

Treatment of Stage I-III Hip Joint Tuberculosis With Open Surgical Debridement and Hip Spica in Children: A Retrospective Study

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Background: This study aimed to evaluate the outcome of surgical debridement combined with postoperative hip spica immobilization in the treatment of hip joint tuberculosis in children.

Methods: This retrospective study enrolled 87 children with stage I to III hip joint tuberculosis treated surgically at our hospital from January 2010 to January 2016. All patients considering hip tuberculosis routinely received a 4-week conservative treatment first, including rest, protected weight-bearing, and 4-drugs antitubercular chemotherapy. Surgical debridement was indicated when there was no relief after this conservative protocol. Patients were divided into 2 groups according to the duration of hip spica immobilization after operation: group A (hip spica for 4 wk, 39 patients) and group B (hip spica for 6 wk, 48 patients). All patients were recommended partial weight-bearing for 7 days and then followed the same hip joint exercises program when spica was removed. Postoperative radiographs, hip dislocation or subluxation, and modified Harris hip score (MHHS) were assessed. All patients were followed up at least 5 years.

Results: There were 87 patients enrolled in our study, including 34 females and 53 males, with a mean age of 7.2 ± 2.8 years old

(range: 2 to 14 y). No significant difference was observed between these 2 groups in baseline data. In group A, the mean MHHS improved from 52.1 ± 14.7 before surgery to 87.8 ± 8.3 at the final follow-up ($P < 0.000$). In group B, there was also a significant difference between the preoperative MHHS (52.7 ± 9.4) and the final MHHS (88.6 ± 6.5) ($P < 0.000$). Although there was no significant difference between these 2 groups in the final MHHS ($P = 0.593$), there were also no significant differences between these 2 groups in wound healing delay (3 in group A and 6 in group B, $P = 0.705$) and pathologic subluxation (3 in group A and 1 in group B, $P = 0.467$). The only difference between group A (79.2 ± 8.5) and group B (75.5 ± 7.5) was the early functional outcome assessed by using MHHS after 1 month of hip joint exercises ($P = 0.032$).

Conclusions: Surgical debridement combined with antitubercular chemotherapy is an effective treatment for stage I to III hip tuberculosis in children when there is no improvement after conservative treatment. Prolonged hip spica immobilization may not reduce the risk of hip subluxation after open surgical debridement but could lead to a delay in early functional recovery. Time of spica immobilization should be individualized and based on the surgeon's evaluation and the patient's condition.

Key Words: tuberculosis, hip joint, hip dislocation, functional outcome

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L.Y. put forward the idea and wrote the first draft of the manuscript and interpretation of data for the work. J.Z. and L.L. completed the data collection and analysis. D.W. and X.Y. completed patients' follow-up and data collection. X.T. and X.Y. performed the clinical practice and revise the manuscript.

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Despite many efforts to the control of tuberculosis (TB), it remains a major cause of childhood morbidity and mortality worldwide, especially in some developing countries.^{1,2} World Health Organization estimates that annually 1 million children have TB disease and nearly 210,000 died of TB.³ Hip joint tuberculosis (HTB) is a common extrapulmonary TB, accounting for nearly 15% of the osteoarticular TB, which may be much higher in children.^{4,5} A delayed HTB could be very difficult in treatment because damages on joint of these growing children usually lead to a poor function.⁶ The primary treatment of early-stage HTB in children remains antitubercular chemotherapy (ATT), combined with other optional therapy including rest, partial weight-bearing, traction, drainage, surgical debridement, or synovectomy.^{7,8} The prognosis of pediatric HTB is poor in general due to various complications, including ankylosis,

advanced arthritis, joint deformation, pathologic hip dislocation or subluxation, and growth disturbance.^{9,10}

There have been many studies focusing on pulmonary TB and spinal TB, although fewer studies involved the pediatric HTB, especially the surgical treatment and the rare complication of pathologic hip dislocation or subluxation, which may result in a dysfunction joint.¹¹

The aim of this study was to evaluate the outcome of patients with stage I to III HTB treated by open surgical debridement combined with postoperative hip spica immobilization.

PATIENTS AND METHODS

This retrospective study was reviewed and approved by the Human and Ethics Committee for Medical Research at Sichuan University in accordance with the Declaration of Helsinki [No. 2022(745)]. Informed consent was obtained from all patients for being included in the study and written informed consent regarding publishing their data and photographs was obtained from parents of all pediatric participants.

From January 2010 to January 2016, totally 91 young patients with HTB of stage I to III received surgical debridement treatment in our department, West China Hospital. Four patients were excluded because of the loss of follow-up, and finally 87 patients were enrolled in the study. Routine chest and spine physical examination, chest x-ray and 3 sputum cultures for mycobacterium were performed for any patient suspected with HTB to search for the potential pulmonary TB and spine TB. If a pulmonary TB or severe spine TB was determined, another treatment strategy would be considered before the debridement of HTB, and these cases were not included in this study. The preoperative diagnosis was mainly a clinical diagnosis based on the clinical presentation, a history of TB or contact with TB, inflammatory markers, TB antibody test, interferon- γ release assay, and the radiographs. All patients who were surgically treated in our department routinely underwent smear and culture of the infection sample, acid-fast stain, and TB polymerase chain reaction for HTB diagnosis.

According to the classification by Tuli,^{7,8} HTB was divided into 4 stages, including synovitis stage, stage of early arthritis, stage of advanced arthritis, and stage of advanced arthritis with subluxation/dislocation (Table 1). Patients with stage IV HTB were not included because dislocation or subluxation already existed before treatment in this stage

and a single debridement procedure might be not enough for the treatment of these dislocated hip.¹²

All patients were less than 14 years of age and received open surgical debridement after 4 weeks of conservative treatment, including rest, protected weight-bearing, and antitubercular chemotherapy (4 drugs: rifampicin, isoniazid, pyrazinamide, and ethambutol).² Patients with obvious relief in symptoms and decrease in laboratory tests of erythrocyte sedimentation rate and C-reactive protein were considered for continuous conservative treatment rather than surgical treatment and were not included in this study. All diagnoses of the enrolled patients were confirmed by polymerase chain reaction testing or pathologic diagnosis of biopsy specimens.

Surgery was performed by 2 senior pediatric orthopaedic surgeons well trained in this technique under general anesthesia. An anterolateral approach was made to access the hip joint with patients in supine position. To achieve a thorough debridement, we performed a T-shaped capsulotomy from anterior and then dislocated the femoral head from the acetabulum. The debridement included the removal of infectious tissues, part of the hyperplastic synovium, necrotic tissues, and the sequestrum. The capsule was not closed, with only 2 sutures of the lateral articular capsule, and no drainage was used. The immobilization time of 4 or 6 weeks is not decided by the surgeon's preference or by a random method but based on the first time when the patients came back for follow-up. We usually recommended patients to come back at the time 4 to 6 weeks after surgery, according to their personal arrangement. A flexible follow-up time made it easier for those parents with full work schedule or those who lived far away from our hospital. After operation, patients in group A (39 patients) received postoperative hip spica for 4 weeks and group B (48 patients) received 6 weeks of hip spica to provide immobilization and postoperative hip instability. When spica was removed, patients were recommended partial weight-bearing for 7 days and then followed the same hip joint exercises program.

Postoperative antitubercular chemotherapy lasted for 1 year, consisting of 4 drugs protocol for 6 months (4 drugs: rifampicin, isoniazid, pyrazinamide, and ethambutol) and 2 drugs protocol for 6 months (2 drugs: rifampicin and isoniazid). All enrolled patients were followed up for at least 5 years, with a mean follow-up of 5.8 ± 1.6 years (range from 5 to 8 y). Patients were followed up about every 2

TABLE 1. Clinical-radiologic Classification of Tuberculosis of the Hip

Stages	Clinical Findings	Radiologic Features
Synovitis	Flexion, abduction, external rotation, apparent lengthening	Haziness of articular margins and rarefaction
Early arthritis	Flexion, adduction, internal rotation, apparent shortening	Rarefaction, osteopenia, bony erosions in femoral head, acetabulum, or both. No reduction in joint space
Advanced arthritis	Flexion, adduction, internal rotation, shortening	All of the above and destruction of articular surface, reduction in joint space
Advanced arthritis with subluxation/dislocation	Flexion, adduction, internal rotation with gross shortening	Gross destruction and reduction of joint space, wandering acetabulum

weeks for 2 months and then every 2 months during the first year, then every 2 years after the second year.

Data were collected from the hospital records, and the final clinical outcome was evaluated by 2 independent pediatric orthopaedic. During follow-up, patients were mainly assessed by postoperative radiographs (Fig. 1), modified Harris hip score (MHHS), complication of hip dislocation or subluxation, and wound healing problems.

SPSS 20 was used for data analysis. Continuous data were reported using the mean \pm SD and range. Categorical data are reported as numbers and percentages. Comparisons of variables between baseline and the endpoint were analyzed using paired *t* tests when the distribution was normal; comparisons of continuous data between these 2 groups were analyzed using independent-sample *t* test. Otherwise, the χ^2 test was used. A *P*-value of <0.05 was considered significant.

RESULTS

In total, 87 patients with HTB underwent open surgical debridement were retrospectively evaluated, including 34 females and 53 males, with a mean age of 7.2 ± 2.8 years old (range from 2 to 14 y). The most common chief complaint was pain in hip, which presented on 85 patients, others including the abnormal gait (46 patients), knee pain (4 patients), and low grade fever (8 patients). The average length of time from symptom onset to clinical diagnosis was 5.6 ± 3.7 months (from 3 wk

to 13 mo). Patients with HTB usually shared some classical characteristics in the laboratory tests, including a high erythrocyte sedimentation rate and an increased level of C-reactive protein. All these baseline data showed no significant difference between these 2 groups. The detailed data are presented in Table 2.

In group A, the mean MHHS improved from 52.1 ± 14.7 before surgery to 87.8 ± 8.3 at the final follow-up ($P < 0.000$). In group B, there was also a significant difference between the preoperative MHHS (52.7 ± 9.4) and the final MHHS (88.6 ± 6.5) ($P < 0.000$), whereas there was no significant difference found in the final MHHS between these 2 groups ($P = 0.593$). The only difference between these 2 groups was the early functional outcome after 4 weeks of exercise assessed by using MHHS. The early MHHS of group A was 79.2 ± 8.5 , significantly higher than that of group B (75.5 ± 7.5 , $P = 0.032$).

According to the modified Moon criteria (Table 3) for outcome assessment, there were 69.0% excellent (60/87), 14.9% good (13/87), 9.2% fair (8/87), and 6.9% poor (6/87) results in this group of patients.

There were 9 patients involved with mild wound healing delay, including 3 in group A and 6 in group B ($P = 0.705$), and successfully treated by dressing changes. During the 5 years follow-up, 4 patients developed pathologic hip subluxation, including 3 in group A and 1 in group B, which also showed no significant difference ($P = 0.467$).

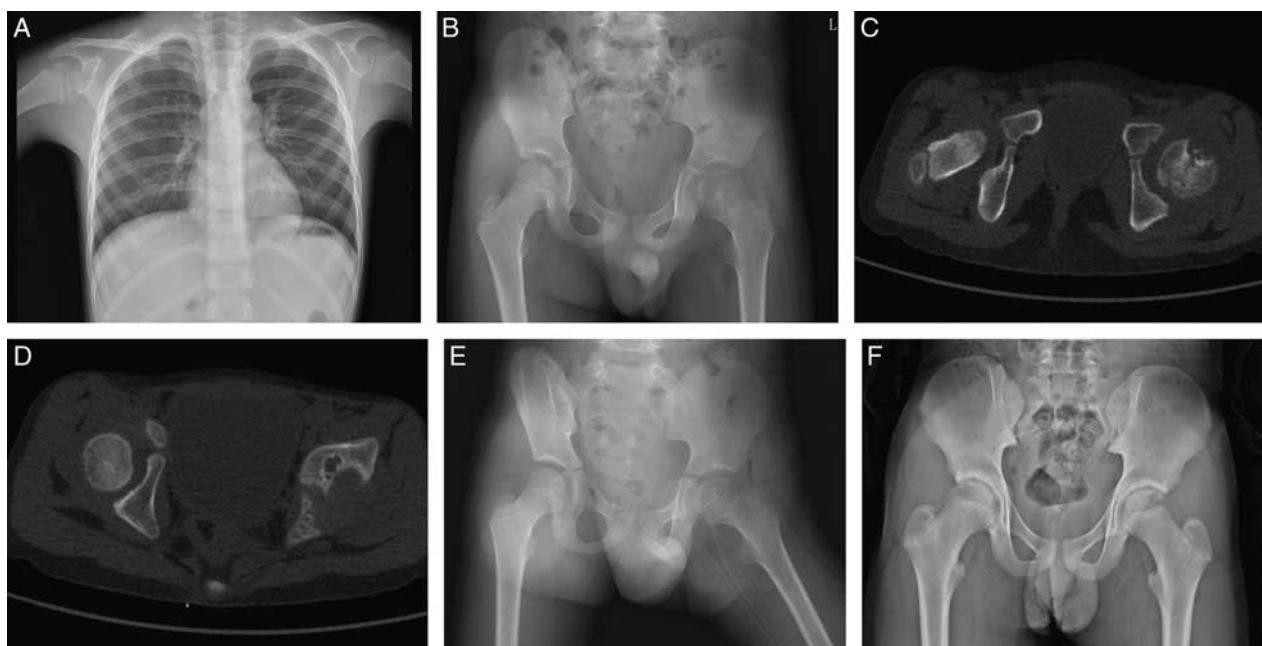


FIGURE 1. Radiographic outcomes of a 5-year-old boy diagnosed with hip tuberculosis of stage II and received open surgical treatment and hip spica. A, Preoperative chest radiograph. B, Preoperative pelvic radiograph. A bony erosion of acetabulum could be identified, and no sign of narrowing joint space or subluxated hip was observed. C and D, Preoperative computed tomography scans of hip joint presented with a centrally located femoral head and bony erosion of acetabulum. E, Postoperative x-ray with hip in an abduction position and a centrally located femoral head. F, Radiography of final follow-up at the fifth year after operation with a stable hip joint and satisfactory outcome.

TABLE 2. Demographic Data and Outcomes of the Patients With HTB

Characteristics	Group A	Group B	P
Sex	—	—	0.097
Female	19	15	—
Male	20	33	—
Age (y)	7.0 ± 2.7	7.4 ± 2.9	0.490
ESR (mm/h)	48.1 ± 25.5	46.8 ± 24.1	0.809
CRP (mg/L)	30.6 ± 18.6	37.8 ± 21.5	0.103
Symptom duration, months	5.25 ± 3.79	5.84 ± 3.60	0.461
Severity staging	—	—	0.474
Stage I	12	10	—
Stage II	18	28	—
Stage III	9	10	—
Preoperative MHHS	52.1 ± 14.7	52.7 ± 9.4	0.810
Early postoperative MHHS	79.2 ± 8.5	75.5 ± 7.5	0.032
Final postoperative MHHS	87.8 ± 8.3	88.6 ± 6.5	0.593
Wound healing delay	3	6	0.705
Subdislocation	3	1	0.467

CRP indicates C-reactive protein; ESR, erythrocyte sedimentation rate; HTB, hip joint tuberculosis; MHHS, modified Harris hip score.

DISCUSSION

Bone TB in childhood is still challenging in early diagnosis and treatment. The most common presentation of bone TB is spondylodiscitis (or Pott disease), and hip joint is one of the most frequent locations of tubercular arthritis in children.^{5,13} Prognosis of HTB depends on the disease extension. If diagnosed and treated at an early stage, ~90% to 95% of patients would achieve healing with near normal function.^{7,14} However, it is still difficult in the early diagnosis of TB, despite the progress of detecting technology.¹⁵ Kabore et al¹⁶ reported a nearly 1-year delay of diagnosis after clinical onset due to the nonspecific symptoms and radiologic characteristics of bone TB at early time. In a retrospective study from China, Chen et al¹⁷ also reported a prolonged time span of 13.16 months on the diagnosis of bone TB, which probably resulted from the atypical clinical characteristics, shortage of effective diagnosis measures and social-economic differences. In their study, the most common onset symptom was local pain (83.18%), followed by local swelling (11.5%) and impairment of function (3.5%). These atypical onset symptoms usually contribute little to the suspicion of bone TB. For childhood TB, finding direct evidence of organism in body fluids or tissues is also more difficult than adult. Only fewer than 40% of childhood TB can be microbiologically confirmed, and more than 60% childhood TB cases are diagnosed by the analysis of signs and symptoms, radiography, tests of infection, and epidemiology.^{18,19}

Because of these difficulties in early diagnosis of childhood HTB, outcomes of pediatric HTB are usually poor. Thus, more available, sensitive, and effective testing methods are still needed. In our study, we observed a 5.6 months delay in the diagnoses of HTB, which was shorter than those in the literature mentioned above. It might be related to the more aggressive operative indications we carried out, which could make it easier to get biopsy specimens for diagnoses. Another reason was that high TB burden in our areas made surgeons here more easily to suspect and early test for HTB.

Antitubercular chemotherapy is still the highly effective and primary treatment for HTB, whereas surgical debridement or synovectomy also plays an important role to avoid further damage of joint when there is no relief after conservative treatment.⁷ A delayed intervention may lead to more severe damage of bone and cartilage, subluxation, or ankylosis.^{20,21} Both open surgery and minimal invasive arthroscopy have been reported as the debridement procedures for joint TB in the literature.^{7,22,23} Moon et al²⁴ reported open surgical debridement or synovectomy combined with post-operation immobilization to treat pediatric HTB, with a good result of 73.1%. Tiwari et al²⁵ described hip arthroscopy as an effective and safe minimally invasive procedure in the treatment of pediatric HTB, which seemed to have more advantages in earlier return to activity, less invasive and less perioperative morbidity when compared with the open procedure. They also described the involvement of the labrum under arthroscopy might indicate a poor prognosis. The other difference between open surgery and arthroscopy procedure was the use of postoperative spica. After open surgical debridement, some authors recommended a hip spica for 4 to 6 weeks or even several months, which usually was absent for the arthroscopy procedure.^{24–26}

Pathologic dislocation or subluxation is a less common complication of hip infective arthritis, which could lead to severe joint dysfunction and difficulty in management.^{6,26} Campbell and Hoffman²⁷ reported an incidence of pathologic hip dislocation due to HTB as high as nearly 17%. Hip spica was a common procedure used in the treatment or prevention of hip dislocation in young patients, especially for these unstable hip joint after surgery. For pediatric HTB, a hip spica for 4 to 6 weeks was recommended as a conservative choice for young children to reduce pain when traction cannot be conducted.⁸ Moon et al²⁴ also reported immobilization with cast for 1 to 3 months after operation in the treatment of pediatric HTB and achieved good clinical outcome.

TABLE 3. Modified Moon Criteria for Hip Tuberculosis Assessment

Grading	Criteria
Excellent	Pain-free and normal ambulation; sitting cross legged and squatting possible
Good	Slight pain, occasional; no compromise in activities; uneasy squatting
Fair	Mild pain, rarely moderate pain with unusual activities, may require analgesics; no effect on average activities; some limitation in squatting and cross legged
Poor	Moderate and marked pain; limitation of ordinary activity and serious limitation of activities

However, long-term immobilization may bring a poor hip joint function. Saraf and Tuli⁸ believed that mobilization exercise could bring more satisfying results when compared with the immobilization by hip spica in pediatric HTB. DiFazio et al²⁸ found that long time cast was one of the predictors of skin complications in using of hip spica. Pisecky et al²⁹ also believed shorter protocols for spica cast immobilization after hip reconstruction led to less complications. Emara et al³⁰ described a 4-week immobilization with less complications and higher patient comfort when compared with the longer protocol in a prospective clinical trial. Literature showed various attempts to establish the duration of hip spica cast, while there is still no standard for the duration of postoperative hip spica in pediatric HTB treatment. In our study, the rate of subluxation in 4 weeks spica group (7.7%) was higher than that in the 6 weeks spica group (2.1%), with no significant difference ($P=0.467$). It might mean that prolonged hip spica showed no benefit on decreasing the risk of pathologic subluxation after debridement treatment, whereas pathologic subluxation could be a result of multi factors, such as parents' compliance, intensity of daily activity during rehabilitation period, and others. Thus, we could not draw a firm conclusion based on the limited available data. We still believed that time of spica immobilization should be individualized and based on the surgeon's evaluation and the patient's condition. Because a hip subluxation or dislocation due to HTB could be a catastrophic outcome in children.

Outcome of delayed pediatric HTB is usually poor because of high risks of complications.^{5,11,27} Moon et al²⁴ reported a 9.3% poor outcome in their retrospective study and nearly 71% minor morphologic abnormalities in the joints. Agarwal et al³¹ also reported a poor outcome of 18.5% in their retrospective study. According to the modified Moon criteria, poor outcomes was observed only in 6 patients (6.9%) in our study. One main reason for the low incidence of poor outcome in our study was the exclusion of stage IV HTB, which usually resulted in a damaged joint and poor outcome. We also used the MHHS to evaluate the functional outcome of patients preoperatively and postoperatively. There were significant improvements of MHHS after surgical treatment in both groups, which meant open surgical debridement combined with ATT was an effective treatment for HTB patients without relief after single conservative treatment. No significant difference was found in the postoperative MHHS between 4 weeks spica group and 6 weeks spica group, which might mean the duration of postoperative hip spica immobilization did not affect the final functional outcome. However, there was an obvious delay in early functional recovery when the immobilization time was increased from 4 to 6 weeks.

We reported 87 cases of HTB, which was a huge number in a single institution. There were several possible reasons. China has the second highest number of TB patients in the world, and some limited available epidemiologic data indicated an increasing trend in extrapulmonary TB in China.³² In a single center study from

China, Pang et al³³ reported 19,279 hospitalized TB patients, with 33.4% (6433 cases) extrapulmonary TB between 2008 and 2017. In their study, the most common extrapulmonary TB was skeletal TB (44.1%). In another epidemiological study of extrapulmonary TB from China between 2015 and 2018, 204 cases of skeletal TB were reported.³⁴ Another reason for this finding was that Western China were TB high-burden areas. The fifth national TB epidemiological survey in China indicated that Western China had the highest prevalence of TB when compared with other regions.³⁵ Our hospital was one of the largest medical centers in Western China receiving patients from many other provinces. These might be the reasons why we had so many HTB cases and even more than the other area of China.

There were still some limitations in our study. Two main functional assessment systems for pediatric HTB have been reported in literature: the MHHS and the Moon criteria, which were both used in our study. Functional assessment of HTB was difficult in children and there was still no consensus on the scoring system. We also do not have much experience on it because few studies focused on this. Thus, both assessment systems above were tried in our study. In our study, the mean postoperative Harris Hip Score was about 80s. This finding should be combined with functional results assessed by another assessment system. According to the modified Moon criteria, there were 69.0% excellent (60/87) results, which meant a nearly normal hip joint function and a high score. The remaining 31% patients had unsatisfactory functional outcomes in various degrees with lower scores. This could be a possible reason for the mean scores of the 80s. Growth discrepancy is less frequent in patients with early-stage HTB or stable hip joint. Sometimes, abnormal gait and false unequal leg length could be observed, which mainly caused by the pelvic obliquity, the poor function of hip joint, or the severe destruction. A true leg length discrepancy is not so common or obvious in early time, and we did not focus on this problem.

Other limitations of our study included small sample size and nonrandomized retrospective study design. In addition, intensity of daily activity in different patients during rehabilitation period were also not considered, which might have influences on the early hip stability and function. Therefore, we could not draw a firm conclusion, and further research was needed.

CONCLUSIONS

Open surgical debridement combined with anti-tubercular chemotherapy is an option for pediatric HTB patients with no relief after conservative treatment. Prolonged spica cast immobilization may not reduce the risk of postoperative dislocation or subluxation but could lead to a delay in early functional recovery. Time of spica immobilization should be individualized and based on the surgeon's evaluation and the patient's condition.

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