

Catch a Ride Through the Canal of Nuck to Explore Radiologic Imaging of Vulvar Region Pathologies

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Disclosure

The authors of this educational poster have nothing to disclose.

Learning Objectives

- Vulvar region pathologies in the pediatric population include a spectrum of congenital and acquired conditions such as infection, neoplasm, and traumatic etiologies
- Imaging including ultrasound, CT and MRI play an essential role in establishing a diagnosis of these entities
- Familiarity with the differential diagnoses and spectrum of pathologies as well as their imaging characteristics is crucial for the radiologist to provide guidance in clinical management and optimizing clinical outcomes

Introduction

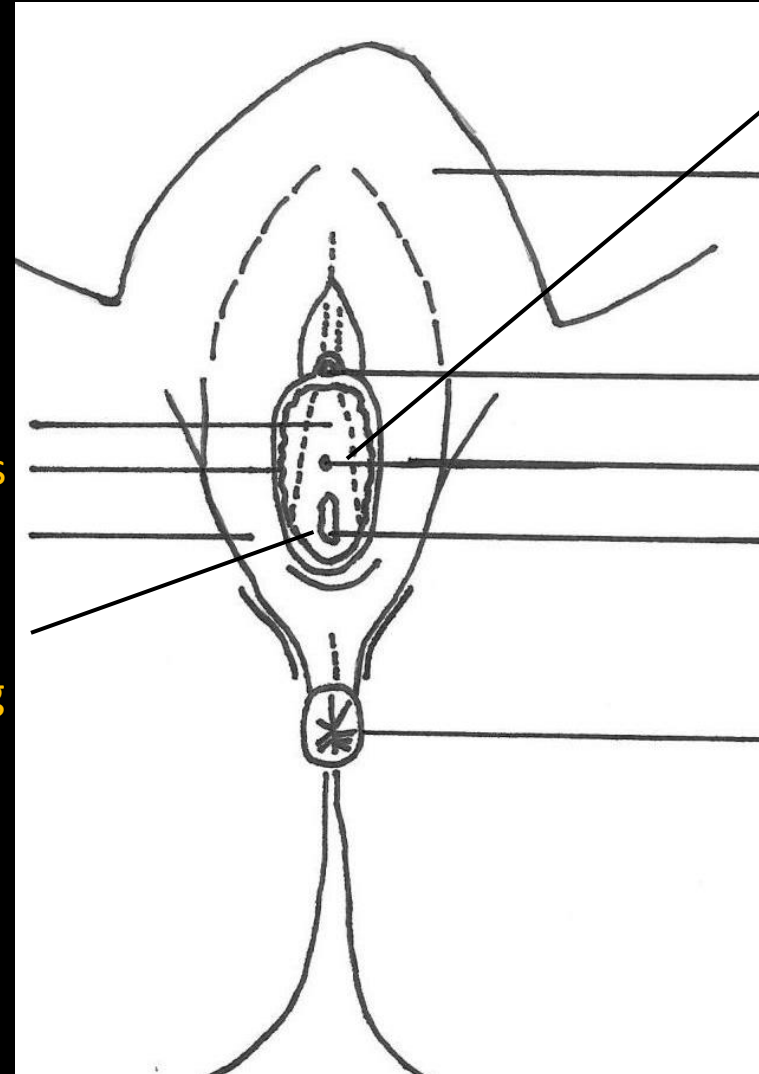
- The vulva can be affected by various pathologies in the pediatric population
- The location results in this area being at the “edge of the film” and findings could be easily overlooked especially on CT or MRI
- The goal of this exhibit is to provide an illustrative review of the various pathologies that can be seen in the vulvar region in the pediatric population
- A brief review of anatomy will be shown followed by a case-based presentation including congenital, infectious, inflammatory, traumatic, neoplastic and idiopathic causes

Normal Anatomy of the Pediatric Vulva

The vulva consists of the following:

- Labia majora
- Labia minora
- Clitoris
- Vestibule of the vagina
- Urinary meatus
- Hymen
- Vaginal opening
- Bartholin's glands
- Skene's glands

Vestibule
Labium minus
Labium majus
Bartholin
gland opening



Skene gland opening
Mons pubis
Clitoris
Urinary meatus
Vaginal opening
Anus

Normal Imaging Appearance of the Vulva

ULTRASOUND

- Important initial imaging modality in the setting of swelling or a suspected mass
- Initial test for defining the location and origin of the pathology
- Scanning should be performed using linear probe of at least 12 MHz
- Apply minimal pressure
- The right and left labia should appear symmetric
- Evaluating for symmetry is helpful (for example in cases of cellulitis or CALME discussed on later slides)

CT

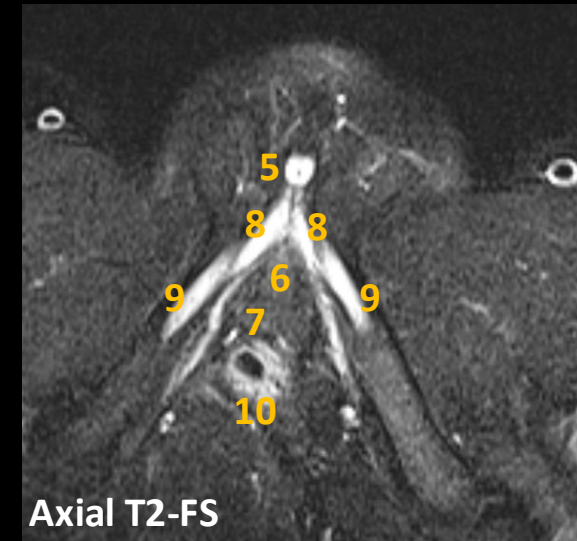
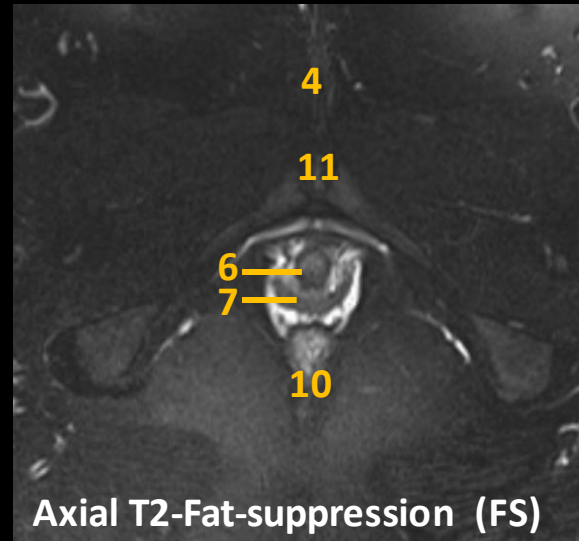
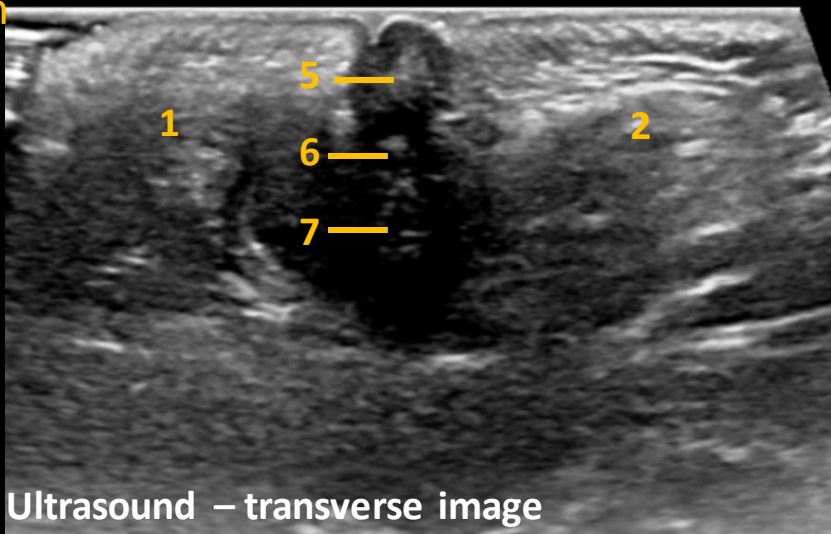
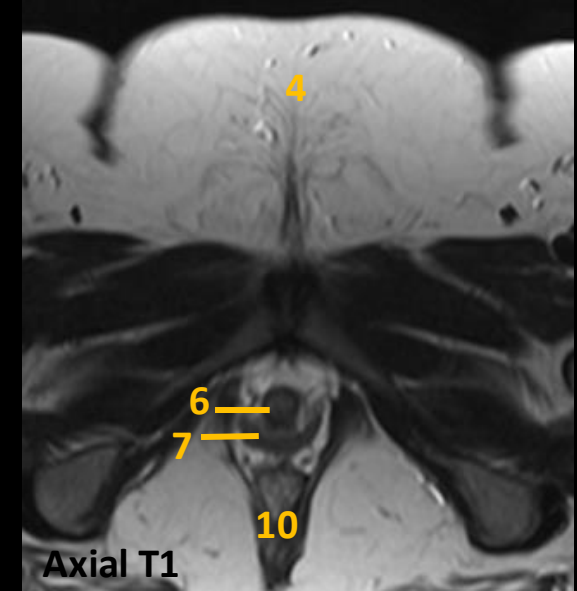
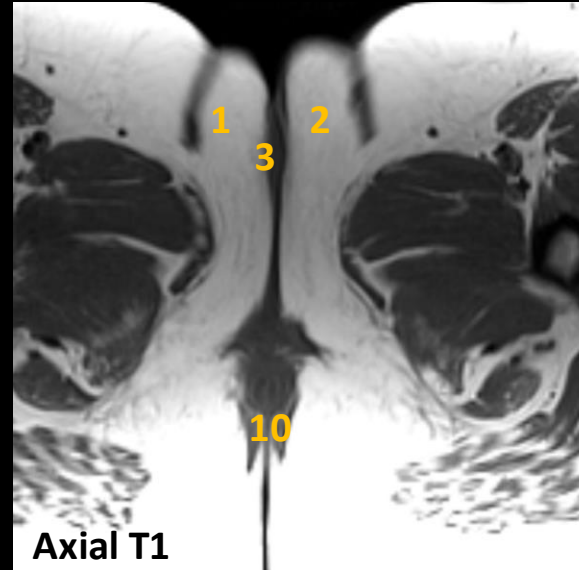
- Helpful for delineating anatomy
- Important to give IV contrast especially if evaluating for a mass of abscess in the setting of infection
- Important to make sure the technologist scans through the entire vulvar region
- Anatomic structures
 - Mons pubis and labia majora should demonstrate fat density without evidence of inflammation or soft tissue thickening/mass
 - Labia minora has soft tissue density

MRI

- Used to improve diagnostic confidence and for surgical planning especially in cases of neoplasm
- MRI pelvis sequences:
 - Coronal and sagittal T2-weighted imaging
 - Axial T2-weighted imaging with and without fat saturation
 - Axial T1-weighted images +/- contrast
- Anatomic structures
 - Mons pubis: hyperintense on T1 since it is composed of adipose tissue
 - Labia majora consist mostly of adipose tissue and glandular tissue posteriorly
 - Labia minora lie medially and appear as soft-tissue intensity

Normal Imaging Appearance of the Vulva

1. Labia majora right
2. Labia majora left
3. Labia minora
4. Mons pubis
5. Clitoris
6. Urethra
7. Lower vagina
8. Vestibular bulb
9. Corpora cavernosum
10. Anus
11. Pubic bone



Vulvar Region Pathologies

- Usually present with swelling, visible/palpable mass, and/or discharge
- Majority of diseases are benign

CONGENITAL

- Canal of Nuck anomalies
- Bartholin's gland cyst
- Skene's gland cyst
- Prolapsed ectopic ureterocele

TRAUMA

- Hematoma +/- active bleeding
- Abuse
- Laceration
- Foreign bodies

TUMORS - BENIGN

- Fibroepithelial polyps
- Müllerian papilloma
- Lipoma

IDIOPATHIC

- Congenital asymmetric labia majus enlargement
- Symmetric labial majus enlargement

INFLAMMATORY

- Secondary involvement from Crohn's such as fistula formation to vulvar region

INFECTIOUS

- Labial abscess
- Cellulitis
- Infected cysts such as Bartholin's gland cyst or urethra diverticulum

TUMORS - MALIGNANT

- Clear cell carcinoma
- Alveolar rhabdomyosarcoma
- Granulosa cell tumor

VASCULAR

- Hemangioma
- Venous, lymphatic, & venolymphatic malformations
- Arteriovenous malformation

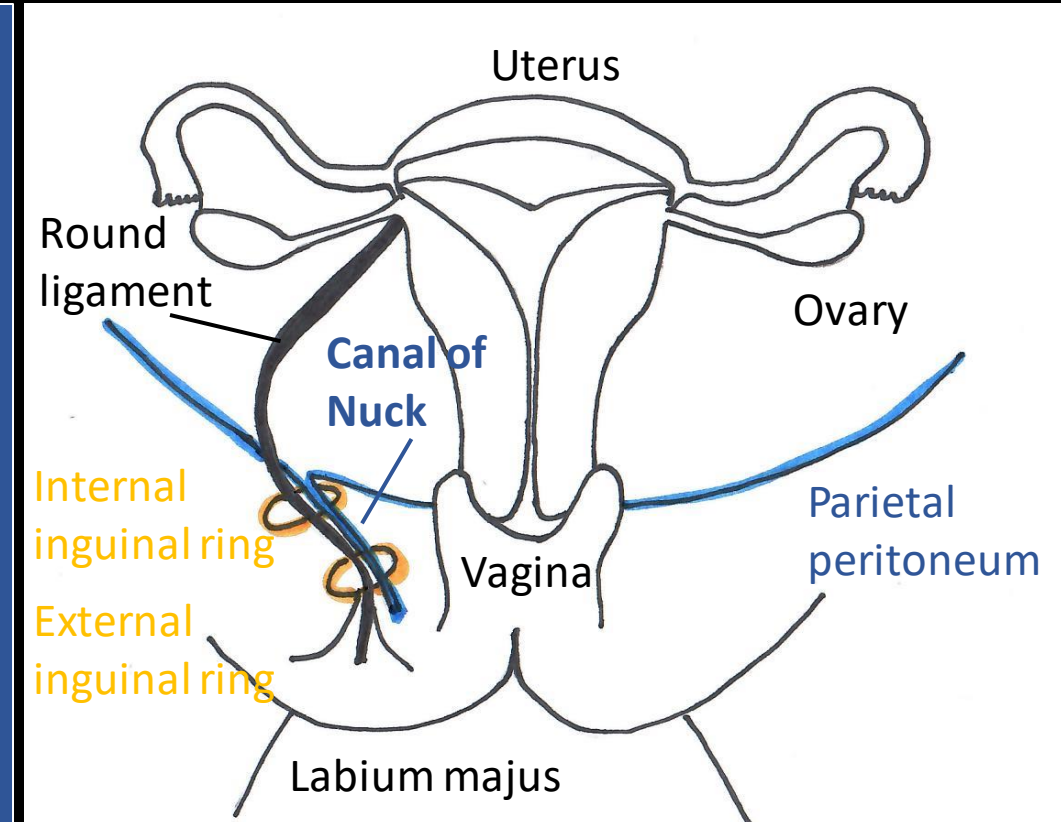
Congenital Malformations and Remnant Structures

CANAL OF NUCK HERNIA

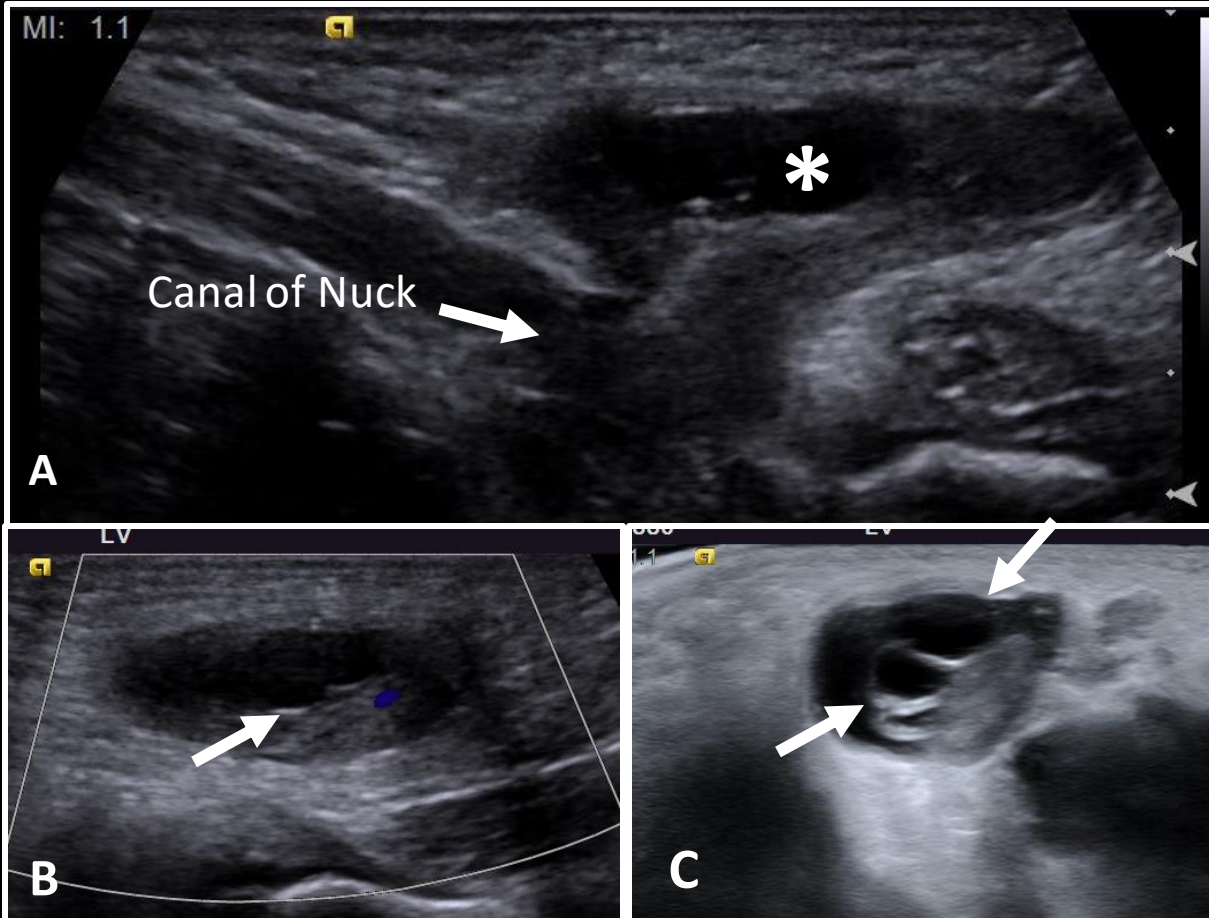
- Results from failure of closure of embryologic processus vaginalis
- Processus vaginalis normally obliterates within the first year of life.
- A patent processus vaginalis can result in pelvic structures herniating from the peritoneum through the inguinal canal into the labia majora
- May contain various pelvic or peritoneal structures
- **Most commonly contains ovaries**
- Presents as labia swelling

HYDROCELE OF THE CANAL OF NUCK

- Also known as canal of Nuck cyst or female hydrocele
- Analogous to spermatic cord hydrocele in males
- Occurs due to failure of obliteration of the processus vaginalis
- May be due to imbalance of absorption and secretion of fluids by the secretory membranes in the canal of Nuck
- Appears as an isolated fluid collection within the canal



Case: Canal of Nuck Hernia

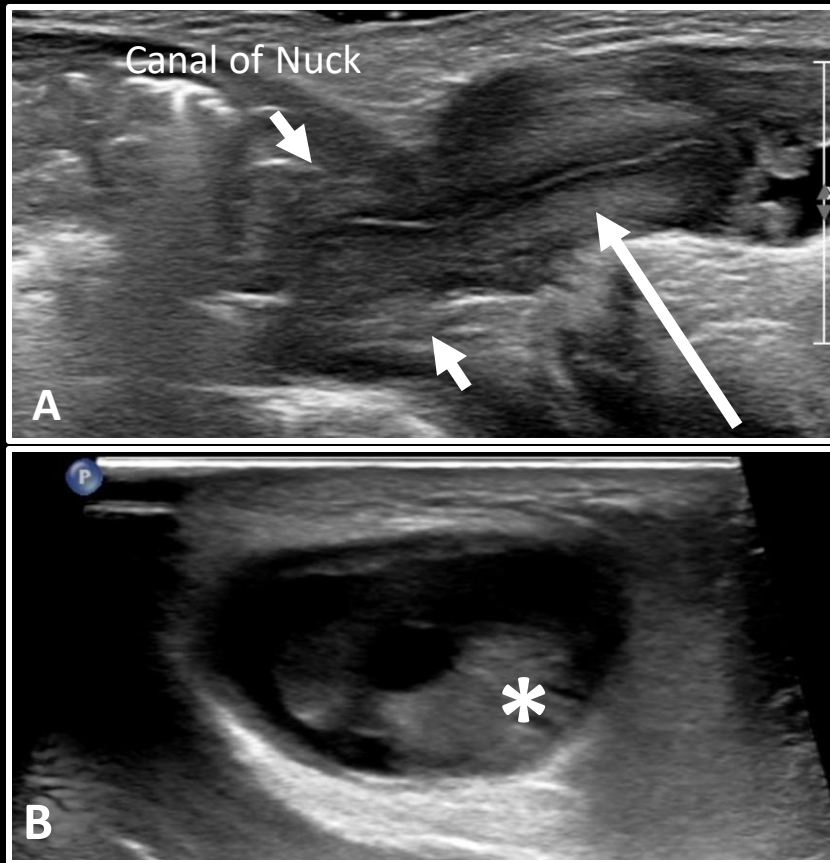


1-month-old female presented with left lower quadrant and pelvic swelling. A mass (*) was found in the left labia herniating from the pelvis through the canal of Nuck (arrow in A). The presence of follicles in images B and C (better appreciated with the higher frequency transducer in image C) confirmed this was the ovary.

KEY POINTS

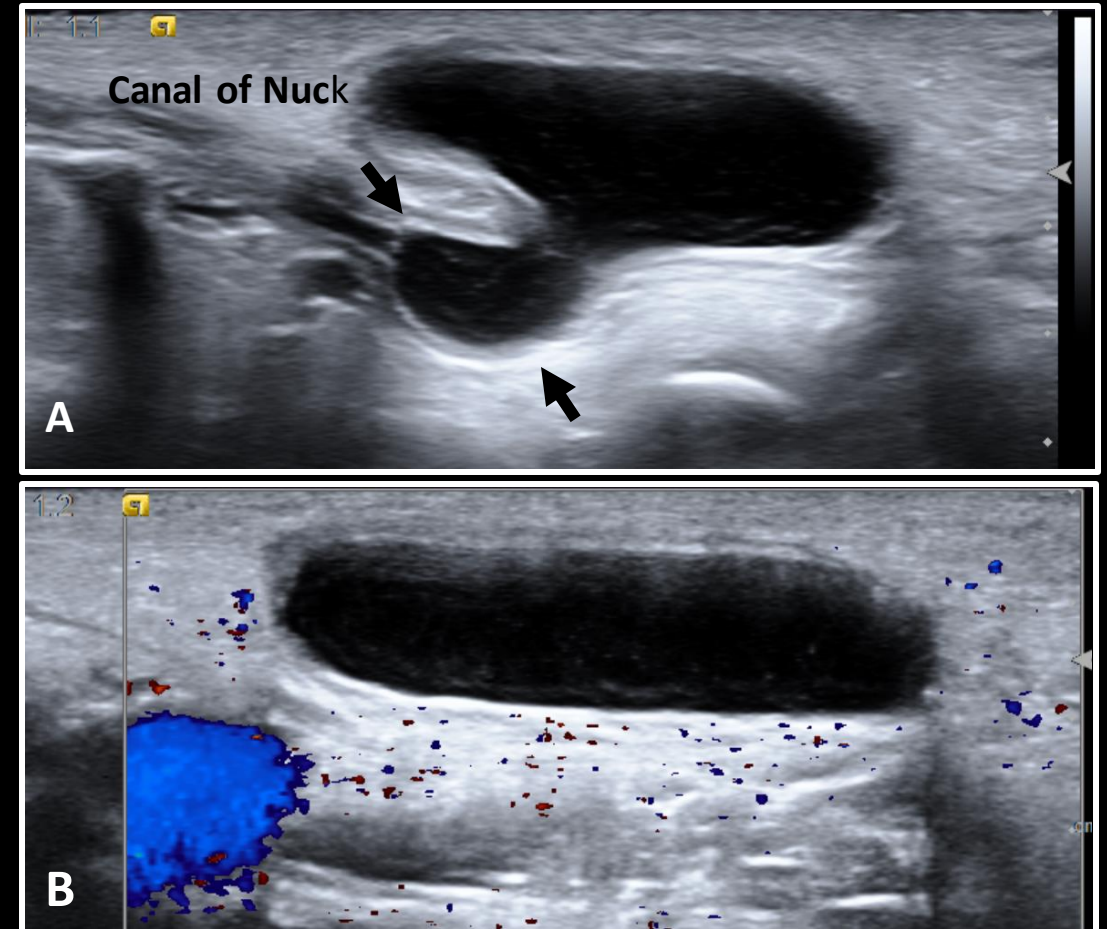
- Palpable, non-tender labial or mons pubis mass
- May contain pelvic or peritoneal structures such as bowel, omentum, ovary, fallopian tubes, uterus or urinary bladder
 - 45% of hernias containing ovaries
- Associated high rate of ovarian torsion, especially if incarcerated
- Primarily diagnosed by ultrasound
- Ultrasound will show direct continuation of herniated contents with the peritoneal cavity
 - Identify follicles to confirm structure is ovary
 - Important to ensure preserved flow to ovary
- Treated surgically

Case: Another Canal of Nuck Hernia



2-month-old female presenting with reducible swelling in the inguinal region. Images show a structure herniating through the canal of Nuck (short arrows in A) which can be identified as the uterus from the endometrial lining (long arrow in A). The right ovary was also herniated into the canal (*), and can be confirmed by the presence of follicles (B).

Case: Canal of Nuck Hydrocele



2-year-old female presented with a pelvic mass. Ultrasound images demonstrate a non-vascular cystic structure extending from the canal of Nuck into the labia majora, consistent with a canal of Nuck hydrocele.

Cystic Lesions of the Female Lower Genitourinary Tract

BARTHOLIN'S GLAND CYST

- Most common cystic lesion in the vulvar region
- Found in the superficial perineal pouch, inferior to perineal membrane
- Located in posterolateral inferior third of labia majora, medial to the labia minora and drain into the vestibule
- Considered analogue of the male bulbourethral gland

GARDNER DUCT CYST

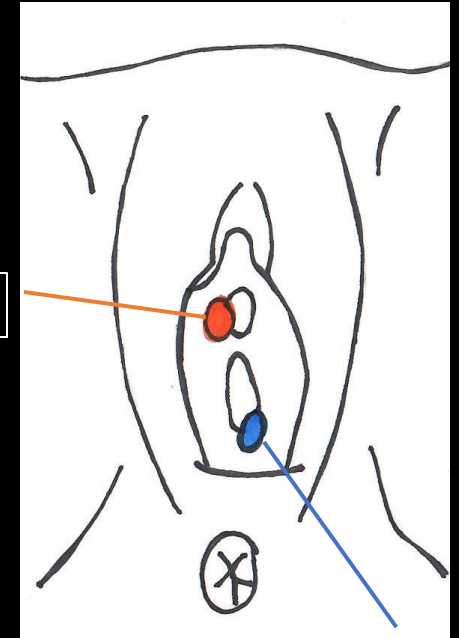
- Arise from mesonephric ductal remnants
- Found superior to the perineal membrane
- Located along the superior aspect of anterior vagina above pubic symphysis

SKENE'S GLAND CYST

- Found in superficial perineal pouch
- Anterior and inferiorly to vagina below pubic symphysis
- Located near the external urethral orifice
- Considered analogue of the male prostate gland

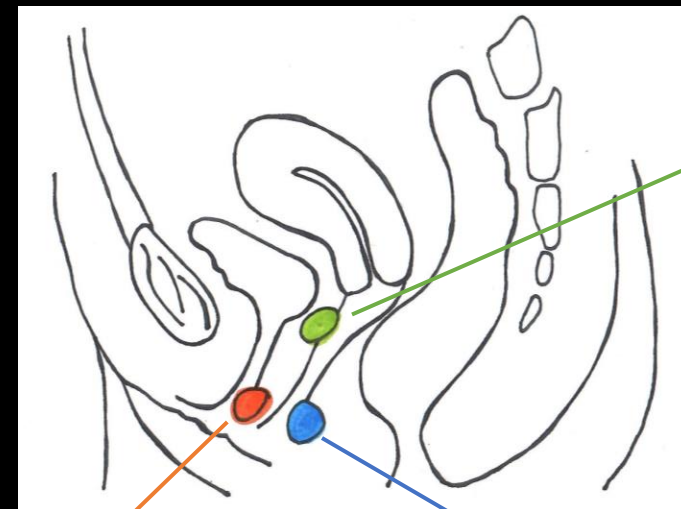
URETHRAL DIVERTICULA

- Found superior to the perineal membrane
- Occur in periurethral location
- May be difficult to differentiate from Skene's gland cyst as both occur in similar location
- At risk for stone formation, infection, malignancy



Skene's gland

Bartholin's gland

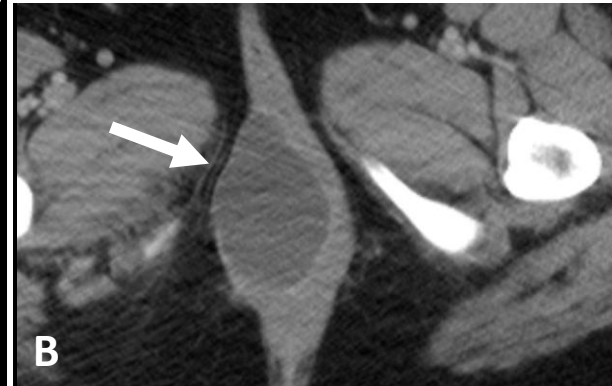
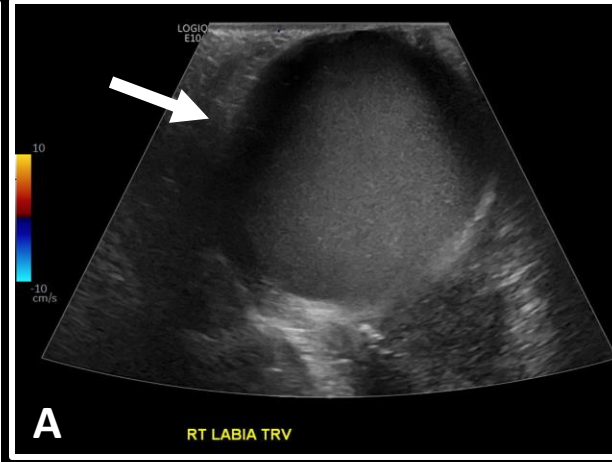
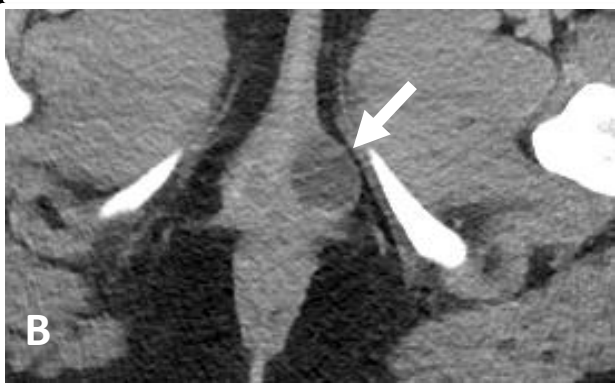


Gardner duct cyst

Skene's gland

Bartholin's gland

Case: Bartholin's Cyst



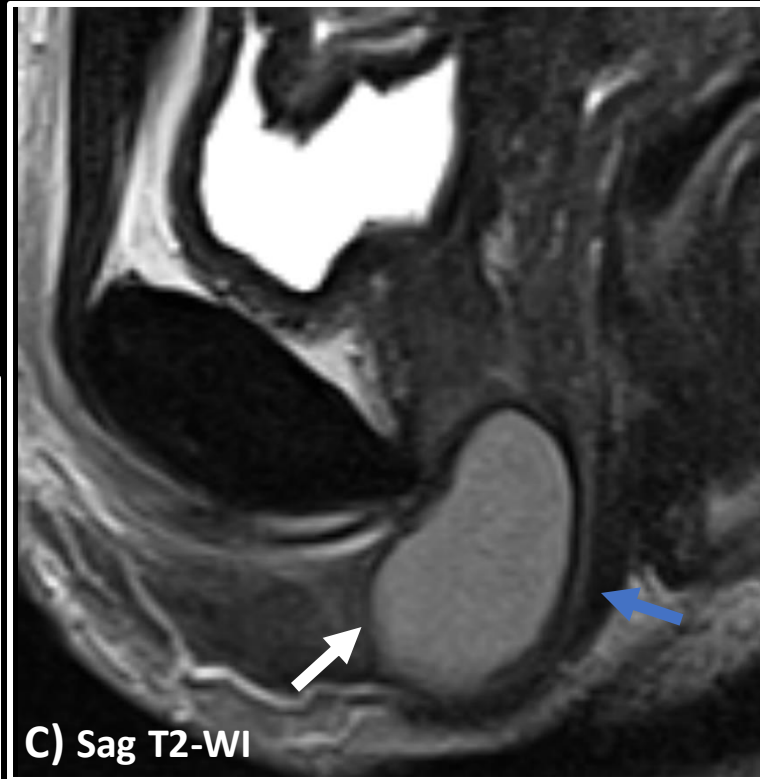
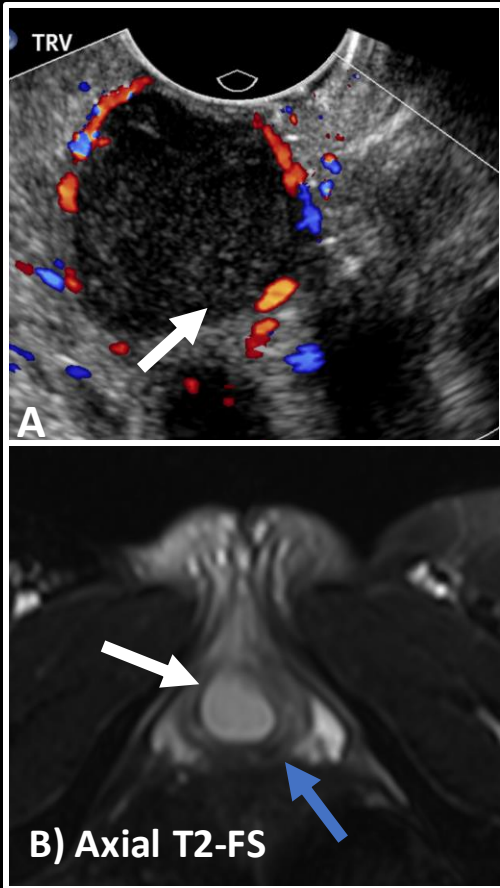
KEY POINTS

- Bartholin's glands secrete mucous for vulvar and vaginal lubrication
- Rarely can become infected in children
- May present with tenderness, redness of overlying skin, or painful vulval mass
- Often incidental finding on imaging
- Usually unilateral, but can be bilateral
- Located along posterior lateral vaginal introitus below the pubic symphysis
- US: anechoic structure, well-defined wall
 - When infected, appears echogenic, +/- septations
- CT/MRI: fluid-filled structure with high T2 signal and variable T1 signal; rim-enhancement and surrounding inflammation/edema when superinfected

17-year-old female with incidental finding of a simple Bartholin's gland cyst in the left labia region (arrows).

19-year-old with right labia swelling. US (A) shows a cystic structure with diffuse internal echoes and no vascularity. CT (B) shows the large cyst. There was no evidence of superimposed infection, and this was likely due to blockage of the Bartholin gland.

Case: Skene's Gland Cyst

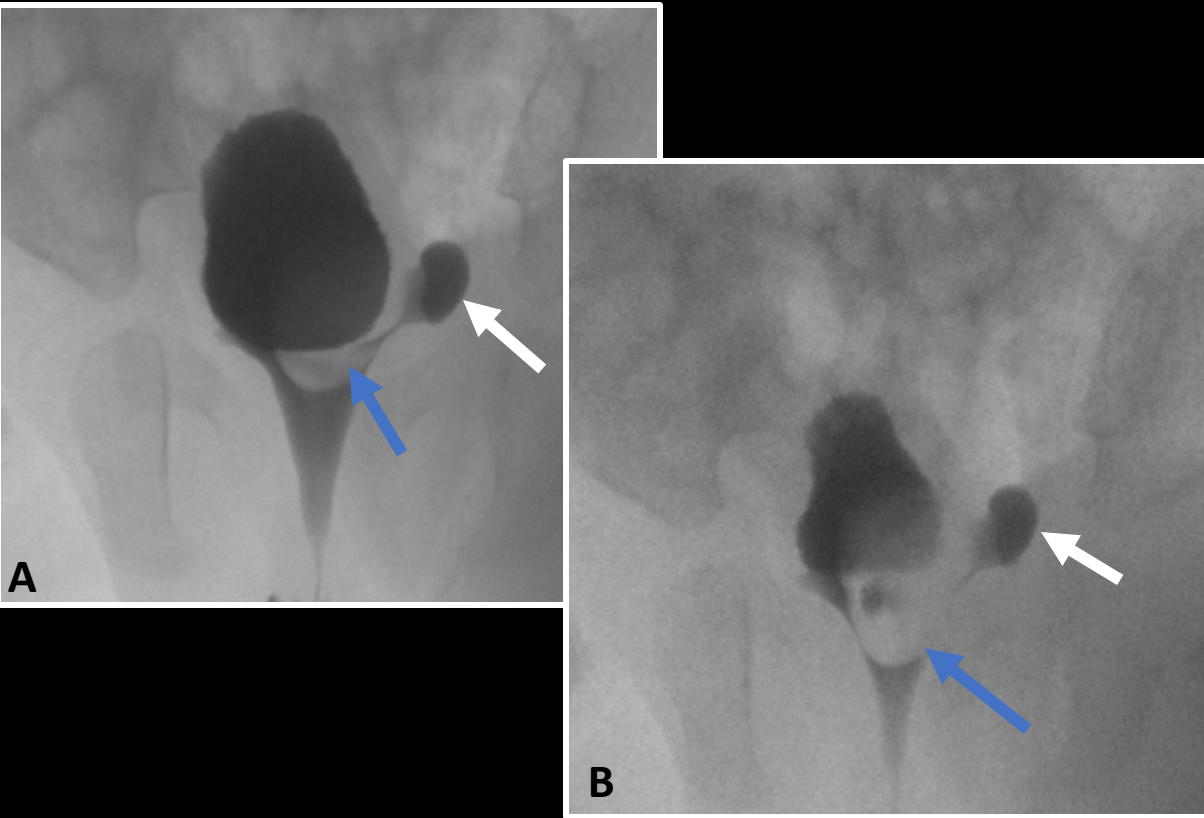


KEY POINTS

- Also called paraurethral duct cyst; skene glands secrete mucous for distal urethra lubrication
- Usually in 3rd or 4th decade, rarely can happen in children and neonates
- Typically asymptomatic, may become infected when large
- Located along anterior vaginal introitus below the pubic symphysis, along posterior margin of the external urethral meatus
- Will appear cystic on imaging unless inflamed or infected
- On MRI can have variable T1 signal based on presence of proteinaceous debris or hemorrhage
- Differential includes urethral diverticulum as it is in a similar location

19-year-old female presented with a vaginal mass. Ultrasound (A) demonstrated a cystic structure (white arrows) with internal echoes at the region of the vaginal opening. MR images (B-C) showed a corresponding T2 hyperintense structure anterior to the vagina (vagina characterized by blue arrows) which was consistent with a Skene's gland cyst and was excised. The T1-WI (not shown) demonstrated high signal without evidence of enhancement likely due to proteinaceous material or hemorrhage.

Case: Prolapsing Ureterocele



KEY POINTS

- Ureterocele is dilation of the distal ureter as it inserts into the bladder
- In 90% of cases, ureteroceles are associated with upper pole moiety in a duplex kidney
- A prolapsing ureterocele into the urethra is very rare, but can occur in females as well as males
- In females can present as a vulvar mass and can lead to bladder outlet obstruction or urinary tract infection
- On imaging ureterocele presents as a cystic mass within the bladder on ultrasound or a filling defect in the bladder on VCUG
- Prolapse into the urethra may be seen on either modality
- These are treated with incision

4 month-old female with a duplex left collecting system. VCUG images demonstrate a large filling defect in the left bladder consistent with a ureterocele with prolapse into the urethra (blue arrows). Small outpouching (white arrows) seen may have represented a diverticulum or eversion of the ureterocele.

Infectious/Inflammatory

INFECTED BARTHOLIN'S CYST

- Bartholin's glands can become dilated from an obstructed Bartholin's duct
- Bartholin's cyst usually incidental and asymptomatic
- Can become superinfected
- 2% of women develop infection or abscess of Bartholin's gland
- Infection is typically polymicrobial

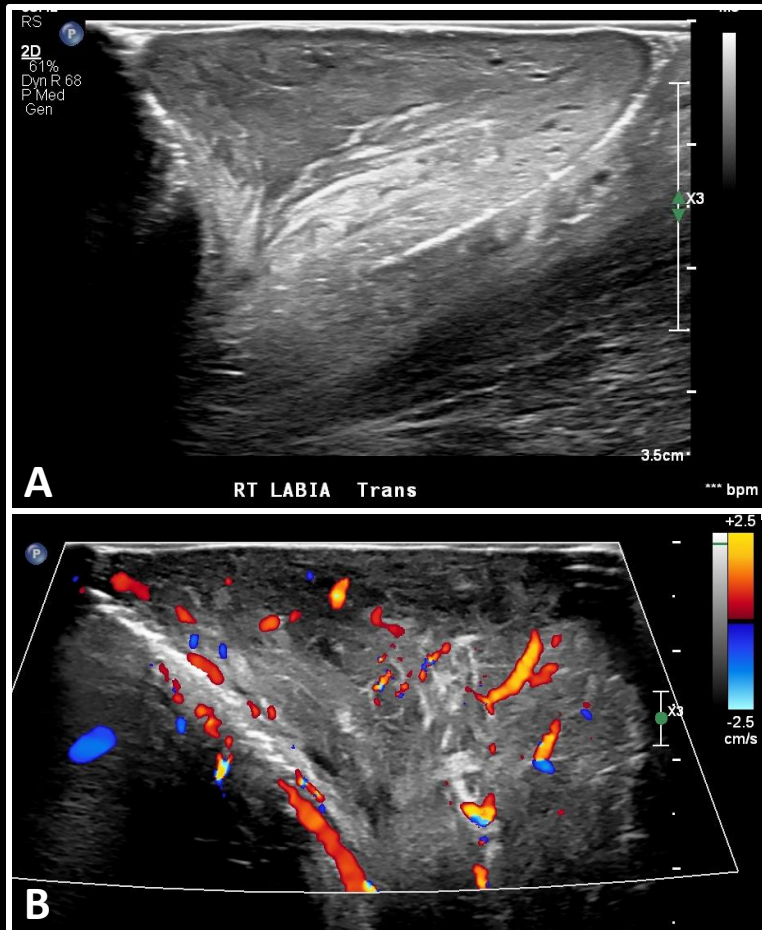
LABIAL ABSCESS

- Usually caused by ingrown hair from shaving, blocked sweat glands or direct invasion of a wound or cut
- Risk factors include poor hygiene, Crohn's disease, eczema, psoriasis, or unprotected intercourse
- Important to differentiate from cellulitis

VULVAR CROHN'S DISEASE

- Contiguous cutaneous Crohn's disease
 - May consist of fistulas and sinus tracts, fissures, skin tags, abscesses
 - Accounts for 58-76% of Crohn's cases with skin involvement
 - Contiguous with gastrointestinal tract
- Metastatic cutaneous Crohn's disease
 - Extremely rare in children, often misdiagnosed
 - Inflammatory granulomatous lesions separated from gastrointestinal tract
 - May precede gastrointestinal involvement by months or years
 - Presents as swelling, tenderness, surface friability
 - Diagnosis usually delayed

Case: Cellulitis

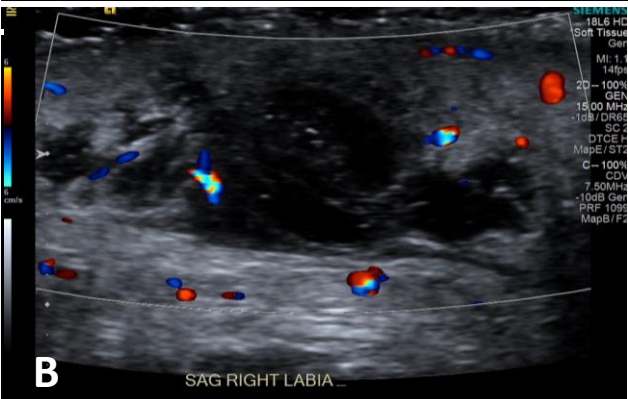


16-year-old female presented with labial swelling. Grayscale (A) and color Doppler (B) ultrasound images demonstrate extensive edema and hypervascularity throughout the right labial soft tissues with no definable fluid collection.

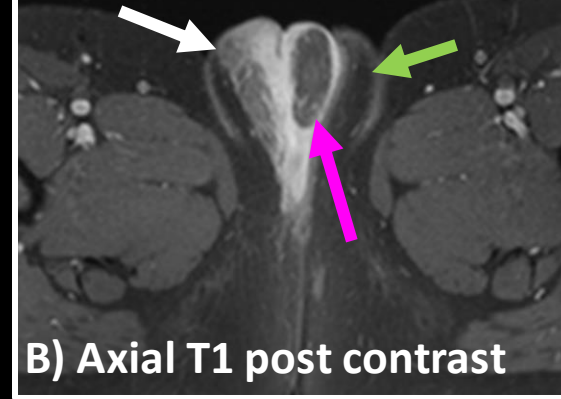
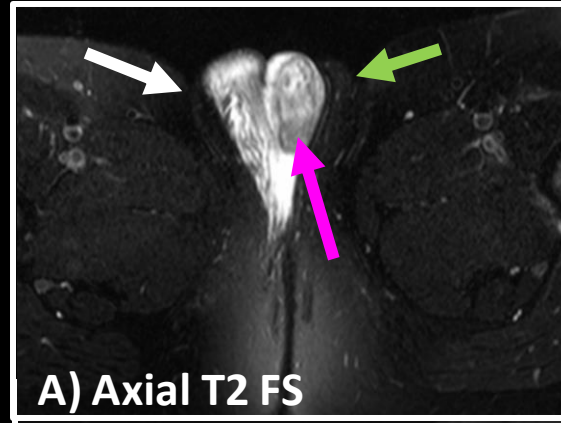
KEY POINTS

- Present with tenderness to palpation, redness of overlying skin, swelling
- Ultrasound will show diffuse thickening of the subcutaneous tissues with increased echogenicity and hypervascularity
- In cellulitis, should not visualize a discrete fluid collection or abscess
- Although rare, important to look for air in the subcutaneous tissues which will appear as echogenic foci with dirty shadowing, and suggests necrotizing fasciitis which is a surgical emergency
- Edema from fluid overload may have similar appearance but will be less hypervascular
- Treated with antibiotic therapy

Case: Labial Abscess



14-year-old female presented with right labial swelling and pain. Grayscale (A) and color Doppler (B) ultrasound images demonstrate a non-vascular complex collection with peripheral hyperemia consistent with an abscess. Culture was obtained and was positive for *Actinomyces turicensis*.

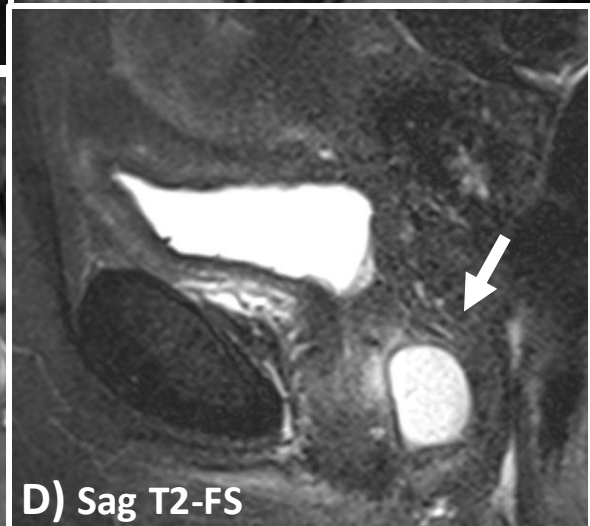
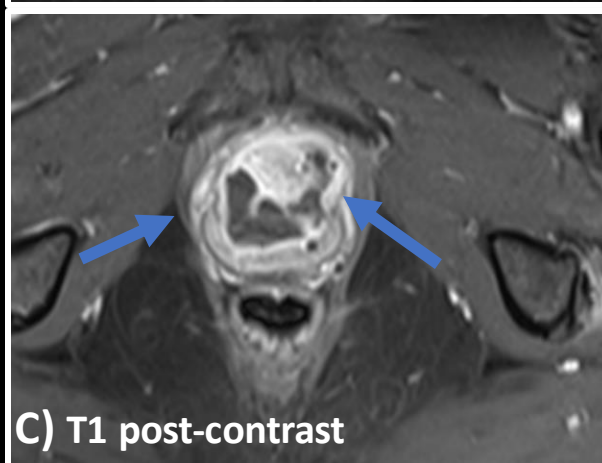
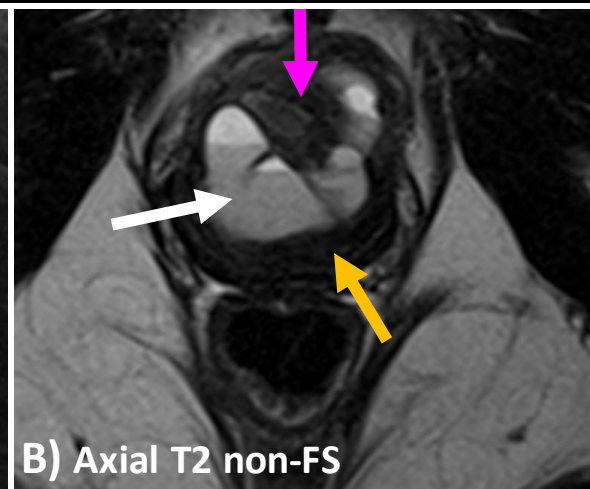
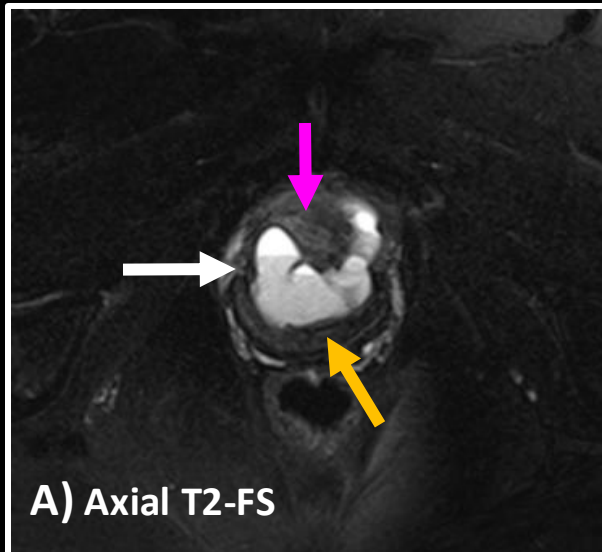


19-year-old female presented with right labia pain & swelling. MR images show enhancing edema in the right labia (white arrows) and a rim-enhancing collection consistent with an abscess (pink arrow). The normal left labia is demonstrated by the green arrows.

KEY POINTS

- Will present with a palpable labial mass, pain, redness, warmth, swelling
- Can be a secondary complication from Crohn's disease with fistula tract formation to the bowel
- Ultrasound : complex cystic structure
 - May appear complex due to internal debris and septations but should have absent flow and no solid or vascular components
 - Surrounding tissues will appear thickened, edematous and hyperemic
- Treated with antibiotics
 - +/- drainage

Case: Infected Urethral Diverticulum

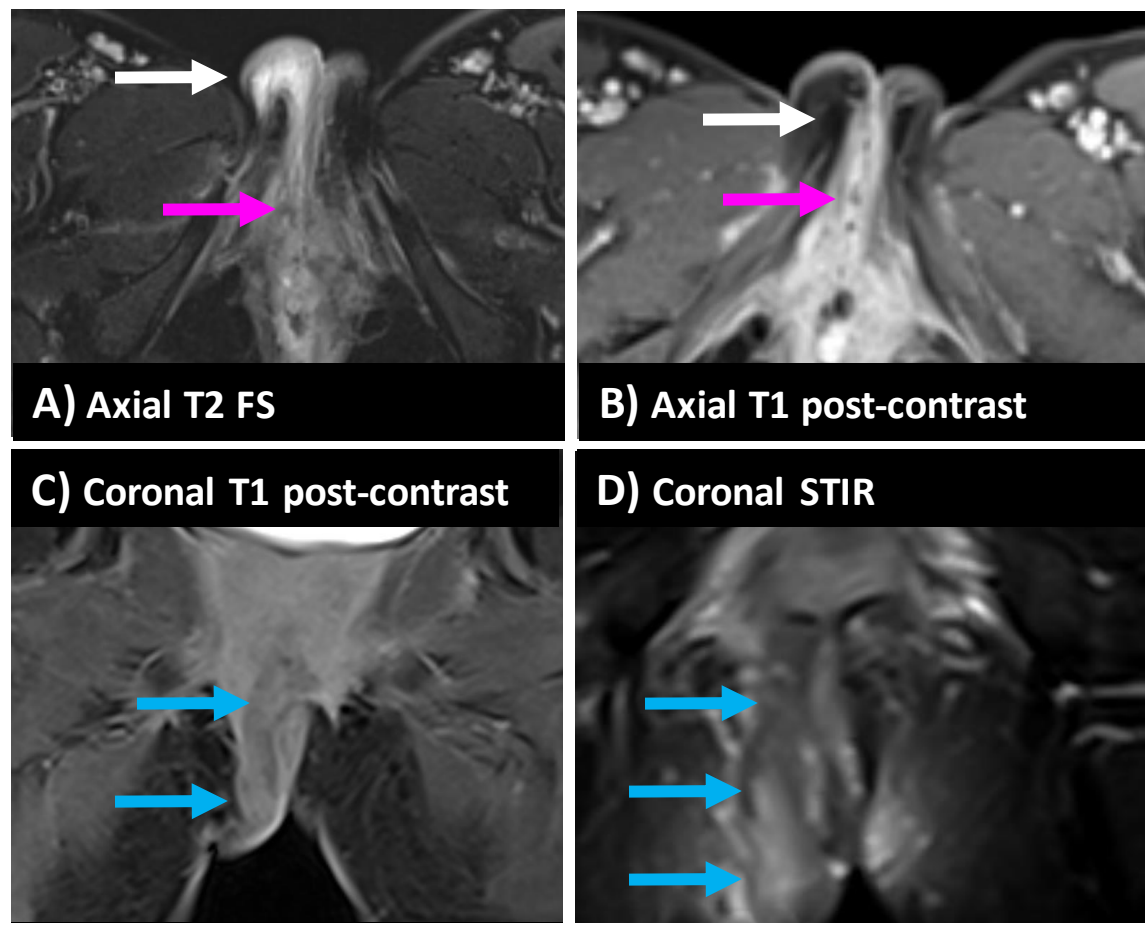


Example of an infected urethral diverticulum in an older patient. There is a cystic structure wrapping around the urethra (pink arrow) anterior to the vaginal wall (orange arrow) in a horseshoe configuration (white arrows). The T2 showed a fluid-fluid level within the structure, and post-contrast shows wall enhancement (blue arrows). This patient was having symptoms of pain and urethral pus and the imaging characteristics were consistent with superimposed infection of a urethral diverticulum.

KEY POINTS

- Urethral diverticulum communicates with the urethral lumen
- Usually in 3rd-4th decade but can occur in younger patients
- Etiology unknown, may be congenital or acquired and recurrent urinary tract infections may be a risk factor
- Present with dysuria, dribbling after voiding, dyspareunia
- CT/MRI: cystic periurethral lesion, classically has teardrop or horseshoe shape around urethra
 - May communicate with urethra
 - Hyperdense, or variable MR signal if complicated by protein/hemorrhage
 - Peripheral enhancement suggests inflammation or infection
- Treated with excision or marsupialization, commonly recur

Case: Crohn's Involvement of Vulva



KEY POINTS

- Cutaneous Crohn's disease is extremely rare in the pediatric population
- Can present as a fistula and/or abscess formation
 - Fistulation into gynecologic structures may be the first sign of Crohn's disease in the pediatric population
- Presents as vulvar swelling, erythema, induration, skin friability
- MRI: labial enlargement, skin thickening, subcutaneous edema
 - Avid postcontrast enhancement
 - Associated T2 hyperintense tubular tract corresponding to a fistula
- Treatment: surgical

14-year-old female presents with weight loss and suspected inflammatory bowel disease. MR enterography demonstrated asymmetric enlargement of the right labia with increased T2 signal and enhancement (white arrows). Two T2/STIR hyperintense fistula tracts (blue and pink arrows) were seen extending from an abnormally thickened rectum (not shown) to the labia.

Trauma

- Children are prone to injury due to underdevelopment of fat within labia majora
- Most commonly the result of trauma to the perineum
 - Straddle injury being the most common mechanism of injury (82% of cases)
 - Can also occur from fall, insertion of foreign body, sexual assault, iatrogenic
- Spontaneous vessel rupture also possible
 - Vulva supplied by branches of pudendal artery

MECHANISMS OF INJURY

STRADDLE

- Hematoma
- Pressure necrosis

BLUNT

- Bruising
- Hematoma

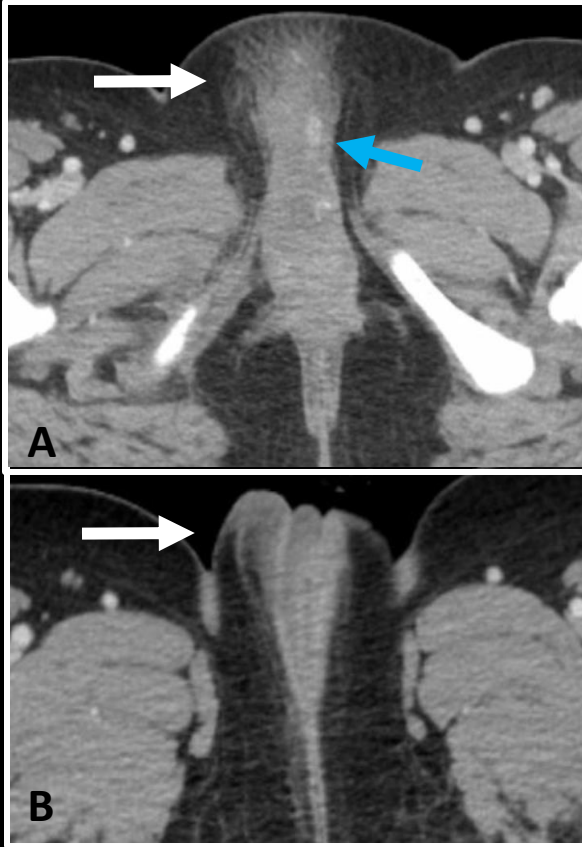
PENETRATING

- Labial laceration
- Vaginal laceration
- Foreign body

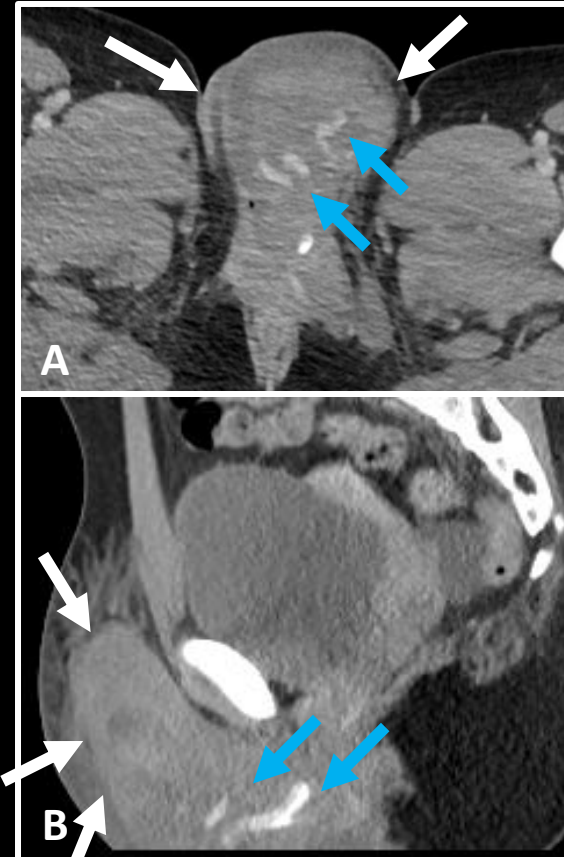
ABUSE

- Non-accidental trauma
- Sexual assault

Case: Vulvar Hematoma



14-year-old female presented after trauma. White arrows on the contrast-enhanced CT images show infiltration of the mons pubis (A) and right labia (B) consistent with soft tissue injury/hematoma. More focal hyperattenuation (blue arrow in A) was concerning for active extravasation.

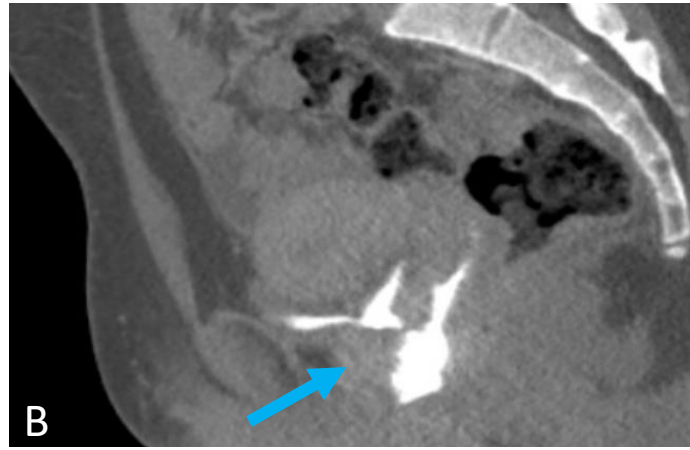
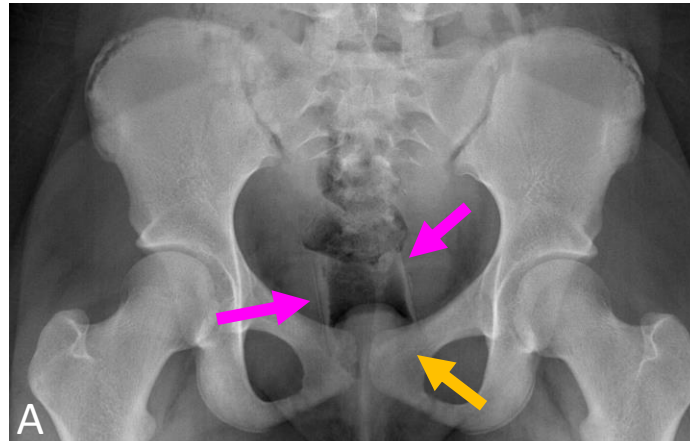
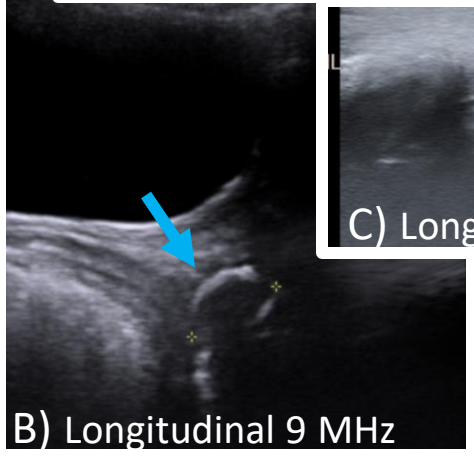
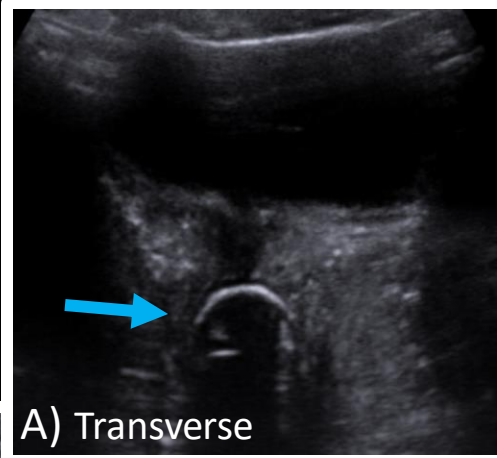


16-year-old female with history of trauma. CT with IV contrast demonstrates a large hematoma (white arrows) in the perineum centered in the region of the left labia and mons pubis with active contrast extravasation (blue arrows).

KEY POINTS

- Usually result of trauma in non-obstetric population, rarely can be spontaneous hemorrhage
- Present with perineal/vulvar swelling and tenderness in the setting of trauma
- Urinary retention may occur due to mechanical obstruction
- US: heterogeneous non-vascular collection
- CT angiography may be used for detection of active bleeding for embolization or surgical planning
- May be treated conservatively if small or if active bleeding/instability may be treated with arterial embolization or surgically

Case: Foreign Body



3-year-old female with vaginal discharge. Ultrasound images demonstrate a peripherally echogenic shadowing structure within the vagina concerning for a foreign body (blue arrows), better appreciated on the high frequency transducer in C. Patient went to surgery and a plastic bead was found. There was no concern for abuse in this case.

12-year-old female presented with concern for foreign body in the vagina. X-ray showed a cylindrical structure in the vagina containing air along the superior aspect (pink arrows) and increased density at the inferior aspect (orange arrows). A vesicovaginal fistula developed as a complication (blue arrow). Unfortunately, this case was related to abuse.

KEY POINTS

- Insertion of foreign body may be incidental or due to child abuse
- Usually presents with bleeding, foul-smelling discharge and pain
- Complications include vesicovaginal fistula and urinary incontinence
- Diagnosis may be challenging if asymptomatic
- Imaging may show an object within a distended vagina
- Radiography: useful in detecting radiopaque objects
- US: may see a structure in vagina with variable appearance but may be hyperechoic
- CT/MRI: useful in evaluation of complications

Masses

BENIGN (RARE)

FIBROEPITHELIAL POLYPS

- Present as mucosal polypoid vaginal or interlabial mass
- US: hyperechoic heterogeneous masses

MÜLLERIAN PAPILLOMA

- Present with prepubertal intermittent vaginal bleeding
- Imaging helps distinguish the mass from foreign body and abuse

LIPOMA

- More common in adults but have been reported in children
- Soft, mobile, painless fat-containing mass
- Need to be differentiated from cyst of Canal of Nuck and Bartholin's gland cyst

LYMPH NODE

- Enlarged and non-enlarged lymph nodes can mimic a mass and be found in the labia

MALIGNANT (EXTREMELY RARE)

RHABDOMYOSARCOMA

- Most common soft tissue sarcoma in pediatric population
- In females, genitourinary rhabdomyosarcoma may arise from the bladder, vulva vagina, cervix, uterus, pelvic side walls or non-genitourinary soft tissues
- Embryonal subtype > alveolar
- Botryoid variant of the embryonal type (5%) presents as "bunch of grapes" with cyst-like structures protruding from vagina or bladder

INVASIVE SQUAMOUS CELL CARCINOMA

- Can presents in teenage years
- May be associated with HPV and immunosuppression

CLEAR CELL CARCINOMA

- Most common primary vaginal malignancy in pediatric population

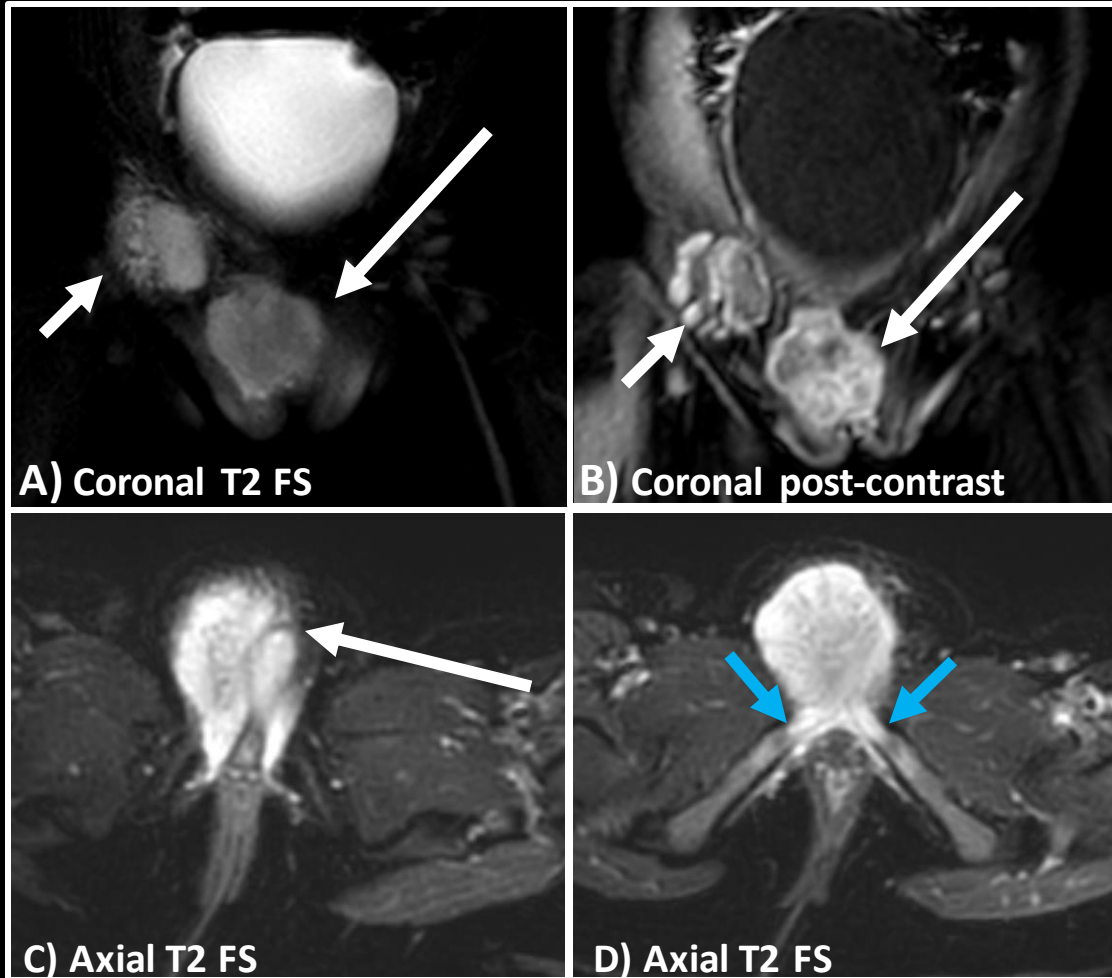
VAGINAL ENDODERMAL SINUS TUMORS

- Girls younger than 3 years
- Elevated AFP

OTHERS

- Yolk sac tumors - aggressive
- Ewing sarcoma/primitive neuroectodermal tumors (ES/PNET)- present in teenage years
- Melanoma - associated with lichen sclerosis
- Granular cell tumor

Case: Vulvar Alveolar Rhabdomyosarcoma



17-month-old female presented with a labial mass. MR images demonstrate a large heterogeneous T2 hyperintense enhancing mass in the right labia (long white arrows). Axial images show abnormal signal/invasion of the bilateral pubic bones (blue arrows). An enlarged, metastatic right inguinal node is seen (short arrows).

KEY POINTS

- Most commonly in vagina, only 13% occur in vulva
- Botryoid variant present as perineal mass or grape-like mass at the vaginal introitus
 - Vaginal bleeding is typical
- US: well-defined, hypoechoic heterogeneous mass with vascularity
- MRI: nonspecific mass
 - Complex T2 hyperintense cystic mass with hypointense internal septa and enhancing nodules
 - Can also appear as a mass with heterogeneous signal without obvious cystic changes and inhomogeneous enhancement on post-contrast images
- Treated surgically

Vascular malformations

- Result of developmental errors during embryogenesis
- Types
 - **Simple**
 - Slow flow: capillary, lymphatic, venous
 - High-flow: AVMs, arteriovenous fistulas
 - **Combined**
 - Consist of multiple slow-flow and fast-flow malformations
 - Example: venolymphatic malformation
 - Malformations associated with other anomalies

LYMPHATIC MALFORMATIONS

- Slow-flow malformation when combined venolymphatic
- Unilocular or multilocular cystic mass
- Classically see fluid-fluid levels due to hemorrhage
- Can become superinfected

ARTERIOVENOUS MALFORMATIONS

- High-flow malformation
- Red, pulsatile mass
- On imaging will see a tangle of high-flow enlarged arteries and veins and a nidus
- Flow voids on MRI from high flow

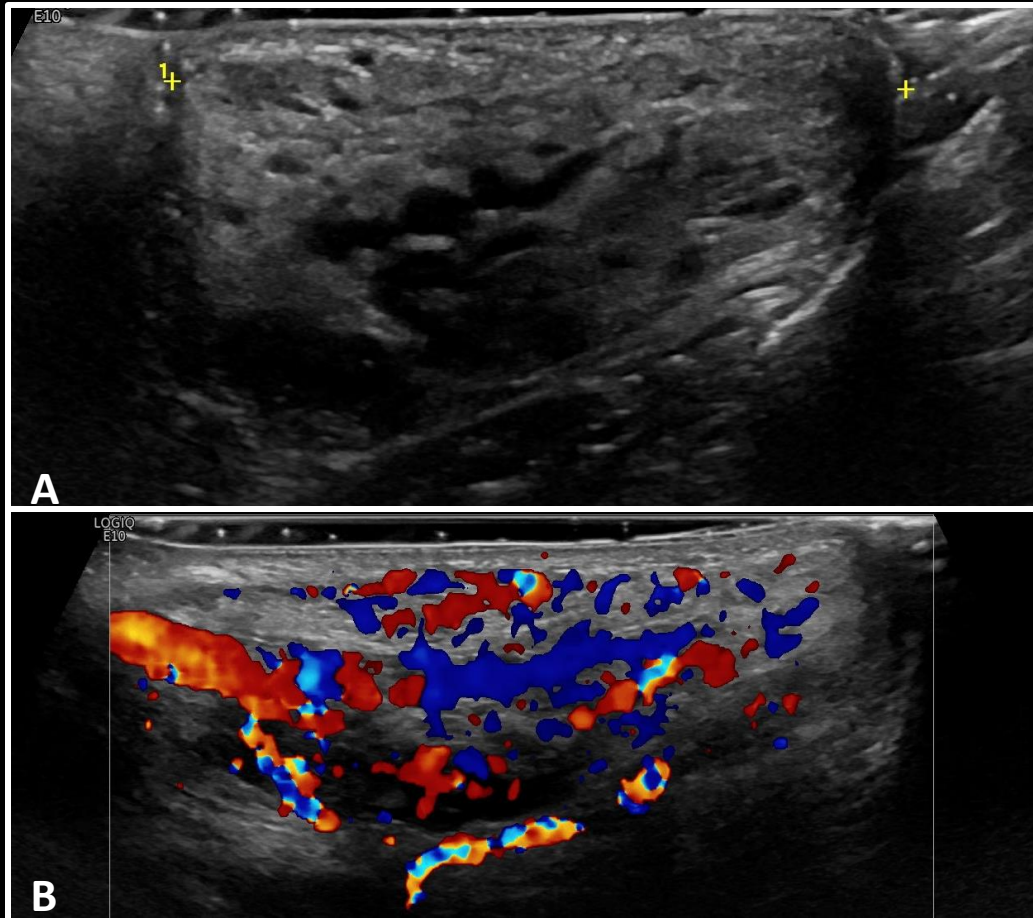
VENOUS MALFORMATIONS

- Slow-flow malformation
- Anomalous veins with deficiency of smooth muscle layer resulting in stretching of lumen over time
- Represent 2/3 of all cases
- On imaging will see multiple dilated veins
- May see phleboliths

HEMANGIOMA

- Slow-flow malformation
- Congenital hemangioma present at birth versus infantile hemangioma which develops during infancy
- Echogenic, compressible mass with multiple vessels demonstrating low resistance arterial waveforms and venous waveforms

Case: Vascular Malformation



3-year-old female presented with a slowly growing right labia mass since 4 months of age with reddish skin discoloration. Grayscale and color Doppler ultrasound images demonstrate an echogenic mass in the area of palpable abnormality appearing very vascular due to multiple serpiginous vessels, favoring an infantile hemangioma.

KEY POINTS

- Labia majora is the most common site of involvement in the female pelvis
- Present with:
 - Red or bluish skin discoloration
 - Soft tissue mass, swelling
 - Pain after prolonged standing or exercising
 - Bleeding, urinary dysfunction
 - Worsening symptoms during menses
- Imaging depends on type of malformation as described in the previous slide
- Evaluating waveforms on ultrasound will be helpful in distinguishing the type of vascular malformation
- Important to distinguish from a mass and to evaluate for compressibility

Idiopathic

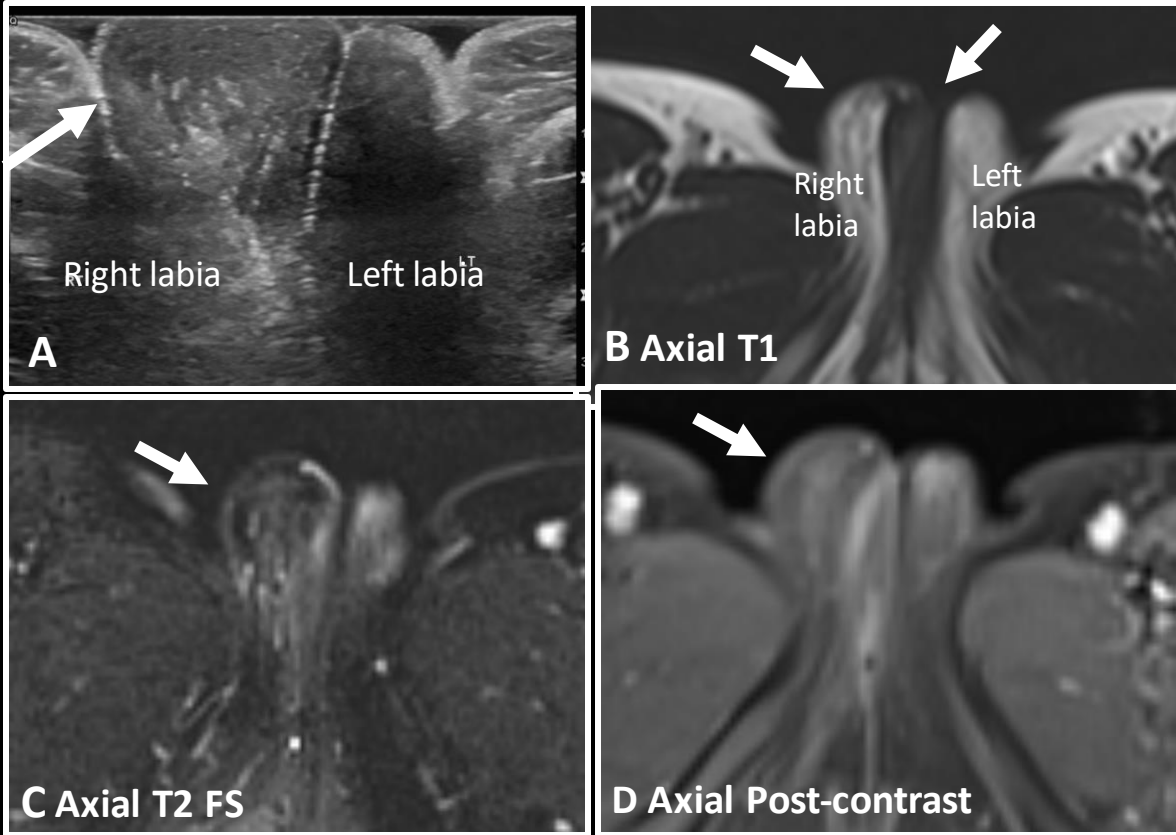
CONGENITAL ASSYMETRIC LABIUM MAJUS ENLARGEMENT

- Also called unilateral fibrous hyperplasia of labium majus
- Rare benign condition
- Presents as painless non-tender labia swelling
- Overlying skin should be normal
- Expansion of normal vulvar tissue in response to prepuberal hormonal stimulation

SYMMETRICAL LABIAL SWELLING

- Seen in precocious puberty
- Diagnosis based on clinical examination, laboratory tests and imaging, which plays an important role
- US may help to localize the gonads
- MRI may be used for better evaluation of pelvic organs

Case: CALME (Congenital Asymmetric Labium Majus Enlargement)



13-year-old female presented with non-acute non-tender right labia swelling. Ultrasound image (A) shows asymmetric soft tissue swelling of the labia without a discrete mass. MRI images demonstrate corresponding asymmetric enlargement of the right labia soft tissues compared to the left side (arrows in B-D) without a discrete mass.

KEY POINTS

- Seen in pre and early pubertal females
- Painless, unilateral labial enlargement
- Normal overlying skin
- US: labial enlargement without a discrete mass
 - Mild or no vascularity
- MRI: unilateral labium majus enlargement
 - Ill-defined T1 and T2 hypointense signal
- Important to recognize this entity from a true mass
- Tissue confirmation may be necessary

Conclusion

- Various pathologies can affect the vulva, ranging from benign entities such as infection, trauma, or vascular malformations to malignant etiologies including tumors (such as rhabdomyosarcoma)
- Understanding the anatomy of the canal of Nuck and the various associated pathologies which can occur is important, as it has clinical implications (for example, the canal of Nuck hernia is treated surgically)
- Additionally, knowledge of benign entities such as CALME can prevent the patient from undergoing invasive procedures/testing
- Imaging is often crucial in determining the etiology of vulvar region swelling and is often necessary in establishing a diagnosis
- Except in the setting of trauma, ultrasound is often the imaging test of choice in the setting of a palpable pelvic/groin lump or swelling in a pediatric patient
- The radiologist plays an important role in making the diagnosis, which subsequently aids the clinician in selecting appropriate treatments and optimizing patient outcomes

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