5 Application of Ultrasound in the Diagnosis of Hip Diseases

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Ultrasound is an important part of modern imaging, and it plays an important role in the diagnosis of abdominal, cardiovascular, thyroid, and breast diseases. With the improvement of the performance of ultrasonic equipment and the advancement of inspection techniques, the application of ultrasound in the musculoskeletal system including the hip joint has become more and more mature. It has excellent performance on soft tissue structures such as muscles, tendons, blood vessels, and nerves. Ultrasound has the characteristics of high resolution, portability, and noninvasiveness. Real-time ultrasound can dynamically observe the movement of muscles and tendons, and provide important information that other images cannot obtain.

5.1 Normal Adult Hip Ultrasound Detection

Adult hip joints are relatively deep. Depending on the size of the subject and the depth of the structure being observed, a combination of a 5 ~ 7 MHz low-frequency probe and a 7 ~ 12 MHz high-frequency probe can be used for detection.

The Ultrasound examination of an adult hip joint includes four parts: the anterior, the medial, the lateral, and the posterior. Mastering several important bony landmarks of the hip, such as the anterior superior iliac spine, the anterior inferior iliac spine, the femoral head, the greater trochanter of the femur, and the ischial tuberosity can help to clarify the anatomy in the sonogram.

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5.1.1 Anterior Part

The patient is examined in the supine position. In this area, we mainly observe the joint cavity, acetabular labrum, anterior muscle group, vascular nerve bundle, etc.

1. Hip joint: The probe is parallel to the femoral neck. The curved, strong echo of the femoral neck and the thin layer joint capsule can be clearly shown on the oblique sagittal position scan. There is a potential cavity between the joint capsule and the femoral neck, which is the anterior crypt of the joint. It is formed by the joint capsule covering the anterior of the hip joint folding back at the intertrochanteric line. Most people's anterior recess is a homogeneous hypoechoic layer on the sonogram. Only a few people have a two-layer structure (Fig. 5.1). Under normal circumstances, there is only a small amount of synovial fluid in the anterior crypt, which acts as a lubricant. The fluid often accumulates in the hip joint effusion first, and is also a common site of synovial hyperplasia of the hip joint.
2. Acetabular labrum: Moving the probe slightly toward the head, we can see the strong echo of the acetabulum and the femoral head. The superior anterior part of the labrum can be seen between the two, which has a triangular hyperechoic structure and acetabular labrum tear often occurs here (Fig. 5.2). A thin layer of hypoechoic articular cartilage is visible on the surface of the femoral head.
3. Anterior muscle group: The iliopsoas muscle consists of the iliacus and the psoas muscle. It ends at the lesser trochanter of the femur through the anterior aspect of the hip joint. At the level of the front of the hip joint, the muscle bundle and the tendon component coexist. In the sonogram, the iliopsoas muscle is located in the anterior medial aspect of the hip joint. The muscle bundle is located in the shallow part showing as a band-like hypoechoic area, and the thin layer of a hyperechoic area of the tendon is located in the deep part (Fig. 5.3). There

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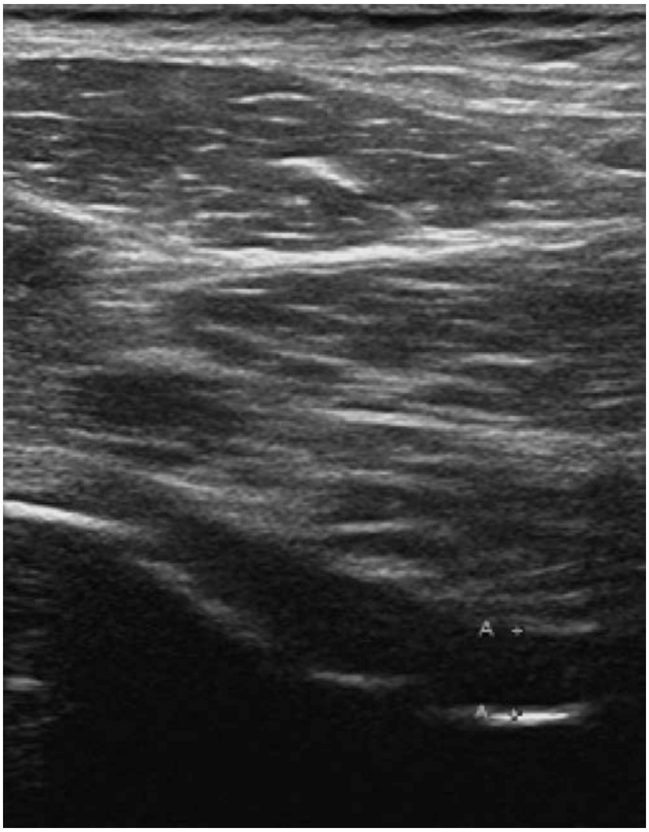

Fig. 5.1 Longitudinal section of the front crypt. The anterior crypt is a thin layer of hypoechoic structure (the scale shows the thickness of the anterior crypt), and the deep curved strong echo is the femoral neck

Fig. 5.2 Sonogram of the anterior labrum of the joint. The acetabular labrum is a triangular slightly hyperechoic structure. The thin layer of cartilage is visible on the surface of the femoral head, showing hypoecho

is a potential cavity between the iliopsoas tendon and the joint capsule, which is the iliac crest sac. Ultrasound can detect bursitis or effusion.

Two anterior thigh muscles, the sartorius muscle and the rectus femoris, are displayed in the longitudinal section of the anterior superior iliac spine and the anterior inferior iliac spine, respectively (Fig. 5.4).

4. Vascular nerve bundle: The probe is placed under the middle of the inguinal ligament, showing the femoral artery and femoral vein. The blood flow signal is detected by color Doppler ultrasound. The femoral nerve can be explored on the lateral side of the femoral artery. The transverse section is a mesh-like structure and in the deep part of the nerve is the iliacus (Fig. 5.5).

5.1.2 Medial Part

The patient is in the supine position, and the hip is slightly abducted and extorted for examination. The medial transverse section of the vascular nerve bundle is scanned. The pubic muscle, the long adductor muscle, and the gracilis muscle are displayed from the outside to the inside. The deeper side of the first two is the short adductor muscle and the deeper adductor Magnus. All of the muscle-tendon talked above are from the pubic bone (Fig. 5.6).

5.1.3 Lateral Part

The patient is placed in lateral position with the lower extremities straightened. This area mainly observes the greater trochanter, gluteal muscles and tendons, and bursa. The greater trochanter of the femur has a strong echo structure with a slightly uneven surface. The tendons of the gluteus medius and gluteus minimus are attached here (Fig. 5.7). The former is attached to the lateral posterior superior part of the greater trochanter, while the latter is attached to the anterior part of the greater trochanter. The bursa is present next to the tendon, and when the pathological changes occur and the effusion increases, ultrasound can be used to detect. The gluteus maximus fibers are visible in the shallow part of the lateral area, and the lower deep muscle fibers end in the gluteal tuberosity. The lower superficial layer and the upper muscle fibers end at the iliotibial band. The iliotibial bundle is

Fig. 5.3 Long axis section of the iliopsoas tendon. The arrow shows the iliopsoas tendon in front of the femoral head, which showing strip-like hyperecho, and the anterior part is the muscular part of the iliopsoas muscle

located in front of the greater trochanter and is the tendon part of the tensor fascia.

5.1.4 Posterior Part

The patient is in a prone position with the lower extremities straightened. The gluteal muscle, the hamstring muscle, and the sciatic nerve are mainly observed in this area. The ischial tuberosity is an important anatomical landmark.

In the transverse or longitudinal section of the buttock, the ultrasound image mainly shows the gluteus maximus muscle. The probe is gradually moved down to observe the hamstring muscles, including the long head of the biceps femoris, the semitendinosus, and the semimembranosus. All three are from the ischial tuberosity (Fig. 5.8). The sciatic nerve ascends on the lateral side of the ischial tuberosity running deep in the gluteus maximus, and has an elliptical mesh-like structure in the cross-section.

5.2 Ultrasound Diagnosis of Adult Hip Disease

5.2.1 Joint Effusion

Joint effusion is commonly detected by ultrasound in cases of hip pain, and is usually located in the anterior crypt.

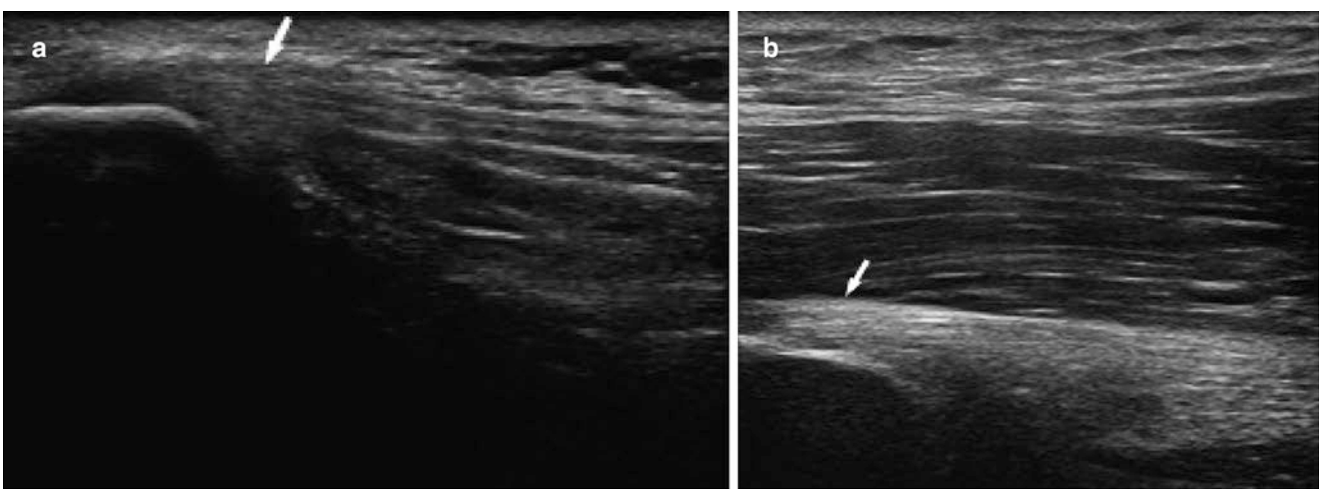

Fig. 5.4 Longitudinal section of the sartorius muscle and rectus femoris. (**a**) The longitudinal section of the sartorius muscle, the proximal end of which is from the anterior superior iliac spine; (**b**) The longitudinal section of the rectus femoris muscle, the proximal end of which is from the anterior inferior iliac spine and the shallow part is the sartorius muscle

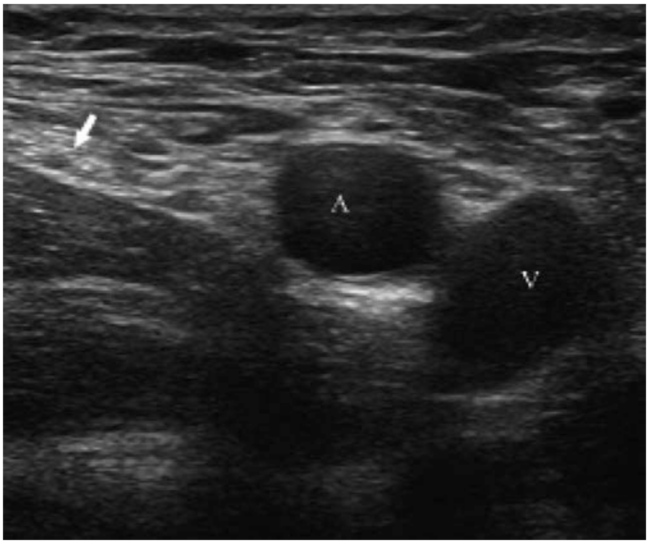

Fig. 5.5 Cross section of vascular nerve bundle in the inguinal region. Transversely below the middle of the inguinal ligament, showing the femoral vein (V), femoral artery (A), femoral nerve (arrow) from the inside to the outside

Fig. 5.6 Hip inner cross section. Transversely below the medial aspect of the inguinal ligament, showing femoral artery (A), femoral vein (V), and pubic muscle (arrow)

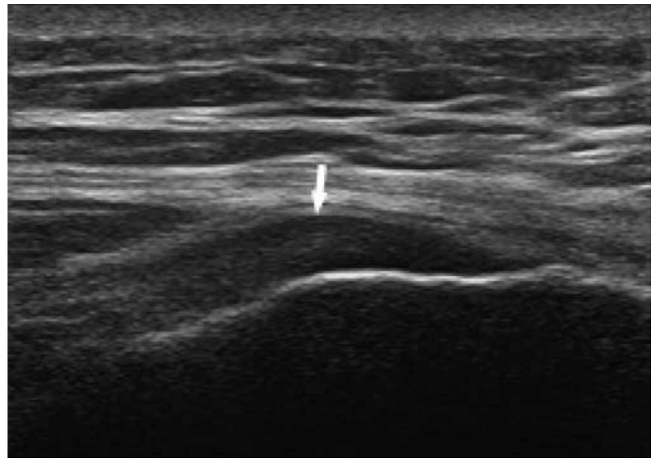

Fig. 5.7 Cross section of the hip. It shows that the gluteal muscle tendon (arrow) is attached to the greater trochanter of the femur, and the surface of the trochanter is smooth

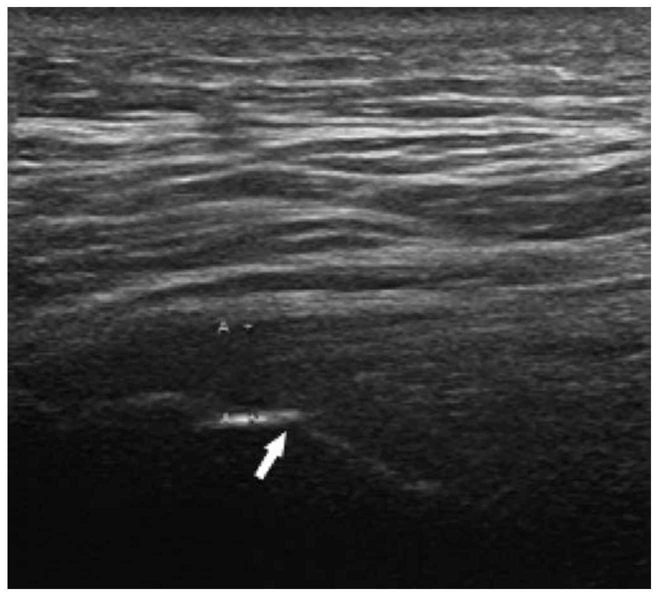

Fig. 5.8 Longitudinal section of the buttocks. Showing the hamstring tendon (scale) attached to the ischial tuberosity (arrow)

Simple effusions are anechoic, compressible, and devoid of Doppler flow [1]. In the oblique sagittal image of the femoral neck in front of the hip, the anterior crypt of the hip is thickened with anechoic inside. When the probe is pressurized, the thickness of the anechoic is significantly thinner (Fig. 5.9). When the liquid is cloudy, it may also be hypoechoic. Sometimes a floating flocculated echo may be seen, representing old bleeding or debris after inflammation. There is no uniform standard for the normal thickness of the anterior crypt. It is generally considered to be meaningful when the value is greater than 8 mm or the difference between the two sides is greater than 2 mm. When the effusion increases, the range of the liquid zone increases, exceeding the anterior crypt to the front of the femoral head or even around the joint.

Fig. 5.9 Hip effusion. A longitudinal section of the hip joint, seeing a large amount of effusion in the anterior crypt, poor sound transmission, flocculent echo floating, is considered to be pus formation

5.2.2 Hip Synovitis

Acute or chronic joint damage, osteoarthritis, infection, joint replacement surgery, systemic diseases (such as rheumatism and gout) can cause hip synovial hyperplasia and synovitis. The best position to observe the synovial membrane is the anterior joint crypt, which is probed in the oblique sagittal position in front of the femoral neck. On the sonogram, the anterior crypt is thickened and hypoechoic (Fig. 5.10). According to the state activity of the disease, it can be divided into active synovitis and quiescent synovitis. The former blood flow signals in the synovium can be detected by color Doppler ultrasound. Changes in synovial thickness and blood flow signals help to determine the therapeutic effect.

5.2.3 Peri-Hip-Joint Mass

Compared with CT and MRI, ultrasound is the simplest and most convenient imaging method for examining tumors around the hip joint. The main roles of ultrasound examination are: (1) To determine whether there is a tumor and to determine the size, level of the tumor, and the relationship with the surrounding tissue. (2) To determine whether the tumor is cystic or solid. Ultrasound has higher accuracy in this judgment, which can be identified by the type of echo and the presence or absence of blood flow signals. (3) For cystic lesions, most of the diagnosis can be based on the history and the anatomical relationship of the lesion and adjacent tissue, rather than the sonographic appearance of the cystic contents. (4) The ultrasound findings of solid tumors are mostly non-specific and require ultrasound-guided histological biopsy for diagnosis.

Fig. 5.10 Anterior crypt synovial hyperplasia. The arrow shows that the synovial of the front crypt is thickened, and the thickness of the synovial is unchanged by the probe with compression

5.2.3.1 Cystic Mass

Common cystic peri-hip-joint mass includes synovial cysts, acetabular labral cysts, bursal cysts, hematomas, and abscesses. The gray scale ultrasound findings of the femoral pseudoaneurysm are similar to cysts. Color flow signal of the tumor can be detected by color Doppler ultrasound.

1. Hip synovial cyst: It can be derived from the joint capsule, muscular layer, etc. Ultrasound can find well-defined anechoic masses at the corresponding sites, and the shape is mostly round or elliptical. Due to the high tension, the mass will not deform under the pressure of the probe (Fig. 5.11).
2. Acetabular labral cyst: Mostly after the labrum is damaged, the joint fluid is formed. The labrum damage is caused by trauma or degeneration, and the upper part is where the damage more likely to occur. The typical clinical manifestation is hip pain, which occurs mostly in the groin. The pain can be severely or progressively aggravated and can be accompanied by a squeaky feeling. A symptom of joint locking can occur when the damaged labrum is embedded into the joint cavity. The activity of the hip joint is limited to varying degrees, and the pain symptoms worsen when the hip joint is adducted and rotated. Due to the limitation of the acoustic window, ultrasound can only observe the anterior labrum of the joint. When the lesion occurs, an oval anechoic cyst can be seen beside the hyperechoic labrum, with clear boundary is clear, and there is no blood flow signal inside.
3. Hematoma: Hematomas in soft tissue often have a clear history of trauma. A small number of patients who use anticoagulant therapy can develop spontaneous bleeding without any cause. There are significant differences in the

sonographic appearance of hematoma at different stages. In the early stage of bleeding, there is an uneven echo mass, and the echo intensity is unevenly distributed from low to high. The shape of the hematoma can be elliptical or irregular. The edges are unclear and there is no blood flow signal inside. As time progresses, the echo of the hematoma gradually decreases. After 4–5 days of hemorrhage, the hematoma is liquefied, showing anecho, and the boundary is clear. This is the best time for pumping (Fig. 5.12). The unabsorbed hematoma gradually organized in the periphery and inside after 2 months, showing a low echo, irregular shape, unclear boundary. There is a strong echo when calcification occurrs.

4. Abscess: An Abscess can be caused by hip trauma, foreign body, osteomyelitis, and joint replacement. The abscess is located in the joint cavity or surrounding soft tissue. Patients with hyperglycemia, abnormal renal function, and low immune function are more likely to have abscesses. The clinical manifestations are local swelling and pain, and fluctuating feeling on palpation. When the abscess is small in a deep position with a thick wall of cavity, the sense of fluctuation is not obvious. In severe cases, systemic symptoms may occur. Ultrasound shows that the lesions are mainly hypoechoic; the blood flow signal in the peripheral inflammatory reaction area increases with no blood flow signal in the internal liquefaction area. When the probe is pressurized, and the liquefaction part shows a floating feeling (Fig. 5.13). For patients with sinus formation, ultrasound can observe the course and distribution of the sinus, and the positional relationship with the abscess, which is helpful for the formulation of the surgical plan.

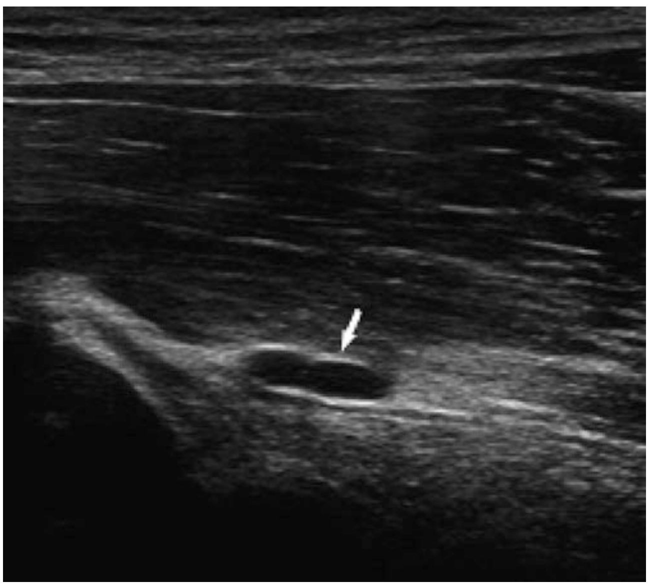

Fig. 5.11 In the anterior oblique sagittal section of the joint, there is an oval anechoic cyst with clear boundary

5. Bursal effusion and bursitis: The bursa is a closed sac containing a small amount of synovial fluid inside. The inner wall covers the endothelial cells, usually located near the joint between the bony prominence and the tendon or between muscle and skin. Its main function is to promote sliding and reduce friction and compression between soft tissue and bone. A few of them are connected to the joints. The hip bursa has the ischial tuberosity sac, the iliopsoas sac, the gluteus medius bursa, and the gluteal minimus bursa, etc., which cannot be displayed under ultrasound under normal conditions. The ischial tuberosity sac and the iliopsoas sac are common places lesions occur. The cause of bursa effusion is hip degeneration and bursitis caused by various causes, including traumatic, infectious, and inflammatory (rheumatoid arthritis). The clinical features of acute bursitis are local pain, swelling, activity disorders, and tenderness in palpation. High-frequency ultrasound can observe the synovial hyperplasia of the sac, the thickening of the bursa wall, the accumulation of fluid, and the deposition of calcium. Color Doppler ultrasound shows a good cor-

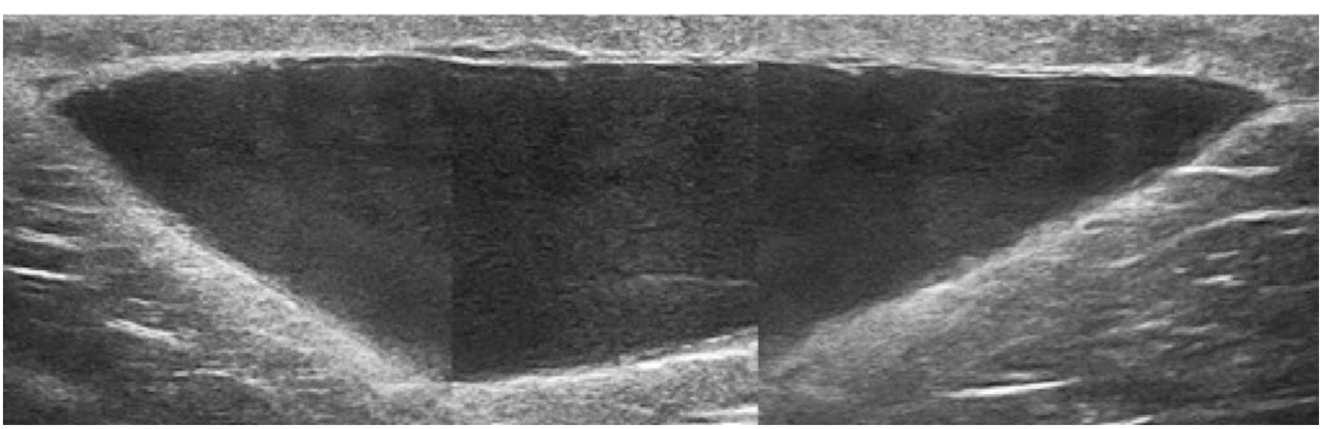

Fig. 5.12 Hip soft tissue hematoma. Female patient, 1 month after hip trauma, the local lateral bulge of the joint, no pain. Ultrasound detects a huge hematoma in subcutaneous tissue

Fig. 5.13 Hip abscess. Transverse scanning at the front of the hip joint, a large abscess formation around the femoral head, mainly hypoechoic, and scattered dotted echoes inside

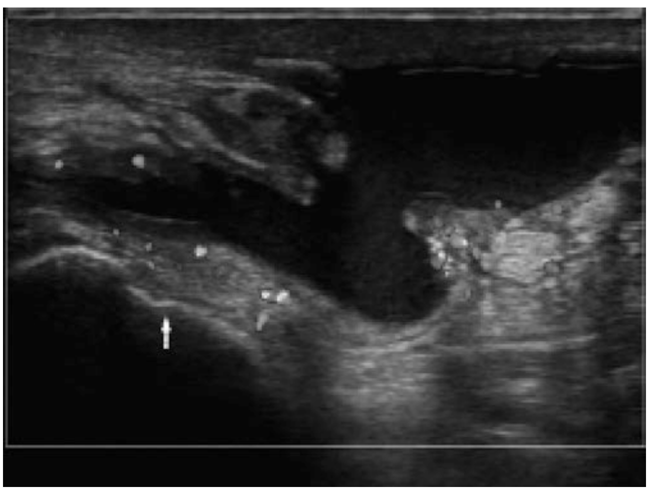

Fig. 5.14 Hip ischial tuberosity bursa. At the posterior longitudinal section of the hip, effusion can be seen in the superficial bursa of the ischial tuberosity (arrow). The liquid permeability is slightly poor, and a rich blood flow signal is visible on the wall of the bursa, suggesting bursitis accompanied by effusion

relation between the richness of the synovial blood flow signal and the severity of the inflammatory (Fig. 5.14). Ultrasound can also guide the puncture suction of the fluid in the bursa.

5.2.3.2 Solid Tumors

Common solid tumors around the hip joint, including lipoma, hemangioma, schwannomas, synovial-derived tumors, and tumor-like lesions. The tumor tissue derived from the mesenchymal tissue has a variety of pathological types, most of which have no specific ultrasound findings. The main purpose of the ultrasound examination is to determine the position and the size of the tumor, and the relationship with the surrounding and the relationship with the surrounding anatomical structure. Color Doppler ultrasound can evaluate the blood supply of the tumor (Fig. 5.15). For those who have doubts about the judgment of benign and malignant, it is feasible to perform an ultrasound-guided biopsy.

5.2.4 Muscle Tear

Improper force, excessive muscle fatigue, or overload often lead to muscle fiber damage. According to the severity of the tear, it can be categorized into four different grades. The sonograms of the different degrees of damage are also varied.

5.2.4.1 Grade 0 Damage

The damaged muscle fibers are reversible. The connective tissue is not involved. There is no abnormal change in ultrasonography.

5.2.4.2 Grade 1 Damage

The muscle stretch is within the elastic limit. The patient has pain, the muscle function is normal, and the muscle damage is less than 5%. Gross pathological examination reveals a small range of broken muscle fibers, often near the junction of the muscle belly and tendon. Ultrasound examination shows that the local muscle fiber texture is unclear and hypoechoic, which may be accompanied by a small amount of bleeding. After a few weeks, the sonogram shows that the muscle fiber structure returned to normal.

5.2.4.3 Grade 2 Damage

The muscle stretch exceeds the elastic limit. The range of muscle fiber damage is further expanded but does not exceed half of the whole in the cross-section. The patient sometimes feels the tearing of the muscles. The muscle function is lost, and the local swelling is obviously visible. An ecchymosis occurs under the skin. The weakened area of the muscles can be found by palpation. The sonogram shows a continuity interruption in a large number of muscle fibers, or the interruption at the junction between the muscle fibers and the epimysium. A hematoma is formed at the interrupted site, with low echo or no echo. When the probe is pressurized, the muscle ends are floating in the hematoma area. In the later stage of the disease, the hematoma is organized, and the surrounding hyperplasia and scar of granulation tissue are formed, gradually replacing the muscle fiber tissue.

5.2.4.4 Grade 3 Damage

The muscle breaks completely and loses its function. The local soft tissue is more swollen, and the local muscle layer can have an emptiness feeling when palpated. Ultrasound examination shows a complete interruption of muscle continuity, retraction of both ends, thickening, irregular edge morphology, hema-

Fig. 5.15 A solid mass in soft tissue in front of the hip joint. The patient is a 45-year-old male. A huge hypoechoic mass is seen in the anterior muscle layer of the hip. The shape is irregular, lobulated, the border is clear. Surgical pathology indicates chondrosarcoma

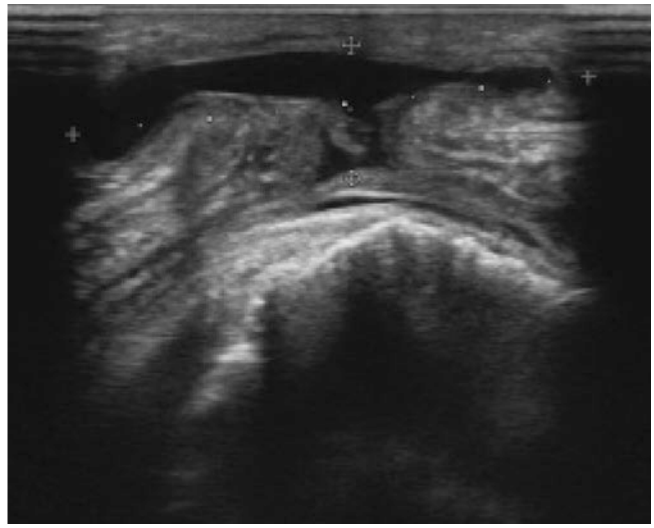

Fig. 5.16 Gluteus maximus tear. The patient is a 35-year-old male. Three days after the car accident, the gluteus maximus is completely broken, the broken end is separated, and the hematoma forms

toma filling between the ends, and increased distance of the end of the limb during passive stretching (Fig. 5.16).

5.2.5 Tendinopathy

Repetitive hip movements cause minor damage to the surrounding tendon, which is the main cause of tendinopathy, and it is common in the elderly or professional athletes. Rheumatism, autoimmune diseases, and other reasons can also lead to inflammatory changes in the hip tendon, and more common in the tendon attachment, also known as attachment inflammation. Hip tendon lesions occur in the gluteus medius tendon and the gluteus maximus tendon attached to the greater trochanter of the femur. Ultrasound shows thickening of the tendon and reduction of echo intensity. When the inflammation is active, the color flow signal can be seen in the tendon. Most of the hip tendonitis is calcified inflammation, and the calcification is mostly punctate, plaque-like echo, with or without sound shadow. Inflammation can cause localized bone erosion (Fig. 5.17).

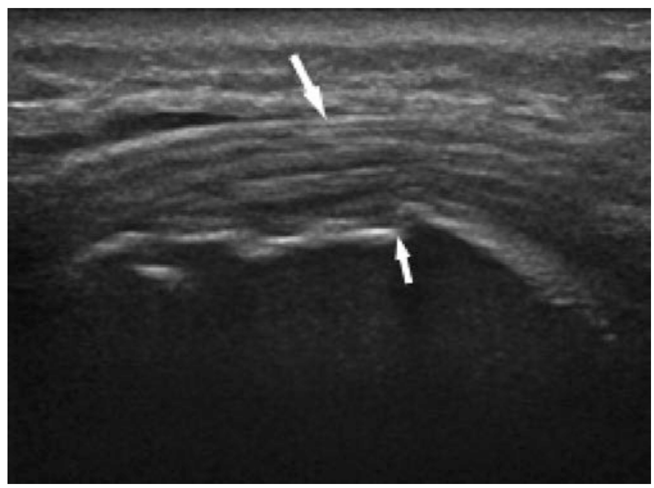

Fig. 5.17 Gluteus minimus tendinitis with bone erosion. Lateral transverse section of the hip, thickening of the gluteus minor tendon, reduced echo intensity, uneven distribution, and the surface of the cortical bone of the greater trochanter is not smooth, showing a worm-like change

5.2.6 Snapping Hip Syndrome

During the active extension or flexion of the hip joint, the patient hears or feels the hips snapping when the hip joint moves to a certain position. According to the cause and location of the snapping, a snapping syndrome is divided into internal or external. An external snapping occurs when there is a friction between the iliotibial band or the gluteus maximus tendon and the greater trochanter of the femur. An internal snapping mostly happens with the friction created between the iliopsoas tendon and the pubic trochanter. It can also be seen in the joint mouse and labrum tearing. Ultrasound is the only imaging examination that can be performed under motion. It plays an important role in the diagnosis of the hip, especially for the snapping caused by the tendon.

5.2.6.1 Iliotibial Band Snapping Syndrome

The patient is placed in the contralateral position, and the probe is transected at the greater trochanter level. During the flexion of the hip joint, the tendon bundle strikes across the

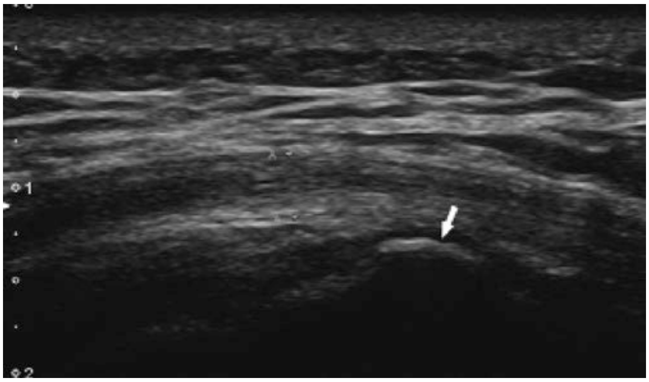

Fig. 5.18 Iliotibial band Snapping Syndrome. The affected side's Iliotibial band is obviously thickened, the echo intensity is reduced, and the arrow refers to the deep greater trochanter. Under the moving condition, the iliotibial band slides across its surface and makes a sound

greater trochanter of the femur in an instant. We also can see the iliotibial band snaps when it crosses the greater trochanter of the femur. Due to long-term friction, the iliotibial band is thicker than normal (Fig. 5.18).

5.2.6.2 Iliopsoas Tendon Snapping Syndrome

Dynamic ultrasonographic examination during provocative maneuvers is the diagnostic test of choice for symptomatic snapping iliopsoas tendons at the level of the pelvic brim or femoral head [2, 3]. The patient is in a supine position, and the lower extremity is extended. The probe is transected at the iliopsoas tendon in front of the hip joint, and the iliopubic tuberosity is shown. The hip joint continuously performs flexion, abduction, extorsion, and extension. At the same time as the sounding, the iliac crest muscle tendon laterally passes over the iliopubic tuberosity and slides inward. In the quiescent state, ultrasound often finds tendon thickening and echo reduction of the iliopsoas tendon.

5.3 Ultrasound Diagnosis of Developmental Dislocation of the Hip

Developmental dislocation of the hip (DDH) is the most common developmental disease in pediatric orthopedics. The currently accepted principles of DDH treatment are early detection and early treatment. The earlier the treatment, the simpler the treatment, and it is easier to get a normal or near-normal hip joint. Since the baby's femoral head is mainly cartilage, it cannot be developed on the X-ray. The DDH diagnosis and treatment guidelines developed by the Chinese Medical Association in 2017 indicate that for infants younger than 6 months, ultrasonography is an important auxiliary examination method for DDH, and it is recommended to use ultrasound screening in areas with better medical conditions. Ultrasound diagnosis of DDH (Graf method) is the earliest method for the diagnosis of DDH based on the coronal plane of the hip joint. It can comprehensively observe the osseous acetabulum and cartilage acetabulum and judge the spatial relationship of the femoral head and acetabulum. It is currently the most widely used method in the world.

5.3.1 Ultrasonic Examination Method

Select a 7 ~ 12 MHz linear array probe according to the age of the child. In the lateral position, the hip joint is slightly rotated and close to the straight position. A special examination bed can be selected to facilitate the fixation. In the contralateral decubitus position, the hip joint is slightly pronated and close to the straight position. A special examination bed can be selected to facilitate the fixation. The probe should be scanned at the lateral side of the hip joint to prevent the sound beam from tilting forward or backward. Generally, check the left side first, and then the right side.

5.3.2 The Normal Sonogram

The sonogram of the normal hip joint clearly shows the morphology and their spatial relationship of the acetabulum and femoral head. The development of osseous acetabulum is good, the top edge of the bone is sharp or slightly blunt, the cartilage acetabulum completely covers the femoral head, and the spatial relationship of the femoral head and acetabulum is normal, and the two are in close contact. The Graf method uses the coronal section of the acetabular center as a standard image for measurement and diagnostic typing, i.e., the image shows the lowest point of the ilium ossification, the flat iliac rim, and the labrum. The standard image also shows the structure of the femoral head, osteochondral interface, bony rim, perichondrium, bone top, cartilage top, joint capsule, and synovial fold (Fig. 5.19).

5.3.3 Ultrasound Measurement

Measurements are taken on standard images through the center of the acetabulum. Taking the apex of the perichondrium as the starting point, the tangential line to the iliac margin is called the baseline; the tangential line to the top of the iliac ossification is called the bony roof line; the line connecting the bony rim to the midpoint of the hip labrum is called the cartilage roof line. The baseline and the bony roof line form the bone angle (α), which reflects the development of the osseous acetabulum. The larger the angle of α, the more mature the acetabular development. The baseline and cartilage roof line constitute the cartilage angle (β), reflecting the development of acetabular cartilage, especially the lateral margin of the cartilage. The smaller the β angle, the better the acetabular coverage of the femoral head (Fig. 5.20).

5.3.4 Ultrasound Classification

According to the measured values of α and β, the Graf method divides the hip joint into type I ~ IV (Table 5.1), which is essential on the difference in the shape of the acetabulum and the positional relationship with the femoral head. Type I is a normal hip joint, and type II contains a series of conditions from mild hip dysplasia to dislocation of the femoral head. Type III and IV are dislocated joints, and the femoral head is displaced posterosuperiorly. Therefore, it is often impossible to display the acetabulum and femoral head simultaneously on a coronal plane. Figures 5.21, 5.22, and 5.23 show the sonogram of the II ~ IV hip joint. Overall, ultrasound has great diagnostic value for adult hip soft tissue diseases, and has a high sensitivity to hip joint fluid and synovial hyperplasia. The

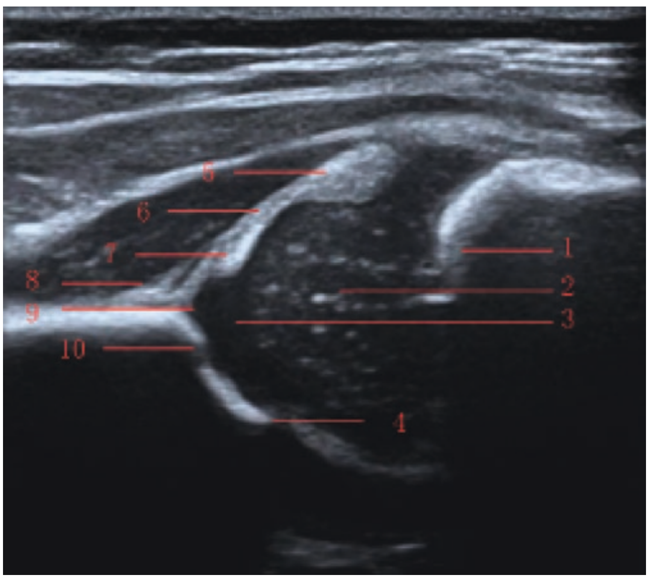

Fig. 5.19 Normal baby hip joint section. (1) Bone cartilage interface of the femoral head; (2) Femoral head; (3) Cartilage acetabular apex; (4) The lowest point of ilium ossification; (5) Synovial reentry; (6) Joint capsule; (7) Labrum; (8) Perichondrium; (9) The outer edge of the ilium; (10) bony rim

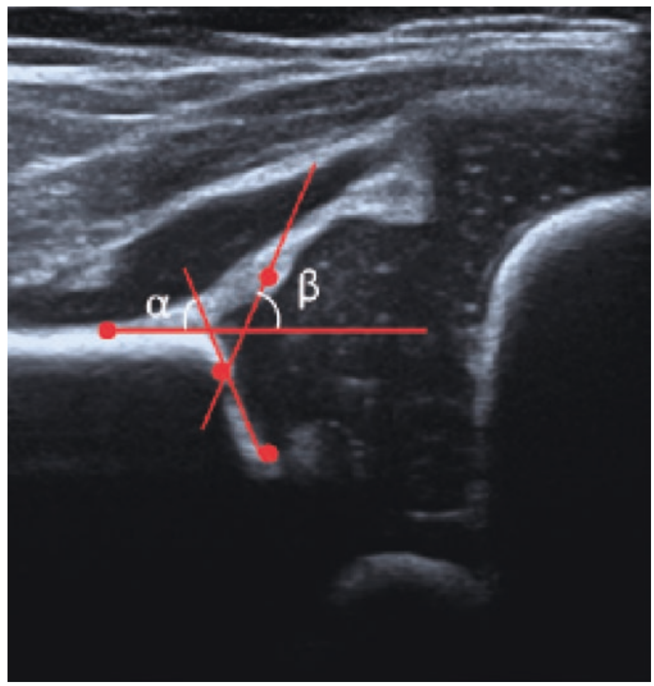

Fig. 5.20 Hip ultrasound measurement

Table 5.1 Graf hip classification

Graf classification	Bone roof/bone roofine angle (α)	Bone edge	Cartilage roof/cartilage roofine angle (β)	Age
Type I	Shape and alignment of femoral head and acetabulum is good α ≥ 60 °	Sharp or slightly blunt	Complete coverage of the femoral head I a: β ≤ 55 ° I b: β > 55 °	Any age
Type II a/b	Slightly poor morphology, no dislocation α = 50 °~59 °	Round or curved	Complete coverage of the femoral head β = 55 °~77 °	II a < 3 months II b > 3 months
Type II c	Poor morphology, no dislocation α = 43 °~49 °	Flat or stepped	Covering the femoral head β < 77 °	Any age
Type III	Poor morphology, femoral head dislocated α < 43 °	Flat	The femoral head is pressurized upwards, and the proximal perichondrium is up close to the ilium wall	Any age
Type IV	Poor morphology, femoral head dislocated α < 43 °	Flat	The femoral head is pressurized downwards, and the proximal perichondrium is pressed between the femoral head and the ilium wall.	Any age

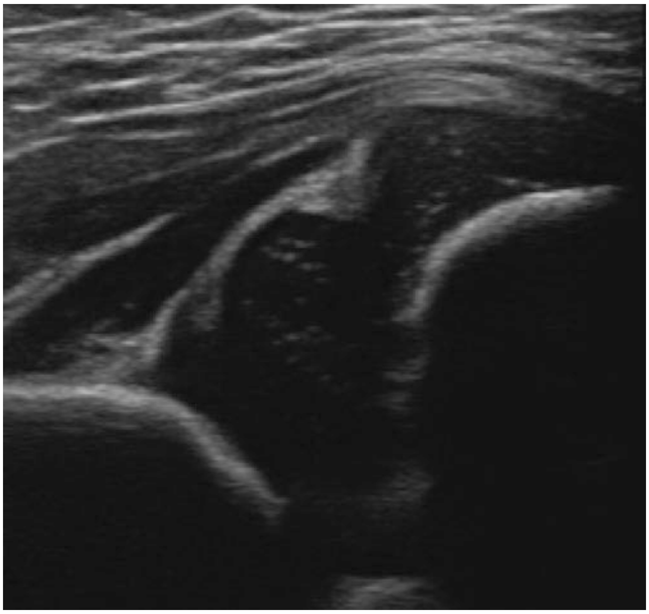

Fig. 5.21 Type II c hip joint. Bone acetabulum is poorly shaped, flattened, and cartilage acetabulum still covers the femoral head, α = 45 °, β = 76 °

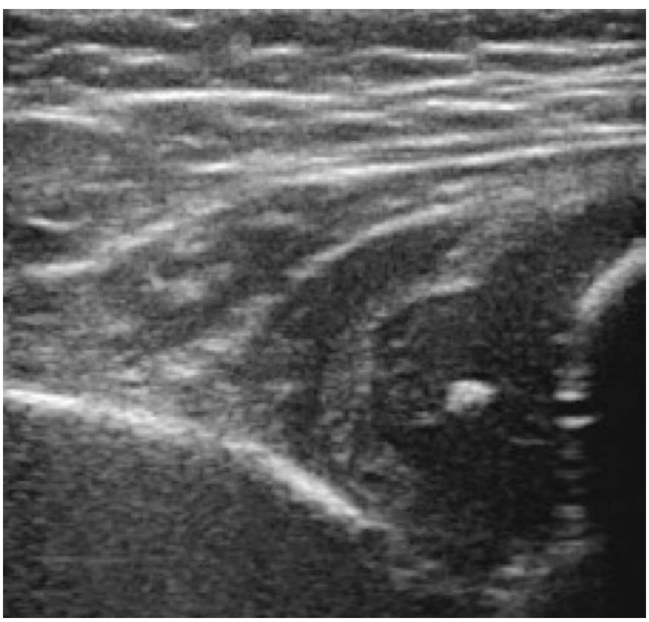

Fig. 5.22 Type III hip joint. The osseous acetabulum is poorly shaped, the top of the bone is flat, the cartilage acetabulum does not cover the femoral head, the femoral head is displaced posterosuperiorly, and the perichondrium always goes upwords

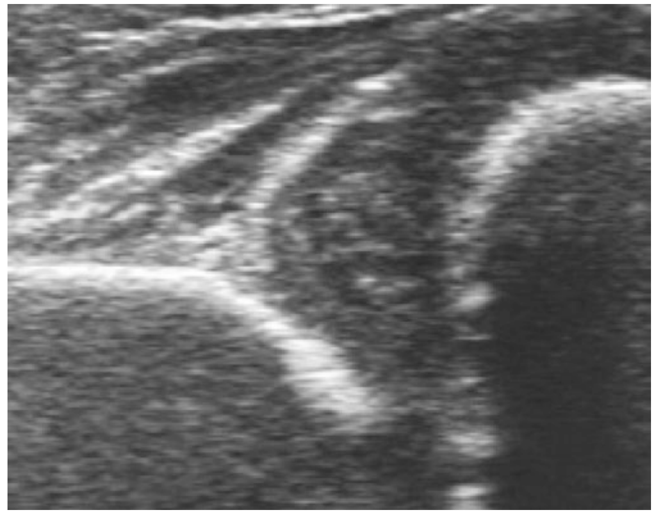

Fig. 5.23 Type IV hip joint. The osseous acetabulum has a poor shape and the top of the bone is flat. The cartilage acetabulum does not cover the femoral head. The femoral head is displaced posterosuperiorly, and the perichondrium is embedded between the femoral head and the tibia wall

shortcoming is that the display of deep structures such as the labrum, ligament, and bone is not as good as MRI, CT, etc. The combination of multiple imaging types facilitates a comprehensive assessment of hip disease. For the diagnosis and follow-up of infant DDH within 6 months, ultrasound can be the preferred imaging method.

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