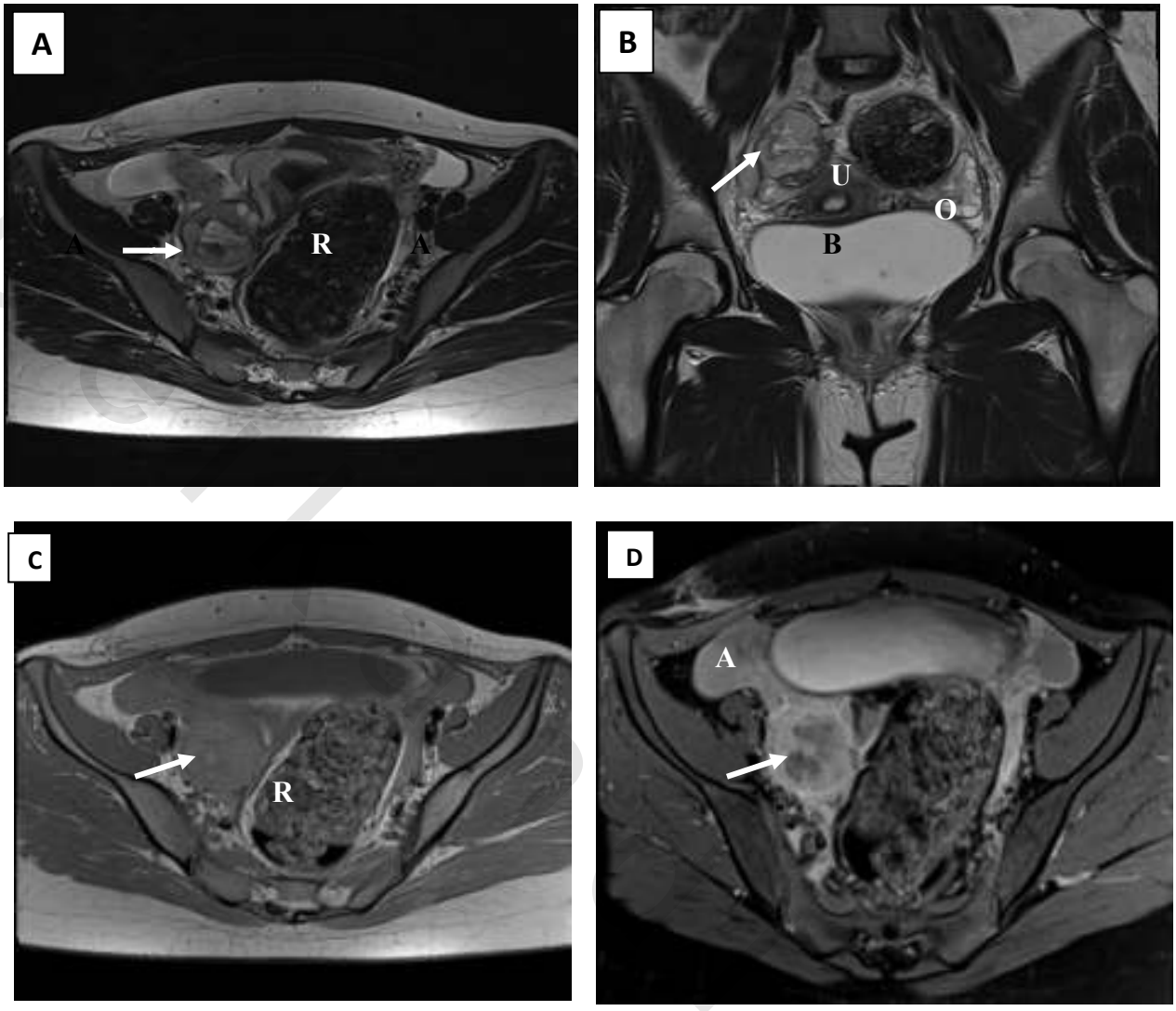



**Figure (52):** **Case 5:** (A) axial T2, (B) coronal T2, (C) axial T1 and (D) Axial T1 fat-sat after GAD injection.MRI images showing the abnormally enlarged right ovary (white arrow) with a heterogenous mass lesion showing both cystic and solid components. It showed mixed signal in T1 and T2 images, mild contrast enhancement and restricted diffusion. Extra ovarian extension was seen together with mild ascites "A" and stranding of the related peritoneum. The normal left ovary (O) is seen also on the coronal view. A: Ascites. B: urinary bladder. U: uterus. R: Rectum. **Pathology revealed yolk sac tumor.**

**Case 6:** A 4 year old girl presented by vaginal bleeding and prolapsing mass in the introitus

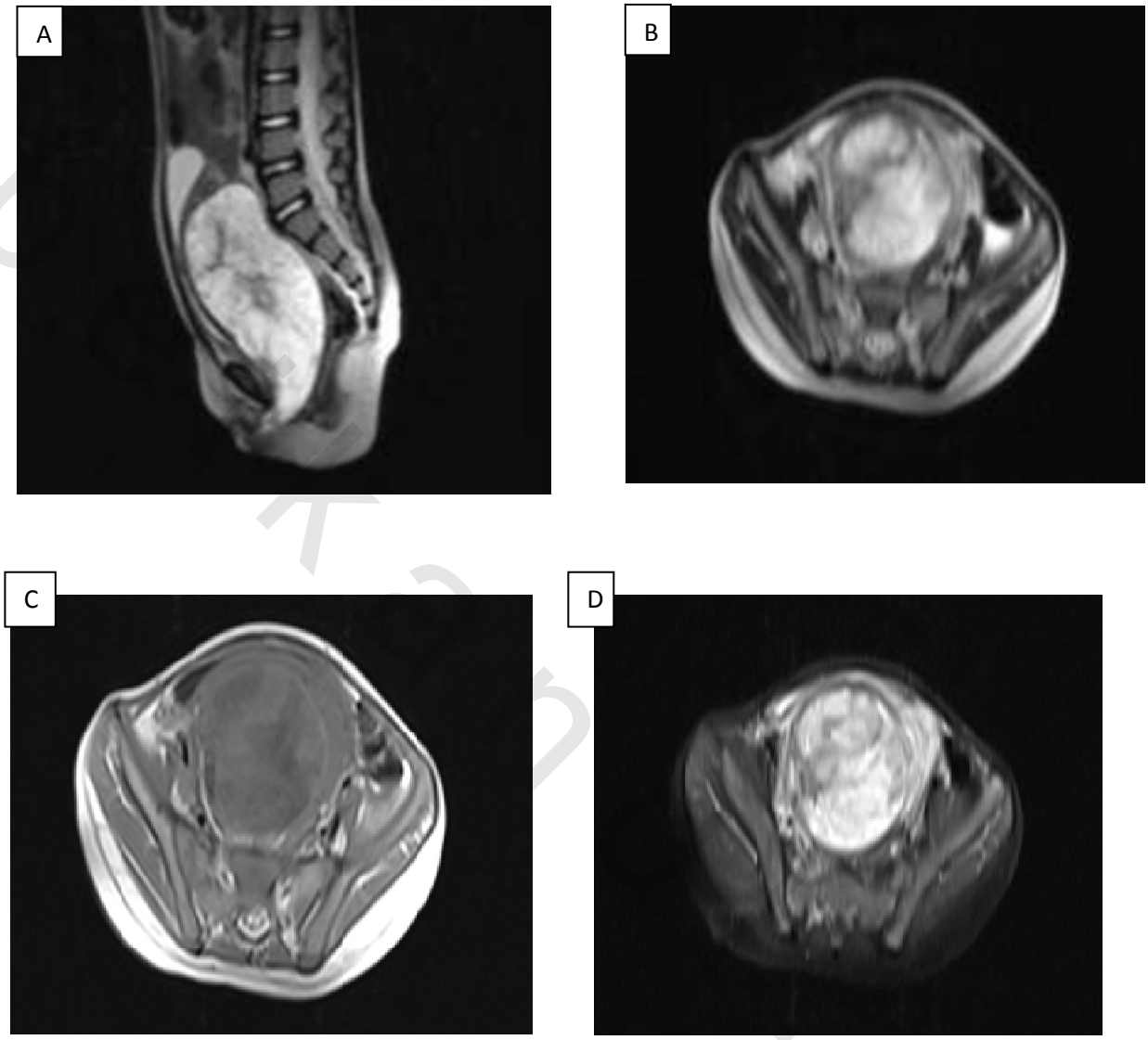



**Figure (53):** **Case 6**: (a) sagittal T2, (b) axial T2, (c) axial T1 and (d) axial T1 with GAD injection. A sizable mass is seen filling the whole uterus, cervix and vagina, slightly heterogenous in signal intensity mainly hypointense in T1 and hyper intense in T2 with intense enhancement after contrast injection sparing few small necrotic nonenhancing areas. It's seen smoothly compressing the rectum and urinary bladder with no signs of invasion. **Pathology revealed cervical rhabdomyosarcoma (of sarcoma botryoides subtype)**

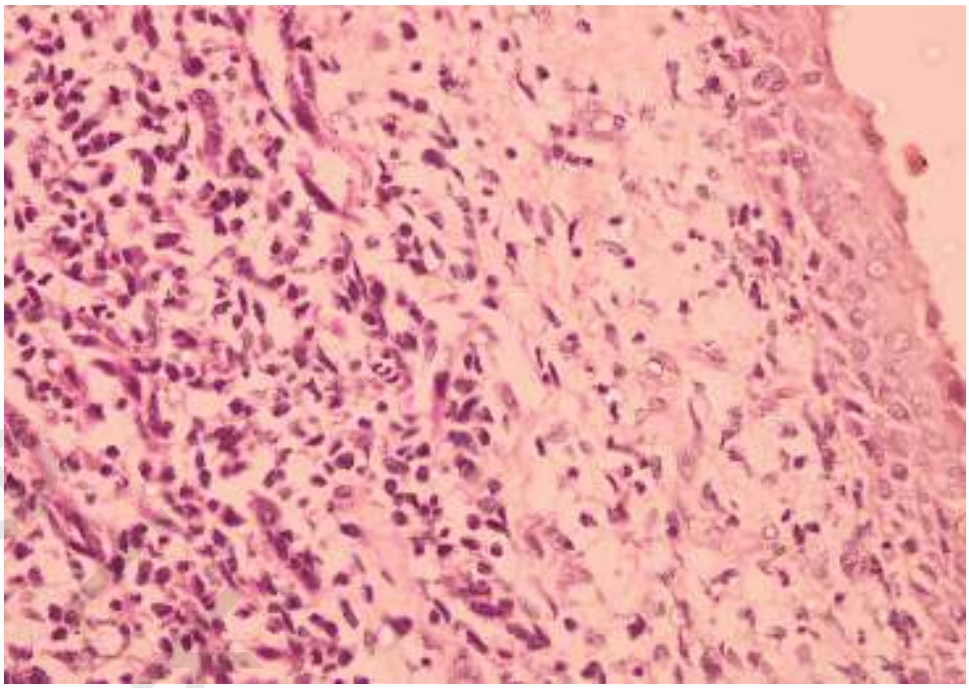


**Figure (53): Continued: Case 6:** a histopathological image of cervical rhabdomyosarcoma showing cambium layer with tumor cells condensed beneath the epithelium in a myxoid stroma (H&E slide x400 magnification)

**Case 7:** An 11 year old boy presented by pelvic pain, dysuria, hematuria and urine retention

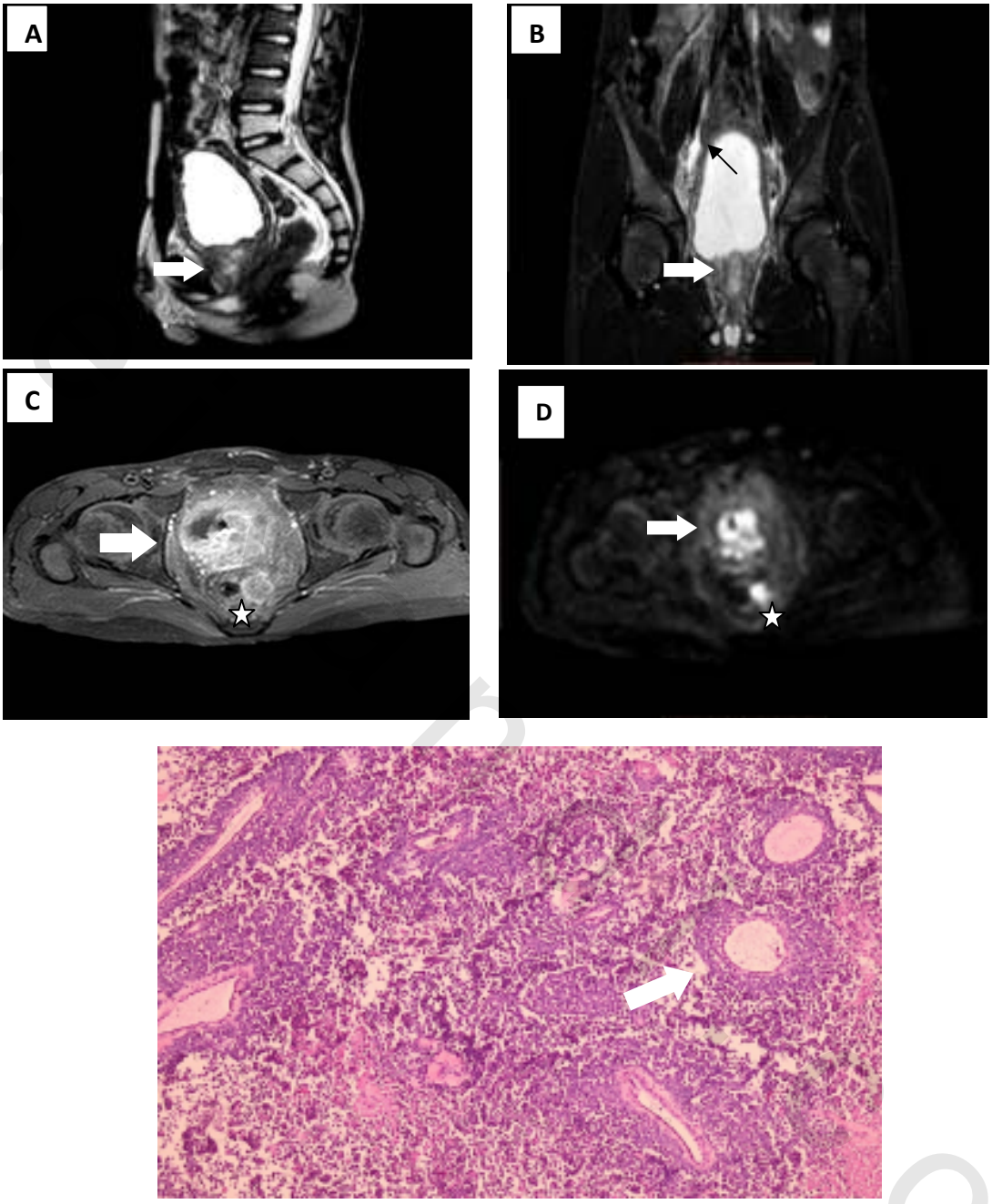



**Figure (54):** **Case 7**: (a) sagittal T2, (b) coronal STIR, (b) axial T1 with fat suppression after GAD injection, (d) DWI, (E) histopathological image. The prostatic mass is evident in all planes (white arrow) being mildly hypointense in T1, hypo to intermediate intensity in T2, showing moderate heterogenous contrast enhancement and significant restricted diffusion (0.9 x $10^{-3}$ $mm^2$ /sec). Also few pelvic nodules were noted, one of them is seen in the mesorectal fat (☆) showing the same enhancement and diffusion restriction as the prostatic masse. Diffuse urinary bladder wall thickening (black arrow in b) is likely sequel to chronic obstruction. (E) Histopathological image (x 400) showing peri-vascular arrangement of small undifferentiated cells (white arrow).**Features of prostatic rhabdomyosarcoma**

**Case 8:** A 7-year-old boy presented by pelvic pain .

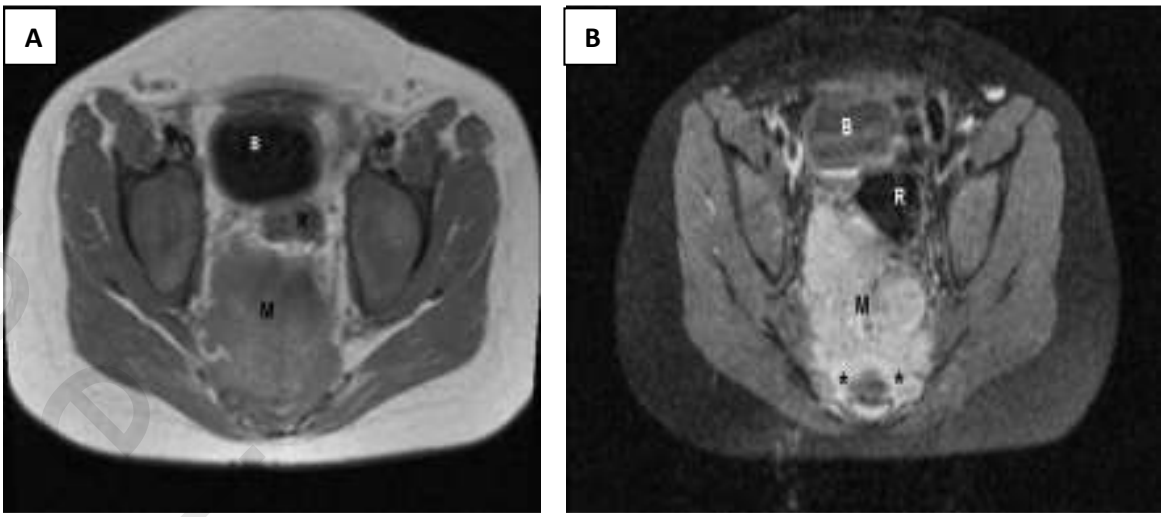



**Figure 55:** **Case 8:** (A) axial T1 (B) axial T1 Fat-Sat after GAD injection. MRI shows a sizable presacral soft tissue mass (M) with intra thecal and intra osseous components. The lesion showed isointense signal on T1, hyper intense signal on T2, moderate inhomogeneous contrast enhancement and restricted diffusion. Infiltration of the mass posteriorly into the sacral vertebrae and neural foramina (*) is evident. The rectum (R) is pushed anterolaterally with no signs of infiltration. B: urinary bladder. Imaging features suggested an aggressive mesenchymal lesion with chordoma on top of differential diagnosis because of the anatomical site, the age and the infiltrative nature. **Chordoma was found on pathology.**

**Case 9:** A 17-year-old girl presented by several months of progressive pain and limited movement of left hip

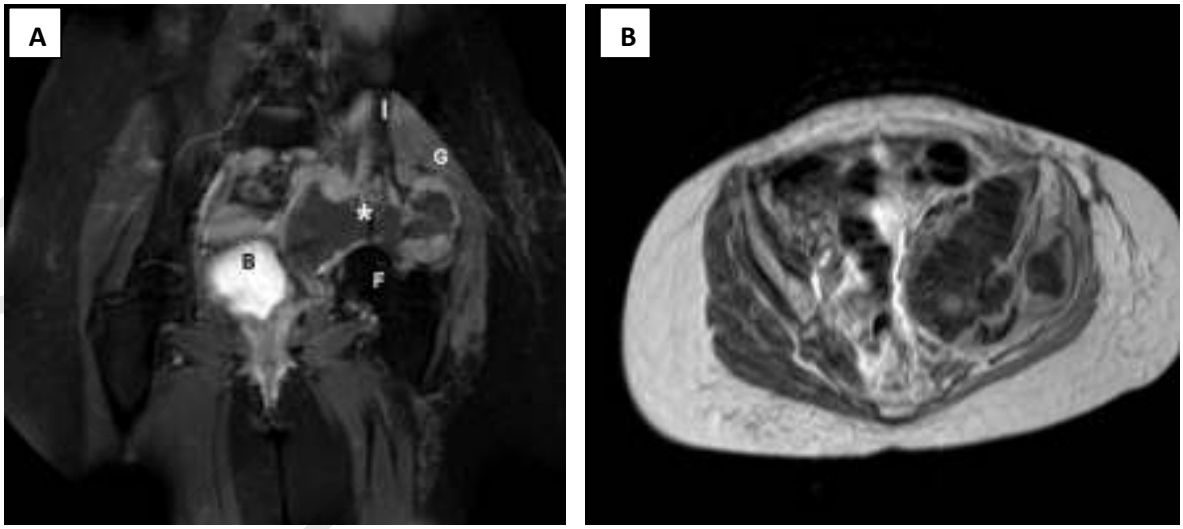



**Figure 56:** **Case 9:** (A) coronal T1 Fat-Sat after GAD injection. (B) Axial T1. The destructive lesion (asterisk) is well seen in both views infiltrating the iliac bone ( I) and gluteus muscle (G).It showed heterogenous T1 hypo and T2 hyper intense signal with moderate peripheral enhancement and large area of central non enhancing necrosis. The mass showed evident diffusion restriction. Also noted is a sizable intra pelvic component displacing pelvic viscera without infiltration**.** The hip joint space and femoral head (F) are spared. **An aggressive mesenchymal neoplastic lesion was suggested based on imaging features and biopsy revealed spindle cell sarcoma.**

**Case 10:** A 2-year-old girl presented by constipation and urine retention. PR revealed a presacral mass

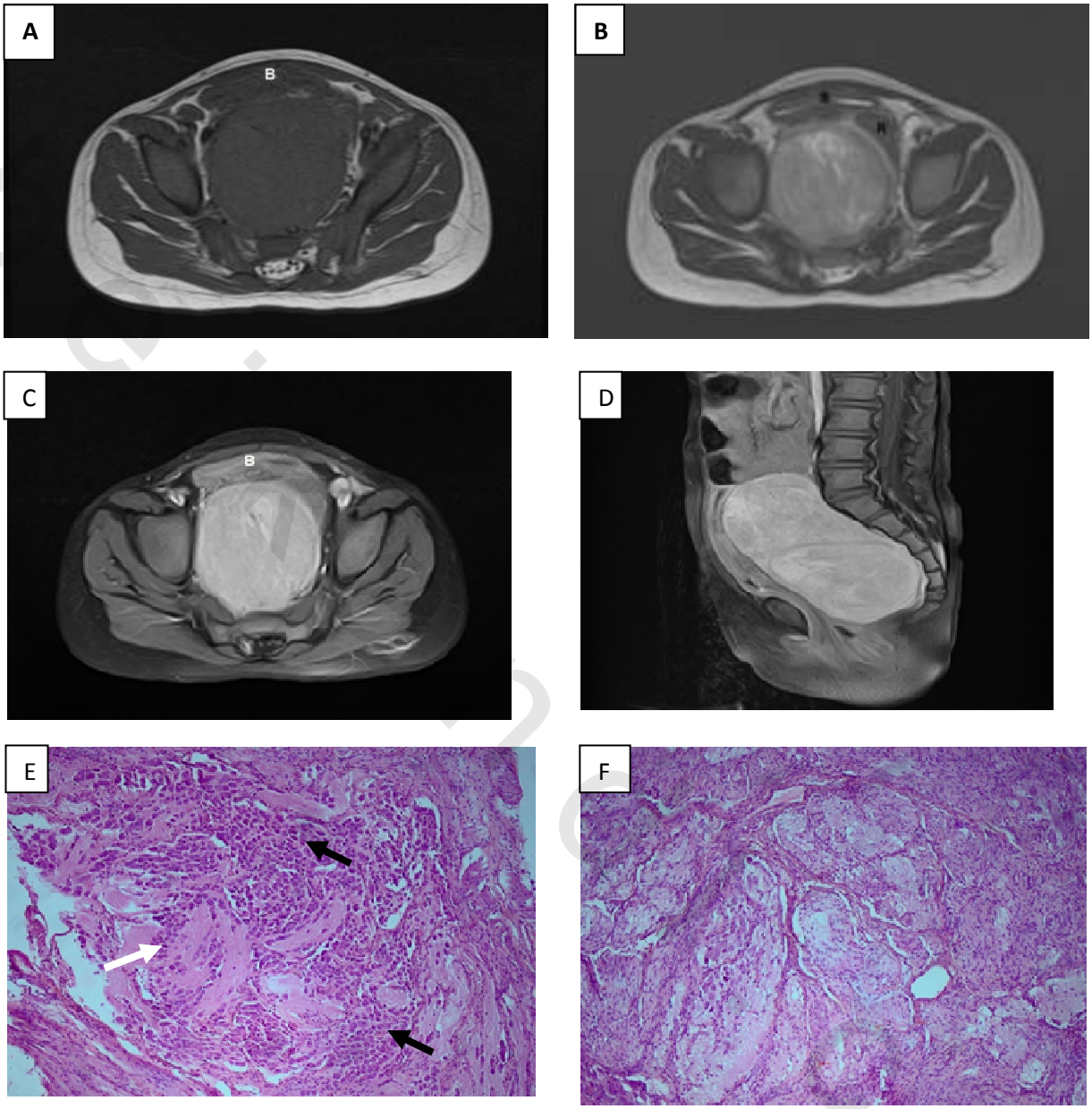



**Figure (57):** **Case 10:** (A) axial T1, (B) axial T2, (C&D) T1 Fat-Sat after Gad injection in axial and sagittal views respectively, (E&F) histopathological slides. The sizable presacral mass is evident with homogenous T1 hypo and T2 mildly hyper intense signal. It showed homogenous intense contrast enhancement and mildly restricted diffusion. It caused significant compression of the urinary bladder and rectum "B and R" but with no invasion. No sacral bony infiltration or neural foramen extension was noted. Histopathological slides (H&E X 400) show clusters of ganglion cells (black arrows) at different stages of maturation surrounded by Schwannian stroma (white arrow).Image (F) is showing clearly the lobulated appearance of the clusters. **Final diagnosis was a mature ganglioneuroma**

**Case 11:** A 15-year-old girl presented by gradually progressive pelvi abdominal pain and distension.MRI and CT were done and revealed:

- Two sizable pelvi abdominal masses, mainly hypointense in both T1 and T2 with some internal hyperintensities. Both lesions showed multiple peripheral small cysts and multiple internal dilated vessels. These were diagnosed as hugely enlarged ovary with diffuse parenchymal infiltration.
- Other smaller multiple pelvic and abdominal masses of same hypointensity involving rectum, urinary bladder ,iliac nodal groups and omentum.
- Mild ascites with omental stranding.

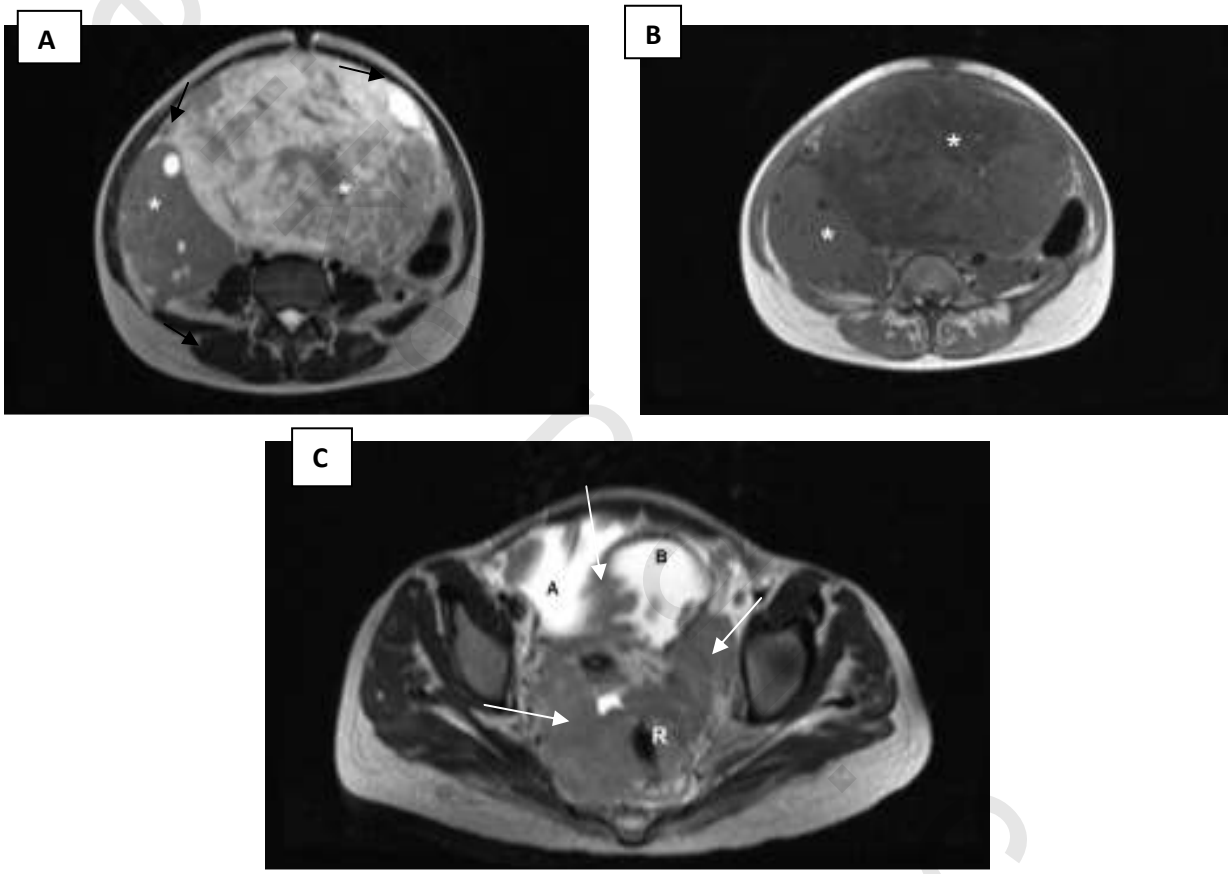



**Figure (58): Case 11:** (A) axial T2 and (B) axial T1 at the same level. The two dominant pelvi-abdominal lesions (asterisk) are seen with mainly hypointense signal in both sequences with some hyper intense areas on T2 in the left sided one. Small cystic areas are seen (black arrows).(C) axial T2 at lower level showing multiple hypo intense masses (white arrows), the largest is seen encasing and compressing the rectum(R).Also multiple hypointense nodules are seen along the wall of the urinary bladder (B). A: Ascites. These imaging features suggested an aggressive neoplastic lesion of peritoneum as DSRCT or other sarcoma or adenocarcinoma. **However, pathological examination of core biopsy revealed Burkitt's lymphoma.**

Another MRI was done after 4 months to assess response to chemotherapy. It showed remarkable response with resolution of all masses except for single residual mass on the left side of the pelvis. The residual mass has become homogeneously hypointense in both T1 and T2 with no restricted diffusion and only minimal contrast enhancement .These features suggested residual fibrotic adnexal mass .This was confirmed on PET/CT done 1 week later that showed no residual metabolic activity

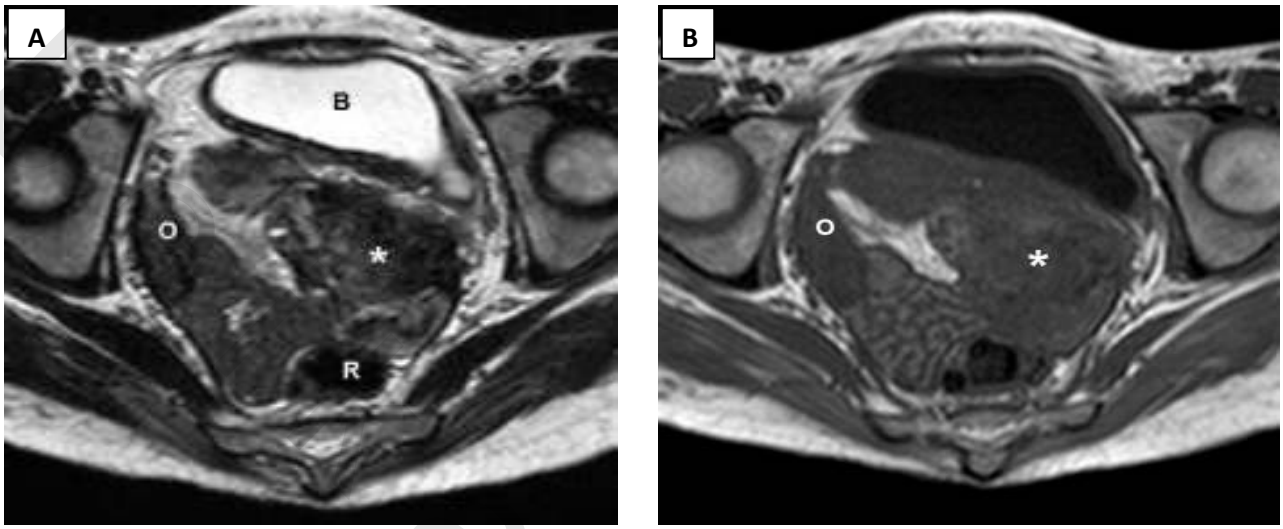



**Figure 59:** **Case 11 (post -treatment):** (A) axial T2 and (B) axial T1 both showing residual small left adnexal mass (asterisk) with hypointense signal in both sequences. O: normal sized right ovary which is also hypointense. B: urinary bladder. R: Rectum.

**Case 12:** A 2-year-old boy with known history of excised pelvic neuroblastoma since 6 months had a CT abdomen and pelvis for follow up which showed an ill defined soft tissue lesion on the right side of presacral space with no definite enhancement.

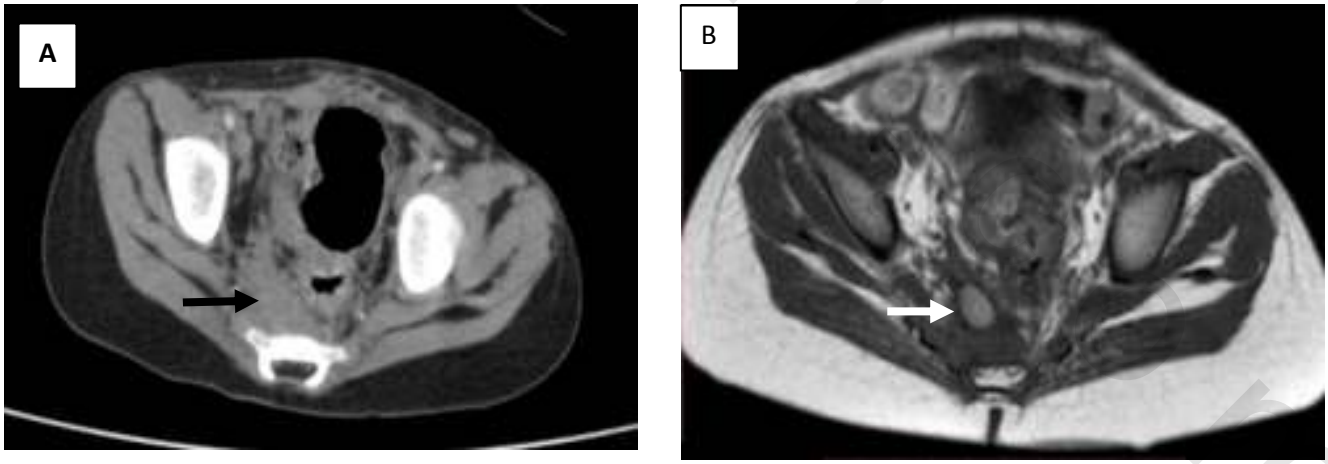



**Figure (60):** **Case 12:** (A) axial CT shows a small non enhancing presacral soft tissue lesion mildly displacing the rectum to the left side. (B) Axial T1 MRI showing a well defined hyper intense nodule in the centre of the hypointense presacral fibrotic lesion. **This was diagnosed as a small recurrence.**

**Cases 13:** A 15 year old female patient presented by primary amenorrhea and recurrent pelvic pain

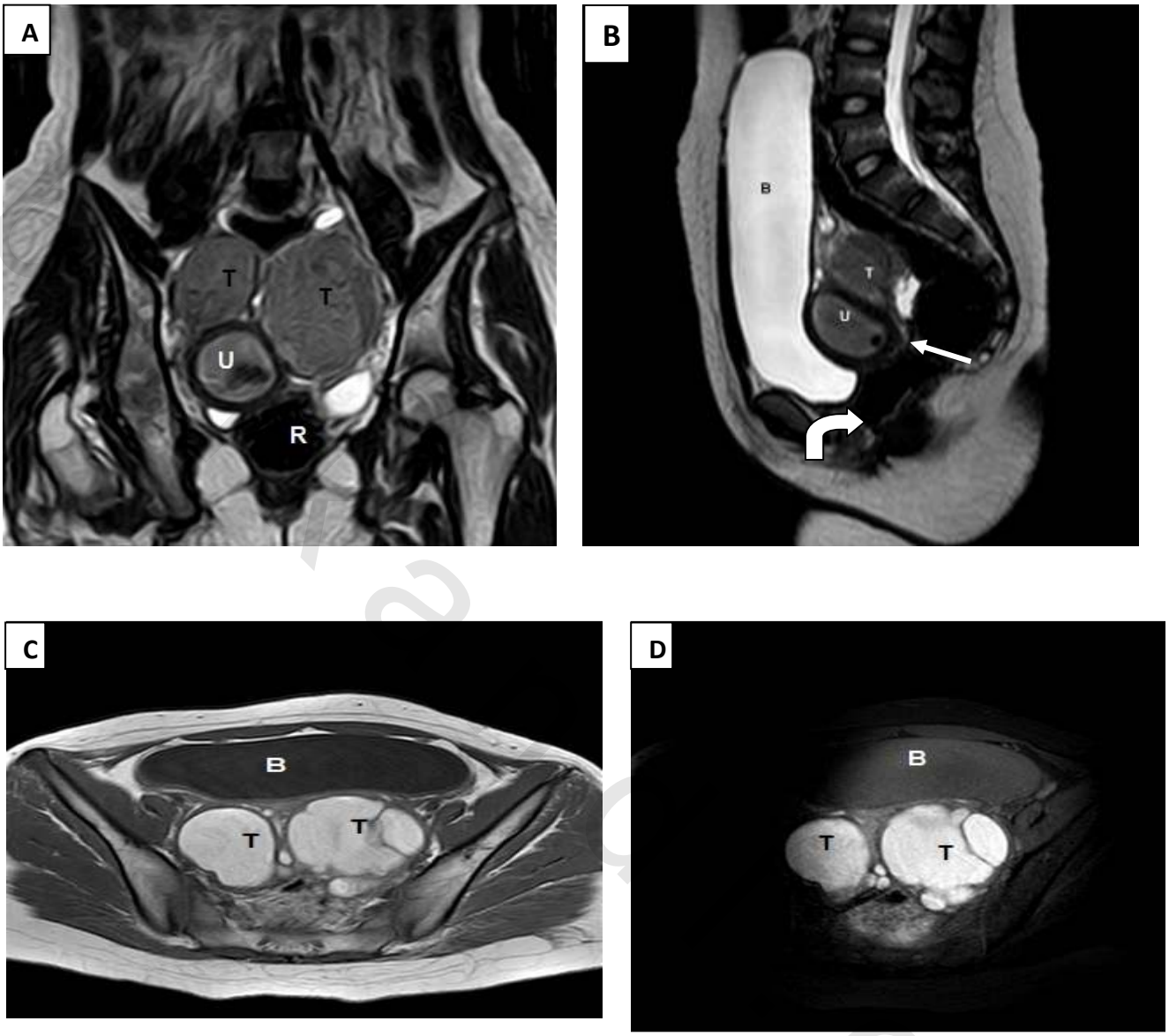



**Figure 61: Case 13:** (A) Coronal T2 showing distended uterus (U) and bilateral tubes (T) with hypointense fluid content. (B)Sagittal T2 also shows the distended uterus and one of the tubes. The curved white arrow points to the visualized lower vagina and the straight white arrow points to the expected site of the absent cervix. (C&D): Axial T1 without and with Fat-Sat also shows bilaterally dilated tubes with hyperintense content that does not suppress on fat suppression confirming it is hemorrhagic fluid rather than fat contents. **The imaging findings of hematometra and haematosalpinges resulting from atresia/hypoplasia of the cervix and upper vagina is matching with Mullerian anomaly type Ib**. Associated findings included overdistended urinary bladder " B" with bilateral megaureteres which may indicate associated neurogenic bladder or reflux disease. R: Rectum

**Case 14:** A 14 year old female patient presented by primary amenorrhea and recurrent pelvic pain

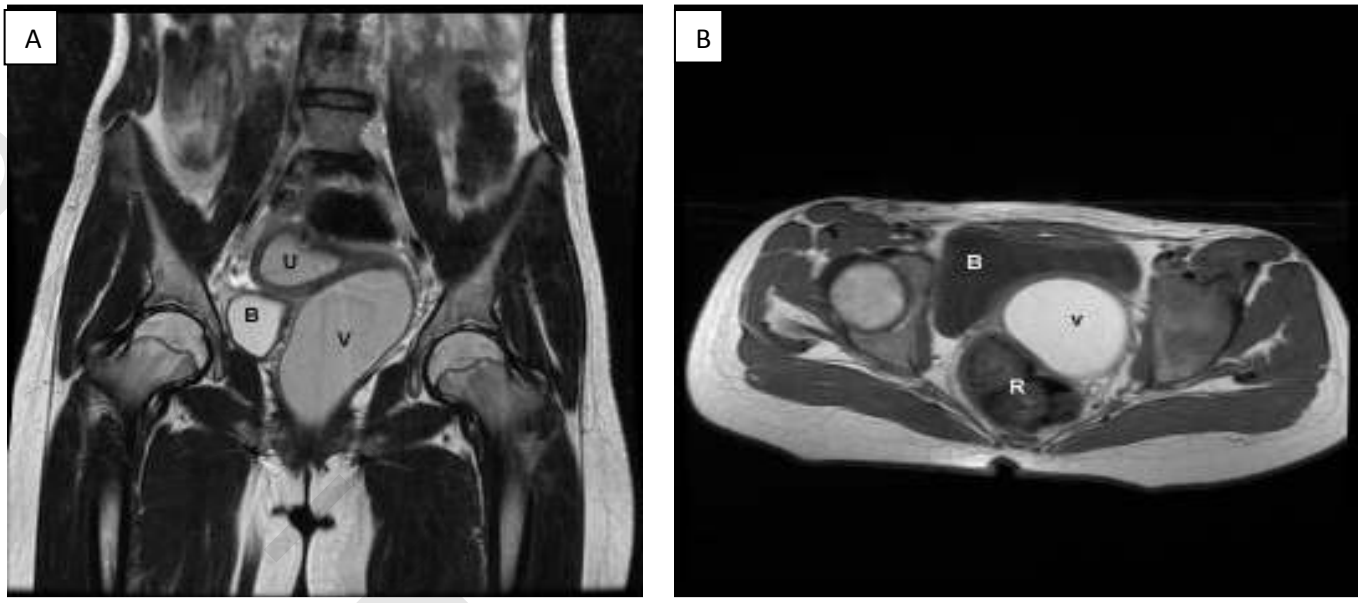



**Figure 62: Case 14:** (A) coronal T2 showing the whole length of the vagina(v) and the uterus(d) distended by homogenous hyperintense fluid content.(B): Axial T1 showing the distended vagina(v) filled with hyper intense fluid content interposed between the urinary bladder(B) and the rectum (R ).**These findings suggested hematometrocolpos due to vaginal obstruction by imperforate hymen. This was confirmed surgically**

**Case 15:** A 13 year old female patient presented by primary amenorrhea and recurrent pelvic pain

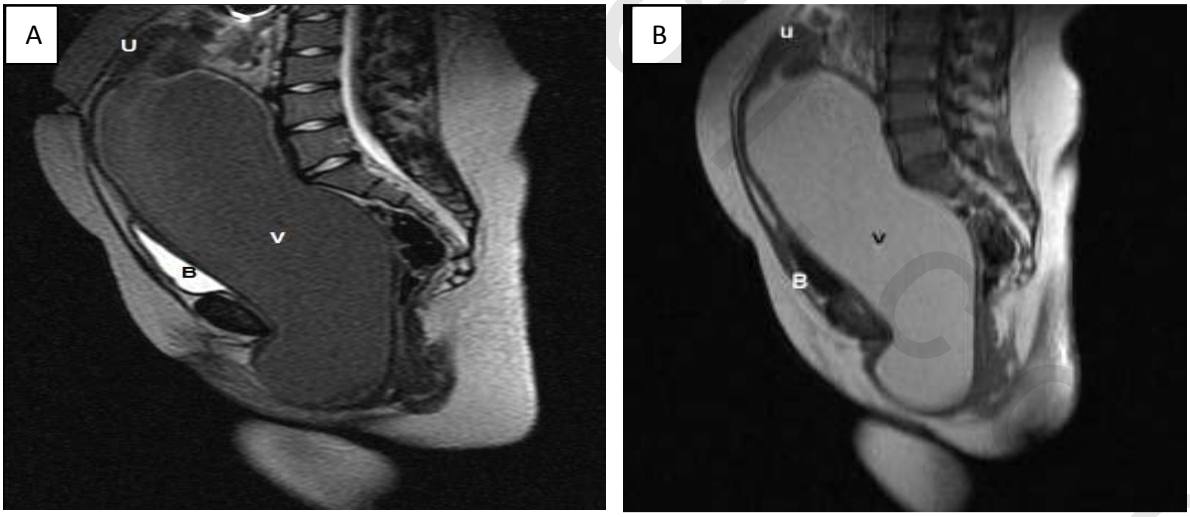



**Figure 63: Case 15:** (A) Sagittal T2, (B) Sagittal T1. Both images show hugely distended vagina (v) which occupies the whole pelvic cavity and its lower end prolapsing in the introitus. The vagina is filled by fluid content with hypointense signal in T2 and hyperintense signal in T1.The uterus (U) is seen on its top only mildly distended. B: Urinary bladder. **These findings suggested hematocolpos due to vaginal obstruction by imperforate hymen. This was confirmed surgically.**

**Case 16:** A 15 year old female patient presented by recurrent pelvic pain with otherwise regular menstruation

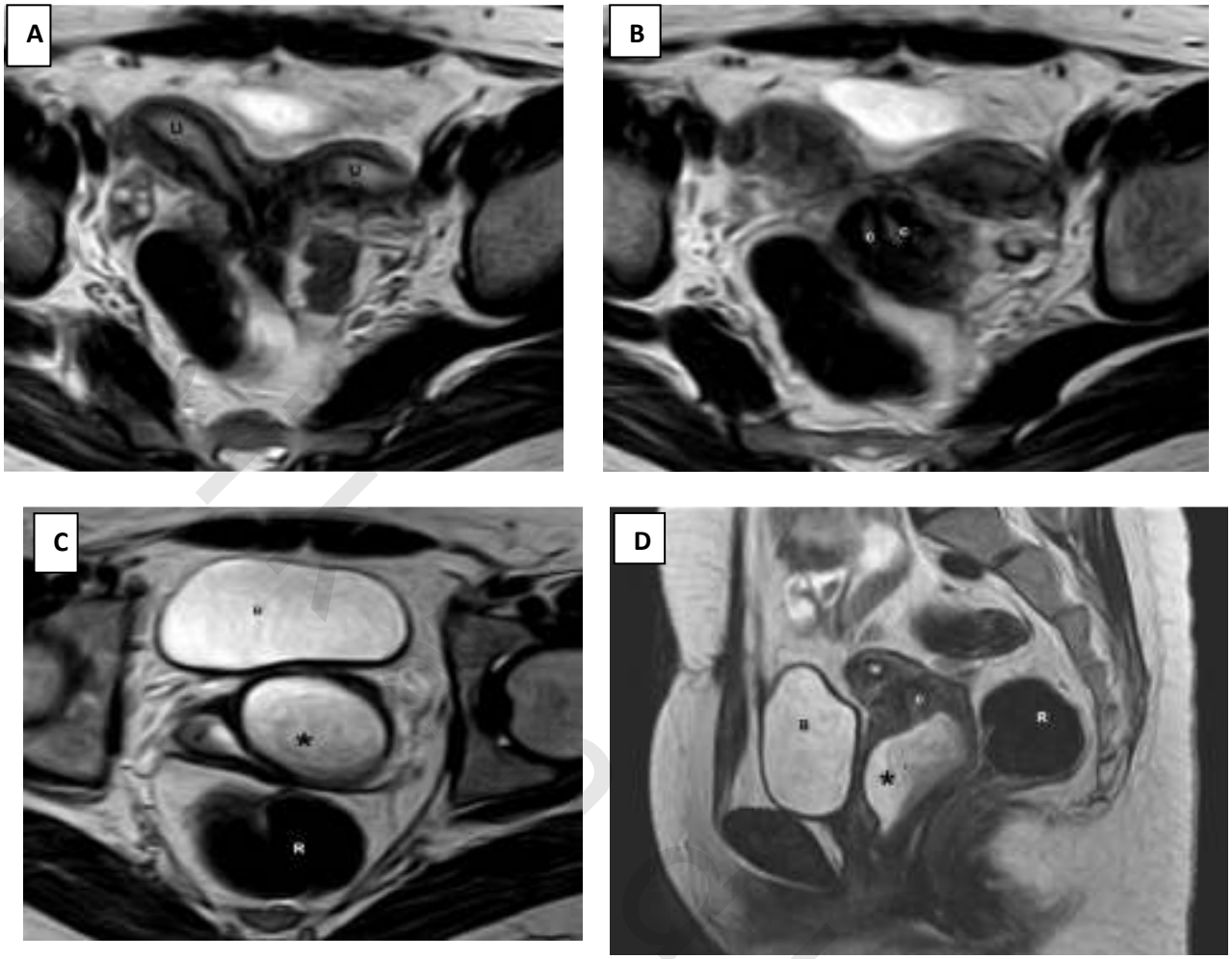



**Figure (64):** **Case 16:** (A, B, C) Axial T2 images from cranial to caudal, (D) sagittal T2. The axial images show two widely divergent uterine bodies "U", two cervices "C" and two vaginae where one of the latter "asterisk" is distended by hyper intense fluid with hypointense sediment. The other vagina "v" is of relatively normal size. Sagittal T2 shows clearly the distended vagina with normal dimension of ipsilateral cervix and uterus. B: Urinary bladder. R: rectum. **These imaging features matched with didelphys uterus with unilateral vaginal distension due to obstruction, likely by a low transverse vaginal septum**. Unilateral renal agenesis was also noted on the left side, ipsilateral to the obstructed vagina. **This is a well described associated finding of a congenital syndrome known as Herlyn- Werner-Wunderlich syndrome.**

**Case 17:** A 5 year old girl presented with an acute attack of right sided pelvic pain associated with vomiting and urgent US revealed abnormal bulky echogenic right ovary with few peripheral follicles and no detected internal vascularity. CT was also done and showed same findings together with no contrast enhancement of right ovary. These findings raised suspicion of acute torsion of right ovary. The parents refused surgical interference at the time but the child came back two months later with recurrent milder attacks of pelvic pain and MRI was done.

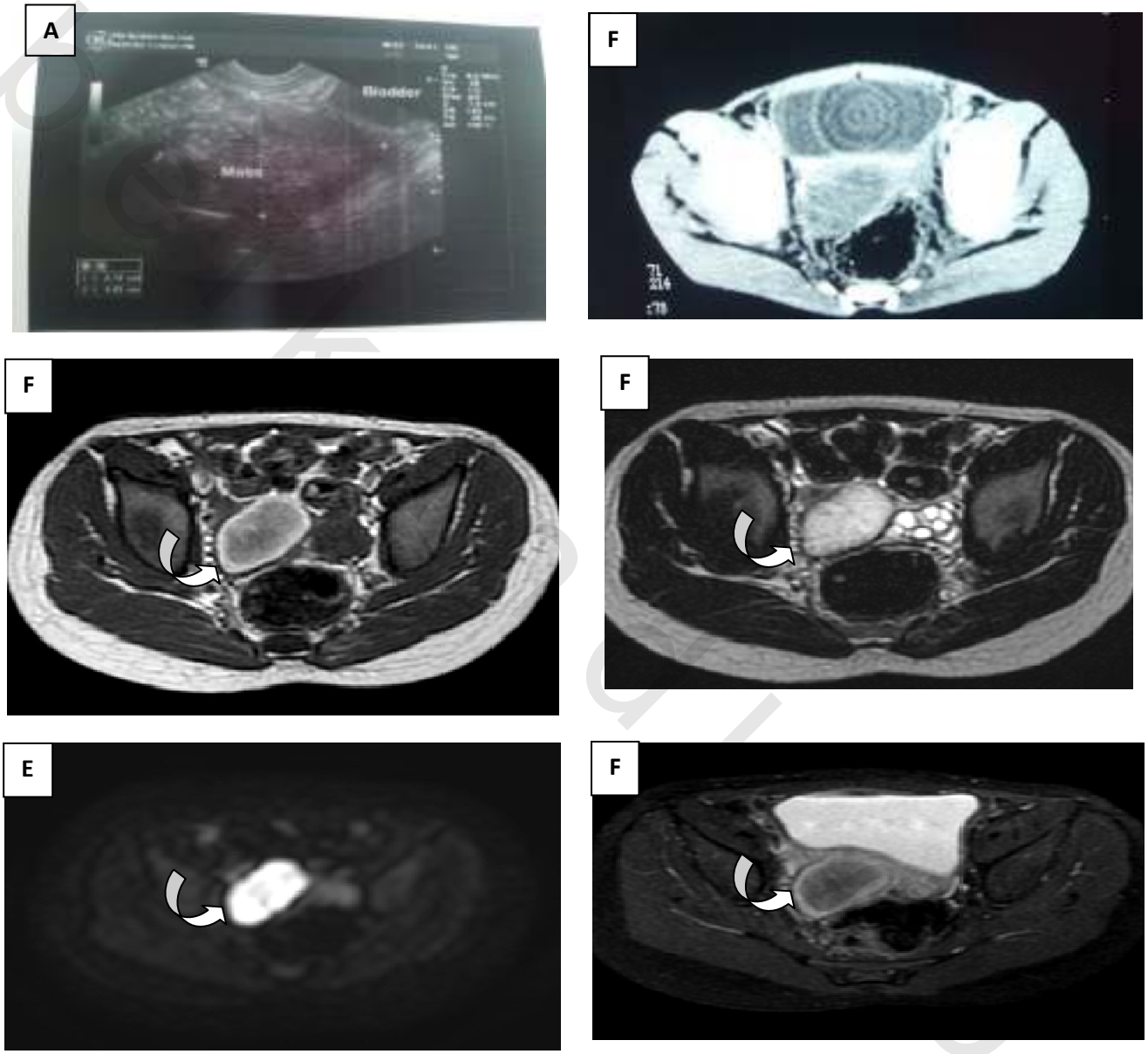



**Figure (65):** **Case 17:** (A) Axial pelvic US images shows the abnormal bulky hyper echoic right ovary. (B) axial pelvic CT scan with IV contrast showing the bulky non-enhancing right ovary.(C) Axial T1,(D) axial T2,(E) DWI , (F) T1 Fat-Sat after GAD injection. The right ovary (curved white arrow) is bulky showing diffuse hyper intense signal more prominent in T2 with hypointense rim in both sequences and no evidence of enhancement after GAD injection. Evident diffusion restriction is also noted .White arrow: normal appearing left ovary. **MRI diagnosis was hemorrhagic necrosis of the right ovary probably secondary to torsion. Surgical exploration and pathological analysis of oophorectomy specimen confirmed this diagnosis**

**Case 18:** A 15 year old boy presented with progressive pelvi-abdominal pain and distension.

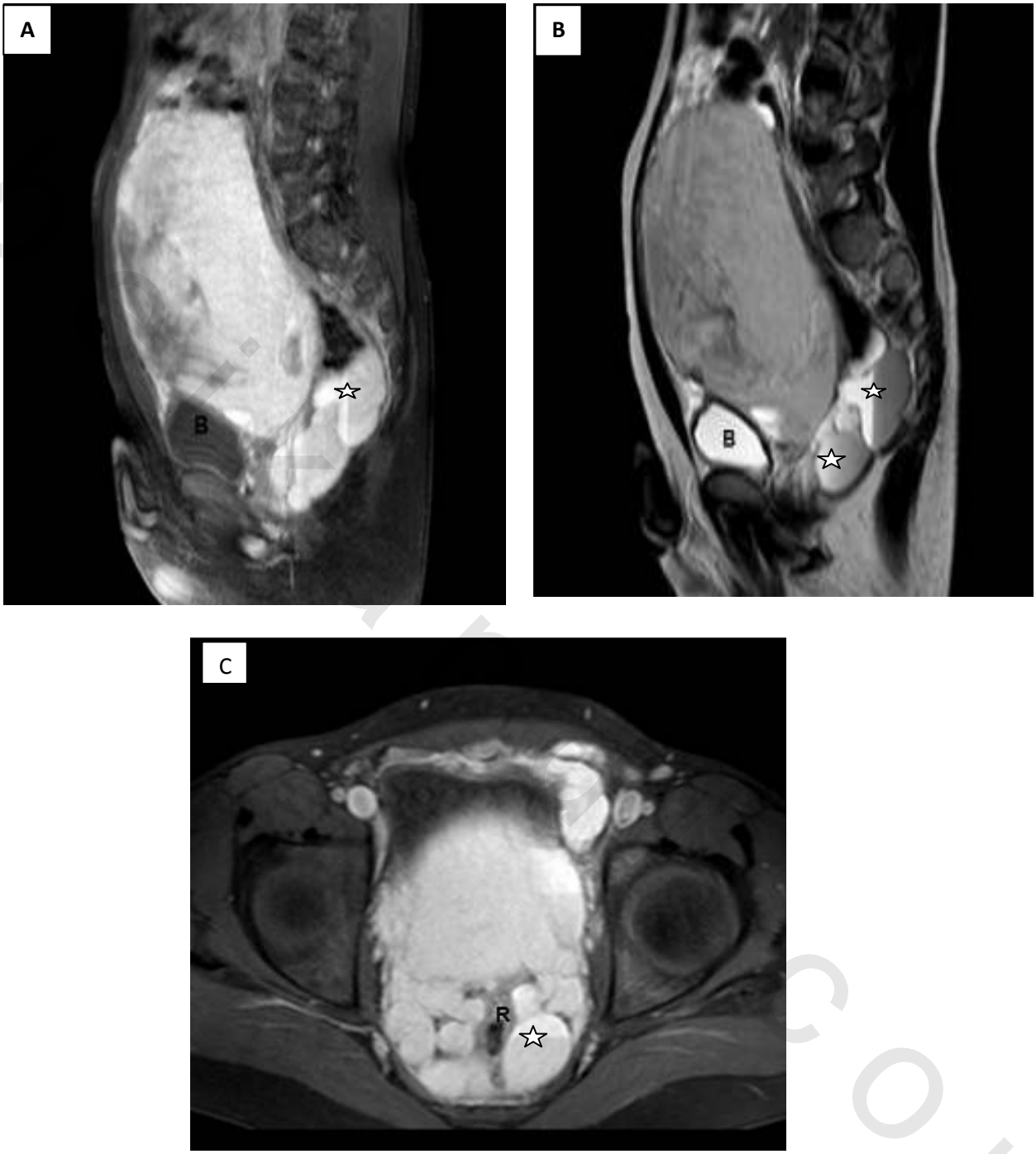



**Figure (66):** **Case (18):** (A) sagittal T1 Fat-Sat, (B) sagittal T2 showing the huge multilocular cystic mass. (C) Axial T1 Fat-Sat shows the mass involving whole pelvic region totally encasing the rectum (R). ☆ : Fluid levels. B: urinary bladder. **Imaging features matched was a lymphangioma which was confirmed by pathological analysis of the surgically excised mass.**

**Case 19:** A 7 year old girl presented with recurrent mild right sided pelvic pain.

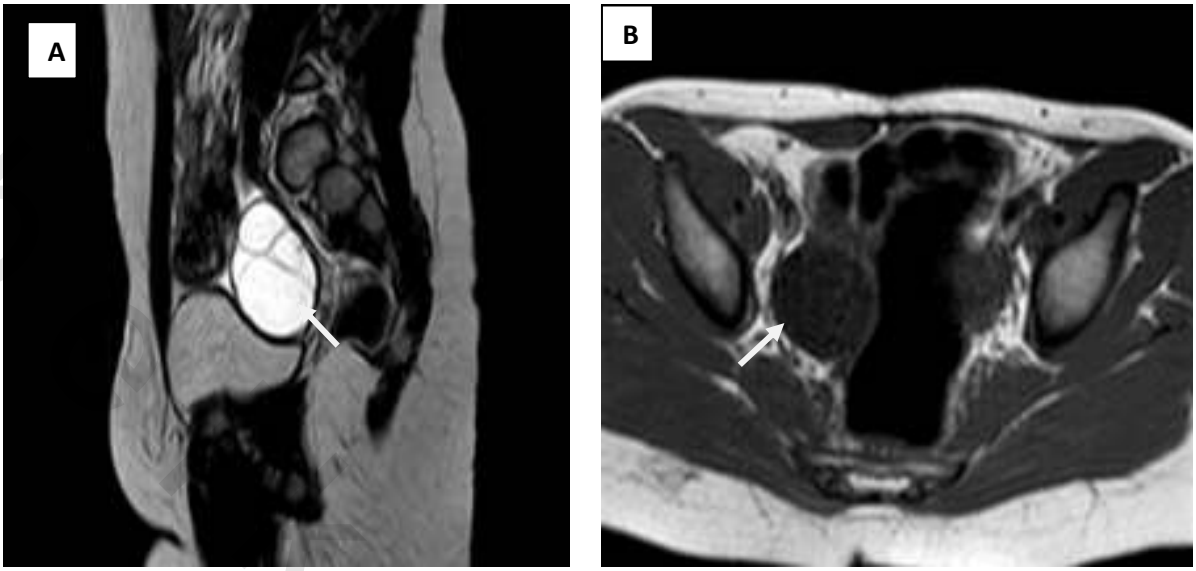
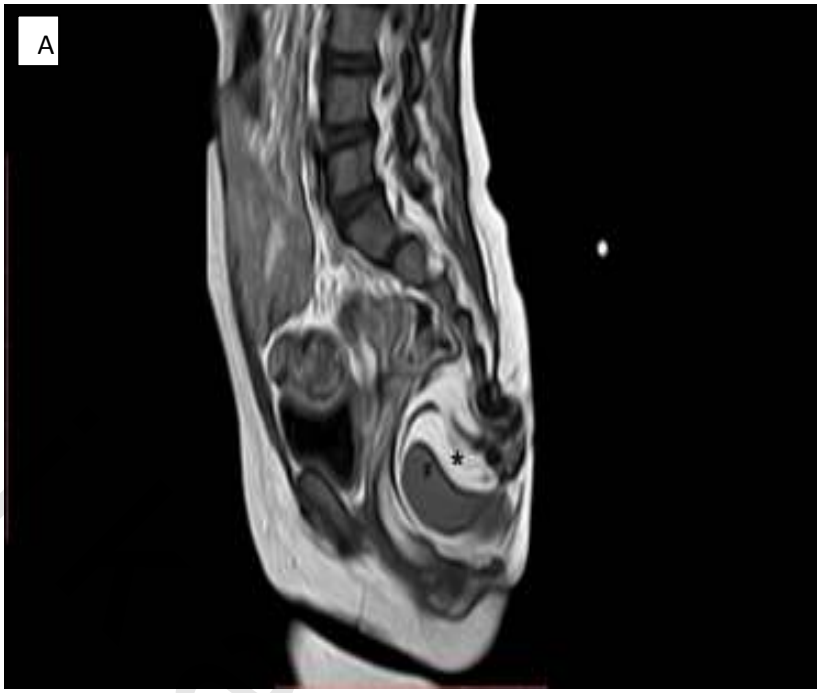
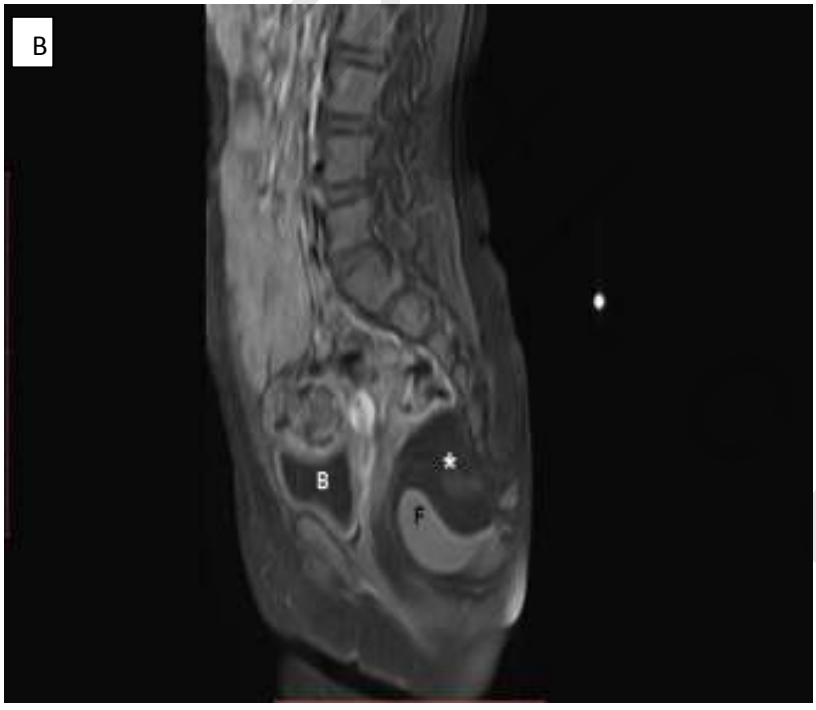



**Figure 67:** **Case 19: (A)** Sagittal T2 and (B) axial T1. Right adnexal cyst is seen showing homogenous T1 hypo and T2 hyperintense fluid content .It has thin regular wall together with few thin hypointense septa (not exceeding 3 mm). No soft tissue or abnormal enhancement was detected after GAD injection and no diffusion restriction. **Imaging features were typical for a complicated benign ovarian cyst, likely a functional cyst. This was confirmed by pathological examination of the excised cyst.**

**Case 20:** A 2 year old girl presented by a non tender lower back swelling with normal overlying skin apart from tiny blind dimple.



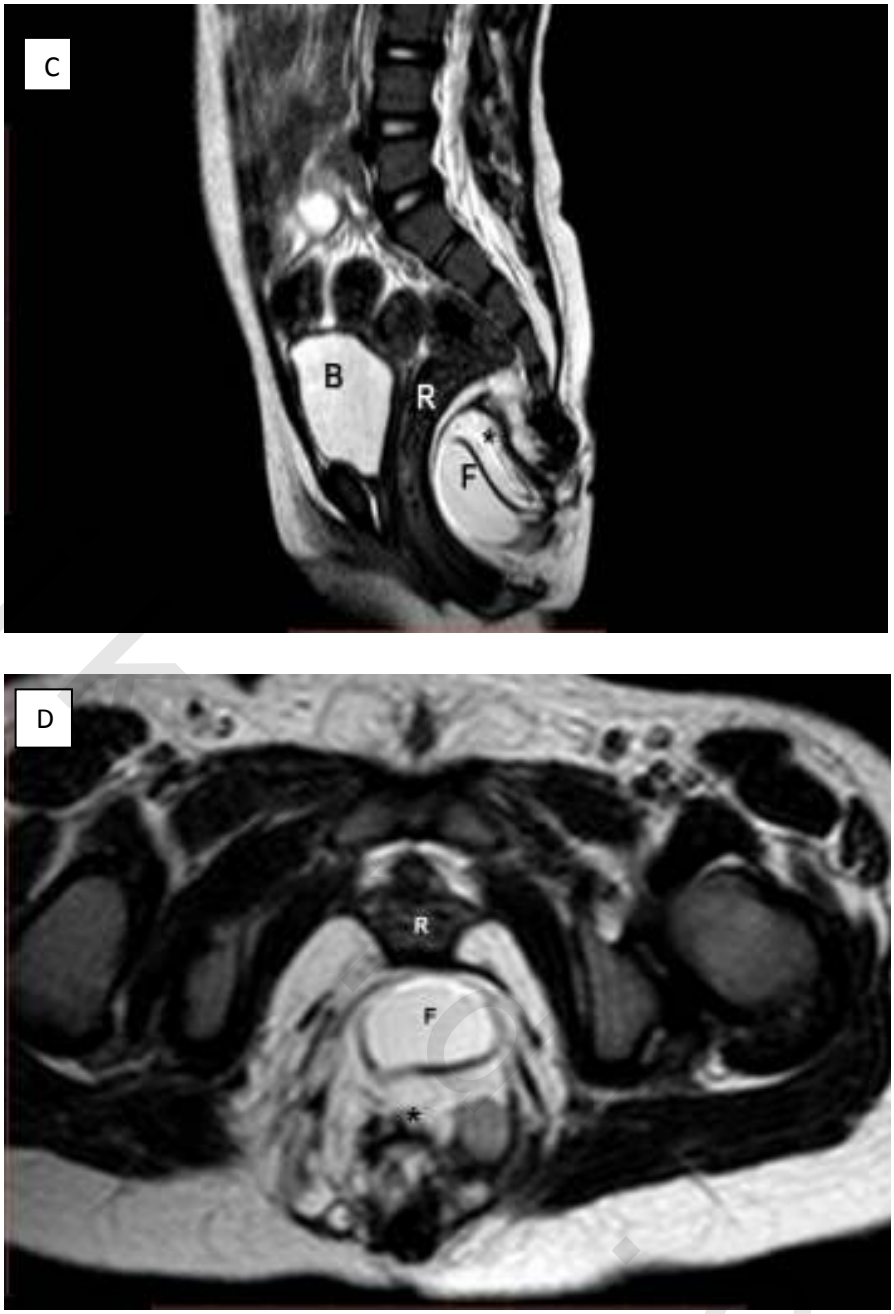



**Figure 68:** **Case 20:** (A) sagittal T1, (B) sagittal T1 Fat-Sat, (C) sagittal T2, (D) axial T2. A well defined presacral mass is seen with heterogenous signal. The fluid content (F) is hypointense in T1 and hyper intense in T2. The fat content (*) is hyperintense in both T1 and T2 and clearly suppressed in T1 Fat-Sat. No enhancing soft tissue could be identified and no connection was noted to the spinal canal with normal development of sacrococcygeal part of the spine. R: rectum. B: Urinary bladder. **MRI diagnosis was a simple presacral dermoid cys**t. Pathological examination confirmed the diagnosis with the findings of a cystic lesion lined by keratinized stratified squamous epithelium filled by lamellated keratinous material with entangled hair follicles and sebaceous glands. No cellular atypia was found. This confirmed imaging diagnosis and the patient was free of recurrence at 6 month follow up.