Musculoskeletal Tuberculosis in Children

### Spinal Tuberculosis

#### 1. Burden of Disease

According to WHO, November 2010, one third of the world's population is infected with the TB bacillus. The incidence of new TB cases in 2009 was 9.4 million with 14 million prevalent cases, most of which occurred in the South-East Asia region. An estimated 1.7 million people died from TB in 2009.
Pathogenesis

The tubercle bacilli tend to lodge in highly vascular areas such as the spine. Vascularity, coupled with the scarcity of phagocytic cells in this area; make it a favourable environment for tuberculosis (4). Although uncommon at one point, pediatric spinal tuberculosis is seen frequently in out-patient pediatric and spinal clinics. The infection reaches the skeletal system through vascular channels, generally the arteries, as a result of bacillemia, or rarely in the axial skeleton through Batson's plexus of veins. Simultaneous involvement of the paravertebral part of two contiguous vertebrae in a typical tuberculous lesion of the spine lends support to the insemination of bacilli through a common blood supply to this region. However, the commoner modes of presentation include:

1. The "central type" of vertebral body disease and "skipped lesions" in the vertebral column is usually due to the spread of infection along Batson's plexus of veins.

2. Typical "paradiscal" lesions are considered to be caused by the spread of disease via the arteries

3. The "anterior type" of involvement of the vertebral bodies seems to be due to the extension of an abscess beneath the anterior longitudinal ligament and the periosteum, stripping the periosteum from the front and sides of the vertebral bodies. This results in the loss of the periosteal blood supply and destruction of the anterolateral surface of many contiguous vertebral bodies (5).

Two types of bone and joint tuberculosis are recognized: the "caseous exudative" type, which is characterized by more destruction, exudation, and abscess formation, and the "granular" type, which is less destructive, having dry lesions and abscess formation being rare. In clinical practice both types coexist, one predominating the other. Lesions in children are generally of the "caseous exudative type" (5).

Clinical Presentation

The most common mode of presentation in a child less than 2 years is development of a gibbus, which usually draws the attention of the parents towards a spinal problem. Often, the constant crying of the baby is regarded and treated as "colic". The child may present with inability to sit and preference for lying down, something which is usually unheard of in an active child. The usual symptoms of anorexia or fever may or may not be always present. Most would typically present to a pediatrician first, and then to the orthopaedic consultant.

Under the age of four, backache in children should be regarded as pathological unless and until proved otherwise. Although nonspecific musculoskeletal pain is considered as the most frequent cause, any back pain in a child needs to be assessed and investigated. One of the earliest signs of spinal vertebral infection is backache. Most patients usually have a mechanical component to their back pain, and find sitting for prolonged periods quite painful, and are relieved on lying down. They may not have developed a gibbus as yet, but routine radiographs may show early signs of vertebral infection. In countries where tuberculosis is rampant, more than 80% of patients with spinal involvement have some sort of detectable kyphosis at the time of presentation (6).

Some patients who have taken treatment for spinal tuberculosis in childhood, may present with deformed spines in their adolescence. The major problem of pediatric spinal tuberculosis is the development of deformity. Tuberculosis causes vertebral body destruction and tends to involve the cartilaginous end-plates. The affliction of the growth plate along with destruction of the anterior portion of the pediatric spine leads to a kyphosis. This deformity is further complicated by an imbalance in the growth patterns, with the posterior growth centres continuing to grow, and the anterior centres not growing.

Figure 1
Predicting Spinal Deformity in Childhood Spinal Tuberculosis

Rajasekaran observed continued progression of the deformity during the quiescent phase until the growth was complete in 40% of his patients, while 43% had spontaneous improvement and 17% showed no change. The progression of deformity was either of an angular kyphosis or by a buckling collapse.

The status of the posterior column and the type of stabilisation undertaken were the main factors determining deformity. The vertebrae can restabilise when there is a large contact area on the distal vertebrae (type-A restabilisation), usually seen when the vertebral body is partially destroyed or in the lumbar region. When vertebral destruction is severe, with marked loss of vertebral height, and the patient already has a moderate kyphosis, one or both facets may subluxate or dislocate, with the proximal vertebra stabilising with point contact on the distal (type-B restabilisation). The compressive force produces suppression of growth resulting in a deformity of between 40 and 60 degrees. The remaining part of the vertebral body may grow as a wedge.

Type-C restabilisation occurs when there is severe destruction of the anterior column. The dislocation of both facets leads to a buckling collapse. The proximal vertebral body may rotate through 90 with its anterior border resting on the distal vertebra. The horizontal vertebrae are spared gravitational forces and hence grow longer, adding to the kyphosis. Buckling collapse is likely to occur in children younger than seven years of age with three or more vertebral bodies affected in the dorsal or dorsolumbar spine.

According to Rajasekaran children at risk of late progressive deformity can be identified early by the presence of “spine-at risk” radiologic signs as illustrated in figure 2.
Prognosis also depends upon location of the lesion: Those with dorsal lesions have maximal deformity at the time of presentation, partly due to the additive effect of the normal thoracic kyphosis. However, the rib cage offers protection against additional collapse\(^7\). Patients with dorsolumbar lesions have the worst prognosis as they tend to collapse more during the active phase of the disease and even more during the growth period\(^7\). Those with lumbar lesions have the best prognosis with the least deformity at presentation, a lesser increase during the active phase, and also a tendency for substantial decrease during the growth period\(^7\).

**Investigations**

**HEMATOLOGICAL** - The erythrocyte sedimentation rate is usually elevated but is neither specific nor reliable in the diagnosis of spinal tuberculosis. Usually a generalized lymphocytosis tilts the balance in favour of a tuberculous diagnosis. The enzyme-linked immunosorbent assay (ELISA) has a reported sensitivity of 74% with extrapulmonary tuberculosis and a very high sensitivity of 96%, against the mycobacterial antigen A60\(^{10}\). Stroebel et al have reported a sensitivity of 94 per cent and a specificity of 100 per cent for osteoarticular tuberculosis by ELISA using antibody to mycobacterial antigen\(^6\). The polymerase chain reaction is being tested for the diagnosis but is currently not available in all clinical settings. A brucella complement fixation test may be useful in endemic areas as brucella can clinically mimic tuberculosis.

**SKIN TESTS** - A positive Mantoux test can be observed, one to 3 months after infection. A previously vaccinated child may show positivity with the Mantoux test for up to 5 years\(^{12}\). The test may be negative in almost 20 per cent patients with active disease if the disease is disseminated, or if the patient is immunocompromised or suffering from exanthematous fevers. Co-existent infection by human immunodeficiency virus may also give a false negative skin test\(^{12}\).

**Imaging**

Radiographs are difficult to interpret owing to the small size of the vertebral body in the very young patient, however, in the juvenile and adolescents, sufficient bony destruction must have happened to be visible on the X-ray. Also, the deformity if it has developed, needs to be measured and documented for future reference.

Where MRI is available it has become a valuable adjunct to plain radiographs. Although the MRI cannot differentiate between pyogenic or tuberculous infection\(^{13}\), certain characteristics are quite unique; and in conjunction with a high index of suspicion, in an endemic country like India, an MRI diagnosis of “most likely tuberculous in origin”, can be made safely.

The MRI characteristics of vertebral body tuberculosis have been extensively reported. The thoracic spine is most commonly affected; the radiological features include bone marrow oedema and enhancement, posterior element involvement, canal stenosis, and spinal cord or nerve root compression\(^{14}\). Inter-vertebral disc enhancement, vertebral collapse and kyphosis deformity are particularly suggestive of tuberculosis\(^{15}\). Vertebral intrasosseous abscesses, disc abscesses, abnormal para-spinal signal intensity, and involvement of multiple vertebral bodies are common in tuberculosis but rare in pyogenic bacterial disease\(^{16,17}\). Brucellar spondylitis cannot be distinguished radiologically from tuberculosis\(^{18}\).

**Management**

The management usually depends upon the time of presentation of the child. It may present in the acute situation or may present late with healed kyphotic deformity.

**Active Uncomplicated Kochs Spine**

If the child presents with the active lesion, early enough, it may be manageable with only chemotherapy and brace or cast. Standard four drug anti-
tuberculous therapy is usually administered, with isoniazid, rifampicin, ethambutol and pyrazinamide.

Non-compressive lesions with paradiscal involvement without significant collapse may be amenable to casting or bracing in conjunction with chemotherapy. Some degree of kyphosis is bound to occur with this method, as healing usually occurs following bone to bone contact and fusion between the adjacent vertebral end-plates. A whole body cast including the thoracic and lumbar spine, extending up to the pelvis is usually provided. The adolescent may be fitted with a removable plastic thoracic brace, for a variable period ranging from 3-9 months. If the cervical spine is involved, a Minerva cast or halo-jacket apparatus may be needed. The use of flimsy four post collars and SOMI brace is mentioned only to be condemned, as they do not produce adequate immobilisation, and provide a false sense of security to the patient and physician alike.

**Active Disease with Abscess or Neurological Compromise**

Sometimes the child may present with a huge epidural or anterior abscess with destruction of the vertebral body, with associated kyphosis. In this situation, decision may be needed to undertake a radical debridement along with reconstruction of the vertebral column. Whenever it can be predicted with reasonable certainty that further growth in the pediatric patient will result in a kyphotic deformity owing to the destruction of one or more vertebral bodies, surgery is indicated (19). In such situations, the four signs of "spine at risk" by Rajasekaran may also be utilised to arrive at a surgical decision (9). Rajasekaran followed 63 children with tuberculosis and kyphosis for fifteen years and documented the outcome of the kyphosis. Among 37 children with two or fewer at risk signs, 34 had a decrease in the initial kyphosis over time, and none progressed more than ten degrees. Among 26 children with three or more at risk signs, 20 progressed by more than 10 degrees of whom seven progressed more than 30.

The major problem of undertaking radical debridement in children is reconstruction of the large defect with bone graft. Overall, in most cases, owing to the greater length and strength of bone graft required, fibula is chosen over iliac crest or rib. Instances have been reported when the entire thoracic spine was involved and the spinal reconstruction had to be done from T2 to T12 with a fibular graft (12). Despite adequate positioning of the fibular graft into the slot in to a normal healthy vertebral body, graft slippage rate is high, especially when more than two vertebral bodies need to be spanned.

![Figure 3](image.png)

Most authors agree that posterior spinal fusion is indicated to prevent late development of kyphotic deformity. Controversy exists regarding the timing of posterior fusion in these patients. One group of authors recommends undertaking posterior surgery within 3 months of the anterior surgery to assist anterior fibular graft during its weakest phase (20). However, another group of authors prefers to wait and observe the child periodically over time and if, there is evidence of increasing kyphotic deformity, a posterior spinal fusion is undertaken. However, this may be too late and predictive recommendations as observed by Rajasekaran need to be considered in pediatric spinal tuberculosis patients. According to him, children younger than seven years of age, with three or more affected vertebral bodies in the dorsal or dorsolumbar spine and two or more 'at-risk signs', are likely to have progression of the kyphosis with growth and should undergo correction (7-9)

**Use of Instrumentation in Spinal Tuberculosis**
The additional use of instrumentation in the pediatric spine, over and above a fusion merits a discussion as well. Although traditional teaching was against the use of metal in presence of infection, the advent of newer anti-tuberculous drugs allows the safe use of instrumentation in the spine. The indications for instrumented stabilization include i) panvertebral disease or ii) long segment disease, requiring a bone graft length greater than two vertebral bodies (21) or iii) when kyphosis correction is contemplated (21-23).

One of the earliest instrumentation systems to be used for Koch's spine included the Hartshill rectangle. This is similar to a Luque rod but constructed as a strong continuous rectangle, and attached to the spine with sublaminar wires posteriorly. Excellent results have been reported in case series of over 30 children with this cost-effective implant (19). The use of more sophisticated equipment like the pedicle screw system in patients with tuberculosis of the spine is becoming popular in countries such as India where tuberculosis remains common and access to spinal instrumentation systems is increasing. The major problem of pedicle screw systems is the nonavailability of low profile systems, in a smaller diameter range, which tends to lead to skin breakdown issues in the pediatric patient population. However, it does provide the benefit of early ambulation and rehabilitation of the patient, in addition to the safety of the graft.

**Surgery in Healed Post-Tubercular Kyphotic Deformity**

Almost 40% of children with tuberculosis of the spine tend to progress and eventually develop a kyphotic deformity (7). Depending upon the extent of the disease, the vertebral stabilisation occurs and kyphosis of varying degrees tends to develop. An internal gibbus also develops which tends to cause late onset paraplegia if kyphosis is allowed to progress. Surgery in healed tuberculosis with kyphotic deformity usually involves spinal osteotomy with corpectomy along with anterior and posterior reconstruction being performed in two stages (24). However, single stage, only posterior surgeries, wherein a pedicle subtraction osteotomy or spondylectomy is carried out have been developed recently. These operations are technically quite challenging (25,26). The basic concept is to shorten the posterior column so as to correct the deformity and achieve bone to bone contact for fusion. Single stage closing opening wedge osteotomy has been described by Rajasekaran for the simultaneous correction of the deformed spine of high magnitude (118 degrees of kyphosis) (27). Such extensive surgeries require meticulous planning and experience for appropriate execution, and should not be attempted by the average orthopedic surgeon.

**Conclusion**

If spinal tuberculosis is treated appropriately and early, grotesque deformities can be prevented from occurring. Most children may be managed with low risk surgeries. Management of pediatric spinal tuberculosis should be a team effort between the pediatrician, the orthopedic surgeon as well as the spine surgeon, as the case may be, to achieve the most optimum result.

**Extraspinal osteoarticular tuberculosis in children**

**Epidemiology, Prevalence, and Regional Distribution**

At present there are nearly 30 million people suffering from active tuberculosis worldwide, and of these 1% - 3% have involvement of the skeletal system. About 1/3 of children with tuberculosis will have extrapulmonary infection (28). Tuberculosis will exist for as long as there are pockets of malnutrition, poor sanitation, overcrowding and immune compromised populations. Although the rates of infection and death from tuberculosis are falling, in 2009 there were 1.7 million deaths and 9.4 million new cases of tuberculosis according to the World Health Organization (1).

Vertebral tuberculosis is the most common form of skeletal tuberculosis, accounting for 50% of all cases in reported series. Approximate distribution in the skeleton are spine (50%), hip (20%), knee (10%), ankle and foot (5%), hand and wrist (3%), elbow (2%), shoulder (1%), bursal sheaths and other bones (8%) (28).

**Pathology and Pathogenesis**

An osteo-articular tubercular lesion results from hematogenous dissemination from a primarily infected focus that may be active or quiescent, and in the lungs, lymph glands, or other visceria. The infection reaches the skeleton through vascular channels, generally the arteries, as a result of bacteremia or, rarely, in the axial skeleton though Batson’s plexus of veins. If whole body screening could be done in all patients, 40% of them would show an additional active, clinical or subclinical, lesion in viscera, lymph nodes or other parts of skeletal system. Development of clinical tuberculosis of the skeletal system is a reflection of weakened immune status of the host.

**Osteoarticular Disease:**

Tubercular bacilli reach the joint space via the blood stream through subsynovial vessels, or indirectly from epiphyseal lesions that erode into the joint space. Destruction of the articular cartilage begins peripherally. Since the weight bearing surfaces are preserved for a few months, there is potential for good functional recovery with effective treatment.

The disease may start in bone or in the synovial membrane, but the one rapidly infects the other. The initial focus starts in the metaphysis in childhood or at the end of the bone in adults. The osseous areas of predilection for hip disease are shown in the figure. (Figure -1)
Cartilage and accumulations of fibrinous material in the synovial fluid may produce the rice bodies found in synovial joints, tendon sheaths, and bursae.

Articular cartilage, granulation tissue forms a pannus that erodes the margins and surface of the joint. Flakes or loose sheets of necrotic articular tissue may be separated by the ingrowth of tuberculous granulation tissue produces kissing lesions or sequestra on either side of the joint.

Where articular surfaces are in contact, the cartilage is preserved for a long time because the spread of pannus is retarded. Necrosis of subchondral bone occurs. The granulation tissue from the synovium extends over the bone at the synovial reflections, producing erosions. At the periphery of articular surfaces in contact, the cartilage is preserved for a long time because the spread of pannus is retarded. Necrosis of subchondral bone may not occur. Where articular surfaces are in contact, the cartilage is preserved for a long time because the spread of pannus is retarded. Necrosis of subchondral bone may not occur. Where articular surfaces are in contact, the cartilage may be completely walled off and the caseous tissue may calcify, persist as a low-grade chronic fibromatous granulating and caseating lesion or may spread locally by contiguity and systematically by blood stream.

Cold Abscess

A marked, exudative reaction is common in tuberculous infection of the skeletal system. A cold abscess is formed by the products of liquefaction and the reactive exudation. It is composed of serum, leucocytes, caseous material, bone debris, and tubercle bacilli. The abscess penetrates the periosteum and ligaments, and migrates or gravitates in various directions, following fascial planes and the sheaths of vessels and nerves. The cold abscess feels warm, although the temperature is not increased to the same extent as in acute pyogenic infections. A superficial abscess may burst to form a sinus or an ulcer lined with tuberculous granulation tissue. On aspiration, the contents of the cold abscess range from serous fluid to thick, purulent pus.

Osseous changes and tubercular sequestra:

Following the infection, marked hyperemia and severe osteoporosis take place. The softened bone easily yields under the effect of gravity and muscle action, leading to compression, collapse, or deformation. Necrosis may also be caused by ischemic infarction of segments of bone. Sequestration gives the appearance of coarse sand and rarely produces a radiologically visible sequestrum. Because of loss of nutrition, the adjacent articular cartilage may become separated as sequestra. Some of the radiologically visible sequestra in tuberculous cavities may result from calcification of the caseous matter.

Prognosis

Before the availability of anti-tubercular drugs, the 5 year follow-up mortality of patients with osteo-articular tuberculosis was about 30%. Presently available antitubercular drugs have changed the outlook, the mortality is very low now. Depending upon the sensitivity pattern, the host immunity and the stage of the lesion at the inception of treatment, the tuberculous lesion may resolve completely, heal with residual deformity and loss of function, be completely walled off and the caseous tissue may calcify, persist as a low-grade chronic fibromatous granulating and caseating lesion or may spread locally by contiguity and systematically by blood stream.

Campbell and Hoffman reported on the outcome of 74 tuberculous hip joints among 73 children treated in South Africa between the 1950s and the 1990s. They found that the prognosis for hip function was 93% good or excellent if the hip had normal anatomy (i.e. in joint and without bony destruction) at presentation. By contrast, a dislocated joint with a narrow joint space after reduction, or an atrophic femoral head and neck due to bony destruction, conferred a poor prognosis for the joint (29).

Clinical Presentation:

Skeletal tuberculosis occurs primarily during the first three decades of life. The characteristics are insidious onset, monoarticular or single bone involvement, and the constitutional symptoms of low-grade fever, lassitude (especially in the afternoon), anorexia, loss of weight, night sweats, tachycardia, and anemia. Local symptoms and signs are pain, night cries, painful limitation of movements, muscle wasting, and regional lymph-node enlargement. In the acute stage, protective muscle spasm is severe. During sleep, the muscle spasm relaxes and permits movement between the inflamed surfaces, resulting in pain and the typical night cries.

Despite the list of symptoms and signs it is not uncommon for the patient to present only with local joint symptomatology. Children can look physically well except for the involved joint.

Diagnosis:
In developing countries the diagnosis of tuberculosis of bones and joints can be made reliably on clinical and radiological examination. It is ideal to have positive proof of the disease by semi-invasive or invasive investigations. Skeletal tuberculosis must be included in the differential diagnosis of chronic or subacute mono-articular arthritis, chronic abscess, a draining sinus or chronic osteomyelitis. It is important to remember that tuberculosis can mimic any disease, and any pathology can mimic tuberculosis on clinical features and on imaging modalities.

**Imaging Findings**

Localized osteoporosis is the first radiological sign of active disease. The articular margins and bony cortices become hazy and there may be areas of trabecular destruction and osteolysis. The synovial fluid, thickened synovium, capsule, and pericapsular tissues produce soft-tissue swelling, and the joint space narrows. As the destructive process advances, bone architecture collapse and joints deform or displace. The epiphyseal growth plate may be destroyed, producing altered growth, angulation, or premature fusion. With healing of the disease process there is remineralization, reappearance of bone trabecula, and sharpening of cortical and articular margins.

In the center of a tuberculous cavity there may be a sequestrum of cancellous bone or calcification of the caseous tissue giving the appearance of an irregular, feathery nidus in a cavity.

If secondary infection supervenes, subperiosteal new bone formation can be seen along the involved bones. Plaques of irregular (dystrophic) calcification in the wall of a chronic abscess or sinus are almost diagnostic of long-standing tuberculous infection.

Computed axial tomography (CT) and magnetic resonance imagining (MRI) demonstrate the localization and extent of bone and soft-tissue lesions, and improve suspicion of the disease at a very early stage (3-6 weeks).

MRI scanning in the earliest stages reveals inflammation and not infection, just as radiosotope scintigraphy may show a hot area during the active stage of the disease. However these are neither specific, nor does it differentiate between the osseous and softtissue pathology. The feathery tubercular sequestra and dystrophic calcification are discernible on CT scans, but cannot be seen on MRI.

**Blood:**

A relative lymphocytosis, low hemoglobin, and increased erythrocyte sedimentation rate (ESR) are typically found in the active stage of disease. A raised ESR, however, is not necessarily proof of activity of the infection. Its repeated estimation at monthly intervals gives a valuable index of the activity of the disease. In counties where tuberculosis is endemic the serological test which has been found to be useful is polymerase chain reaction for tuberculosis (PCR). A positive PCR confirms the diagnosis of tuberculosis if the tested material was obtained from a clinically inflamed area. A negative PCR however does not exclude tuberculosis.

**Biopsy:**

Biopsy is the only certain method which can be used to confirm the diagnosis. Any pathological material obtained from joint, bone, or lymph nodes, should be submitted for histology, microbiology and for PCR for tuberculosis. However even on histology the changes may be non-specific: in some studies the results of biopsy reveal chronic, non-specific inflammation in 50% of cases. All attempts however must be made to confirm the diagnosis before empirically initiating antitubercular drugs.

Whenever there is doubt (particularly in the early stages), it is best to prove the diagnosis of tuberculosis by biopsy of the diseased tissue (granulations, synovium, bone, lymph nodes, of the margins of tuberculous ulcers or sinuses). Microscopic examination of material from the aspirate, core biopsy, needle biopsy, or open biopsy will reveal typical tubercles in untreated cases. The presence of epithelioid cells surrounded by lymphocytes, even without central necrosis or peripheral foreign-body giant cells, is adequate histological evidence of tuberculous pathology in a patient who is suspected to be suffering from the disease. At the time of open biopsy of a joint or bone, the orthopedic surgeon should perform therapeutic synovectomy or curettage. The infections of bone and joint that present as granulomatous lesions are, in order of frequency: tuberculosis, mycotic infection, brucellosis, sarcoidosis, and tuberculosis leprosy. Guinea pig inoculation is perhaps the most reliable proof of tuberculous pathology, however it is no longer considered cost-effective.

**Management of Osteoarticular Tuberculosis**

**General principles:**

Drug treatment is the mainstay of tuberculosis therapy. Treatment requires multiple drugs, for a prolonged period, and should be given in the context of directly observed therapy (DOTS) in order to be effective for the individual, and to reduce the risk of drug resistance in the community. One drug needs to be bactericidal. In children the usual combination recommended is isoniazid and rifampin for at least six months, with pyrazinamide for the first two months. This regimen is successful in 95% of children with tuberculosis. Details of dosing including special circumstances such as drug resistance and HIV infection are found at the Centres for Disease Control website at [http://www.cdc.gov/tb/publications/guidelines/Treatment.htm](http://www.cdc.gov/tb/publications/guidelines/Treatment.htm). These guidelines are regularly updated. At present only 3.3% of tuberculosis is multiple drug resistant, and this difficult form is much more likely to be encountered in countries of the former Soviet Union than in Africa (1).

With the use of modern drugs, the indications for surgery have become universally more selective and directed towards the prevention and correction of deformities and the improvement in function of the diseased joints. At the stage of tuberculous arthritis, if the disease remains closed, the natural outcome is generally a fibrous ankylosis. If an abscess discharges and sinuses develop, the outcome may be a bony ankylosis. The prognosis in articular tuberculosis depends upon the stage of the disease when the specific treatment is started (Table-1). Concomitant disease must be treated. Associated pulmonary involvement is important to recognize. Admission to hospital is necessary only for complications or for those requiring traction under supervision to correct deformities.

**The Functional Treatment of Articular Tuberculosis: (Rest, mobilization, and bracing)**
In the active stage of disease, the joints are rested in the position of function by means of removable splints. Prolonged immobilization may lead to spontaneous ankylosis, especially when large joints are destroyed. Patients with early disease are allowed one-hourly intermittent guarded active and assisted exercises under antitubercular drug cover, with the aim of retaining a useful range of movement in the functional arc of the involved joint. Traction helps to correct deformity and to rest the diseased part. Gradual mobilization is encouraged, with the help of suitable braces, approximately 3 months after the start of treatment, while the healing is progressing (30).

As the disease heals and pain subsides, weight-bearing and activity are encouraged. If symptoms and signs of activity increase the patient goes back a stage. If there is steady progress, activity is increased within the limits of comfort. Bracing is gradually discarded after about 2 years although in most cases this period is much shorter. Aspiration is the method of choice for large collections. Open drainage of an abscess is indicated if the collection is significant and aspiration fails. It is customary to instill streptomycin + isoniazid after aspiration; however it is not essential because antitubercular drugs easily penetrate the tuberculous lesions after systemic therapy. The large majority of ulcers and sinuses heal within 6-12 weeks under the influence of systemic anti-tuberculous drugs. The full course of treatment is still necessary. Fewer than 1% of sinuses require longer treatment and excision of the tract, with or without debridement. Sinus ramification is always greater than can be appreciated, and complete surgical excision is therefore impracticable.

Final end Result: The expected outcome patients with advanced disease on diagnosis depends upon he stage at which the treatment was started (Table-1). For many joints in the ultimate outcome will be an ankylosis the position of function.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Clinical</th>
<th>Radiology</th>
<th>Usual effective treatment</th>
<th>Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Synovitis</td>
<td>Movement present(&gt;75%)</td>
<td>Soft-tissue swelling osteoporosis</td>
<td>Chemotherapy and movement Rarely synovectomy</td>
<td>Full mobility</td>
</tr>
<tr>
<td>II Early arthritis</td>
<td>Movement present</td>
<td>In addition to, moderate diminution of joint space and marginal erosion</td>
<td>Chemotherapy and movement Rarely synovectomy or debridement</td>
<td>Restoration of 50 to 75 % motion</td>
</tr>
<tr>
<td>III Advanced arthritis</td>
<td>Loss of movement (&lt;75%) in all directions</td>
<td>In addition to II, marked diminution of joint space and destruction of joint surfaces</td>
<td>Chemotherapy, rarely joint debridement</td>
<td>Ankylosis</td>
</tr>
<tr>
<td>IV Advanced arthritis with pathological disociaction/ subluxation</td>
<td>Loss of movement (&gt;75%) in all directions</td>
<td>In addition to III, joint is Disorganized with disociaction, subluxation</td>
<td>Chemotherapy, rarely joint debridement</td>
<td>Ankylosis</td>
</tr>
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* After completion of skeletal growth, elbow and hip arthritis may be treated by excision arthroplasty.

The commonly used drugs and dosages have been summarized in table. 2 The doses and drugs are worked out on the bases of age and weight of patients and any drug reaction. The duration of therapy must last for 12 to 18 months.
Anti-tubercular drugs are the most important therapeutic measure in osteo-articular tuberculosis, speeding recovery and minimizing the incidence of complications, recrudescence, and death. Patients with early disease, sensitive organisms, and a favorable pathological lesion (absence of large cavitations, pathological dislocation, ischemic tissue, and infarcted bone) achieve full clinical healing without recourse to surgery. Osseous tubercular lesions are slower to heal than synovial lesions.

After prolonged antitubercular therapy the histological appearance ceases to be characteristic. The epithelioid cells become less compact and the tubercle is unrecognizable, because both the epithelioid cells and lymphocytes are widely scattered. Central caseation may disappear, but fibrosis remains a significant feature in advanced tuberculous disease.

**Surgery in Tuberculosis of Bones and Joints**

Surgery is never a substitute for a correct course of anti-tubercular drugs. A trial of conservative treatment is usually adequate in pure synovial tuberculosis, low-grade or early arthritis of any joint, and even advanced (Table 1-2 stage III or IV) arthritis, especially in the upper extremity. Surgery should be considered only when the general condition of the patient has been stabilized by drug treatment, before the development of drug resistance. In general, a minimum of 1-4 weeks of drug therapy is advisable before any major surgical intervention.

**Extent and Type of Surgery**

Fusion of a major joint (except in the spine) is seldom indicated as primary treatment during childhood. Juxta-articular osteotomy, soft-tissue release, synovectomy, and debridement should produce mobile, stable joints. If a juxta-articular osseous focus is threatening the joint despite adequate antitubercular drugs, excisional surgery of the focus should be performed. Non-responsive cases of tubercular synovitis and early arthritis respond to subtotal synovectomy and synovectomy combined with joint debridement, respectively. At any stage of the disease, if a lesion is proving resistant or the diagnosis is in doubt, operation is mandatory. Debridement should be limited to infected synovium, sequestra, cavities of pus, and sinuses. Repetitive active and assisted movements of the joint should preserve a functional arc of movement after the operation.

In advanced arthritis (Of hip, knee, ankle, wrist and elbow) with pathological dislocation the best position of function is achieved by traction with periodic corrective plaster or by operative repositioning of the joint. Once the best position of function is achieved the joint is splinted for 3 to 6 months with intermittent active exercises.

In advanced arthritis of the knee, ankle, wrist, hip: and elbow, the position of function is achieved by operative debridement followed by splinting for 3-6 months. If the disease has healed leaving a painless range of movement (20 degrees or more) in an unacceptable position, a juxta-articular osteotomy may be performed to yield the best functional arc. Osteotomy may also be indicated to correct varus or valgus deformity particularly in the hip or knee. If the growth plates of the involved joint are open, surgical arthrodesis should be deferred until the child is older than 12 years.

Pathological fractures are rare among children with tuberculosis, but can be treated by standard techniques, including operation or internal fixation if necessary, as long as medical treatment is also used (28).
Summary

Many children with tuberculosis will present with musculoskeletal disease. The most common site of involvement is the spine. Typical radiographic patterns of bony involvement aid in the diagnosis of tuberculosis, but radiographs alone are never diagnostic. The most important aspect of treatment is a correct course of antitubercular drugs. Indications for operation on the spine include unstable or progressive kyphosis and/or neurological compromise in the presence of adequate medical therapy. Tuberculosis of the appendicular skeleton is often adequately managed by drugs, physical therapy, and splinting to maintain a position of function and an adequate arc of motion of the joint. Synovectomy, osteotomy, or arthrodesis are sometimes indicated as an adjunct to drug treatment of tuberculosis in the appendicular skeleton.

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