

# Role of imaging modalities in the Adolescent

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**Summary:** Imaging modalities comprising of radiography, ultrasound, color Doppler, CT scan and magnetic resonance imaging form an integral part of the diagnostic armamentarium in the adolescent girl, especially so, as an intact hymen precludes a per speculum and pervaginal examination. Endoscopy techniques which include vaginoscopy, colposcopy and laparoscopy alongwith the above imaging modalities assist the gynecologist in the diagnosis, treatment and follow-up of these young patients.

## Introduction

Adolescence is the period in life in which a young girl matures from childhood to adulthood with rapid acceleration of physical and emotional development. Psychologically, at this time, the girl is also developing her own personality and individuality. Adolescence spans a period of 10 years from age 10 to 20 years of life (Coyaji 1991). This period is characterised by its own set of specific gynaecologic problems ranging from mullerian anomalies, inflammatory genital tract diseases, pelvic tumours, abnormal sexual development, pelvic pain to abnormal genital tract bleeding. Various imaging modalities alongwith endoscopy help to diagnose and treat these varying disorders.

### 1. Plain Radiography

A plain X-ray of the abdomen and pelvis (antero-posterior view) is taken in the supine or standing position and with the urinary bladder empty (a full bladder may mimic a pelvic mass). Pelvic and abdominal masses lend a soft tissue shadow on plain X-ray. Site of the mass, displacement of adjacent structures and calcification can be appreciated but plain radiography cannot diagnose the nature of the mass, whether solid or cystic (Armstrong & Wastie 1992).

Calcification in a pelvic mass is seen in fibroids, especially in postmenopausal women, benign cystic teratomas and ovarian tumors, namely cystadenoma, cystadenocarcinoma and gonadoblastoma (White House and Wright 1990). Calculi, faecoliths, phleboliths, intra-uterine device, pelvic calcification

in Koch's and radio-opaque foreign bodies in the vagina can all be appreciated on plain radiography.

A plain film of the pelvis and abdomen is used as the first film in an intravenous urography IVU profile. Also, diagnosis of intestinal pathology in the form of paralytic ileus and rupture of hollow viscus with gas under the diaphragm can be diagnosed on a standing, plain X-ray abdomen.

## II. Special Radiography

### a. Intravenous urography:

IVU is one of the methods in diagnostic radiology which uses an intravenous contrast medium for delineating the urinary system – the kidneys pelvicalyceal system, ureters, bladders, urethra. Congenital anomalies of the urinary system, namely, polycystic kidneys, pelviureteric junction obstruction, bifid collecting system, ectopic kidney, ectopic ureters, horse shoe kidneys can be appreciated on IVU. Also, back-pressure effect on the urinary tract due to pelvic masses and malignancies, presence of urinary calculi, fistulae and diverticuli can all be well ascertained by IVU. IVU forms an integral part of the pre-operative investigations in cases of large pelvic tumours – fibroids, ovarian and para-ovarian tumors and also in the evaluation and staging of gynaecological malignancies (Armstrong, 1992).

### b. Vaginography

A vaginogram is a plain X-ray obtained after instillation of contrast material into the vagina. A radiolucent or non-radio-opaque foreign body in the

vagina as well as vaginal calculi and congenital vaginal abnormalities can be demarcated by a vaginogram (White House and Wright 1990). Vaginal calculi develop as part of calcification around a foreign body. They may also develop due to constant urine leakage into the vagina from an ectopic ureter or a urinary fistula. Transverse ridges in the upper vagina are seen in cases with in utero exposure to di-ethyl stilbestrol.

#### c. Genitography

This is a radiological investigation of the urogenital sinus and its communicating structures in cases of pseudohermaphroditism. A French (no 9) balloon catheter is introduced into the perineal orifice and contrast is injected under fluoroscopy in the left lateral position. The x ray picture delineates the urogenital sinus, urethra and vagina and helps in formulating management. (White House and Wright 1990)

#### d. Pelvic Arteriography

Color Doppler imaging provides the initial suspicion of an arterio-venous malformation or an angioma of the uterine vessels as the cause of abnormal and severe uterine bleeding. This is followed by a pelvic angiogram which provides the exact site of the anomalous blood supply. Treatment in the form of gelfoam embolisation can be done in the same sitting.

Tumour directed infusion of chemotherapeutic agents can also be done under pelvic angiographic control.

#### e. Hysterosalpingography

The main use of HSG in adolescence appears to be academic in the investigation of end organ failure i.e. pelvic Koch's causing amenorrhoea, either primary or secondary.

### III. Ultrasonography

Transabdominal USG uses a full urinary bladder as an acoustic window and allows a detailed morphologic evaluation of the uterus, cervix, adnexa and urinary

tract.

The most common indication for gynaecological USG is the evaluation of a pelvic mass. (Grainger and Allison 1997). USG gives the location, size, shape, consistency of the mass, back pressure effect on the urinary tract and characteristics of malignancy in the mass.

In young girls, transrectal USG probe obviates the need for a full bladder and allows excellent visualization of the uterus, adnexa and parametrium. Transperineal USG is also a great help especially in the evaluation of mullerian anomalies and abnormal sexual development.

#### Interventional ultrasound

Drainage of hematocolpos and hematometra, aspiration of cystic adnexal masses, drainage of pelvic abscess and hematoma and methotexate injection in to an unruptured ectopic sac can all be achieved under USG guidance.

### IV. Color Doppler imaging

Neovascularity with a vascular bed of low-impedance and high velocity blood flow are tumor characteristics seen on doppler (Grainger and Allison 1997). The vascular pattern of fibroids, pelvic tumors and inflammatory pelvic masses can be studied with color doppler. Evaluation of patients with pelvic congestion syndrome presenting with pelvic pain and dysmenorrhoea and patients with abnormal uterine bleeding has been possible with Doppler imaging.

### V. Role of CT Scan – Computerised Tomography

A pelvic CT scan plays an integral part in the staging and assessment of pelvic neoplasms. CT assesses local tumor invasion and also gives accurate tumor localization for both biopsy and radiotherapy.

Initially, contiguous 1 cm cuts are taken for the CT scanning and subsequently 3-5 mm cuts are obtained if it is necessary to define boundaries of a mass and to assess the extent of local spread more accurately. Intravenous contrast-enhanced CT helps to identify and differentiate

pelvic vessels from lymphnodes. Various techniques are used for excellent soft tissue differentiation, like a tampon to localise the vagina, 500 ml of 2% oral gastrografin 6-12 hours prior to opacify the large bowel, use of 500 ml of gastrografin 30 to 45 minutes prior to the scan to identify the small and large intestine and a limited enema to define the rectum and pelvic colon.

The drawbacks of CT are its limitation to only the transverse plane of imaging, relative lack of soft tissue contrast resolution, artefacts from pelvic and metallic inserts, the necessity for injection of contrast material with its attendant potential dangers and exposure of tissues to ionising radiation. USG shows greater specificity over CT in the diagnosis of ovarian neoplasms; more over CT shows an inability to identify normal ovaries (Schwartz and Weiner 1979).

## **VI. Role of MRI-Magnetic Resonance Imaging**

MRI is well suited for the study of the female pelvis as it provides a unique, non-ionising, non-invasive means of evaluating tissue density with respect to uterine zonal anatomy. MRI provides excellent morphological display of benign tumours of the uterus and also has the unique ability for staging pelvic malignancies (Hricak and Chang 1987). MRI allows soft tissue imaging with greater contrast resolution than CT, allows multiplanar imaging and generation of different views of tissues.

USG will remain the initial procedure for evaluating clinically suspected pelvic masses and MRI will supplement CT and play an important role in patients in whom USG findings are suboptimal, patients in whom the origin of the pelvic mass cannot be determined by USG and patients in whom differentiation between simple fluid lesions and other types of adnexal lesions is not possible with USG. Most important, MRI will continue to play a significant role in the staging of genital malignancies (Hricak 1987 and Chang).

## **VII. Vaginoscopy, Colposcopy**

In-utero exposure to di-ethylstilberstrol is associated with vaginal and cervical lesions in the form of adenosis, adenocarcinoma, erosion, ectropion, cockscomb cervix, pseudopolyp formation and transverse cervico-vaginal ridges. Vaginoscopy and colposcopy allows an excellent means of diagnosis, evaluation and follow-up of young girls with abnormal vaginal bleeding which may be due to vaginal foreign bodies or vaginal tumours like sarcomas.

## **VIII. Laparoscopy**

Laparoscopy is indicated in the evaluation of acute and chronic abdominal pain which may be due to pelvic inflammatory disease, ectopic pregnancy, endometriosis, torsion of ovarian mass or a non-gynaecologic cause and also in the evaluation of young girls with abnormal genitalia, primary amenorrhoea and intersex abnormalities (Logsdon, 1997).

Ovarian torsion is common in young girls due to the laxity of ligamentous structures surrounding the young ovary. (Shaker et al 1993). Ovarian torsion may be associated with normal adnexa or an adnexal tumour. USG helps to detect the adnexal mass and doppler imaging detects the diminished or absent ovarian blood flow with torsion.

Menstruating adolescents with chronic, cyclic pelvic pain who are unresponsive to analgesics and oral contraceptive pills are candidates for laparoscopic evaluation after gastrointestinal and genitourinary causes are eliminated. In a study by Goldstein et al, 1980, 53% of such adolescents had early endometriosis identified by close-up, magnification view through the laparoscope. In 20% cases, the only findings were petechial and bleblike lesions of early endometriosis.

Clinical Situations in Adolescent girls warranting imaging modalities.

### **a. Mullerian anomalies**

1. Imperforate hymen: USG helps to detect hematocolpos and hematometra and back-pressure

effect on the urinary system. Drainage of the blood collection can be done under USG guidance.

2. A transverse vaginal septum is associated with a normal lower vagina with hematocolpos and hematometra. USG detects the hematocolpos and hematometra, measures the thickness of the septum and deciphers the level of obstruction.

MRI helps in the differential diagnosis of a high transverse vaginal septum from Mullerian duplication with a proximal atresia.

3. Disorders of lateral fusion of mullerian ducts encompasses uterus didelphys, bicornuate uterus, unicornuate uterus with rudimentary horn, septate, subseptate, arcuate uterus, longitudinal vaginal septum. Mullerian anomalies may be associated with urinary tract anomalies.

Imaging modalities helpful in the anatomical classification of such anomalies are USG, MRI, IVU (intravenous urography).

4. Congenital absence of uterus and vagina (Mayer – Rokitansky – Kustner – Hauser syndrome) is second only to gonadal dysgenesis as a cause of primary amenorrhoea. It occurs in 1 in 4000 to 1 in 20,000 female births. (Kim and Laufer 1994). Urinary tract anomalies are associated in 40% cases and spinal anomalies in 12% cases.

Thus USG, helped by MRI in a few cases helps detection of presence of uterus, cervix, vagina, presence of ovaries, urinary tract anomalies and back pressure effect on the kidneys.

### **b. Abnormal sexual development**

USG of gonads helps differentiate testis from the ovary. (Logsdon 1997). USG also allows detecting the presence of mullerian derivatives. If in case of ambiguous genitalia, mullerian structures are present, then it signifies female pseudohermaphroditism or virilisation of a female fetus.

Presence of palpable gonads but absent mullerian structures on USG is a pointer to male pseudohermaphroditism or hypovirilised male.

Karyotypic analysis is a must in cases of abnormal sexual development as dysgenetic gonads i.e., those with a Y cell line are prone to a 30% risk of gonadal malignancy before the second decade of life (Krstic, et al 1995). The risk of tumours like gonadoblastoma, dysgerminoma, embryonal carcinoma is 20-30% in dysgenetic gonads of Turner's syndrome (Speroff et al 1994). In all cases of dysgenetic gonads, gonadectomy is resorted to prior to puberty to avoid neoplasia and virilisation which occurs at puberty. The only exception to this rule is complete androgen insensitivity wherein gonadectomy is done at age 18 to allow puberty to occur uninterrupted as the risk of gonadal tumour is only 5% before the age of 25 (Manuel et al 1876).

Precocious puberty due to hypothalamic and pituitary tumours are diagnosed by MRI brain while ovarian and adrenal masses are diagnosed by USG. Doppler imaging and MRI.

### **c. Ovarian Tumours**

Germ cell tumours are the most common benign and malignant ovarian tumours in adolescents. Teratomas comprise 10% of ovarian tumours, of which 96% are dermoids or benign cystic Teratomas. A plain radiograph reveals a soft tissue pelvic mass with dental calcification in 30% and osseous classification in 40% of dermoids (Blackwell, et al 1946). Radiolucency is due to sebaceous material contained in the dermoid. USG shows a mass of mixed or variable echogenicity due to fat, inverse layering which is echogenic fat floating on cystic elements and a solid plug of hair and calcified elements. Differentiation of fat from fluid is well appreciated on CT.

Ovarian malignancy is evaluated with USG, Doppler, CT, MRI and IVU (intravenous urography). USG characteristics of malignancy in an ovarian mass are bilaterality of tumour, solid components, thick and irregular septae, capsular rupture, tumour nodules or

papillae on the tumour surface, ascites, peritoneal deposits, liver and kidney and lymphnode metastasis.

**d. Fibroids**

Plain radiography shows multiple and large fibroids as a soft tissue pelvic mass. Calcification is very rare in fibroids seen in adolescents. USG distinguishes fibroids from extra uterine pathology, gives the endometrial thickness, associated ovarian cyst or tumour and also presence of hydroureter and hydronephrosis. IVU is a must in large fibroids reaching the pelvic brim and also broad ligament fibroids which are prone to cause ureteric compression and displacement.

**e. Abnormal Vaginal Bleeding**

USG will help to rule out organic causes of abnormal vaginal bleeding in the form of vaginal and uterine tumours, functional ovarian cysts, ovarian tumours, foreign body in the vagina, polycystic ovaries, pregnancy associated bleeding. Doppler imaging & pelvic angiography is of paramount importance in the diagnosis of pelvic congestion syndrome as a cause of dysmenorrhoea, arterio venous uterine aneurysms causing abnormal uterine bleeding and various pelvic tumours.

**f. Pelvic Inflammatory Disease**

USG detects hypoechoic or complex, symmetrical echo pattern in the adnexa. Fluid in the posterior pouch and hydrosalpinx formation are other characteristics on USG. In PID cases, the uterus is slightly enlarged, more trans-sonic with unclear uterine margins. Also, the endometrial echo is quite prominent with a sonolucent margin due to endometritis.

Pelvic tuberculosis is diagnosed by hysterosalpingography, hysterolaparoscopy and histopathology or tissue diagnosis.

**g. Endometriosis**

A diagnostic laparoscopy clinches the clinical diagnosis of endometriosis. USG helps detect endometriotic ovarian cysts as a hypoechoic mass in the adnexa with haemorrhage. MRI gives a characteristic appearance of

the ovaries due to recurrent haemorrhage in the endometriomas.

In conclusion, of all the imaging modalities utilised in diagnosing the various problems encountered in adolescents, pelvic sonography plays a very prominent role. Either by itself, or when complemented by cytogenetic studies and endocrine profile, sonography clinches the diagnosis in most cases.

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