Sequelae of Septic Arthritis of The Hip

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Preface

Septic arthritis of the hip is seen most commonly in children, and may result in severe disability. While long-term problems are uncommon when prompt surgical drainage and antibiotics are provided, many of the world's children lack access to immediate medical care, and instead present for treatment at a late stage in the disease process.

The symptoms and physical findings are most dramatic with bacterial sepsis; in contrast, children with tuberculous arthritis typically present with a more protracted clinical course. In either case, the disease may result in a spectrum of residual problems that may cause chronic pain, and interfere with ambulation.

This spectrum is captured in the classification proposed by Choi et al, and the variety of treatment options will be discussed based upon the degree of involvement.

The clinical material has been collected from the Hospital & Rehabilitation Centre for Disabled Children in Banepa, Nepal, and from Uganda.

While the majority of cases may not be preventable, significant morbidity can be averted by early recognition and treatment, highlighting the need to strengthen the delivery of health care at primary health centers in such resource challenged environments. Practitioners caring for musculoskeletal problems in such environments will necessarily be confronted with neglected hip sepsis, and we hope that the information in this monograph will help to formulate a treatment plan for these challenging cases.

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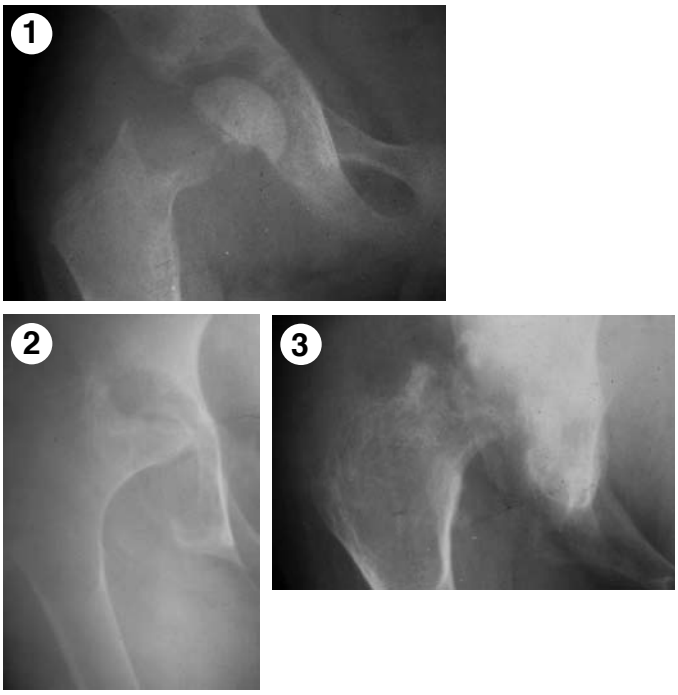


The radiographic evolution in severe septic arthritis of the hip. The patient presented with dissociation and avascularity of the capital femoral epiphysis [1], which was followed by dissolution of that fragment [2], and finally progressed to subluxation of the proximal femur with destruction on both sides of the joint.

Septic arthritis may be seen in association with acute or chronic osteomyelitis.

Sequelae of Hip Sepsis

Septic arthritis of the hip may result in a spectrum of pathologic changes on one or both sides of the joint. Although the etiology is most often pyogenic, similar clinical and radiographic findings may be seen with granulomatous infection (tuberculosis). The findings depend upon the severity of the infection, whether treatment was provided during the acute stages, and whether there is a coexisting osteomyelitis of the proximal femur. Treatment is based upon the prescence or abscence of clinical infection, the degree of residual deformity, the patient's symptoms, and often on cultural variables. Recommendations must be individualized, and the indications and techniques for reconstructive surgery remain controversial.

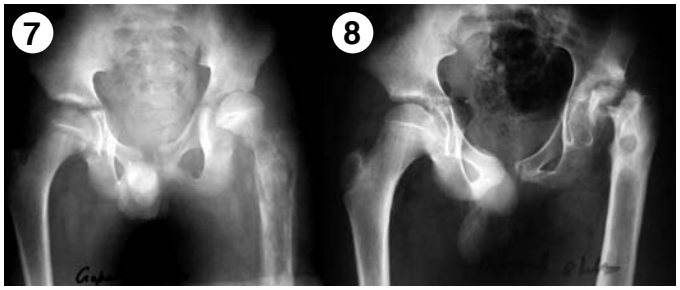
Pathophysiology

Septic arthritis may result from hematogenous seeding of the joint, or to direct spread from a contiguous focus of osteomyelitis. The unique circulation about the hip in infancy makes septic arthritis a common complication of proximal femoral osteomyelitis. The metaphyseal and epiphyseal vessels communicate until approximately 12-18 months of age, after which the physis serves as a more effective barrier to the spread of infection.

Sepsis may result in both direct and indirect consequences to one or both sides of the joint. Direct damage to the articular cartilage is common, and if severe, partial or complete joint destruction may culminate in ankylosis (fibrous or bony) or instability from subluxation/dislocation [1-8]. Indirect consequences result from physeal damage and avascular necrosis. In addition to joint destruction, consequences of neglected hip sepsis include joint instability, abductor insufficiency, and leg length discrepancy. Leg length discrepancy results from physeal arrest, joint subluxation/dislocation, and/or malpositioning of the extremity from contracture or ankylosis.

Clinical Findings

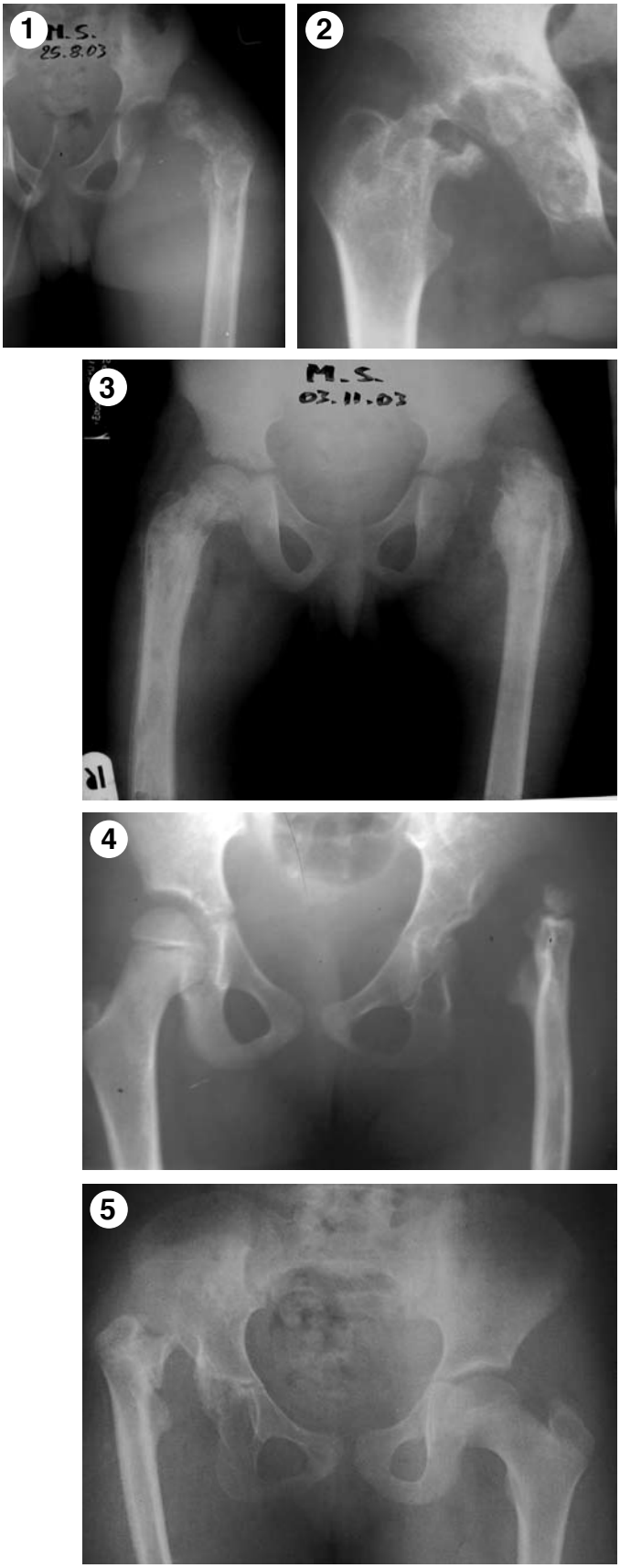
Although a minority of patients will be asymptomatic, most present complaining of gait disturbance, pain or both. Pain is more likely in the case of fibrous ankylosis, and may also be secondary to abductor insufficiency. Causes of gait disturbance include shortening of the involved extremity (subluxation, dislocation, contracture), pistoning from instability, abductor insuficiency, soft tissue contracture, and joint ankylosis (fibrous or bony).



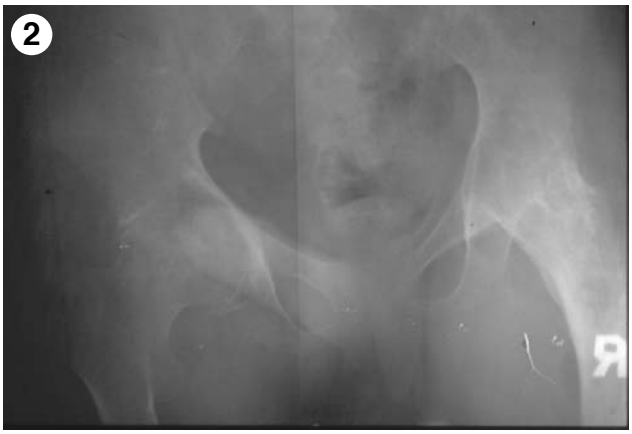
Dissolution of the femoral head/neck following extension of proximal femoral osteomyelitis into the joint.

Natural History

The natural history has been reported at long term followup in several small series. Betz et al reviewed 32 patients who had been followed for 42 years. They observed that 59% were pain free, and that those with disease onset prior to 3 months of age tended to be more mobile, but approximately 50% had pain. In the group with disease onset at greater than 3 months, the hips were stiffer (often ankylosed), but only one of ten was painful. The mean leg length discrepancy was 3.3 centimeters if the hips were located, and 5.6 centimeters if dislocated. Wopperer et al reviewed 8 cases with disease onset at less than 3 months of age, and found that two patients had poor Harris hip scores at 31 years followup. The experience of others has been different, and we suggest that the outcome is much less favorable then in thse other reports. Gait disturbance is uniform, and many patients have pain and restriction of motion. In addition, our impression is that the results are even less favorable when the hip sepsis occured in early childhood versus the first few months of life. This scenario is more common in developing countries.



Septic Subluxation/Dislocation Partial or complete destruction of the femoral head, with or without the femoral neck, in association with capsular distention/laxity, and muscle imbalance or contracture, may result in varying degrees of hip instability (varying degrees of subluxation, or dislocation). Proximal migration may be observed, with a corresponding decrease in the length of the involved extremity.



Spontaneous ankylosis is often observed following untreated hip sepsis (pyogenic or granulomatous), with or without an associated proximal femoral osteomyelitis. With bony ankylosis, the main clinical concern is malpositioning of one or both extremities. In some cases, the hip may fuse in a relatively functional position, and the main issue will be leg length discrepancy. In bilateral cases there may be a windswept deformity with abduction of one extremity and adduction of the other [3,4,5]. Fibrous ankylosis may be associated with pain and restricted motion, in addition to malpositioning of the extremity.

Classification

The goals for any classification scheme are to help guide treatment, and to facilitate comparison between studies from different centers. The Hunka classification was reported in 1982, and is based on the findings in 10 cases with the onset of sepsis before the age of 18 months [1]. The Choi classification is a modification of the Hunka classification, based upon 34 cases. Treatment recommendations have been made for each subtype, and the most comprehensive assessment has been presented by Choi et al (2005, 2006).

Hunka Classification

Type I:

There is minimal collapse of the femoral head, which is later followed by reossification. These observation sare most consistent with an ischemic etiology (avascular necrosis), and the radiographic course is comparable to that seen in Perthes disease.

Type II:

Deformity of the femoral head. In subtype IIa there is no evidence of physeal damage, while in Subtype IIb there is premature physeal closure, resulting in deformity of the femoral neck as well.

Type III:

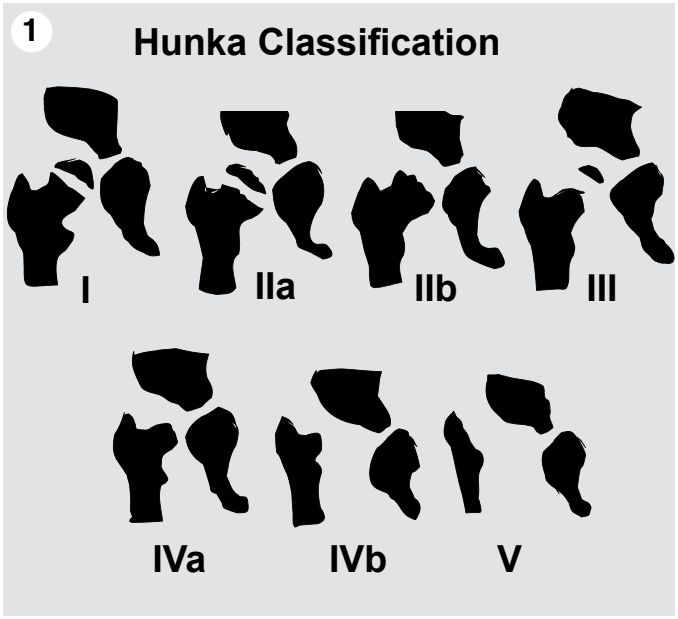
A pseudarthrosis of the femoral neck is observed. If the femoral head is viable, the authors recommend bone grafting, and a valgus osteotomy may promote healing by increasing compressive forces across the site of nonunion. If the femoral head is nonviable, resection of the head and neck followed by greater trochanteric arthroplasty is suggested.

Type IV:

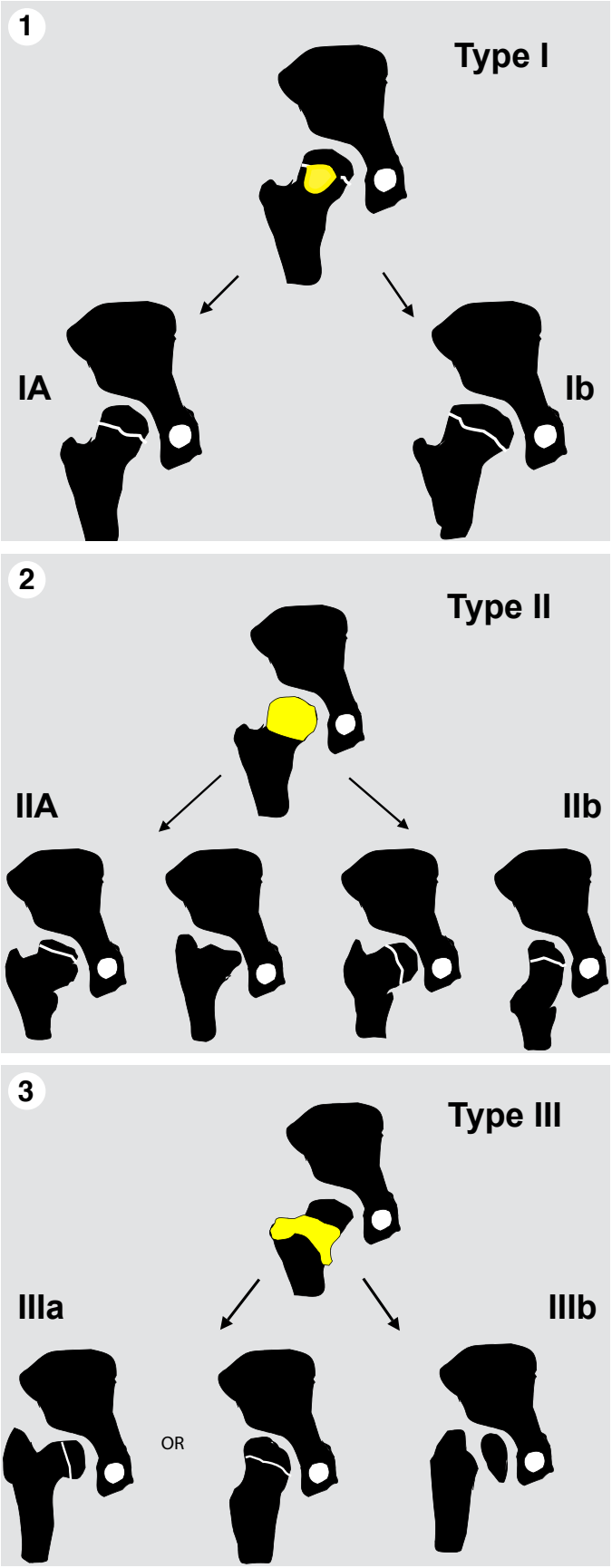
Destruction of the femoral head, with retention of a variable portion of the femoral neck, is seen in Type IV deformities. In subtype A, there is sufficient femoral neck present to maintain a stable articulation, and the recommended treatment is to maximize hip joint motion by soft tissue release (adductors and/or psoas). In subtype B, only a small portion of the femoral neck is retained, and the articulation is unstable. In this situation, one should consider resection of the residual femoral neck and conversion to a greater trochanteric arthroplasty.

Type V:

Destruction of both the femoral head and the femoral neck is seen, and the recommended treatment is greater trochanteric arthroplasty with or without femoral and pelvic osteotomies.



The Hunka classification: Examples include II [2,3], III [4], IVb [5], and V [6].



Choi Classification

This scheme was developed after a review of 34 patients with the onset of sepsis prior to one year of age. There are four major types, and eight subtypes. The number of categories reflects the spectrum of pathology seen following neonatal hip sepsis. A treatment algorithm based upon this classification was reported by Choi et al (2005, 2006), and is as follows:

Type I [1]:

This group includes those patients with a normal radiographic appearance (Ia), and those with evidence of avascular necrosis (Ib). Some patients with type Ib will require containment treatment, similar to Perthes disease.

Type II: Involvement of the epiphysis, physis, and metaphysis [2]:

This type results from ascular necrosis, with or without significant damage to the capital femoral physis. Asymmetric physeal arrest within the femoral neck may result in alterations in the neck-shaft angle. In subtype A, there is coxa breva associated with deformation of the femoral head. During the early stages, the avascular necrosis is treated by containment, and a greater trochanteric apophysiodesis may help to manage abductor insufficiency. A pelvic osteotomy is recommended for coverage if necessary, and leg length discrepancy may require epiphysiodesis later in life. The second subtype involves either coxa vara or coxa valga from asymmetric closure of the proximal femoral physis. Treatment involves realigning the neck shaft angle by osteotomy, and also completing the growth arrest of the proximal femoral physis to prevent recurrence. Leg length discrepancy may be managed by epiphysiodesis later on.

Type III: Damage to the femoral neck [3]:

In Type IIIa, there is coxa vara, coxa valga, with or without excessive femoral anteversion or retroverion. The treatment is proximal femoral osteotomy. In Type IIIb there is a pseudarthrosis of the femoral neck, and the recommended treatment is valgus osteotomy with bone grafting.

Type IV: Loss of the femoral head/neck [4]

In Type IVa, a segment of the femoral neck is preserved, which may confer some degree of stability. In younger patients (< 6 years) with a femoral neck remnant and a cartilage cap, treatment by open reduction can be considered. A modified Harmon operation (osteotomy at base of neck remnant with wedge bone graft to lengthen the femoral neck) and distal transfer of the greater trochanter may be preformed at the same time. If this fails, then a pelvic support osteotomy may be the best choice. In patients less than 6 years of age who have no femoral neck (or a remnant that cannot be salvaged), greater trochanteric arthroplasty can be considered.(modified to include proximal varus osteeotomy) with or without a pelvic osteotomy. For those older than 6 years of age (Type IVa or IVb), or those in whom a greater trochanteric arthroplasty has failed, a pelvic support osteotomy is recommended.

Treatment

Given this spectrum of pathology, treatment recommendations must be individualized. The goals of treatment are a pain free, stable articulation, with adequate motion and equal leg lengths.

In addition to the history, physical findings (range of motion, leg lengths, and gait), and results of imaging, other variables of importance include how far the patient lives from the treatment center, and whether the family will be able to endure a prolonged course of treatment with multiple hospital visits (or a prolonged hospital stay). Cultural concerns will also impact upon the decision making process. In addition to plain radiographs, other imaging studies such as ultrasound, arthrography, or MRI (if available) may be required to accurately define the proximal femoral anatomy in order to plan treatment.

For patients who are pain free and have an adequate range of motion, observation is appropriate. Leg lengths should be monitored as a subset of patients may benefit from an epiphysiodesis. If there is evidence of persistent sepsis, then debridement or resection arthroplasty may be required, in addition to antibiotics, to achieve control of infection. Once the infection is eradicated, then the patients symptoms and function can be reevaluated, and reconstructive options discussed [5].

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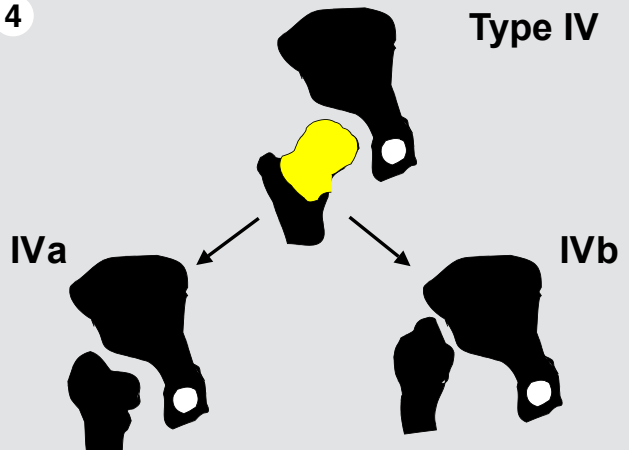

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Surgical Options

A. Painful Joint Degeneration
1. Resection Arthroplasty
2. Hip Arthrodesis
3. Greater Trochanteric Arthroplasty
4. Pelvic Support Osteotomy
5. Total Hip Replacement

B. Abductor Insufficiency
1. Greater Trochanteric Growth Arrest
2. Greater Trochanteric Transfer
   a. Distal, Lateral, Or Both
3. Pelvic Support Osteotomy
4. Arthrodesis

C. Leg Length Discrepancy
1. Soft Tissue Release
2. Osteotomy
3. Epiphysiodesis
4. Lengthening
5. Pelvic Support Osteotomy

D. Instability (Pistoning)
1. Open Reduction
2. Greater Trochanteric Arthroplasty
3. Pelvic Support Osteotomy
4. Arthrodesis Or Total Hip Replacement

E. Loss of Motion
1. Soft Tissue Release

F. Malpositioned Extremity
1. Realignment Osteotomy

An arthrogram may help to deine the antomy of the cartilagenous epiphysis when planning treatment. Courtesy of Premal Naik, M.D..

Painful Joint Degeneration

In cultures where motion is more desirable than stability for work, play, and for using in ground toilet facilities, a procedure that preserves motion is desirable. Arthrodesis provides excellent relief of pain, but may limit function and activities of daily living. If the technology is available, total joint replacement is an option in older adolescents, however concerns remain regarding implant longevity in a younger, more active population.

Abductor Insufficiency

Abductor insufficiency manifests as an abductor lurch, a positive Trendelenberg sign, and aching discomfort following prolonged ambulation. If there is a reasonably normal articulation at the hip, then arresting the growth of the greater trochanter may be sufficient in patients less than 7 years of age. Alternatively, the greater trochanter may be transferred either distally, laterally, or both. In the case of joint subluxation or dislocation, if the joint surfaces are relatively well preserved, it is reasonable to consider femoral osteotomy, with or without pelvic osteotomy, to enhance joint stability and improve abductor function.

Leg Length Discrepancy

Ipsilateral limb shortening may be significant, and contributing factors include subluxation or dislocation, arrest of the upper femoral physis, and malpositioning of the extremity due to soft tissue contracture and/or bony malalignment. An adduction or abduction contracture will create an apparent discrepancy of approximately 3 centimeters for each 10 degrees of contracture.

This 7 year old male presented with an ankylosed hip, and gait disturbance from adduction contracture and leg length discprepancy. Although he was pain free, he was unable to squat, which resulted in significant problems with activities of daily living. Treatment options discussed with the family included realignment osteotomy and resection arthroplasy. Given their desire for motion, at the expense of stability, they consented to a femoral head and neck resection. The surgery was followed by a period of skeletal traction, after which range of motion exercises, and gradual resumption of weightbearing, was begun. Given the adduction deformity, he was placed in a spica cast to stabilize the opposite hip during traction, to facilitate hip abduction.

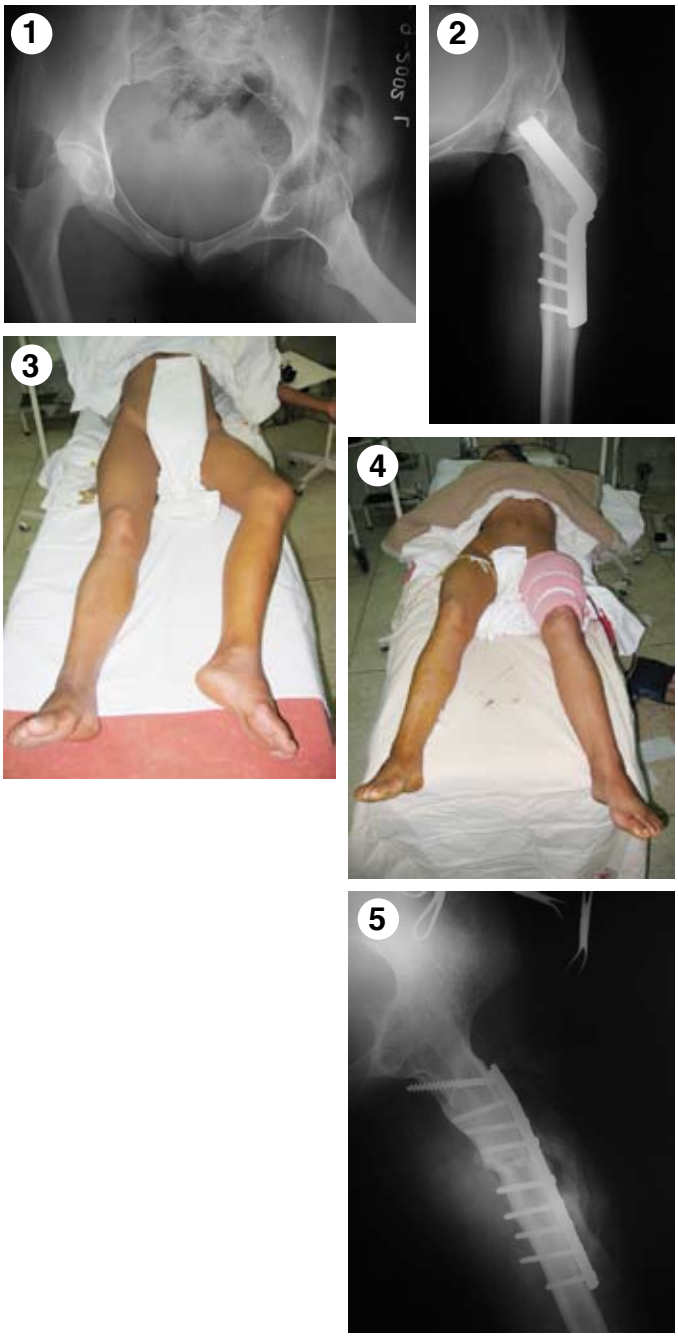
The choice of treatment method will depend on the both the current discrepancy and the anticipated discrepancy at skeletal maturity. Epiphysiodesis should be considered for an anticipated discrepancies between 2.5 and 5 centimeters. Limb lengthening, if the technology is available, is indicated for anticipated discrepancies in excess of 5-6 centimeters. A prerequisite is a stable joint above and below the segment to be lengthened. In the abscence of stability, options include stabilization by femoral and/or pelvic osteotomy or greater trochanteric arthroplasty, or perhaps the best choice is a pelvic support osteotomy, depending upon the age of the patient. Femoral lengthening following hip reconstruction with a vascularized iliac crest pedicle graft has been reported by Chen et al. Tibial lengthening can also be considered, however a difference in knee heights will be observed following treatment.

Instability/Pistoning

This problem is seen with gross instability at the hip, usually when there has been destruction of the femoral head and neck. This can be treated by hip arthrodesis if enough bone stock is available, by greater trochanteric arthroplasty, or by a pelvic support osteotomy.

Loss of Motion

Soft tissue contracture, usually in flexion and adduction, may be treated by the soft tissue release, or an osteotomy may be required to reposition the limb.



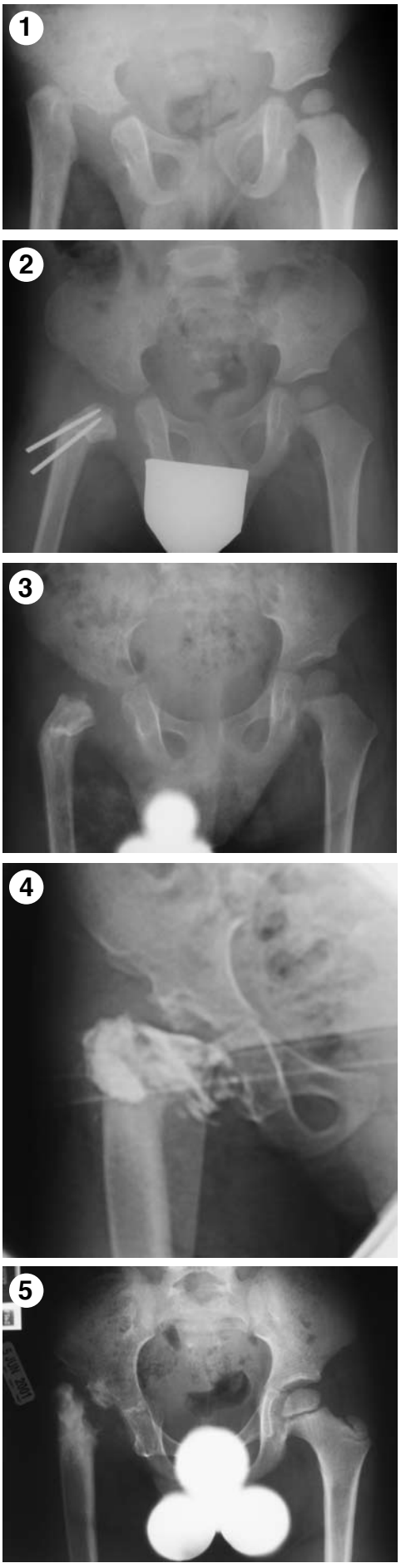
This 17 year old female presented with an externally rotated extremity following a realignment osteotomy for an ankylosed, malaligned hip joint following untreated septic arthritis [1,2]. By history, she initially had nearly 90 degrees of hip flexion deformity associated with significant abduction. She underwent a proximal femoral varus and extension osteotomy with blade plate fixation, which resulted in a suitable correction of flexion and abduction. However, she was concerned about excessive external rotation [3]. Subsequent treatment included implant removal and a proximal femoral derotational osteotomy in the subtrochanteric region [4,5]. The procedure was performed without an implant set. The drill was from a local hardware store, and the implants were chosen from a mixed set of plates and screws which had been donated.

This young man presented with windswept hips and leg length discrepancy following untreated osteomyelitis and hip sepsis. There was an asymmetric flexion deformity of both hips, and the right hip was ankylosed in abduction while the left was subluxated in adduction position. Limb repositioning was accomplished by bilateral proximal femoral osteotomies.

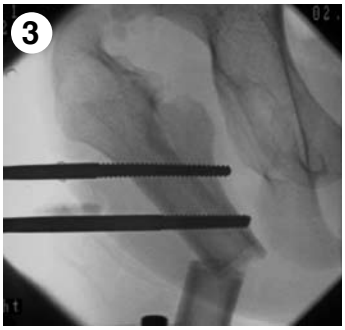
This lady presented with windswept hips and severe flexion deformity following untreated sepsis, with the left hip ankylosed in abduction, and the right subluxated and adducted [5, 6]. Bilateral proximal femoral osteotomies were recommended for limb realignment [7,8].

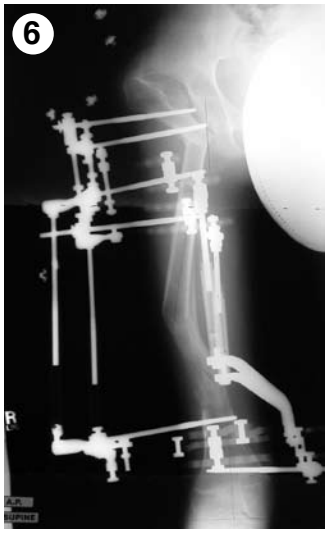
Greater Trochanteric Arthroplasty

Variants of this procedure have been used to treat septic destruction of the femoral head and neck. The greater trochanter is surgically placed into the acetabulum in order to restore stability at the articulation (prevent pistoning). The cartilagenous apophysis does have the potential to remodel. Although the results have been favorable in some series, others have suggested that the results deteriorate with time, and that stiffness, pain, and resubluxation/dislocation are relatively common at longer term followup.The procedure should be considered in younger patients (< 6 years) with loss of the femoral head and neck, even as a temporizing measure, as a pelvic support ostetomy will rapidly remodel and need to be repeated within a relatively short period of time.The original technique was described by Colonna, and involves circumferential muscle release around the trochanter, with care to avoid subperiostial dissection. The neck is debrided flush with the femoral shaft, and the trochanter is placed within the acetabulum. The abductors are advanced and sutured to a trough in the lateral aspect of the femur (tensioned at 20 degrees abduction). The vastus lateralis is reefed over the new insertion of the glutei. The patient is placed in a spica with the hip in extension and 20 degrees abduction. Better results have been observed when a varus osteotomy at the base of the trochanter is performed at the same time, and in some cases a pelvic osteotomy may be required to improve containment.



This 5 year old male presented with a history of sepsis during the first year of life, but was untreated [1]. The major complaint was pistoning of the hip, and leg length discrepancy. A greater trochanteric arthroplasty was performed. A greenstick fracture was created in the intertrochanteric region, and Kirschner wires were used for fixation [2]. At more than a year following the procedure, it appeared that the hip had lateralized [3], so an arthrogram was performed [4]. This demonstrated maintenance of an articulation. The patient was pain free, without evidence of pistoning, at 5 years followup [5]. Long term folowup will be required. (Radiographs courtesy of Steven Sundberg, M.D.)





Pelvic Support Osteotomy

This technique was first described by Ilizarov, and has recently gained popularity as a treatment option for the more severe sequelae of hip sepsis. This treatment method addresses all of the major clinical problems encountered, including instability, abductor insufficiency, and leg length discrepancy.

Preoperative Planning

A standing AP radiograph both lower extremities from hips to ankles is required to evaluate alignment and limb lengths. Additional studies may include an AP of the pelvis/proximal femur with the limb in maximum adduction, and a trendelenberg view (standing AP of the pelvis with the uninvolved leg held off the ground) [1,2]. Each of these two films has been used to gauge the degree of valgus required to achieve adequate pelvic support. Some have used the degree of maximal adduction, while others have added 15 degrees to the degree of adduction on the trendelenberg view, to determine the magnitude of abduction (valgus) required [2]. Leg lengths should be measured both clinically and radiographically.

Technique

The procedure involves two osteotomies, one for pelvic support (proximal) [3], and one for lengthening and realignment of the mechanical axis (distal). An external fixator is employed, either an Ilizarov ring fixator [4], or a hybrid construct with an articulated fixator proximally (to stabilize the proximal osteotomy) and a lengthening rail distally [5].

The proximal, abduction osteotomy is performed in the subtrochanteric region, at the level of the ischial tuberosity [3]. This component of the procedure provides pelvic support for the proximal femur (eliminates pistoning), and also lengthens the abductor moment arm by lateralizing the greater trochanter (improves abductor insufficiency. Pain from an incongruous articulation or breakdown of cartilage is relieved by joint distraction. The distal osteotomy is performed at the diaphyseal level, and is used for lengthening and restoration of the mechanical axis of the limb [6]. The amount of lengthening can be estimated preoperatively, and then modified based upon clinical exam and radiographs postoperatively. Remodeling is common in younger patients, thus the procedure is ideal for those close to skeletal matrurity [7].

Case 1:

A fourteen year old male presented with pain and intermittent drainage from untreated hip sepsis [8]. He underwent debridement, and a hip arthrodesis was attempted. Unfortunately, this resulted in nonunion and persistent wound drainage. He was then treated by repeat debridement and resection of the residual femoral head and neck. Three years later, although the infection had been controlled, he had a shortened, weak, and unstable lower extremity [10]. Following control of sepsis he was treated by pelvic support osteotomy using a combination of two monnolateral fixators. After the completion of treatment [12-15], radiographs demonstrated restoration of the mechanical axis, and his leg lengths were equal with a positive but mild trendelenberg sign.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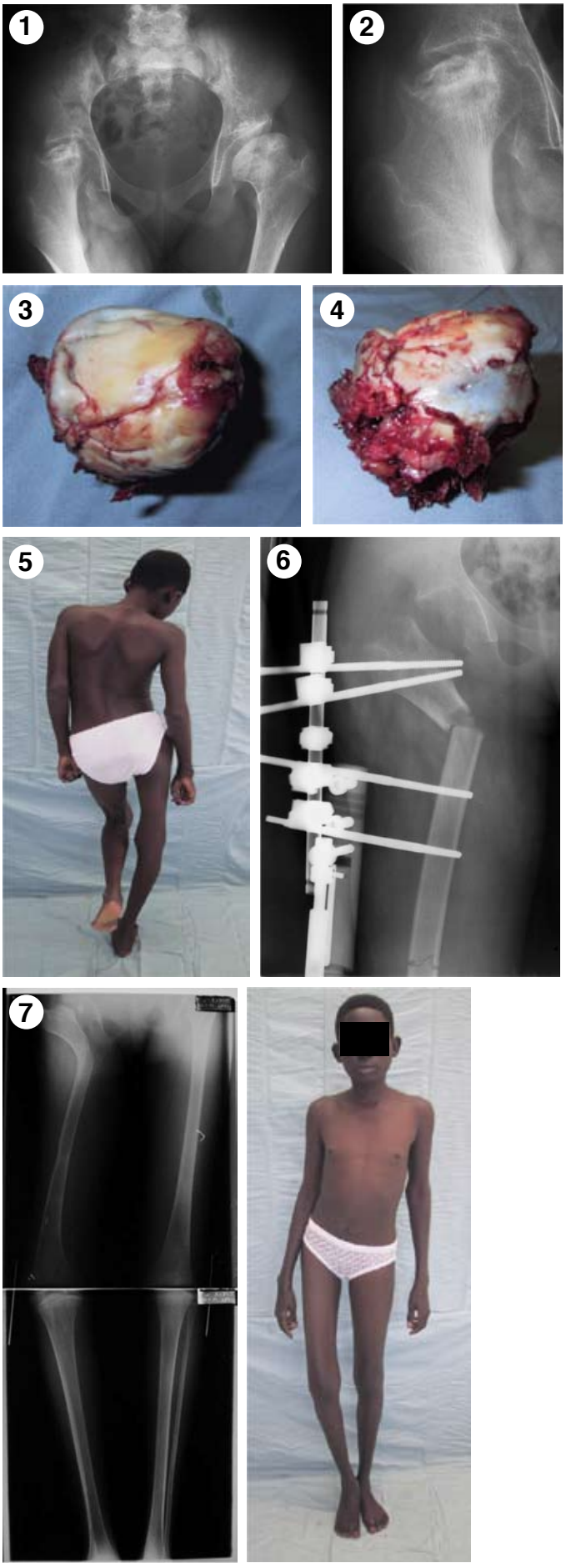
Case 2:

This 16 year old female presented with a history of hip sepsis, which had been associated with osteomyelitis of the ilium. She was initially treated by debridement and a Girdlestone arthroplasty. Although she was pain free, and there were no signs of persistent infection, she was unable to stand without support. Her preoperative AP radiograph [1] demonstrates significant adduction deformity of the limb. She was treated by a pelvic support osteotomy, utilizing a "double stacked" arrangement with an articulated fixator above, and a lengthening rail below [2]. The two central half pins were common to both fixators. The limb was well aligned after healing, with the axis aligned under the medial wall of the acetabulum [3,4]. Her postoperative range of motion was adequate in both adduction [5] and abduction [6]. Her leg lengths were brought within an acceptable range [7], and she had a negative Trendelenberg test at followup.

Case 3:
This 12 year old male presented with post septic involement of both hips with avscular necrosis [1]. Although the left side had revascularized and was asymptomatic, he had severe pain with an adduction and flexion conttracture on the right side [2]. He underwent resection of the femoral head and neck, and the gross specimen revealed considerable degenerative changes with loss of sphericity and erosion of the articular cartilage. His trendelenberg sign was markedly positive preoperatively [5]. He was then treated by pelvic support osteotomy [6]. Although he had mild varus of the extremity at followup, his pain was relieved [7].

Summary

The sequelae of septic arthritis of the hip involves a spectrum of pathology. Clinical problems include pain, instability (pistoning) from subluxation or dislocation, abductor insufficiency, and leg length discrepancy. The treatment must be individualized, and many options are available. Residual sepsis should be treated by debridement and antibiotics, and reconstruction should be delayed until sepsis has been controlled. Once the infection is eradicated, patients desiring stability at the expense of motion may consider an arthrodesis of the hip. For those desiring motion, options include resection arthroplasty, pelvic support osteotomy, and total joint arthroplasty. Limb length discrepancy is universal, and varies in magnitude. Apparent discrepancy due to malpositioning of the limb in space (contracture or ankylosis in a nonfunctional position) may be treated initially by soft tossie release or realignment osteotomy to reposition the limb. Residual discrepancy may be managed by epiphysiodesis, or by limb lengthening (> 5-6 centimeters). Pelvic support osteotomy allows the surgeon to treat joint degeneration, abductor insufficiency, limb malalignment, and leg length discrepancy simultaneousely. However, this strategy requires a circular or hybrid fixator, specialized training in the technique, and the willingnesss of the patient and his or her family to submit to a prolonged course of treatment in which complications are likely.



Annotated Bibliography

Axer A, Aner A. A new technique for greater trochanteric hip arthroplasty. J Bone Joint Surg 66B:331-333, 1984.

This case report describes a technique for greater trochanteric arthroplasty in which the proximal femur is rotated 180° following subtrochanteric osteotomy. Fixation was achieved with a short intramedullary nail. Shortening of the femoral shaft was avoided (no varus required). Several years later the limb was lengthened 5 cm. Despite fragmentation of the apophyseal fragment, presumably due to avascular insult, the fragment healed, remodelled, and contributed to longitudinal growth. At 20 years of age, the patient was pain free and had a mild limp.

Betz RR, Cooperman DR, Wopperer JM, Sutherland RD, et al. Late sequelae of septic arthritis of the hip in infancy and childhood. J Ped Ortho 10:365-372, 1990.

In a multicenter review (32 hips in 28 patients) with a followup of 42 years, a comparison was made between patients with disease onset less than three months, and at greater than three months of age. For those with onset less than three months of age, 10/19 were pain free, while 5 had mild pain and 4 had moderate pain. In the older group, 9/10 were pain free, 3 had mild pain, and 1 required a THA for severe pain. Hips in the infantile group were usually mobile, whereas those patients with a later onset of the disease tended to have stiffer hips, many of which were ankylosed. Despite Harris scores were in the fair range (70-80), 59% of these hips were pain free. Leg length discrepancy averaged 3.3 cm. in located hips, and 5.6 cm. in dislocated hips. The authors recommend avoiding reconstructive surgery in most cases. Femoral osteotomy to reposition a hip which has autofused may be helpful. Leg length discrepancy should be treated.

Bryson AF. Treatment of pathological dislocation of the hip joint after suppurative arthritis in infants. J Bone Joint Surg 30B:449-453, 1947.

A review of 16 cases treated by Colonna arthroplasty (1), subtrochanteric osteotomy (4), and arthrodesis (11) was performed. Subtrochanteric osteotomy was successful in 1 of 4 cases, and this patient had a painless fibrous ankylosis of the hip. The Colonna arthroplasty failed in a single patient. Arthrodesis was the most successful treatment. Given reasonably good function in childhood, and the tendency for flexion/adduction contracture to develop in patients fused early, the authors recommend waiting until the patient is 12-13 years of age.

Chang CH, Huang SC. Reconstruction for sequelae of septic hip in children. J Formos Med Assoc 96(5):353-358, 1997.

13 hips were reconstructed [Hunka IIb (6), Iva (4), IVb (2), V (1)] at an average age of 6 years with the goal of achieving containment, and later equalizing leg length discrepancy. Procedures included open reduction, femoral and pelvic osteotomy for containment, and valgus osteotomy and limb lengthening for LLD. Preoperatively, patients had a painless limp and an average leg length discrepancy of 3.3 centimeters. Although 4 patients required secondary procedures for resubluxation, all were stable at 6 year followup. The authors recommend early surgical stabilization of the hips, and equalization of limb lengths at a later time.

Cheng JCY, Aguilar J, Leung PC. Hip reconstruction for femoral head loss from septic arthritis in children. A preliminary report. Clin Orthop Rel Res 314: 214-224, 1995.

Eight patients with complete loss of the femoral head and neck (Choi IVb) were treated by a vascularized iliac crest pedicle graft. The cartilagenous side of the crest is aligned superiorly to contact the acetabulum. Patients were all pain free at 7 year followup, and 7 of 8 cases exhibited vertical stability at the hip. Severe resorption was seen in one graft, and 5/8 did not consolidate fully. Ultrasound suggested a mobile fibrocartilagenous mass within the acetabulum. Those which healed completely did show evidence of remodelling at followup. Achieving stability in this manner may facilitate later limb lengthening procedures.

Cheng JCY, Lam TM. Femoral lengthening after type IV B septic arthritis of the hip in children. J Ped Ortho 16:533-539, 1996.

Four patients with loss of the femoral head and neck (Choi IVb) underwent successful femoral lengthening from 4.5 to 13 cm., without loss of hip stability or range of motion of the hip or knee. All had multiple joint sepsis, which contributed to the magnitude of their discrepancy. Three of four were treated by a vascularized iliac crest pedicle graft to reconstruct the absent femoral head and neck prior to their lengthening.

Choi IH, Pizzutillo PD, Bowen JR, Dragann R, et al. Sequelae and reconstruction after septic arthritis of the hip in infants. J Bone Joint Surg 72a:1150-1165, 1990.

Thirty-four patients with residual deformities from septic arthritis (< 1 year old) were retrospectively reviewed, and a classification scheme was presented. Recommendations for treatment were made.

Choi IH, Shin YW, Chung CY, et al. Surgical treatment of the severe sequelae of infantile septic srthritis of tthe hip. Clin Orthop Rel Res 2005;434:102-109.

An algorithm for treatment of the sequelae of hip sepsis is presented based upon management of 45 hips, using the classification developed by the senior author and associates in 1990. For Type IIIa hips, patients with coxa vara/valga and/or excessive femoral anteversion or retroversion are treated by proximal femoral realignment osteotomy. For the IIIIb hips (femoral neck pseudarthrosis), bone grafting of pseudarthrosis and/or valgus osteotomy is recommended. For younger patients with Type IVa, in which a remnant of the femoral neck is preserved, open reduction can be considered. When an adequate cartilage cap is observed on the femoral head, a modified Harmon procedure was employed (osteotomy at the base of the femoral neck remnant, place a wedge bone graft to lengthen the residual femoral neck). Open reduction is not recommended in older patients due to the risk of stiffness, and the Type IVa cases are treated like IVb cases. Trochanteric arthroplasty was successful in only 5 of 10 hips, all of whom were less than 6 years of age. Pelvic support osteotomy is ideal for older patients with Type IVb hips, or in Type IVa hips when other treatment methods have failed.

Choi IH, Yoo WJ, Cho TJ, et al. Operative reconstruction for septic arthritis of the Hip. Orthop Clin N Am 2006;37:173-183.

An excellent review article on this subject which includes the authors extensive personal experience combined with a synopsis of the literature.

Colonna PC. A new type of reconstruction operation for old ununited fracture of the neck of the femur. J Bone Joint Surg 17:110-122, 1935.

Six cases of greater trochanteric arthroplasty are described for femoral neck nonunion in older patients. The technique involves circumferential muscle release around the trochanter, with care to avoid subperiostial dissection. The neck is debrided to be flush with the femoral shaft, and the trochanter is placed within the acetabulum. The abductors are advanced and sutured to a trough in the lateral aspect of the femur (tensioned at 20 degrees abduction). The vastus lateralis is reefed over the new insertion of the glutei. The patient is placed in a spica with the hip in extension and 20 degrees abduction.

Dobbs MB, Sheridan JJ, Gordon JE, et al. Septic arthrtitis of the hip in infancy: Long term followup. J Pediatr Ortho 2003;23:162-168.

Five patients treated by greater trochanteric arthroplasty are reviewed at 15 years followup all of whom had complete destruction of the femoral head from sepsis within the first 3 months of life. An iliofemoral approach is utilized, and the recturs femoris is tagged. The hip capsule is opened to inspect the femoral head and neck, and if there is extensive destruction, then the remnant of the head/neck is removed flush with the base of the trochanter. The iliopsooas is released, and the glutei are extraperiostially released form the tip of the trochanter. A varus subtrochanteric osteotomy is then performed. through a seperate lateral incision.

A spica cast is used for immobilization. All hips were stable, painless, and one patient had a mild limp. The authors recommend staging the varus osteotomy and the trochanteric arthroplasty by a few months as one patient developed avascular necrosis. Patients had an average of three surgical procedures, and additonal procedures included shelf arthroplasty, epiphysiodesis, varus/vangus osteotomy, and implant removal.

Fabry G, Meire E. Septic arthritis of the hip in children: Poor results after late and inadequate treatment. J Ped Ortho 3:461-466, 1983.

29 children with septic arthritis +/- osteomyelitis were followed for > 12 years. Patients were divided into two groups (< 1 month, 1 month-3 years old). The prognosis was worse in younger children, and in those with coexisting osteomyelitis. As for most series, symptoms and functional parameters do not necessarily correlate with the degree of changes on radiographs. Trochanterplasty (technique not described) was of limited success, due to stiffness and/or dislocation. In general, reconstructive procedures were not felt to be successful.

Freeland AE, Sullivan DJ, Westin GW. Greater trochanteric hip arthroplasty in children with loss of the femoral head. J Bone Joint Surg 62a:1351-1361, 1980.

The Colonna greater trochanteric arthroplasty was performed in 17 children, 7 of whom had sequelae of septic arthritis. Followup was 11 years. For those with septic arthritis, in addition to greater trochanteric arthroplasty, 5/7 underwent a pelvic osteotomy (Salter or Pemberton) and 3/7 had a varus proximal femoral osteotomy. One was also treated with an acetabuloplasty, in which the acetabulum was reamed to accept the greater trochanter. Four patients were treated by epiphysiodesis at a later time. At followup, 1/7 had required a total hip arthroplasty, and fobrous ankylosis was seen in 2. Two patients had completely fused. In the group as a whole, greater trochanteric arthroplasty alone resulted in stability initially, but this deteriorated to subluxation, stiffness, and degenerative changes. Results in those also treated by pelvic osteotomy were similar, although containment was improved. The best results were achieved in those having a varus proximal femoral osteotomy as a component of the procedure.

Hallel T, Salvati EA. Septic arthritis of the hip in infancy: End result study. Clin Orthop Rel Res 132: 115-128, 1978.

Twenty-four hips in 21 patients with septic arthritis within the first 7 months of life were reviewed at 17 year followup. Abduction splinting or casting failed uniformly if the femoral head and neck were absent, but was successful in 10/14 with at least a small head and neck remnant present. Arthrography is not helpful in determining the proximal femoral anatomy due to scarring. The study was prior to MRI, and surgical exploration was performed to assess the status of the femoral head and neck, and an open reduction is recommended in the prescence of a stable head and neck. Trochanteric arthroplasty was performed in 6 patients, 3 of whom remained located. Benefits of successful arthroplasty include stability, a decrease in abductor lurch, and less LLD. However, those that failed were stiffer, and some progress to subluxation/dislocation and have pain. Another possible benefit of trochanteric arthroplasty is to promote more favorable conditiions for prosthetic reconstruction later in life.

Hunka L, Said SE, MacKenzie DA, Rogala EJ, et al. Classification and surgical management of the severe sequelae of septic hips in children. Clin Orthop Rel Res 171:30-36, 1982.

A classification system, and treatment recommendations, are presented based upon a review of 10 cases with 11 year followup. All patients had septic arthritis before 18 months of age. Irrespective of the degree of involvement, most children were pain free.

Kim YH, Oh SH, Kim JS. Total hip arthroplasty in adult patients who had childhood infection of the hip. J Bone Joint Surg 2003;85A:198-204.

One hundred and seventy arthroplasties (123 cementless) performed at a mean of 41 years of age (sepsis was at a mean of 7 years of age) were reviewed at 9.8 years. The Haris hip score improved from 50 to 85, and there was no recurrence of infection when a quiescent period was > 10 years. Early revision for aseptic loosening was performed in 17% of cmeneted or hybrid and 15% of cementless components. The early loosening was atttributed in part to component design, but likely also relates to the activity level in the young population.

Kocaoglu M, Eralp L, Sen C, et al. The Ilizarov hip reconstruction osteotomy for hip dislocation. Outcome after 4-7 years in 14 young patients. Acta Orthop Scand 2002;73:432-438.

The pelvic support osteotomy was used to treat high dislocations of the hip (11 developmental dysplasia, 1 paralytic, 1 PFFD) in 14 patients with a mean of 4.4 cm. LLD (12-33 years old). The AP radiograph in maaximum adduction determines the site of osteotomy, as well as the amount of abduction (valgus). Some extension is added to inmprove lumbar hyperlordosis. Pain was relived in all but one patientand the lumbar hyperlordosis (and associated back pain) disappeared in 10 patients postoperatively. All but one patient was satisfied, and complications included minor pin tract infection (3) and a single mild case of malalignment.

Krumins M, Kalnins J, Lacis G. Reconstruction of the proximal end of the femur after hematogenous osteomyelitis. J Ped Ortho 13:63-67, 1993.

Seven children with loss of the femoral head and neck were treated by proximal femoral osteotomy with external fixation. The proximal femoral segment (head and neck remnants) is gradually medialized into the acetabulum using the fixator. The gap created eventually consolidates. Hip stability and ambulation improved at short term followup (< 5years).

Manzotti A, Rovetta L, Pullen C, and Catagni MA. Treatment of the late sequelae of septic arthritis of the hip. Clin Orthop Rel Res 2003;410:203-212.

Fifteen patients were treated by the Ilizarov hip reconstruction for the sequelae of septic arthritis of the hip, and followed for 9 years. The mean age was 21 years. The mean femoral shortening was 6.1 cm. and the mean LLD was 6.5 centimeters. All had hip pain and a trendelenberg gait. The preop supine radiograph in maximum adduction was used to identify the osteotomy site, as well as the type of pelvic support (acetabular, subacetabular, or superior pubic ramus). The fixator was worn for a mean of 225 days. The results were excellent/good (10), fair (3), and poor (2). Thirteen patients were satisfied. Complications included frequent pin tract infections, a common peroneal palsy, loss of alignment (2), and mild knee subluxation (1). Leg lengths were equal in 11/15, and within 2 centimeters in all patients. Gait was improved, and pain was relieved.

Rozbruch SR, Paley D, Bhave A, et al. Ilizarov hip reconstruction for the late sequelae of septic arthritis of the hip. J Bone Joint Surg 2005;87A:1007-1018.

Eight patients with Choi Type IV or V hips and a mean age of 11.2 years were treated by the pelvic support osteotomy. The level of osteotomy is determined from the AP radiograph in maximum adduction, The amount of valgus is determined by adding 15 degrees to the degree of adduction measured on the standing radiograph (affected limb).Both valgus (mean 44 degrees) and extension (mean 19 degrees) were incorporated, and a mean of 5.7 centimeters was achieved distally . The mean LLD at followup was 0.7 cm, and gait was considerably improved. Complications included premature consolidation (2), superficial pin infections (3), and knee stiffness or subluxation (3). Remodelling may lead to loss of correction in younger children, and the procedure may need to be repeated at or near skeletal maturity in this subset of cases.

Weintroub S, Lloyd-Roberts GC, Fraser M. The prognostic significance of the triradiate cartilage in suppurative arthritis of the hip in infancy and early childhood. J Bone Joint Surg 63B:190-193, 1981.

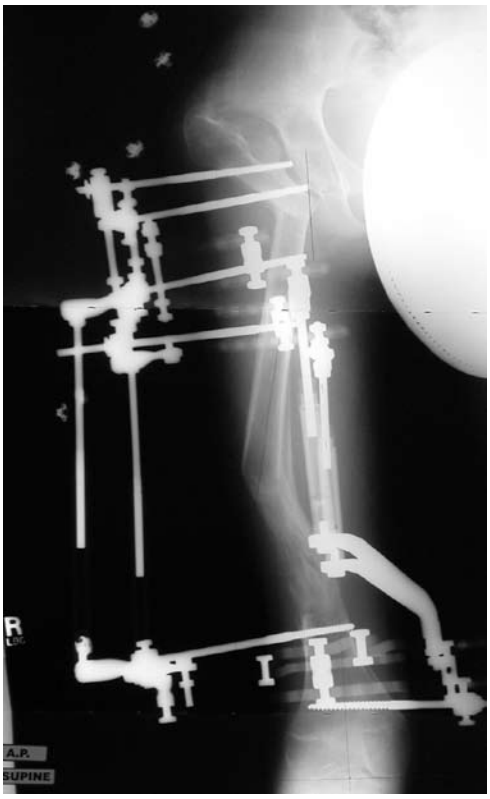
Septic arthritis of the hip may be complicated by arrest of the triradiate cartilage. Radiographic narrowing and irregularity of the triradiate reliably predicts severe involvement of the femoral head, and acetabular dysplasia may develop over time. In the abscence of such changes, a mobile femoral head will usually be found in the acetabulum.

Weissman SL. Transplantation of the trochanteric epiphysis into the acetabulum after septic arthritis of the hip. J Bone Joint Surg 49a:1647, 1967.

This case report describes a technique for greater trochanteric arthroplasty. After removal of all fibrous tissue, in addition to release of the psoas and detachment of the short external rotators and the gluteus medius and minimus, the greater trochanter is sutured down into the acetabulum. A varus osteotomy (100°) was then performed. At nearly seven years followup, remodelling of the apophysis was seen, and the hip remained stable.

Wopperer JM, White JJ, Gillespie R, Obletz BE. Long-term follow-up of infantile hip sepsis. J Ped Ortho 8:322-325, 1988.

The natural history of infantile hip sepsis (< 3 mos) in 8 patients (9 hips) is reported at 31 year followup. The spectrum of pathology included mild deformity (3), absent or deficient femoral head and neck without dislocation (3), and an absent or deficient head/neck with dislocation. Results based upon Harris hip scores included 6 excellent, 1 good, and 2 poor. The authors question the value of reconstructive surgery, but recommend epiphysiodesis to treat the coexisting leg length discrepancy.



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