Tuberculosis of the Skeletal System
(Bones, Joints, Spine and Bursal Sheaths)

FIFTH EDITION

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Foreword
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The Health Sciences Publisher
New Delhi | London | Philadelphia | Panama
Dedicated with gratitudes to

Shanti Tuli and Ram Lal Tuli my Parents;
Prof KS Grewal, Prof PK Duraiswami and Prof Balu Sankaran my teachers;
and a large number of my stimulating students, and my ungrudging patients,
who provided me the opportunities to study and enjoy
the Science and Art of Medicine
Foreword to the Fifth Edition

It is a privilege to write the foreword for the fifth edition of this book, which carries the experience and wisdom of one of the most gifted clinicians, a great teacher and a brilliant academician of our times.

Tuberculosis is an ancient disease but unfortunately is still not a disease of the past. By even a conservative estimate, there are more than 3 million people with active bone and joint tuberculosis in the world today. The problems of multidrug resistance, co-infection with HIV along with increased global travel have unfortunately helped to increase the incidence of this disease worldwide. Compared to yesteryears, the clinical picture of the disease has changed a lot with many atypical forms and presentations of the disease. Similarly, advances have occurred and new knowledge has been added in the fields of diagnosis, imaging studies, drug therapy and surgical techniques. There is no doubt that a textbook dedicated to osteoarticular tuberculosis providing safe guidelines in management is the need of the hour.

The fifth edition of this already hugely popular book will thus fill-in a timely need for a comprehensive and latest update on the changing profile of the disease and the advances that have occurred in the treatment of this disease. Prof Tuli has been involved in the management of this disease over the last 50 years and has authoritative experience. His proposal of ‘Middle path regime’ was one of the landmarks in the management of spinal tuberculosis. His professional experience has covered the various advances in tuberculosis management for the past many decades and the book, no doubt, will carry the best of wisdom from personal experience and also the summary of current trends.

This edition is carefully structured to provide a complete coverage of all relevant knowledge on the subject. It includes all necessary details but is also sufficiently concise to provide easy readability. It contains material that is required both for the surgeons in training and for the practicing orthopedic surgeons, and hence will find a useful place on the desk of one and all. I pray for the Almighty’s Grace that we have Prof Tuli to write many more editions of this wonderful monogram.

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Foreword to the Second Edition

The resurgence of tuberculosis as a global phenomenon makes the present book very topical. The recognition of AIDS as a major public health problem, its association with tuberculosis, and drug-resistant forms of tuberculosis pose a renewed challenge to the management of all tubercular lesions including those of the skeletal system. Widespread and often indiscriminate use of antibacterial drugs, some of whom have antitubercular activity plus the changing virulence of the ubiquitous *Mycobacterium tuberculosis*, has lead to a subtle alteration in clinicoradiological presentation. The newer diagnostic modalities, i.e. CT and MRI have clarified some of these diagnostic dilemmas. However, it has also created a few problems with the myriad patterns in partly or fully treated cases. Other chronic infections mimicking tuberculosis are also posing newer problems in the diagnosis and management.

This new edition of Prof Tuli’s book is most timely as we stand at the crossroads of changing disease spectrum and improved diagnostic capability. Health economics in the management of such a chronic disorder which often results in enforced nonemployment needs emphasis.

Prof Tuli’s scholarship and long experience with these lesions has been focussed in this book, which I am sure would be of great benefit to not only orthopedic surgeons but also neurosurgeons, neurophysicians and other clinicians.

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Foreword to the First Edition

It is a pleasure to write this foreword to Dr SM Tuli’s book *Tuberculosis of the Skeletal System*. It has a great deal of relevance to orthopedic surgeons in developing countries. Since many cases are missed in their early stages, particularly in adults when manifestations of the disease are masked by other problems of aging, it is important for all the physicians to be aware of the early clinicoradiological features.

With the spread of acquired immune deficiency syndrome to all the countries of the globe in some measure or other, there is every likelihood of the problem again cropping up in developed countries as well. This book is, therefore, timely. With the vast experience of the lifetime that Dr Tuli has had in the field, particularly in clinical diagnosis, operative and conservative management, it would be a reference book in the many libraries of the world. Dr Tuli has been an enthusiastic teacher and his talents as a writer have provided him with the tools required for clear message for the needs of busy residents and orthopedic surgeons. We also should remember that adult skeletal manifestations of tuberculous disease in affluent and developing countries quite frequently occur in patients with diabetes mellitus, an observation often forgotten by the young orthopedic surgeon. I wish the book and the author success in the endeavor to enlighten orthopedic surgeons and physicians all over the world.

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Preface to the Fifth Edition

The first edition of this book *Skeletal Tuberculosis* was published in 1991. Much has been changing since then. Availability and employment of effective antitubercular drugs has permitted the physicians to aim at healing of the osteoarticular disease with retention of a useful range of motion of the joint (“functional treatment”) rather than its fusion as was practised earlier.

Newer imaging modalities, especially the availability of MRIs for clinical use were made available since 1988 in the Indian subcontinent. This has provided us the tools to diagnose the disease at a predestructive stage even in the most difficult anatomical locations like craniovertebral, cervicodorsal, lumbosacral, sacroiliac and sacral regions. Timely treatment has enhanced the quality of life at the healed status of disease. Indications for operative intervention are now more selective essentially for complications. With generalized success stories of total hip replacement, the orthopedic surgeons are now exploring the possibility of using joint replacement procedures for grossly destroyed hip and knee disease, the evolving consensus for replacement procedures seems to be after 3 years of sustained healed status of infection.

Due to compromised cell-mediated immunity associated with aging, diabetic state, HIV disease, and use of immunosuppressive drugs, the physicians are confronted with MDR and recurrence of disease. Though explosion of information in medical sciences continues, these are challenges for the current generation and also probably for the next generation to find solutions to control or eradicate such “super-bugs”.

New pictures have been added in most of the places as composites to express the story as it evolves in clinical management. With prevalent abundance of modern “search engines”, there is dominance of exhaustive number of references in many articles published (3 pages of text and 3 pages of references). I have added many new references, only those which were actually read and found relevant for the text. I hope this new edition continues to spread the knowledge of biological processes of activity and healing of skeletal tuberculosis, and offers logical options for management of skeletal tuberculosis.

SM Tuli
Preface to the First Edition

Tuberculous disease in man predominantly affects the humanity in the eastern hemisphere of the world. Up to three quarters of the world’s population lives in the eastern hemisphere and it is here that many live poorly nourished, overcrowded and in subnormal social conditions. Such pockets would keep on perpetuating human-cultures as media for the *Mycobacterium tuberculosis*.

In an increasingly shrinking world, many persons from such pockets due to economic reasons would be interacting and dealing with the society in the affluent parts of the world. Thus, prevention and treatment of tuberculosis should not be a concern only of the East and poor but also of the West and affluent. For elimination of this disease from the face of mother earth, we must improve the social standards of life for all, and alleviate poverty.

Last three decades have seen such a tremendous improvement in the therapeutic armamentarium available in the biological control of tuberculosis that the present-day physician has picked up courage to challenge the long established norms for the treatment of skeletal tuberculosis. Removing or segregating such patients, to the sanatoria, aspiration of cold abscesses through the “antigravity points”, dissemination of tuberculous infection as miliary tuberculosis or meningitis (especially after surgery), development of nonhealing postoperative ulcers and sinuses, amyloid disease due to chronic suppurations, treatment by enforced recumbency to patients in plaster-beds, plaster-jackets, and plaster-casts for 12 to 18 months should now form a part of history of medicine. With biological control of disease by the employment of modern antitubercular drugs, the present-day orthopedist and physician can give a better quality of life to the patient and better function to the involved joint. We have now broken the myth that, “antitubercular drugs do not penetrate the skeletal tuberculous lesions in sufficient concentrations,” and “ankylosis of the joint is the only method to achieve no recurrence of disease”. If diagnosed and managed effectively by “functional treatment” (i.e. by repetitive exercises of the joint rather than immobilization), early disease can resolve completely; in moderately advanced disease, many joints would heal with retention of functional arc of motion for many years; and in advanced disease of hip, elbow and other joints, surgical treatment can offer a mobile joint with healed status. Fusion may be confined predominantly for too painful and advanced a disease of the knee joint. One day in the burgeoning field of joint replacement (prosthetic or biological) more sophisticated
mobilizing procedures may be available for the burnt-out disease. Though science and knowledge are universal, however, the art of its application to the people must naturally reflect the local concerns, priorities, resources, environments, social customs and the needs of the society. For this purpose, personal observations are discussed here with those of contemporary researchers reported in the easily accessible literature.

The first part of the book is devoted to the general principles, and therefore, is applicable to the disease of any part of the skeletal system. The second part is organized chapter-wise to each region of the body. Each chapter more or less follows a uniform pattern presenting pathogenesis, clinical features, radiological findings, differential diagnosis, methods of treatment, role of surgical treatment, surgical technique and relevant anatomy. Each chapter in the second part stands by itself, and both the novice and the relatively inexperienced would be able to follow the management with ease. Part three of the book deals with various aspects of tuberculosis of the spine which constitutes nearly 50 percent of all cases of osteoarticular tuberculosis. This part would be of special interest to physicians, neurologists and neurosurgeons in addition to orthopedic specialists. For convenience of consultation, the bibliography has been arranged separately for spinal tuberculosis and for extra-spinal tuberculosis. Some common references may be found in either part.

It is hoped that this book will be of great assistance to the trainees in orthopedics and infectious diseases, to the experienced surgeons working in the developing countries, to the specialists in the affluent societies (where the disease is misdiagnosed) who encounter this condition only infrequently, to the general medical practitioners on whom many patients would depend upon for follow-up treatment. Even the most experienced orthopedic surgeon would find enjoyment in perusing the illustrations and the text reflecting total change in the methodology of treatment.

This treatise is an expansion of the book *Tuberculosis of the Spine* written in 1975. I was encouraged to take up this project essentially because the younger generation of the enquiring orthopedic surgeons asked for it, whenever I interacted with them in the class, workshops and conferences. Whatever is presented here is based upon nearly 30 years of close observations on clinical behavior, radiological features, operative findings and laboratory studies. Most of the work referred to in this book was done in the Department of Orthopedics, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. It is but natural that cooperative effort of a large number of outstanding colleagues has been drawn upon. Over these years, wittingly or unwittingly, I provoked controversies and discussions on many areas of orthopedic tuberculosis. Many friends and colleagues were subjected to this harassment. I admire the tolerance shown towards me by Prof BP Varma (late), Prof TP Srivastava, Dr SV Sharma, Dr SC Goel,
and Dr SK Saraf. I am indebted to them for the pleasure and profit of many stimulating exchanges of ideas during many years of fruitful association.

I would like to thank many of my technical staff and medical photoartists for their timely and continued assistance. Mr S Chaudhury, Mr OP Gupta, Mr GC Saxena, Mr AP Mathur, Mr K Raman, Mr Vipul Tuli helped in preparing the data, photographs, line illustrations, typescript and other associated jobs. Shri Jitendar P Vij (Group chairman), Mr Ankit Vij (Group President) and Mr Tarun Duneja (Director-Publishing) of Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, have been of tremendous help in the matters of editing, layout of text and illustrations, and printing. The get-up of this book speaks for itself.


Acknowledgements would be incomplete without thanks to my loving wife Swarn whose conscientious assistance in preparation of the text, index, bibliography and correction of proofs, and affectionate understanding helped make this work possible. Dr Neena and Dr Varuna, our daughters, tolerated many of my eccentricities during the period of preparation of this book.

SM Tuli
Acknowledgments

The preparation for the “next edition” in clinical subjects starts before the release of the current edition. The raw text material with many deletions, modifications and additions reached the publishing house. Many new illustrations cut and pasted were sent for preparation for publication. The whole raw material was deposited in the publishing house as small bits over many months, where it was formatted as a beautiful book.

My sincere appreciation also goes to Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Group President) and Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for their support to this project.

The dedicated team coordinated by Ms Samina Khan (Executive Assistant to Director-Publishing) at M/s Jaypee Brothers Medical Publishers (P) Ltd made the whole process of completion less stressful and more enjoyable.

I would also like to appreciate Ms Seema Dogra (Cover Designer), Ms Disha Singh Tomar (Proofreader), Mr Lalit Kumar (DTP Operator) and Mr Nitin Bhardwaj (Graphic Designer) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, for their hard work to complete this project.

I acknowledge them all and appreciate their contribution.
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Tuberculosis of the Knee Joint

The knee joint is the largest joint in the body having the largest intra-articular space. It is the third common site for osteoarticular tuberculosis and accounts for nearly 10 percent of all skeletal tuberculous lesions.

PATHOLOGY

The initial focus occurring by hematogenous dissemination may start in the synovium, or in the subchondral bone (of distal femur, proximal tibia or patella), or as a juxta-articular osseous focus. The synovial lesion may for many months remain purely as tubercular synovitis. The synovial membrane gets congested, edematous and studded with tubercles. The naked eye examination reveals a pinkish-blue or pinkish-gray appearance. The synovial lining which is normally a single cell layer in thickness becomes hypertrophied and thickened with granulation tissue. The joint fluid in the initial stages is increased, serous, opalescent, turbid, yellowish and may contain fibrinous flakes. In advanced stage of the disease, tuberculous process becomes osteoarticular. The tuberculous granulation tissue like the pannus erodes the articular margins, destroys the bones, and involves the cruciate ligaments, periarticular tissues, capsule and ligaments. As a rule, osseous erosion by the pannus starts at the site of synovial reflections, i.e. at the margins of the articular cartilage, and the capsular attachments. The pannus may erode the margins of the articular cartilage, grow between the articular cartilage and the subchondral bone, thus detaching the cartilage from the bone, and may grow over the articular cartilage as a sheet of granulation tissue (Fig. 9.14). Flakes of articular cartilage may sequestrate and lie free in the joint cavities. Nutrition of the articular cartilage is thus interfered. It looses its smooth glistening appearance, there may be fibrillation of its surface, it becomes roughened, pitted and softened, or erosion of the cartilage exposes the subchondral bone like pock-marks.

In cases which start as osseous lesions there may be tuberculous abscess in the subchondral bone, epiphyseal bone, or in the metaphyseal region.
usually in children (Fig. 9.1) leading to various degree of destruction of bone. Abscesses in the epiphyses and metaphyses may sometimes be seen traversing the epiphyseal cartilage plate giving an appearance of a lesion sitting astride the physis (Fig. 9.1) The initial tubercular focus may start in the metaphysis in children or the juxta-articular bone in adults.

As the disease advances, large areas at pressure points show osseous destruction, and the whole joint is filled/obliterated with granulation/fibrous tissue, capsular apparatus and ligaments are disrupted and the joint gets a triple dislocation (triple deformity), i.e. flexion of joint, posterior subluxation, lateral subluxation and lateral rotation, and abduction of tibia (Figs 9.2 to 9.4).

**CLINICAL FEATURES**

The onset and course is insidious with usual systemic and local features of tuberculous disease. The knee shows swelling, filling up all parapatellar fossae appreciated earliest in medial parapatellar fossa, suprapatellar pouch, and even popliteal fossa (Figs 7.2 and 7.3). The swelling is warm, patellar tap is present if the swelling is predominantly due to the synovial effusion, the thickened synovium gives a boggy (doughy or semielastic) feel and can be rolled between the fingers and the underlying femur. It is best palpated

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**Figs 9.1A and B:** Tuberculosis of the distal end of femur, (A) which has spread to the knee joint. There is a classical tuberculous cavity sitting astride the epiphyseal cartilage plate of femur, the cavity contains a few feathery sequestra. X-ray (B) of the same patient 11 years after treatment by drugs, traction and repetitive knee exercises. The patient retained the healed status of the disease and full range of painless mobility with excellent stability till his last follow-up.
Fig. 9.2: Advanced (Stage IV) active tubercular arthritis of knee with triple deformity. Note soft tissue swelling, flexion deformity and posterior subluxation, diminished joint space, fuzzy joint margins, cloudy appearance of bones, and lytic areas in the patella on the medial side of knee because vastus medialis remains muscular up to its insertion to patella and gets waisted early. Muscles on lateral side are aponeurotic and these are covered by thick iliotibial band. The skin may be stretched and blanched giving the appearance of a white swelling (tumor alba), and is edematous. Tenderness to pressure is most marked at the synovial reflections and along the joint line. In the synovial disease, for a long time there may be only terminal restriction of movements (Fig. 7.3). When arthritis has set in the movements are grossly restricted, painful and accompanied by muscle spasm (particularly of hamstrings). Quadriceps muscles show gross wasting and there is regional lymphadenopathy. In neglected cases due to the spasm and contracture of hamstrings particularly the biceps femoris, the leg is pulled into a deformity of flexion, posterolateral subluxation, external rotation and abduction (Figs 9.2 to 9.4). Once the flexion deformity is established, the tensor fasciae latae through iliotibial band further exantuates the deformity. Posterior capsule of the knee joint gets contracted in cases of long-standing. Complications from prolonged immobilization employing up to groin plaster-cast or hip spica for one year or more, included premature fusion of physes around the knee (“frame knee”) on the affected side. Such complications should not occur now because currently articular tuberculosis is best managed by functional treatment. In the growing child, transient limb lengthening due to chronic juxta-physeal hyperemia may be observed in some cases.
Figs 9.3A and B: Advanced tubercular arthritis (Stage IV) of the knee joint with triple displacement (i.e. lateral and posterior subluxation and lateral rotation). Note gross diminution of the joint space, irregularity of articular margins and a coke-like sequestrum contained in a cavity in the lateral femoral condyle. There are destructive kissing lesions in the lateral and medial compartments of the joint. These are the x-rays done one year after the treatment, therefore, the joint margins are quite sharp. The joint aspirate had grown mycobacteria. The patient was a physician, he refused to get an arthrodesis, however, by antitubercular drugs and functional treatment he obtained a healed status with painless range of movements from 10 degrees to 90 degrees. With an above the knee orthosis he continued his normal activities for 15 years when he died of unrelated causes.

Figs 9.4A and B: Typical radiological appearance in a child suffering from advanced tuberculous arthritis of the knee joint with “triple deformity”. Note flexion of the knee, lateral subluxation and lateral rotation of tibia, and its posterior subluxation.
Roentgenograms, like other joints, in the synovial stage show generalized osteoporosis, and increased soft tissue swelling caused by synovial effusion, thickened synovium and capsule. As arthritis sets in the x-rays reveal loss of definition of articular surfaces, marginal erosions, diminution of the joint space and destruction of the bones forming the joint (Figs 9.1 to 9.4). In advanced stage of arthritis, marked diminution of the articular space, gross destruction and deformation of bone ends, osteolytic cavities, tuberculous sequestra and triple deformity may be seen (Figs 9.2 to 9.6).

DIFFERENTIAL DIAGNOSIS

Tuberculosis of the knee requires differentiation from other monoarticular affections, such as rheumatic arthritis (in children), chronic traumatic synovitis due to chronic internal derangement of knee (e.g. meniscal tears, loose bodies, osteochondritis dissecans, chondromalacia patellae, discoid semilunar cartilage, etc.), rheumatoid arthritis (in adults), subacute pyogenic arthritis/synovitis, hemarthrosis, dysenteric arthritis, villonodular synovitis, synovial chondromatosis, synovioma, hamartoma/lipoma arborisence, juxta-articular (Fig. 9.7) osseous lesion (leading to irritable joint), foreign-body granuloma, etc. Careful history, examination and investigations help arrive at correct diagnosis in majority. In doubtful cases, biopsy for histological and microbiological investigations is mandatory. In any persistent swelling of the knee of insidious origin, possibility of tuberculous pathology must be
Figs 9.6A and B: An advanced case of tubercular arthritis of knee joint managed by functional treatment and followed-up for 12 years. Despite irregular joint surfaces the patient maintained a stable, nearly painless and fairly mobile (5 to 50 degrees) knee joint. The x-rays show a healed status with incongruous congruity and degenerative changes.

Figs 9.6C and D: Stage II-early arthritis of knee showing diminished joint space especially in the lateral compartment and fuzzy joint margins. After 6 months of the ‘functional treatment’, one can appreciate the remineralization of articular margins, she could regain a useful range of motion from full extension to 70 degrees of flexion entertained, otherwise they would be treated as rheumatoid disease (Su 1985). Inadvertently given intra-articular steroids may flare up the inflammatory signs in a case of tuberculous joint. PCR for mycobacterial infection, fine needle aspiration cytology and/or a needle biopsy of the thickened synovium (Fig. 9.10) or an enlarged lymph node, or a core biopsy of an osseous lesion are some of the semi-invasive outdoor procedures available these days to reach the final diagnosis. A positive PCR may be of immense value (in the presence of clinically inflamed knee), however, a negative PCR does not exclude tuberculous infection.
PROGNOSIS

With the modern methods of management the functional results are directly related to the extent of disease at the onset of antitubercular drugs (Lee et al. 1995, Hoffman et al. 2002). In the stage of synovitis, nonoperative (or operative when indicated) treatment often results in complete healing with an excellent range of movements. In advanced arthritis with subluxation, severe restriction of motion is inevitable, therefore, arthrodesis (in adults) in functioning position (5 to 10 degree of flexion) may be one of the options of treatment. In early or advanced arthritis (when a patient has been managed by functional treatment), a reasonable range of movements in the functional arc may be the outcome in many cases. The patient may continue to have a painless and a fairly mobile joint (Figs 9.1, 9.3 and 9.6) for many years (5 to 12 years). Arthrodesis or joint replacement in such cases should be deferred to when the joint becomes painful and starts losing movements due to early degenerative arthrosis (Fig. 9.8).

TREATMENT

Nonoperative treatment with antitubercular drugs is employed in tubercular synovitis and in children. Traction is applied to prevent (or correct) flexion and subluxation deformity, and to keep the joint surfaces distracted. In addition to the systemic drugs, the joint may be aspirated (when accompanied
Figs 9.8A to D: A Sarvodaya social worker presented with advanced tubercular arthritis of right knee. The disease healed (A, B) under the influence of antitubercular chemotherapy with a mobile joint (5 to 90 degrees). The pain on prolonged walking, however, interfered with his profession. After 2 years of waiting and trial he accepted Charnley’s compression arthrodesis (C, D). He was treated 12 years ago for tuberculous infection of fifth toe, thereafter he remained free from any clinical disease. The fresh disease in the knee was probably precipitated because the patient now developed diabetes by excessive effusion), and streptomycin and isoniazid in solution may be instilled intra-articularly once weekly. With the quiescence of acute local signs, gentle active and assisted knee bending exercises should be carried
out intermittently, for 5 to 10 minutes each half to one hourly. Usually, after 12 weeks of treatment the patient may be permitted ambulation with suitable orthosis and crutches. After 6 to 12 months of treatment, in cases with favorable response, the crutches or orthosis (caliper) may be discarded. Unprotected weight bearing is usually permitted 9 to 12 months after the start of treatment. Excellent results are obtained in majority of cases of synovial disease.

Fig. 9.9: Diagrammatic representation showing the application of “double traction” in cases of triple deformity of knee joint. Correction of such deformities (Figs 9.2, 9.4) by wedging plasters would increase the posterior displacement further.

Fig. 9.10: A diagrammatic representation showing the technique of obtaining a piece of inflamed/thickened synovial membrane using a trochar with a catch at its terminal part or by a biopsy punch. The tissue is best obtained from the suprapatellar pouch.
In children with arthritis, the deformity and subluxation is corrected/ minimized by employing double traction (Fig. 9.9) or rarely by corrective plasters. Once the deformity is maximally corrected, the child can be mobilized wearing orthosis. Arthrodesis or joint replacement of the grossly destroyed knee in children should be deferred till the completion of growth potential of the distal femur and proximal tibia.

**Operative Treatment**

In synovial stage, if the disease is not responding favorably or the diagnosis is uncertain even after semi-invasive procedures (Fig. 9.10), arthrotomy and synovectomy should be carried out. In early arthritis, in addition to synovectomy, removal of loose/rice bodies, debris, pannus, loose articular cartilage, and careful curettage of osseous juxta-articular foci should be carried out. Postoperatively, triple drug therapy, traction, intermittent active and assisted exercises, suitable brace ambulation should be continued.

In adults with advanced arthritis or in cases which resulted in painful fibrous ankylosis during the process of healing (Fig. 9.8), the knee joint may be treated by arthrodesis. This operation provides a painless stable knee, prevents recrudescence, corrects deformity, and the patients can do long hours of standing and walking. Sufficient bone is removed to expose healthy cancellous bone, to overcome deformity, and to provide sufficient purchase/hold for compression devices. Healing of the operative incision after synovectomy is seldom a problem. However, operations in cases of advanced arthritis often show wound dehiscence and sinus formation. This is because in advanced disease overlying capsule, subcutaneous tissue and skin may be scarred, and may also be affected by the disease process.

Charnley (1953) reluctantly recommended compression arthrodesis in tuberculous disease of the knee joint in children. He advocated against forceful flexion of the knee while operating. He advised great caution in clearance of all destroyed areas and caseous debris, and during denuding of the articular cartilage for adequate exposure of the subchondral bone. Arthrodesis of knee joint leads to significant disturbance of kinematics of locomotion over the years. Socially, it entails gross limitations of traveling by public transport and participation in many social functions. Arthroplasty operations are now considered more rational for healed status of advanced disease in adults.

If the disease has healed with a painless range of movement (minimum of 20 degrees) in an unacceptable position, a supracondylar femoral osteotomy may be performed to put the residual range of motion of the knee in a position that is functional to the patient. It frequently results in a mobile joint that is useful for another 10 to 15 years (Fig. 9.11). Osteotomy is also occasionally appropriate where a varus or valgus deformity is associated with relative sparing of one side of the joint and a useful range of movement.
Figs 9.11A and B: Tuberculosis of left knee joint in this young patient healed with gross limitations of movements. At the age of 15 years, the range of knee motions was from 40 to 105 degrees. A supracondylar femoral osteotomy was performed to bring/transfer the joint movements in the functional arc. Seventeen years after, at 32 years of age, the patient had a painless range of movements from zero degree to 100 degrees. Note the adaptive changes in the knee. (A) in maximum flexion and (B) in maximum extension.

SURGICAL TECHNIQUES

Synovectomy of Knee Joint

The operating surgeon is free to modify the approach according to the extent of pathology and local needs. Though “total synovectomy” is desirable but for all practical purposes most of the synovectomies are subtotal. A 15 to 20 cm curvilinear parapatellar incision (Fig. 9.12) may be made along the lateral or medial border of patella. After cutting skin, superficial fascia, deep fascia one would cut through the quadriceps expansion about 0.5–1 cm away from the patella. The exposure extends proximally to the suprapatellar pouch and distally to the insertion of ligamentum patellae. By sharp dissection a plane of cleavage is developed between the quadriceps expansion and suprapatellar synovial pouch. Starting from its proximal borders the suprapatellar pouch and the thickened synovial membrane surrounding the articular margins of femoral and tibial condyles are excised. The knee joint is now flexed (Fig. 9.13) to 90 degrees and inspected from front, and any loose bodies are removed. The unhealthy synovial membrane is removed as far as possible from the cruciate ligaments and intercondylar fossa. Rotational movements of the tibia with knee in flexion would help access for excision of considerable part of synovial membrane of the posterior compartment. This maneuver also
helps inspection of menisci. The surgeon before closure should test if one can achieve at least 90 degrees of flexion of the knee joint easily. Any obstructing intra-articular lesion or extra-articular adhesions should be cut carefully, capsulectomy or capsulotomy performed, to obtain the desired flexion on the operation table. This completes the synovectomy. Antibiotics are instilled locally, suction drainage is introduced and located in the suprapatellar region. The capsule and the quadriceps are then closed with interrupted sutures.
Synovectomy with Debridement (Joint Clearance)

In cases of early tubercular arthritis when the disease has spread beyond the extent of the synovial membrane, in addition to synovectomy, joint clearance has to be done. The pannus when present is stripped off the underlying articular surfaces. Smaller areas of destruction are curetted. Larger areas of destruction on articular surfaces and margins are curetted and filled up with cancellous bone grafts obtained from nearby healthy bone, irregular surface and margins are smoothed, destroyed and degenerated menisci, absolutely loose and destroyed articular cartilage, destroyed capsule and ligaments may be carefully removed. If more than 50 percent of articular cartilage is destroyed the outcome is likely to be less than half of the normal range of joint motion. The patients must be forewarned about such a prognosis. Before closure, raw areas of bone and areas of prospective bleeding are cauterized. The wound is closed over a suction drainage and postoperative management is similar to that of synovectomy. Where facilities are available, synovectomy and joint debridement can also be done by arthroscopic procedure.

Postoperative Regimen for Synovectomy with or without Debridement

After the closure a well-padded compression bandage is applied and the tourniquet (if used) is released. Postoperatively, the limb is nursed on pillows, below the knee skin traction or tibial pin traction is applied, the limb is elevated and the knee joint kept in about 5 to 10 degrees of flexion with the help of a rolled towel or a small pillow behind the knee. Exercises at ankle and static quadriceps exercises are started the same evening. Within a day or two of the operation, knee bending exercises are done at hourly basis within the range of the compression bandage. The suction drainage is removed after 48 to 72 hours and more knee bending is encouraged. The suction drainage system virtually eliminates post-synovectomy hemarthrosis. The size and bulk of the compression bandage is reduced between 10 to 14 postoperative days when more vigorous assisted and active knee bending and quadriceps development exercises are done at one hourly intervals.

Ambulation with the help of weight relieving caliper (orthosis) and crutches is started about one month after the operation when the patient can perform knee flexion to 90 degrees and is able to lift the limb with extended knee against gravity, which-so-ever is later. Appropriate antitubercular drugs and supportive therapy is continued for 12 to 16 months. Crutches are gradually discarded between 3 and 6 months, and orthosis is gradually discarded between 18 and 24 months depending upon the local progress and healing of the infective process.

Arthrodesis of the Knee Joint

This operation may be indicated in advanced (Fig. 9.14) tubercular arthritis (gross limitation of movements, marked diminution of the joint space,
destruction of the apposing joint surfaces), tubercular arthritis with triple deformity, cases with gross instability (Friedman and Kapur 1970, Martini 1988) and cases of painful ankylosis after earlier operations like synovectomy or synovectomy with debridement, or as a result of healing by drug therapy (Figs 9.8 and 9.14) or for patients with failure of joint replacement.

Because there is a finality about the loss of movements and restrictions imposed by arthrodesis of the knee joint it is mandatory to explain to the patient and his/her attendants about the resultant domestic, marital, professional, and social limitations. A patient with gross ankylosis (with or without deformity) and pain has nothing to lose except “pain”. Whenever in doubt, the “acceptability test” of this operation is advisable by simulating the functional restrictions imposed by arthrodesis of the knee joint. A light above the knee plaster cast is applied to the limb leaving the ankle and foot free for walking. The patient is sent back to his/her social, domestic and professional environments. The patient and his family are advised to report back in the hospital after 3 to 6 weeks, with their mind made up regarding the acceptability of operation.

The operation is performed under tourniquet, with patient supine, towards the edge of the operating table, and a sandbag beneath the knee. An anterior curvilinear parapatellar incision is made starting from the suprapatellar pouch extending up to the tibial tubercle. The quadriceps expansion is cut in the same line leaving 0.5–1 cm of muscle attached to the patellar border. The capsule is erased subperiosteally with the help of a sharp chisel and hammer from the medial and lateral tibial and femoral condyles near the articular margins. The knee joint is gradually flexed, quadriceps expansion

Fig. 9.14: Intraoperative photograph of the right knee joint with advanced tuberculous arthritis and active disease. Note gross destruction of articular cartilage, erosion of subchondral bone, attenuation of anterior cruciate ligament and medial semilunar cartilage, and nodular appearance of the thickened synovium on the medial side.
and patella are reflected to the medial side in case of lateral parapatellar incision (or lateral side in case of medial parapatellar incision). Grossly diseased synovial membrane and bone are excised preserving the healthy bone and its continuity with quadriceps and patellar tendon. With the knee joint in varying degrees of flexion, the articular cartilage and subchondral bone is removed from the upper end of tibia and distal end of femur up to the cancellous bone. The bone may be cut using sharp osteotomes and/or an oscillating saw. The apposing surfaces of tibia and femur are shaped and brought into contact to obtain maximal contact without rotation, gross displacement and angulation. The articular surface of patella is rawed and is apposed at the site of arthrodesis while closing. Grossly diseased bone, sequestera, tuberculous cavities, caseous tissue and granulation tissue are gouged/curetted out from the end of the bones. The resultant cavities are filled up with cancellous bone chips obtained from nearby healthy bone. Towards the end of bone resection one must ensure good apposition of the largest possible areas of bone. No more than a few degrees (5 to 15 degrees) of flexed position of arthrodesis is desirable. There should be no lateral angulation at the level of knee. The neutral position in the long axis of leg is achieved by the screw-home movement of the tibia, placing the tibial tubercle a little lateral to the midline of thigh (giving 5 to 7 degrees of external rotation). The stability at the site of arthrodesis is obtained generally by employing Charnley’s compression clamps. We have as a rule employed Charnley’s compression apparatus for more than 30 years (Fig. 9.15) with universal success. In cases with long-standing disease and severe osteoporosis, it is advisable to insert

Fig. 9.15: Diagrammatic representation of Charnley’s compression arthrodesis of knee
Steinmann pins well away from the line of arthrodesis through the area of lesser osteoporosis.

Antibiotics are instilled locally, suction drainage is introduced and the wound closed in layers. A well-padded dressing is applied with sufficient cotton-wool between the skin and the clamps. Over a thick layer of cotton, compression bandage is applied on the operated area, the tourniquet is released and the limb is supported with mild flexion at the knee level on a strong posterior plaster shell and/or a half ring Thomas bed-knee splint. Axial rotation of the leg is prevented by incorporating a derotation bar in the plaster.

Postoperatively, the limb is kept elevated on pillows. Considerable postoperative blood loss is expected from the raw cancellous bone ends, and it is mandatory to replace one unit of blood (500 mL) soon after the surgery. Appropriate antibiotic and chemotherapy is continued for 12 months to 16 months.

About 72 hours after the operation, the suction drain is removed, the bandage covering the compression clamps is cut longitudinally and the compression nuts are exposed. The desired degree of compression is maintained by frequent tightening of the screws, initially by one round and later by 1/2 to 1/3 of the round every 24 hourly for about 4 to 6 weeks, when the compression apparatus and the pins are removed and an up to groin well-fitting plaster cast is applied on stockinet excluding the ankle and foot. Weight bearing in the plaster cast is commenced 5 to 6 weeks after the operation, and the walking plaster is retained for 3 to 6 months. Sound fusion, as confirmed by the x-rays (Fig. 9.8), is generally obtained by this time to permit unprotected weight bearing.

In patients with severe flexion deformity (more than 90 degrees), care must be taken to prevent damage to the neurovascular bundles by sudden correction of deformity. Preoperative skeletal traction in cases of fibrous ankylosis would minimize this risk by reducing the degree of deformity. While operating in the presence of a severe fixed flexion deformity, the soft tissues behind the upper end of tibia and knee should be carefully erased subperiosteally before correcting the deformity. Lateral popliteal nerve should be exposed and released from its surroundings around the neck of fibula and along the medial border of the tendon of biceps femoris. About 8 cm of upper end of fibula is excised to relieve any tension on the lateral popliteal nerve on straightening the knee. The excised fibula may be used as a bone graft for fillings around the site of arthrodesis.

**Arthroplasty for Tuberculous Arthritis**

Besser (1980), Wray and Roy (1987) performed arthroplasty inadvertently in the preoperatively unsuspected cases of tuberculosis of the knee. Reactivation of infection after the operation was controlled by modern
antituberculous drugs. The range of motion obtained in the knee joint is, however, not clearly mentioned by the authors. Eskola et al. (1988) reported the results of replacement arthroplasty in 6 patients who had the primary disease about 35 years ago. Marked improvement in the function of the knee joint was observed during a follow-up of nearly 6 years. Kim (1988) reported good results after total knee arthroplasty in selected cases of old healed tuberculosis of knee. Gale and Harding (1991) reported a short term result of total knee arthroplasty in the presence of active disease. Koga et al. (1988) reported an interesting series of resection and interposition arthroplasty in 25 patients who had infection of long-standing (tuberculosis in 8 cases). The interposition material was a preremoved and chromacized autogenous graft of fascia lata. During a mean follow-up of 22 years, none had severe pain, 13 had more than 60 degrees of movements, 12 had a range of 45 degrees or less, and radiographs showed adaptive remodeling of bone ends. This methodology may offer another solution with the adoption of continuous passive, assisted and active motion during the postoperative period.

In a grossly destroyed painful knee joint, with or without deformity, the traditional treatment has been arthrodesis in the best functional position. It may still be the best option for a young patient doing heavy manual work or standing for long hours. Arthrodesis of knee, however, imposes lot of restrictions in sitting, using public transport, and many other social activities. Indications for arthroplasty for a healed disease may be more justified for the knee than for any other joint. While resecting the bone one must ensure preservation of medial and lateral ligaments of knee, correction of deformity, and placement of implants in a way to achieve about 7 degrees of valgus. Once the knee arthroplasty is infected no satisfactory outcome is achieved by resection arthroplasty, arthrodesis, or revision arthroplasty (Thornhill et al. 1982).

At present, replacement arthroplasty of knee is being offered to selected patients. Most of the authors suggest this operation at least 3 to 5 years after the last evidence of activity of infection (Eskola et al. 1988, Kim 1988, Gale and Harding 1991). Mandatory coverage by modern antitubercular drugs for about 5 months after replacement surgery is advised.

We should also be aware of development of tuberculous arthritis in patients after replacement knee arthroplasty performed for non-infective pathology. In the last 12 years (1996 to 2008), the author has observed 10 such patients from well-equipped institutions. The diagnosis of tuberculous pathology was confirmed by histology, microbiology and by PCR.

**RELEVANT SURGICAL ANATOMY OF THE KNEE JOINT**

The knee joint is the largest articulation in the body. For stability, it depends upon the strength of the capsule, the collateral and cruciate ligaments and the surrounding muscles. The fibrous capsule completely invests the joint
particularly on its posterior aspect which is strengthened by the oblique popliteal ligament. Medially and laterally, it is reinforced by collateral ligaments. Forward and backward stability of the tibia on the femur in flexed position is predominantly provided by the anterior and posterior cruciate ligaments, respectively. Gross destruction of the posterior cruciate ligament would result in posterior subluxation of the knee joint. The anterior capsule is replaced by/composed of the quadriceps expansion inserting into the patella, the ligamentum patellae (infrapatellar tendon), and the blending of fibrous aponeuroses from the vasti medialis and lateralis. The “capsule” is thinnest between the ligamentum patellae and the collateral ligaments, up to its attachment to the anterior margin of the tibial plateau.

The synovial membrane lines the inner aspect of the capsule. It extends upwards as the suprapatellar pouch on the anterior aspect of femur under cover of the quadriceps expansion up to the extent of a hands breadth. A diverticulum of synovium is prolonged (or herniated) posteriorly and distally between the proximal part of popliteus and the underlying femur and tibia. Another synovial pouch extends/herniates posteriorly to communicate with a bursa lying between the semimembranosus and the medial head of gastrocnemius. Generally, a bursa beneath the lateral head of gastrocnemius also communicates with the joint (Fig. 9.16). Any disease involving the synovium would easily extend to the communicating synovial prolongations.

**Fig. 9.16:** Diagram showing the bursal sheaths and bursal herniations around the knee joint. Any one or many of these may be involved by tuberculous pathology. DI = deep infrapatellar, P = bursa along the origin of popliteus, G = bursa related to the medial head of gastrocnemius, S = bursa related to the semimembranosus insertion.
and present as popliteal cysts/swellings. These ramifications also preclude complete surgical excision in an operation attempted to be a total synovectomy (Fig. 9.16). There are many more unnamed synovial pouches and bursae around the knee joint.

The cruciate ligaments are intracapsular but are not intrasynovial. It is as though they had been herniated into the synovial membrane from behind, carrying forward over their surfaces the synovial fold which invests their anterior, lateral and medial surfaces but leaves their posterior surfaces uncovered. The synovium from the lateral and medial sides of the cruciate ligaments becomes continuous with the synovial lining of the intercondylar notch of the femur. Anteriorly, the synovium is invaginated by the infrapatellar pad of fat which lies extrasyovially distal to the patella up to the anterior margins of medial and lateral tibial condyles.

On the lateral aspect of the knee joint, the head of the fibula has attachment of fibular collateral ligaments extending from the fibular head to the lateral epicondyle and condyle of femur. The tendon of biceps femoris is inserted into the head of fibula, splitting into two parts to enclose the fibular collateral ligament. The common peroneal (lateral popliteal) nerve lies just behind the biceps tendon insertion and passes distally to wind around the neck of fibula under the peroneus longus muscle. Clinically the nerve is palpable medial to the tendon of biceps and on the neck of fibula. This nerve is likely to be damaged by stretching or rough handling while correcting a severe flexion deformity (90 degrees or more) of long-standing. A bursa exists in between and around the conjoint insertion of sartorius, gracilis, and semitendinosus (pes anserinus) on the proximal medial aspect of tibia medial to the tibial tubercle. Bursa pes anserinus may rarely get involved by tuberculosis.