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Radio imaging features of hip tuberculosis; journey from ancient to modern concept, and its mimickers

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Abstract
Hip tuberculosis (TB) is second to the spine and only hence, the majority of cases visit the medical clinic annually. In the early stages of hip TB, there is a diagnostic perplexity when plain X-rays are negative. Currently, diagnostic modalities have advanced compared to ancient times and, radio imaging features have become the backbone in proper diagnosis. When the disease has progressed gradually, definite radiological changes reveal on plain X-ray with the advent of time. Advanced diagnostic facilities such as ultrasonography (USG), magnetic resonance imaging (MRI), computed tomography (CT) scan as well as, nuclear medicine (in some instance), is universally established. Many radiologists referred hip TB as a double-edged sword in clinical practice as making a false diagnosis is potentially as harmful as missing the diagnosis in genuine cases. The incorrect diagnosis of hip TB results in the futile treatment as well as, the toxic side effects due to administered antitubercular drugs. A range of clinical situations mimics hip TB such as pyogenic arthritis (septic arthritis), transient synovitis, juvenile rheumatoid arthritis, and so on. Without radio imaging findings, it is extremely troublesome to make an accurate diagnosis. This review delineates radio imaging feature of hip TB and its mimickers, as well as, by the time, advancements in radio imaging concept of hip TB.

Keywords: Musculoskeletal TB, hip TB, radio imaging features, pyogenic arthritis (septic arthritis), transient synovitis

1. Introduction
Worldwide, the annual incident of tuberculosis (TB) has been reported nearly 30 million. Musculoskeletal TB is undoubtedly rare extrapulmonary complication, accounting for about 1-3% of total TB cases globally; however, as one-fourth of all cases of TB exist in India. In developing countries, this figure is dramatically increased due to poor sanitation and malnutrition. The incidence of hip TB is at seconded rank followed by spinal TB and, it accounts for about 15% of all cases of musculoskeletal TB [1]. Hip TB results in the gradual destruction of joint if untreated at an early stage, and can even lead to pathological dislocation. The pain, loss of movement, and progressive development of deformity results in loss of function of the affected hip. Subluxated or dislocated hips following infection are challenging to manage for stable, mobile, congruous, and concentric joint to be obtained. Generally speaking, these hips with advanced lesion luxate ultimately cause osteoarthritis or ankylosis even after healing of the condition [2-6]. To date, skeletal tuberculosis has been downgraded to the status of a rare disease in resource-rich countries and, the modern generation of the physician is mysterious about the manifestations of this condition. Early diagnosis and efficient chemotherapy are crucial in treating the condition and protecting the joint. Almost existing literature on the topic is of the view that the diagnosis in endemic regions can be made based on clinical features and plain X-ray findings, further investigations in the form of ultrasound (USG), computed tomography (CT) scan or magnetic resonance imaging (MRI) of the hip, and/or biopsy may be mandatory. However, in developing countries, radiologic examinations are the mainstay for the diagnosis of hip TB and thereby, also helpful in the determination of appropriate therapy as treatment choice is based on stages of condition that is identified by not only clinical features but also radiologic findings.
The clinical characteristics have become more disparate because it seems to affect an older age group patient more and, even a thriving class of society. In the majority of TB cases

around the hip, pain and restricted movements of the hip are typical presentation and there comes, the riddle of accurate diagnosis because multiple pathologies can perhaps mimic this presentation. Hence, many radiologists viewed it as a 'great mimicker'. The differential diagnosis of this condition includes pyogenic arthritis (septic arthritis), transient synovitis, juvenile rheumatoid arthritis, Legg-Calve-Perthes disease, osteomyelitis, osteoid osteoma, pigmented villonodular synovitis and so on. The present review highlights the radio imaging feature of hip TB and advances in its concepts with the advent of time. Interestingly, radiological findings of clinically relevant mimickers of this condition have also been recapitulated.

2. Methodology

A Pubmed search was performed using the term "TB of the hip joint", "tubercular arthritis of the hip", "TB hip in children and musculoskeletal TB". We were able to trace about 159 papers on this matter. Apart from this, a book from co-author Tuli is one of good mine of information. The details from all these references were pooled and, the relevant information was included in this review paper.

2.1 Pathogenesis and Pathology

TB of bones and joints is secondary to primary pathology in lungs, lymph nodes or any of the viscera. The bacteria enter either synovium or bone through the hematogenic route. While it initially abides in the synovium, the synovial membrane gets swollen and congested. From the synovium, the granulation tissue extends over the bone inducing necrosis of sub chondral bone, sequestra and maybe touching lesion on either side of joint. The bacteria may also abide first in the epiphyseal or metaphyseal area of the adjoining bones such as head or neck of femur, greater trochanter or acetabulum to begin the destructive process [Fig 1]. It may begin as extra-articular or juxta-articular lesion. When the disease commences as intraarticular, it progresses quickly to involve the entire joint. An extra-articular lesion can also progress further to involve the joint. A cold abscess that commonly forms within the joint may perforate the capsule to present surrounding the hip joint in the femoral triangle, medial, lateral or posterior aspects of the thigh, ischiorectal fossa [1].

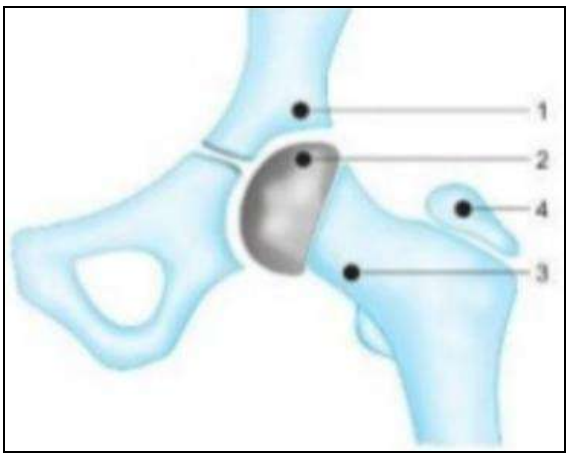

Fig 1: A pictorial illustration of the area of osseous origin of tuberculosis of the left hip joint; (1) acetabulum (2) femoral head/epiphysis (3) femoral neck/metaphysic (4) greater trochanter (Redrawn from *Tuli* [1])

2.2 Classical Shanmugasundaram's morphological classifications for hip TB

Historically, in 1983, *Shanmugasundaram* [7] introduced a radiological classification for hip TB on plain x-rays, which was applicable for lesions in children and adults. His viewpoint was that the radiological presentation of the hip ultimately forecasts the final clinical outcome. With this regards, morphological types based on the destructive pattern can be classified into seven types; normal, travelling/wandering acetabulum, dislocating type, Perthes type, protrusio acetabuli, atrophic, mortar & pestle type.

According to this classification, the disorder chiefly includes the synovium in the normal-appearing hip. The femoral head, collar, or acetabulum may have cysts or cavities yet, gross destruction of subchondral bone is unremarkable and, the joint space is normal. In the 'travelling acetabulum' type, the lesion is in the roof. The joint space is narrowed, with the progressive upward displacement of the femoral head [Fig 2].

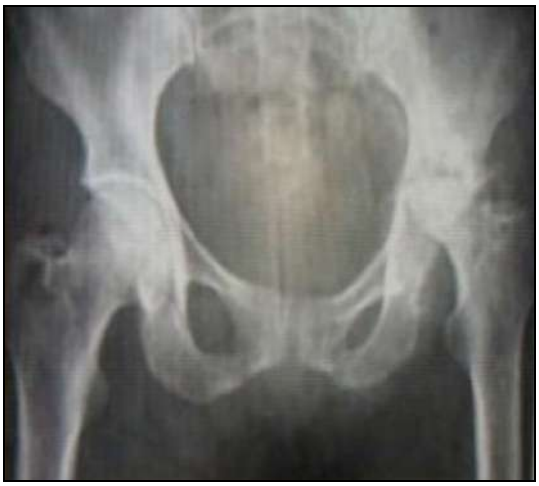

Fig 2: Radiograph presenting travelling acetabulum type of hip TB (Redrawn from *Tuli* [1])

In the 'dislocating' type, the head dislocates posteriorly, or subluxes because of laxity of ligaments and capsular distension [Fig 3].

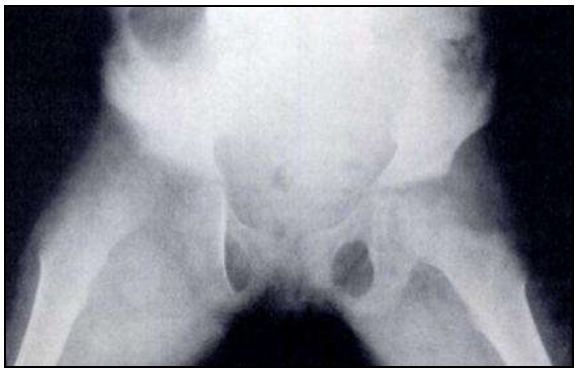

Fig 3: Radiograph illustrating dislocation type of hip TB (Redrawn from *Tuli* [1])

In the Perthes' type, the epiphysis is fragmented, dense and flattened. The neck of the femoral is broadened. It is similar to Perthes' disease and is likely due to embolic episodes [Fig 4].

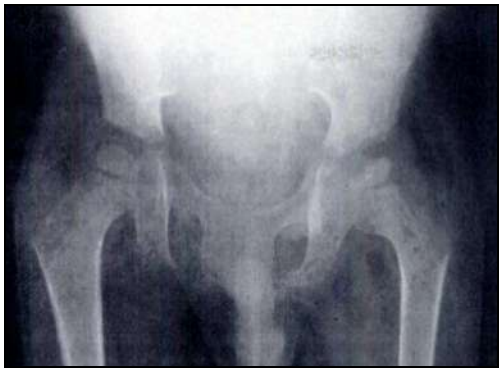

Fig 4: Radiograph displaying Perthes' type of hip TB (Redrawn from *Tuli* [1])

In the 'protrusio-acetabuli' type, the lesion is frequently on the floor of the acetabulum. With progression, medial displacement of the floor occurs through femoral head pressure. The os innominatum gets thinned out in the acetabulum [Fig 5].

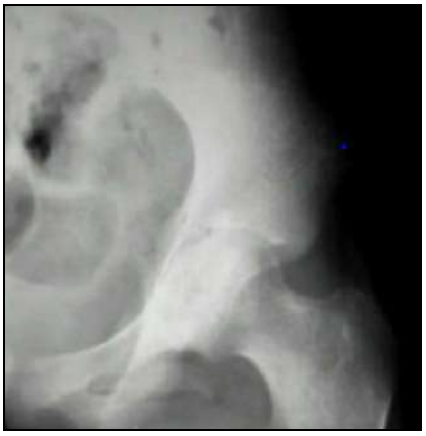

Fig 5: Radiograph showing protrusio-acetabuli' type of hip TB (Redrawn from *Tuli* [1])

The 'atrophic' hip is delineated by marked narrowing of the joint space [Fig 6].

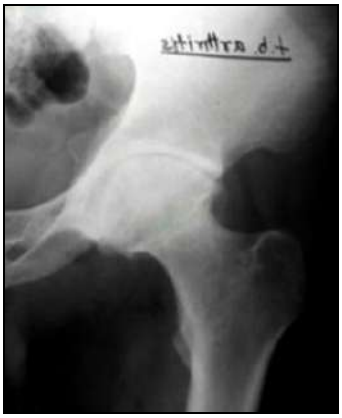

Fig 6: Radiograph showing atrophic type of hip TB (Redrawn from *Tuli* [1])

Agarwal et al [8] hypothesized that some hip involvements cannot be classifiable by traditional types. Consequently, 8th type-unclassified was added to Shanmugasundaram radiological classification. Fig 7 illustrates the modified classification, which was prepared from Shanmugasundaram radiological classification. In the unclassified type, three different patterns were added: triradiate, pseudarthrosis coxae and ankylosed. The Triradiate pattern has a prime focus on the acetabular floor. The lesion develops and persists initially confined to the lower acetabulum. Rest of the hip remains unaffected. The pseudarthrosis coxae pattern is likely a consequence of the primary femoral epiphyseal focus resulting in the complete loss of femoral head and occasionally the femoral neck. This pattern indicates loss of cervicocephalic articulation. It is disparate from the dislocating type because it lacks a femoral head. The third pattern, the ankylosed hip is an old or healing disease with ankylosis [Fig 7].

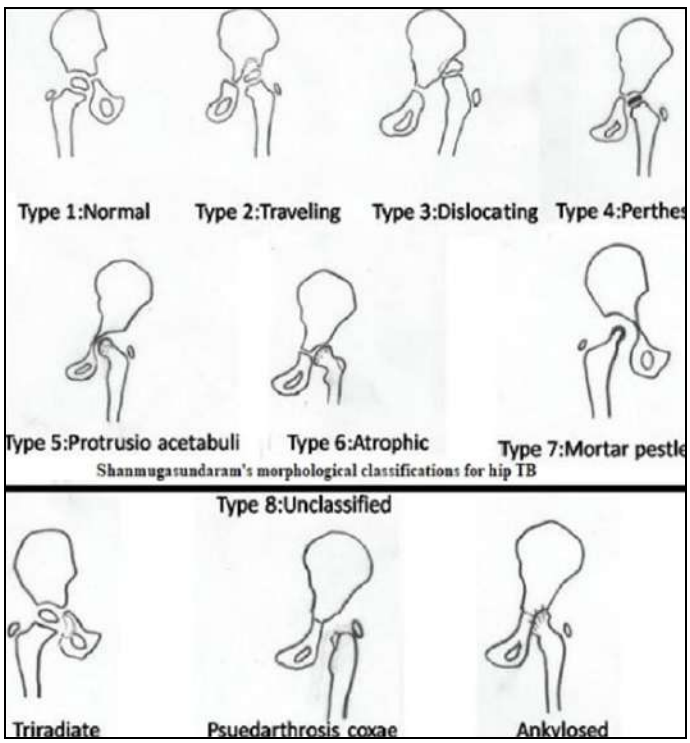

Fig 7: A line diagram of hip joint showing the original seven radiological types of Shanmugasundaram and unclassified type 8 (Redrawn from *Agarwal et al.* [8])

Dramatically, Shanmugasundaram radiological classification was modified and, in 2014, *Agarwal et al.* [8] put forward the novel classification of hip TB in pediatric [Table 1]. On the grounds of, limited sample size and some basic pattern observed in the unclassified category, this classification was not validated and has been represented as clinical observation only.

Table 1: Modified Shanmugasundaram radiological types for pediatric hip tuberculosis (adopted from *Agarwal et al* [8])

Type	Radiology
Normal type	Joint space is normal. There may be cysts or cavities in the femoral head, neck or acetabulum, but there is no gross destruction of subchondral bone
Travelling acetabulum	The acetabular roof is affected and there is proximal migration of the femoral head
Dislocating type	Hip gets dislocated or subluxated
Perthes type	The hip is sclerotic. Distinction from true Perthes disease may be extremely difficult
Protrusio acetabuli	The medial acetabulum is diseased and eroded
Atrophic type	Decreased joint space. Probably the result of subchondral erosion
Mortar and pestle	There is destruction of either femoral head or acetabulum or both leading gross mismatch between the articular surfaces
Unclassified*	Triradiate: Primary focus near acetabular floor. Involvement of nonweight bearing lower acetabulum
	Pseudarthrosis coxae: Loss of cervicocephalic articulation due to destroyed femoral head and sometimes neck
	Ankylosed: Fibrous or bony ankylosis

'**Note:** Common patterns observed in unclassified category. However, due to limitation of small sample size Yaidations of the type 8-unclassified was not done. It is cinical observation

2.3 Clinical and Radiological presentations
Cornerstone for novel classification

Hip TB generally begins during the first three decades, yet no age is exempt. In almost every case, there is a pain in the hip, limp, restriction of movement. Based on the extent of involvement, there can be deformity, shortening of the limb, swelling, pathological dislocations, and sinuses. Clinically, the progression of hip TB can be mainly classified into four stages, including synovitis, early arthritis, active arthritis and advanced arthritis with subluxation/dislocation [Fig 8].

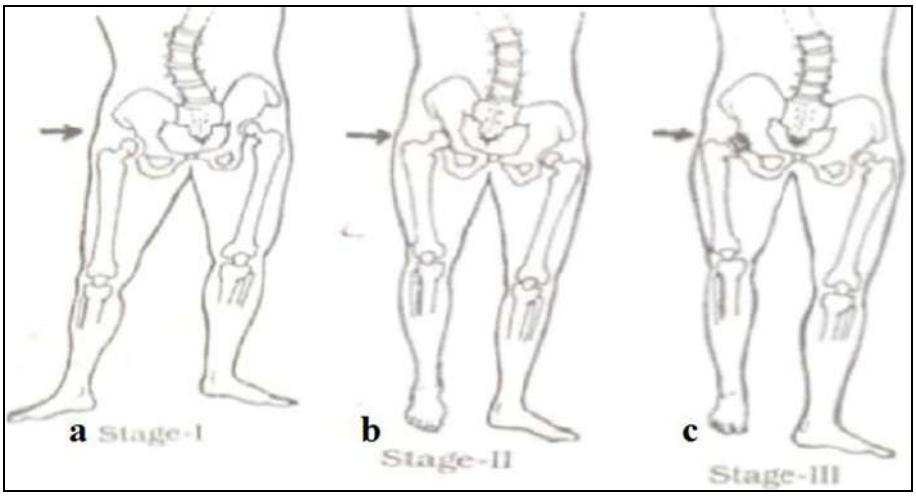

Fig 8: Clinicoradiological staging of hip TB representing (a) stage I: synovitis (b) stage II: early arthritis (b) stage III: advanced arthritis. (Redrawn from *Tuli* [1])

The stage of synovitis creates a classic irritable hip syndrome appearance. There is effusion in the joint and, the involved limb is flexed, abducted, and externally rotated with an apparent lengthening of the extremity. In all planes, attempted movement is painful [Fig 9a]. The stage of early arthritis is the advancement of the synovial form of the disease, the lesion begins to appear, and may start with the femoral epiphysis or medial aspect of the head or neck. The lesion may begin independently in bone and persist intraosseous yet extraarticular [Fig 9b]. This stage is represented by fixed deformities in the hip. With progressive destruction of the joint, the limb goes into flexion, adduction, and internal rotation, with an apparent limb shortening. There is a marked restriction of hip movements and muscle wasting nearby the hip. Plain radiographs demonstrate generalized osteopenia nearby the hip, with an osseous focus of destruction in either the acetabulum or the femoral head or neck without affecting the articular surface. In the arthritis stage, the lesion surfaces on the articular area, becoming an intraarticular lesion that induces patchy destruction of the articular surface of the femoral head. Further development results in the involvement of the whole articular surface with marked diminution or loss of joint space. Each tried hip movement can be painful with actual shortening of the limb and, the child walks with an antalgic gait. In the stage of advanced arthritis, the destruction causes irregular and hazy joint margins with diminished joint space. The movements of the hip are very painful and grossly restricted with shortening of the limb [Fig 9c]. Pathological dislocation/subluxation may also occur in the advanced stages because of the gross deterioration of the femoral head or the superior acetabular

margin (wandering acetabulum), which leads to further shortening and deformity [Fig 9d]. The tendency of the limb and deformity does not all the time correlate with stages of the disorder. The hip is subluxated posteriorly and superiorly with true shortening of the affected limb [9]. Occasionally, the head of the femur rather displacing posteriorly may project medially by the weakly destroyed acetabulum.

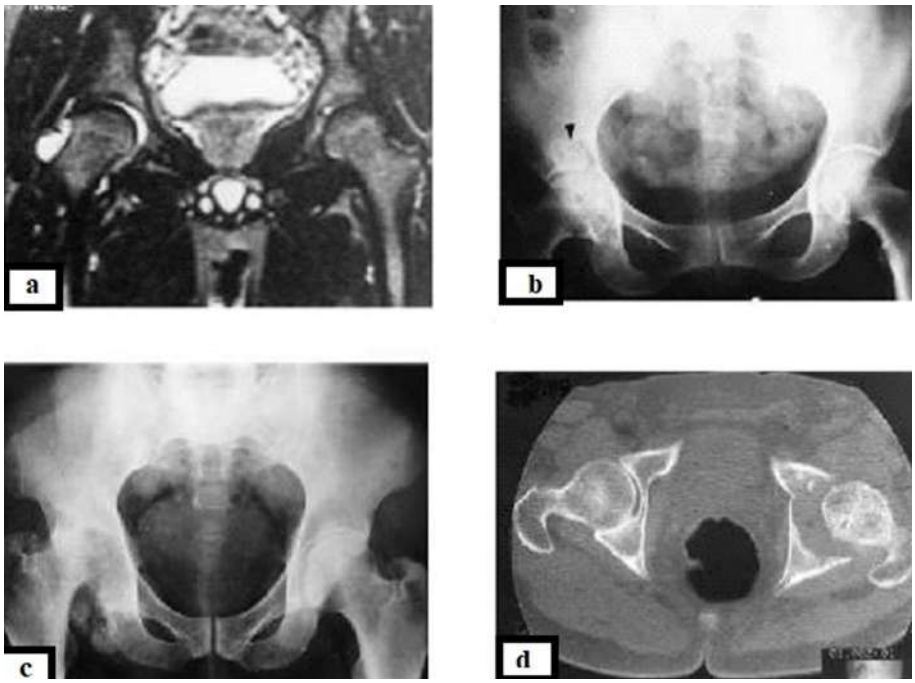

Fig 9: Representation of stages of hip TB (a) A magnetic resonance imaging scan of the pelvis shows effusion and synovitis in the pelvis right hip (stage I).The patients presented with a classic triple deformity. The plain radiograph was normal. (b) A radiograph of the pelvis shows loss of joint space, and patchy destruction of the femoral head and the acetabulum (Stage II). (c) A radiograph shows established arthritis and a destroyed and atrophic femoral head on the right side (d) A CT scan show the extent of destruction (Stage IV). (Redrawn from *Agarwal et al.* [8])

In 2002, *Babhulkar and Pande* [10] proposed a novel classification, regarding mentioned clinicoradiological presentations into the stage of synovitis, early arthritis, arthritis and advanced arthritis. The existence of apparent shortening or true shortening departed early arthritis and arthritis [Table 2]. In the same year, *Tuli* [1] hinted modification in this classification [Table 3] and classified it as synovitis, early arthritis, advanced arthritis and advanced arthritis with subluxation/dislocation. To date, Tuli's modified classification has emerged as the newest classification in research era.

Table 2: Clinico-radiological classification of tuberculosis of the hip (adopted from *Babhulkar and Pande* [10])

Staging	Clinical Findings	Radiologic Features
Stage of synovitis	Flexion, abduction, external rotation, apparent lengthening	Haziness, rarefaction
Stage of early arthritis	Flexion, adduction, internal rotation, apparent shortening	Rarefaction, osteopenia, bony lesion in femoral head acetabulum or both, No reduction in joint space
Stage of arthritis	Flexion, adduction, internal rotation, shortening	All of the above and destruction of articular surface, reduction in joint space
Stage of advanced arthritis	Flexion. adduction, internal rotation with gross shortening	Complete destruction, no joint space, wandering acetabulum

Table 3: Modified clinico-radiological classification of tuberculosis of the hip (adopted from *Tuli* [1])

Stages	Clinical	Radiology
Synovitis	Movement present (> 75%)	Soft tissue swelling, osteoporosis
Early arthritis	Movement present (50% to 75%)	In addition to Stage I, moderate diminution of joint space and marginal erosions
Advanced arthritis	Loss of movement of > 75% in all directions	In addition to Stage H, marked diminution of Joint space and destruction of Joint surfaces
Advanced arthritis with pathologic dislocation or subluxation	Loss of movement of > 75% in all directions	In addition to Stage HI, Joint is discrganized with dislocation or subluxation

Babhulkar and Pande [10] presented a classification of hip TB based on disease progression, whereas, Shanmugasundaram's classified it based on the destructive pattern. Though, it was challenging to convert their classification into Shanmugasundaram's. *Moon et al.* [11] presented their working classification and compared it

with Shanmugasundaram's. He classified hip TB in children with regards to joint stability, cephalocotyloid morphology and its anatomical relationship. As well in Fig 10, the association between the classifications of the *Moon et al.* [11] and *Shanmugasundaram* is demonstrated for comparison. He elucidated that the hips in Perthes type, atrophic hip, and protrusio acetabuli were stable, whereas, the travelling acetabulum, mortar and pestle, and dislocating hip types were unstable.

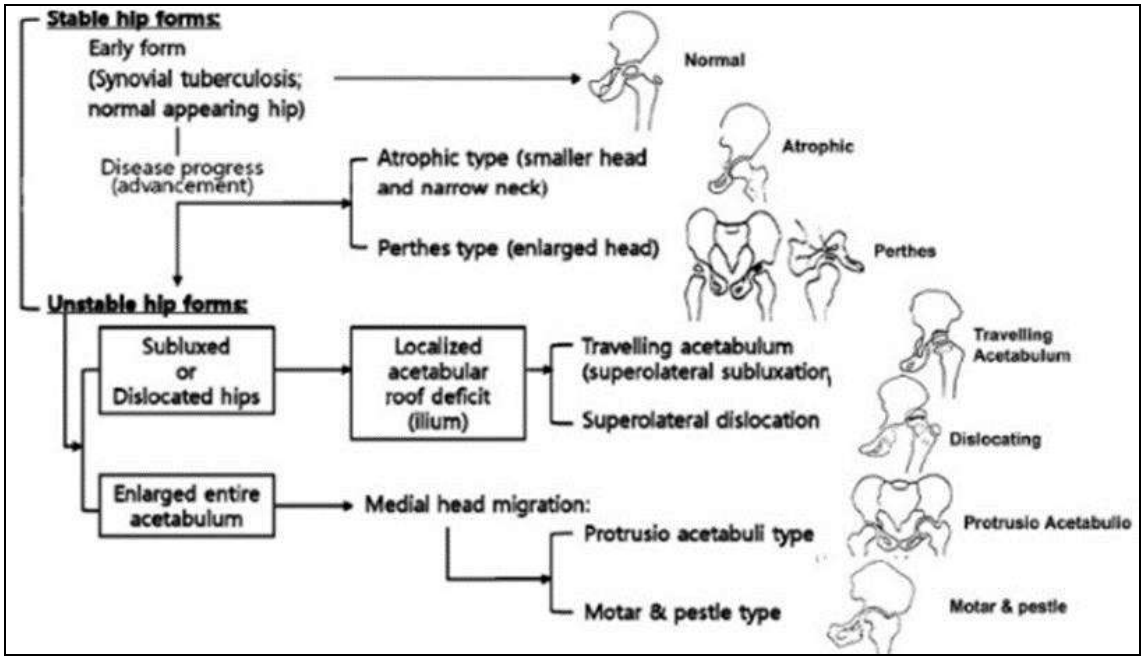

Fig 10: Classification of tuberculosis of hip in children, based on the joint stability, cephalocotyloid morphology and its anatomical relation with Shanmugasundaran's classification (Redrawn from *Moon et al* [11])

2.4 Strengths and shortcomings of clinicoradiological features

In the stage of synovitis, no alterations were found in the joint and lots of time the diagnosis is failed to hint; as the confirmation of the tubercular bacilli or histological features in the biopsy is advisable. In advance stages of arthritis, radiological changes are classic and, tissue diagnosis may not be needed. In the stage of synovitis, plain X-rays do not reveal any findings or at the most soft tissue swelling is apparent. As the disease progresses on, periarticular osteoporosis, hazy, and irregular joint margins with a reduction in the joint space is viewed. In advanced arthritis, the portrait is of travelling/wandering acetabulum, dislocated hip, Perthes type, protrusio acetabuli, atrophic type, mortar, and pestle are seen as outlined in the classification of Shanmugasundaram. In agreement with Campbell and Hoffman [12], there is an association between different types of radiology and the functional outcome. In the present moment, MRI has assisted in to identify the early morbid pathology in the joint since it reveals the predestructive lesion such as edema and inflammation. It is a sensitive test to identify soft tissue abnormalities in and around the joint. But still, MRI is not specific for TB of the hip [13]. MRI in early stages may display synovial effusion and varying degree of bone oedema, smallest areas of bone destruction, however, tissue diagnosis may be advised, in such situations [14]. Existing literature on the matter concurs that the diagnosis in endemic regions can be made based on clinical features accompanied by plain X-ray findings alone, but, in the countries where the condition is rare, further investigations including ultrasound or MRI of the hip, and/or biopsy may be required.

2.5 Radio imaging features of hip TB and its mimickers

Here, we present radio imaging feature of hip TB and some conditions that mimic it, this gathered information may be worthwhile for the radiologist for differential diagnosis of hip TB.

2.5.1 Hip TB

In plain radiography, a triad of radiologic abnormalities-periarticular osteoporosis, peripherally located osseous erosion, and progressive diminution of the joint space (Phemister's triad) is chief indicative of hip TB. [15-20] Additional radiographic features comprise joint effusion and osteolytic bone destruction. [15] Seldom, wedge-shaped areas of necrosis (kissing sequestra) may be found on both sides of the affected hip. In late stages of this condition, bone sclerosis and periostitis may occur, excluding children, in whom a layered periosteal reaction may be observed. Nevertheless, there is no single particular radiographic feature that allows a definite radiological diagnosis of hip TB. The end-stage of hip TB is represented by severe joint destruction and ultimately sclerosis and fibrous ankylosis when the active infectious stage was slowly extinguished. In fact, conventional radiography is the preferred modalities in the evaluation of hip TB as plain films may be negative early stage of the disease.

Ultrasound findings may display the presence of joint effusions. It plays a vital role during the aspiration of these effusions for microbiological and histopathological examination and PCR. Yet in the diagnosis of hip TB, USG is not accurate.

CT scan is especially beneficial for determining the degree of bone destruction, sequestrum formation (although rare),

and surrounding soft tissue extension.

MRI is also preferred modality for early detection of hip TB. Synovial proliferation because of hip TB is typically hypointense on T2W images, which may be a very valuable indicator for differentiating hip TB from other proliferative synovial arthropathies [21, 22]. In agreement with *Suh et al.* [23], this comparatively low signal intensity may be due to the occurrence of haemorrhage, inflammatory debris, fibrosis, and caseation necrosis. After administration of intravenous gadolinium contrast, the thickened synovium improves vividly. Likewise, focal areas of normal-appearing chondral elements may be manifested. At a stage when the joint space is still well preserved, chondral lesions and subchondral bone erosions may become evident. Related bone marrow oedema, osteomyelitis and soft tissue anomalies such as myositis, cellulitis, para-articular abscess forming, tenosynovitis, bursitis and skin ulceration/sinus tract development may be visible [21]. Sinus tracts are defined by linear high signal intensity on T2W images with marginal 'tram-track enhancement' on gadolinium-enhanced images [24] Para-articular abscesses frequently display a thin and smooth enhancing wall [22]. The definite diagnosis of TB needs aspiration or synovial biopsy. Fig 11 showing X-ray and MRI findings of hip TB.

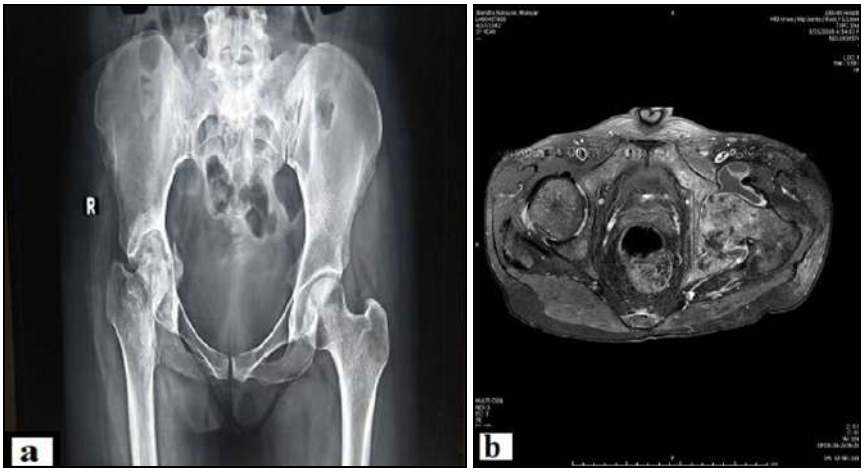

Fig 11: (a) X-ray findings: Asymmetric joint space narrowing is seen at the left hip with ill-defined osseous erosive changes at the articular surface. Focal osteopenia is noted. This is consistent with infective arthritis. The articulation at right hip and the right proximal femur show normal appearances. **(b)** MRI findings: Left hip joint reveals thickened, enhancing synovium with effusion, subarticular bony changes and irregularity of left femoral head suggestive of infective arthritis. Marked reduction of the left hip joint space is seen.

2.5.2 Pyogenic arthritis

Pyogenic arthritis is also termed as "Septic arthritis" a debilitating arthropathy caused by an intraarticular infection that is commonly associated with severe symptoms including, pain and reduced range of motion. The disease requires timely care to prevent permanent joint damage, which can lead to chronic deformation or mechanical arthritis. Its diagnosis is usually regarded as straightforward. Painful joints, fever, and purulent synovial fluid are the main clinical presentation. Usually, imaging plays an adjunct role to arthrocentesis in the diagnosis of joint sepsis. If synovial fluid cannot be retrieved, then radiologic studies become of paramount importance.

Plain radiographs may be normal in the very early stage of the disease. Seldom, joint effusion, juxta-articular osteoporosis due to hyperaemia, narrowing of the joint space due to cartilage destruction in the acute phase, destruction of the subchondral bone on both sides of a joint may be seen. When left untreated, reactive juxta-articular sclerosis and, in serious cases, ankylosis may develop.

Ultrasound is beneficial especially, in superficial joints and children. It mainly manifests joint effusion. Perhaps, echogenic debris and increased peri-synovial vascularity in colour doppler may be present. Moreover, it can be used to guide the joint aspiration.

The findings of CT are analogous to those found on radiographs. In the absence of trauma, a fat-fluid level may be a precise prognostic.

MRI is sensitive and more specific for early cartilaginous damage [25].

- **T1:** Low signal within the subchondral bone
- **T2:** Perisynovial oedema
- **C+ (Gd):** Synovial enhancement

2.5.3 Transient synovitis

Transient synovitis of the hip signifies to an acute inflammatory condition which is self-limiting and affects the synovial lining of the hip. It is regarded as one of the most prevalent causes of hip pain and limping in young children. About 90 per cent of children's hip joint effusions appear to be due to transient synovitis. The predominance of the male is recognized for this condition. Patients usually experience hip pain for one to three days associated with limping or a failure to bear weight.

In plain radiograph, features are nonspecific; however, occasionally increase in medial joint space in the affected hip is seen.

Ultrasound may be showing a joint effusion which is often viewed in the anterior recess. Herniation of the synovial membrane through a joint capsular defect (pseudodiverticulum) between the iliopsoas muscle and the anterior border of the joint capsule may be observed in a much small figure of patients (~2%).

MRI features includes symptomatic hip joint effusion, synovial enhancement, contralateral joint effusion, synovial thickening, signal alterations and enhancement in surrounding soft tissue, typically no signal alteration in the adjacent marrow [26].

2.5.4 Juvenile rheumatoid arthritis

Juvenile rheumatoid arthritis is the well-known chronic arthritic disease of childhood having an annual incidence of

~13 per 100,000. It usually starts before 16 years of age and females are affected twice time more than males. Clinically, patients having the acute onset of symptoms or more gradual onset. Symptoms frequently get worse in the morning but usually continue to some degrees throughout the day. In case of systemic-onset (also referred to Still disease), intermittent spiking fevers are primarily noted, which helps to distinguish juvenile rheumatoid arthritis from other conditions such as infection, other inflammatory diseases and malignancy. Migratory salmon-coloured light pink rash involving the trunk and/or extremities and hepatosplenomegaly may often be seen in this case. Serum rheumatoid factor is present in a higher number of cases. Imaging shows a varied spectrum of involvement, based on the severity and duration of the disease. There is usually a preference for large joints rather than small joints. Plain radiograph showing soft tissue swelling, osteopenia, loss of joint space, erosions, growth disturbances (epiphyseal overgrowth or "ballooning") and joint subluxation.
MRI reveals synovial hypertrophy, joint effusions and osseous and cartilaginous erosions. Active synovitis is defined by enhancement on T1-weighted gadolinium contrast studies [27].

2.5.5 Legg-Calve-Perthes disease
Legg-Calvé-Perthes disease (LCPD) is avascular necrosis (AVN) of the proximal femoral head results from the compromise of the tenuous blood supply to the region being affected. Its incidence is usually seen in children aged 4-10 years. The disease has an insidious onset, a unilateral presentation in the majority of cases and may occur after a hip injury. Both hips are involved rarely, and the joints are involved successively, not simultaneously. Limping, pain or stiffness in the hip, groin, thigh or knee and limited range of motion of the hip joint are the typical clinical presentation of this condition.
Initial radiographs can be normal, but radiographic changes can be classified into five different stages that represent a progression of the disease process, as mentioned below:

Stage 1: Cessation of femoral epiphyseal growth
Stage 2: Subchondral fracture
Stage 3: Resorption
Stage 4: Reossification
Stage 5: Healed or residual stage

Early radiographic changes may demonstrate only a nonspecific effusion of the joint associated with a slight widening of the joint space, metaphyseal demineralization (decreased bone density around the joint), and periarticular swelling (bulging capsule). This is the acute phase, and it may last 1-2 weeks. After a few weeks, decreasing bone density in and around the joint is observed. When the disease is progressing, the joint space between the ossified head and acetabulum widens as the necrotic ossification centre resembles denser than the surrounding structures. Narrowing or collapse of the femoral head allows it to look widened and flattened (coxa plana). Because of damage to the femoral head growth center and overgrowth of the greater trochanteric apophysis, a varus deformity of the femoral neck may happen. Ultimately, the disease may progress to collapse of the femoral head, rise in the width of the neck, and demineralization of the femoral head. The final shape of this area based on the extent of necrosis and the degree of collapse. Obtained findings are associated with the progression of the disease and the extent of the necrosis. This is the active phase, and it can last 12-40 months. A bone scan is advantageous to assess the site for avascular necrosis [28].

2.5.6 Osteomyelitis
Osteomyelitis applies to inflammation of bone that is usually caused due to infection by bacterial. This content mainly deals with pyogenic osteomyelitis, which may be acute or chronic. It can occur at any age, however, it is more prevalent between the ages of 2-12 years and highly predilection for males (M: F of 3:1). In some cases, radiographic characteristics are specific to a region or a particular type of infection, such as subperiosteal abscess, Brodie abscess, pott puffy tumour, sclerosing osteomyelitis of Garré.
In plain radiograph, adjacent soft tissues +/- muscle outlines with swelling and loss or blurring of normal fat planes are the earliest noticeable changes. Perhaps, effusion may be observed in an adjacent joint. Generally, osteomyelitis must extend at least 1 cm and compromise 30 to 50% of bone mineral content to produce remarkable changes on plain radiographs. Early observations may be subtle, and changes may not be evident until 5 to 7 days from the onset in children and 10 to 14 days in adults. Radiographs have been taken after this period show several changes as follows:

a) Regional osteopenia.
b) Periosteal reaction/thickening (periostitis): variable; may appear aggressive, including the formation of a Codman's triangle.
c) Focal bony lysis or cortical loss.
d) Endosteal scalloping.
e) Loss of bony trabecular architecture.
f) New bone apposition.
g) Eventual peripheral sclerosis.

In chronic or untreated cases, the eventual formation of a sequestrum, involucrum and/or cloaca may be noticeable. The CT features are mainly similar to plain films, though; CT is superior to both MRI and plain film in illustrating the bony margins and identifying a sequestrum or involucrum. The overall sensitivity and specificity of CT is low, even in the setting of chronic osteomyelitis. Some restrictions CT include:

a) Inability to assuredly identify marrow oedema; since a normal CT does not exclude early osteomyelitis.
b) Trace artifact deterioration in the picture when metallic implants are present.

MRI is the most sensitive and specific and is able to identify soft-tissue/joint complications. Bone marrow oedema is the earliest characteristic of acute osteomyelitis detected on MRI and can be identified as soon as 1 to 2 days after the onset of infection.

- **T1:** intermediate to low signal central component (fluid), surrounding bone marrow of lower signal than normal due to oedema and cortical bone destruction
- **T2:** bone marrow oedema and central high signal (fluid)
- **T1 C+:** post contrast enhancement of bone marrow, abscess margins, periosteum and adjacent soft tissue collections

Although ultrasound excels as a fast and inexpensive examination of the soft tissues and can guide the drainage of soft tissue collections, it has little role in the direct assessment of osteomyelitis, as it is unable to visualize within the bone. It does, however, have a role in the assessment of soft tissues and joints adjacent to infected bone, as it can be used to visualize soft tissue abscesses, cellulitis, subperiosteal collections, and joint effusion. Ultrasound is also helpful in the assessment of orthopaedic instrumentation's extraosseous elements, as it is not influenced by metal objects [29].

Several nuclear medicine techniques may be used to detect foci of osteomyelitis including bone scintigraphy (Tc-99m), indium-111 labelled WBC scintigraphy, Gallium-67 scintigraphy and PET-CT.

2.5.7 Osteoid osteomas

Osteoid osteomas are benign bone-forming tumours that usually found in children, adolescents, and young adults, between the ages of 10-35 years and there is a male predilection (M: F 2-4:1). Classically, patients present with nocturnal pain, soft tissue swelling and if close to a growth plate, accelerated growth may be evident, presumably related to hyperaemia. Keep in mind that the sclerosis is reactive and does not represent the lesion itself. The nidus usually has a diameter of <2cm and is typically ovoid. It may have a central region of mineralisation.

A plain radiograph may be normal or may manifest a solid periosteal reaction with a cortical thickening. The nidus is seldom appeared as a well-circumscribed lucent region, occasionally with a central sclerotic dot. It usually presents a focally lucent nidus within the underlying reactive sclerotic tissue. You may also see a central sclerotic point.

On ultrasound, focal cortical irregularity with adjacent hypoechoic synovitis may be visible at the site of intra-articular lesions. The nidus can reveal hypoechogenicity with posterior acoustic enhancement. Ultrasound may be able to recognise the nidus as a hypervascular nidus on Doppler examination.

Although MRI is sensitive, it is non-specific and is often inefficient to identify the nidus. The hyperaemia and resultant bone marrow oedema pattern may cause the scans to be misunderstood as representing aggressive pathology. The signal intensity of the nidus is variable on all sequences as is the degree of contrast enhancement.

Apart from this, skeletal scintigraphy will show typical focal uptake and at times will show a double density sign (also known as the less catchy hotter spot within hot area sign) which if present is highly specific and valuable in differentiating it from osteomyelitis. The central focus displaying intense uptake within a surrounding lower but nonetheless increased uptake rim.

2.5.8 Pigmented villonodular synovitis

Pigmented villonodular synovitis, also referred to diffuse tenosynovial giant cell tumor, is a benign proliferative disease of unknown etiology that affects synovial lined joints, bursae, and tendon sheaths. This condition leads to various degrees of villous and/or nodular changes in the affected structures.

On radiographs, features are comparatively nonspecific with features being predominantly those of joint effusion. Bone density and joint space are preserved until the late stages. Calcification is not observed. Extrinsic marginal pressure erosions may be present, but it is not possible to distinguish pigmented villonodular synovitis from synovial chondromatosis (non-ossified synovia osteochondromatosis). There may be the suggestion of focal areas of soft tissue swelling surrounding the joint +/- dense soft-tissues from haemosiderin deposition.

In CT findings, joint effusions commonly co-exist. The hypertrophic synovium looks like a soft tissue mass, which on account of haemosiderin, may appear slightly hyperdense compared to adjacent muscle. Calcification is very rare in the synovial mass. Erosions are usually well-observed on CT scan.

MRI typically shows mass-like synovial proliferation with lobulated margins. This may be extensive in the diffuse form or limited to a well-defined single nodule in the localised form with low signal intensity due to haemosiderin deposition.

Signal characteristics include:

- **T1:** Low to the intermediate signal
- **T1 C+ (Gd):** Variable enhancement
- **T2**: Low to the intermediate signal and some areas of the high signal may be present likely due to joint fluid or the inflamed synovium

STIR: predominantly high signal
GE: low and may demonstrate blooming

3. Conclusions

Authors recommended that in the endemic regions for TB, a clinical diagnosis supported by radiographs is good enough for starting the treatment. Imaging modalities like radiograph, USG, CT Scan and MRI is of the paramount essential diagnostic tool. Interestingly, clinical features supported by radio imaging features have been emerging in the new era. With typical radiological findings, several diseases which mimicking hip TB can be distinguished undoubtedly and also support clinicians to make an accurate diagnosis.

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