Abstract

Objective: To investigate the clinical efficacy of one-stage total hip arthroplasty (THA) for treating the advanced hip tuberculosis. Methods: A retrospective study was conducted from July 2013 to June 2018, including 19 patients with advanced hip tuberculosis. All patients underwent total hip arthroplasty through posterior approach, and the surgical efficacy was evaluated. Results: Nineteen patients were followed up from 24 months to 48 months, the mean follow-up were 32.1 months. All the incisions healed in grade A. There were no aseptic loosening, dislocation or recurrence of hip tuberculosis after operation. At the last follow-up, the Harris score of the patients was (89.3 ± 6.7), which was significantly higher than (38.2 ± 10.5) of the patients before operation (P < 0.05); the flexion-extension range of motion was (93.6 ± 12.1°), which was significantly larger than (38.2° ± 10.5°) of the patients before operation (P < 0.05). Conclusion: The one-stage total hip arthroplasty with regular antituberculosis treatment can attain satisfactory clinical efficacy in the treatment of advanced hip tuberculosis, which can relieve the joint pain and improve the joint function, without recurrence of hip tuberculosis.

Keywords

hip, one-stage total hip arthroplasty, treatment, tuberculosis

Background

Tuberculosis (TB) is a chronic bacterial infection caused by Mycobacterium tuberculosis (MTB), accounting for approximately 6.4 million new tuberculosis cases worldwide in 2018. Osteoarticular tuberculosis accounts for about 10% of extrapulmonary tuberculosis. Tuberculosis (TB) of the hip consists of 10% to 15% of all patients with osteoarticular tuberculosis. Because the early symptoms and radiological changes are not characteristic, early diagnosis and treatment was often missed. Patients with the advanced hip TB often suffer from severe pain, deformity and instability caused by severe cartilage and bone destruction. Total hip arthroplasty (THA) is the most successful intervention for pain relief, infection control and reconstruction of the hip function. Two-stage THA achieves a satisfactory clinical efficacy for treating the advanced hip tuberculosis. However, two-stage replacement must spend several months after debridement, which may lead to poor joint mobility, even stiffness and muscle atrophy, increasing the difficulty of whole treatment procedure. Several studies suggested that single-stage THA could attain satisfactory clinical efficacy and effectively shorten the time of treatment. The purpose of this study was to...
investigate the clinical outcomes of one-stage THA in the treatment of advanced hip tuberculosis. We retrospectively analyzed 19 cases of advanced hip tuberculosis under one-stage THA performed in our institution. The clinical outcomes were satisfactory.

Methods

Inclusion criteria: (1) patients with unilateral stage III and IV hip tuberculosis; (2) patients with regular antituberculosis treatment for more than 4 weeks before surgery; (3) preoperative ESR decreased significantly or less than 40 mm/h; (4) patients with hip tuberculosis diagnosed pathologically after surgery; (5) patients treated with one-stage THA; and (6) patients who received routine antituberculosis treatment after surgery.

Exclusion criteria include (1) patients who received debriement before the THA; (2) those cannot tolerate THA and anesthesia; (3) patients who cannot tolerate antituberculosis drugs or have drug resistance; (4) patients with active extra osteoarticular tuberculosis.

From July 2013 to June 2018, a total of 19 patients were involved in this study, including 9 males and 10 females, age range from 34 to 71 years, with an average age of 48.5 years. The course of the disease ranged from 9 months to 12 years, with a median of 5 years. According to clinical and radiologic classification suggested by Babhulkar and Pande,12 stage III and IV hip TB were involved in advanced hip tuberculosis, including 13 cases in stage III and 6 cases in stage IV. Ten cases had a history of pulmonary tuberculosis. Comprehensive laboratory examinations were finished before surgery, including blood routine examination, tuberculosis T-SPOT examination, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and other routine examinations. Radiological examinations including X-ray, CT and MRI showed destruction of acetabulum and femoral head, and 13 cases with dead bone and abscess. No sinus formation was seen in all patients. The mean erythrocyte sedimentation rate (ESR) was 36.3 ± 14.2 mm/h before operation. This study was approved by the ethics committee of our hospital, and the patients were informed and agreed to this study.

All patients received regular antituberculosis therapy with an average 36.4 days (from 28 days to 52 days) before operation. The antituberculosis drugs were as follows: isoniazid 5 mg/(kg·d), rifampicin 450–600 mg/D, ethambutol 15 mg/(kg·d), and pyrazinamide 15–30 mg/(kg·d). Blood routine, liver and kidney function, ESR and CRP were reviewed weekly during antituberculosis chemotherapy. One-stage THA was performed when the ESR level decreased significantly or less than 40 mm/h.

Surgical technique

The senior surgeon performed THA by using the same surgical technique and perioperative protocol for all patients. All operations were performed under general anesthesia, and the whole anesthetic procedure was under management of an experienced anesthetist.

Through the posterior approach, the hip joint capsule was incised to fully expose the acetabulum and femoral head. All tuberculous lesions were removed completely. Pathological biopsy should be performed to confirm the diagnosis of TB. The acetabular reaming was performed to maintain an abduction angle of 40°–45° and an anteversion angle of 15°–20°. Autogenous bone graft or allogeneic bone can be used to fill the bone defect of the acetabulum. Osteotomy was performed at the base of femoral neck. Granulation tissues and dead bones around acetabulum and trochanter should be removed completely. Diluted iodine complex and pulse irrigator were used for rinsing. Streptomycin powder was sprayed into the joint cavity before the prosthesis was placed. After the fluoroscopy with a C-arm X-ray machine showed that result was satisfactory, stem prosthesis and femoral head prosthesis were implanted. After the movement and stability of hip joint were re-tested, an intra-articular suction drain was placed.

Postoperative management

Once the procedure was finished, patients were transferred into PACU (Postanesthesia care unit). After the pain and PONV (postoperative nausea and vomiting) were controlled and active bleeding disappeared, patients were then transferred to the ward. Low molecular weight heparin calcium was injected subcutaneously 12 hours after the operation, and rivaroxaban was given orally for anticoagulation 5 weeks after operation. The wound drainage was removed 48–72 hours after operation. After operation, routine antituberculosis treatment was given, and the average time of the treatment was (9.8 ± 2.8) months. During the follow-up, the liver and kidney function and ESR of the patients were reviewed.

The primary outcome measures included visual analog score (VAS) and Harris hip score (HHS). The length of stay (LOS) and hip flexion-extension range of motion (ROM) were recorded. All patients were regularly followed up in 1, 3, 6 month(s) and then annually after the operation. The X-ray examination of pelvis should be examined. If necessary, CT or MRI of hip joint was reexamined to observe whether there was loosening and dislocation of prosthesis, recurrence of tuberculosis and other postoperative complications.

Statistical methods

SPSS 21.0 statistical software was employed for statistical analysis. Measurement data were expressed as mean ± standard deviation (SD). Repeated analysis of variance was used for comparison between time points before and after surgery in the groups. Paired t test was used for pairwise comparison. Inspection level was set at α = 0.05.
Table 1. Comparison of results before treatment and at the last follow-up (x ± s).

|                      | VAS score | HHS score | ROM (°) | ESR (mm/h) | CRP (mg/L) |
|----------------------|-----------|-----------|---------|------------|------------|
| Before treatment     | 6.9 ± 2.1 | 38.2 ± 10.5 | 32.3 ± 8.9 | 36.3 ± 14.2 | 18.2 ± 7.9 |
| Last follow-up       | 1.1 ± 0.8 | 89.3 ± 6.7  | 93.6 ± 12.1 | 10.3 ± 3.0  | 4.6 ± 2.0  |
| Paired t test        | <0.05     | <0.05      | <0.05    | <0.05      | <0.05      |

Results

All the patients had a smooth surgical procedure with no vascular and nerve injuries or complicated fractures, and the incision was healed in stage I. The postoperative pathological diagnosis of 19 patients were tuberculosis. Nineteen patients were followed up from 24 months to 48 months, the mean follow-up were 32.1 months. No radiolucent line was found on X-ray films, indicating no prosthesis loosening. No dislocation of prosthesis and recurrence of tuberculosis were found in all patients. At the last follow-up, the VAS pain score, HHS score, the ROM, ESR, and CRP were significantly improved compared to before treatment (Table 1).

Case

Here we chose a case example which could represent the synopsis of the general treatment procedure of all the patients. A 69-year-old male, complained of repetitive pain and limited mobility of right hip for 2 years. Physical examination indicated obvious pain when right hip was hyper-extended, with a definitely positive Patrick test and Thomas sign. The right hip joint was limited in abduction, adduction, external rotation and extension. The X-ray showed a slight bone destruction of the right hip joint. MRI showed narrowing of the hip joint space, thickening of the joint synovium, effusion in the joint cavity, and swelling of the proximal femur and the soft tissue around the joint muscles. In addition, this patient had a history of pulmonary tuberculosis and was healed 20 years ago. The diagnosis of tuberculosis of the right hip joint was fully confirmed. Regular antituberculosis treatments was given, and the symptoms were improved after 4 weeks. After laboratory examinations including ESR and CRP were tested, a one-stage THA was performed. Postoperative pathological biopsy confirmed hip tuberculosis, while the negative cultures were reported. Regular antituberculosis treatment was continued for 12 months after operation. After 2-year follow-up, the symptoms of the right hip joint improved significantly (Figure 1).

Discussion

Osteoarticular tuberculosis is the second most common forms of extrapulmonary tuberculosis which is only less than spinal TB. Hip tuberculosis (TB) is the most common osteoarticular tuberculosis, consisting of 10% to 15% of total joint TB cases. Early-stage tuberculosis of the hip is often undetected due to its atypical symptoms. Since the disability rate is very high, the early diagnosis and treatment for hip tuberculosis is important for restoring the limb function. Diagnosis of osteoarticular TB is difficult since the blood examinations may not have high sensitivity and specificity. Vaccination of BCG made Mantoux test less significant in diagnosis of osteoarticular TB. There could be severe bone destruction of acetabulum and femoral head in patients with advanced hip tuberculosis, associated with the narrowed or even disappeared joint cavity. MRI is essential for the diagnosis, which could show the roughness and narrowing of the joint cavity, thickening of synovial, abscess in joint capsule, destruction of bone, etc. The clinical symptoms of hip tuberculosis are often not characteristic. Typical symptoms of tuberculosis such as swelling, pain, low fever, fatigue, weight loss, night sweats, and chronic cough might not be found. A history of pulmonary TB is helpful for diagnosis. Meanwhile, differential diagnosis including purulent arthritis, neoplastic lesions and rheumatoid arthritis should be strictly compared through radiological and laboratory examinations. Diagnostic antituberculosis treatment can work as well. Pathological biopsy is the gold standard for diagnosis of hip TB. In this study, the radiological imaging and laboratory examinations of all patients suggested a diagnosis of tuberculosis. ESR, CRP and symptoms were significantly improved after preoperative antituberculosis (ATT) treatment. Intraoperative pathological biopsy also confirmed the diagnosis of tuberculosis. All of the evidences provided solid support for the successful one-stage THA.

Surgical procedures including debridement, hip arthrodesis (HA) and arthroplasty were commonly used for treating hip TB. Compared with HA, THA is a superior treatment for advanced tuberculous arthritis. Two-stage THA after a lesions debride ment used to be the most common surgical option, which could lead to a significant improvement of hip function and pain relief. However, the disadvantages of staged THA were also obvious: the joint function of the patients might not been fundamentally improved due to the prolonged treatment and function loss caused by stiffness and muscle atrophy. With the progress of surgical technique and antituberculosis treatment, single-stage THA was gradually used in the treatment of advanced hip tuberculosis, which could effectively reduce the time and cost of the treatment. Zhang and Zhang suggested that one-stage THA with prolonged regular antituberculosis treatment can attain a better long-term efficacy.
without increasing the rate of TB recurrence. However, whether one-stage THA affects the recurrence rate of tuberculosis is still controversial. The purpose of this retrospective study was to investigate the short-term efficacy and safety of single-stage THA for treating patients with advanced hip tuberculosis. The results of our study suggested that one-stage total hip arthroplasty with regular antituberculosis treatment can attain satisfactory clinical efficacy. Meanwhile, in our opinion, one-stage THA is not suitable for all cases. Patients with discharging sinuses should not receive a single-stage procedure, for a draining sinus could increase the risk of reactivation and provide the free access for pyogenic organisms to adhere with THA prosthesis. In addition, large bone defect (>10 mm) or bone cavities of acetabulum might result in inadequate debridement, leading to recurrence after one-stage THA. Patients with draining sinus or large bone defect (>10 mm) or bone cavities of acetabulum were excluded from one-stage THA in our institution.

The treatment of patients with advanced tuberculous arthritis remains challenging. Antituberculosis treatment before and after operation is essential for treating osteoarticular TB. Effective preoperative ATT can reduce the burden of Tuberculosis bacteria, relieve the pain and malnutrition caused by the long-term suffering of TB. Kim et al. described a series of 44 patients of hip TB, all patients were performed THA but without receiving ATT in the pre- and postoperative periods. Six patients (14%) in their study were found reactivity. Several studies suggested that regular and long-term pre- and postoperative ATT must be conducted in all tuberculous arthritis to prevent reactivity and reoccurrence. The study of Tiwari et al. suggested that the prognosis is good with prolonged antibiotic therapy, while the optimal duration remains unclear. Complete debridement of tuberculosis lesions is also important for avoiding the recurrence. All 19 patients with advanced tuberculosis of hip in our study were given routine antituberculosis treatment before operation for at least 4 weeks. During the operation, all the tissues of tuberculosis were completely removed, associated with high pressure and pulsing squirt gun. All patients were implanted with cementless prosthesis. After operation, the standard

Figure 1. A 69-year-old male with joint tuberculosis of right hip. (a) Preoperative anteroposterior X-ray. (b and c) Preoperative coronal MRI. (d) Postoperative pathological biopsy. (e) Postoperative anteroposterior X-ray 12 months after operation.
antituberculosis treatment was continued for at least 12 months. All cases attained satisfactory clinical outcomes without any recurrence. After single-stage THA, the pain was significantly relieved, and the hip function was effectively improved. In our opinion, long-term and regular antituberculosis treatment before and after the surgery is essential for reducing the recurrence. Although the guidelines of the Infectious Diseases Society of America recommend 6 to 9 months’ ATT for patients with osteoarticular TB could be enough if the postoperative inflammatory markers are normal and clinical findings satisfactory,24 our suggestion is to continue ATT for at least 12 months with ESR was normal for 3 months consecutively, considering that reactivation or superinfection can be a devastating complication of THA. In recent years, the continuous development and clinical application of antituberculosis drugs have made it possible for one-stage total hip arthroplasty to treat advanced hip tuberculosis effectively and safely.25 Meanwhile, cementless THA was an effective treatment for advanced tuberculosis of the hip.24 The adhesion of Mycobacterium tuberculosis to the surface of prosthesis is poor. Studies have shown that MTB propagates slowly, sometimes in a dormant state, and would produce less adhesion molecules in the process of reproduction, which has low adhesion on the surface of titanium alloy and cobalt chromium molybdenum alloy. It is uneasy for MTB to form biofilm so that is easy to be treated with antituberculosis drugs.26 This is the main theoretical foundation for single-stage THA to treat advanced hip TB. Similar to our study, Kim et al.27 reported the long-term follow-up results of 60 patients with hip tuberculosis treated by one-stage total hip arthroplasty, and the efficacy was satisfactory.

Based on our experience, we suggests several tips for improving the efficacy of the operation. (1) Before operation, X-ray and MRI of the hip are essential and should be performed to confirm the scope of lesions. CT might be performed if preoperative three-dimensional navigation is needed. ESR and CRP should be significantly decreased or close to normal after preoperative antituberculosis treatment. (2) Debridement of the lesions should be performed completely; (3) Routine indwelling wound drainage tube for 48–72 hours, which could reduce the residual tuberculous bacteria in joint cavity, (4) Sufficient and regular antituberculosis treatment before and after the surgery is essential. (5) Enhancing clinician comprehension of all aspects of the disease and applying new treatment methods to clinical practice can ultimately benefit the patients.28

This study had several limitations. First, the sample size was relatively small, which made it hard to identify the complications that may be resulted from the treatment and operation. Second, the follow-up period is not enough to observe the long-term outcomes and recurrence rate. Those limitations could be avoided in future larger sample-sized and long-term follow-up studies.

Conclusion

Overall, our results suggest that, the clinical efficacy of stage I total hip arthroplasty in the treatment of advanced hip tuberculosis is satisfactory with significant postoperative pain relief, joint function improvement, and no recurrence of hip tuberculosis. But in clinical practice, more attention should be paid to strict compliance with the indications and prevention of the early complications. The long-term efficacy needs to be further observed.

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References

1. Moreira A, Kritski AL and Carvalho A. Social determinants of health and catastrophic costs associated with the diagnosis and treatment of tuberculosis [in Portuguese]. J Bras Pneumol 2020; 46(5): e20200015.
2. Fan J, An J, Shu W, et al. Epidemiology of skeletal tuberculosis in Beijing, China: a 10-year retrospective analysis of data. Eur J Clin Microbiol Infect Dis 2020; 39(11): 2019–2025.
3. Sun Q, Wang S, Dong W, et al. Diagnostic value of Xpert MTB/RIF Ultra for osteoarticular tuberculosis. J Infect 2019; 79(2): 153–158.
4. Cansü E, Erdogan F and Ulusam AO. Incision infection with Mycobacterium tuberculosis after total hip arthroplasty without any primary tuberculosis focus. J Arthroplasty 2011; 26(3): 505.e1–505.e3.
5. White LV, Edwards T, Lee N, et al. Patterns and predictors of co-morbidities in tuberculosis: a cross-sectional study in the Philippines. Sci Rep 2020; 10(1): 4100.
6. Bhosale PB, Jaiswal R, Purohit S, et al. Total hip arthroplasty in 52 active advanced tubercular hip arthritis. J Arthroplasty 2021; 36(3): 1035–1042.
7. Saraf SK and Tuli SM. Tuberculosis of hip: a current concept review. Indian J Orthop 2015; 49(1): 1–9.
8. Sultan AA, Dalton SE, Umpierrez E, et al. Total hip arthroplasty in the setting of tuberculosis infection of the hip: a systematic analysis of the current evidence. Expert Rev Med Devices 2019; 16(5): 363–371.
9. Li L, Chou K, Deng J, et al. Two-stage total hip arthroplasty for patients with advanced active tuberculosis of the hip. J Orthop Surg Res 2016; 11: 38.
10. Chang CH, Hu CC, Chang Y, et al. Two-stage revision arthroplasty for Mycobacterium tuberculosis periprosthetic joint...
infection: an outcome analysis. *PLoS One* 2018; 13(9): e0203585.

11. Zhang YC and Zhang H. One-stage total joint arthroplasty for patients with active tuberculosis. *Orthopedics* 2013; 36(5): 328–330.

12. Babhulkar S and Pande S. Tuberculosis of the hip. *Clin Orthop Relat Res* 2002; 398: 93–99.

13. Shirzad-Aski H, Hamidi N, Sohrabi A, et al. Incidence, risk factors and clinical characteristics of extra-pulmonary tuberculosis patients: a ten-year study in the North of Iran. *Trop Med Int Health* 2020; 25(9): 1131–1139.

14. Slogotskaya L, Bogorodskaya E, Ivanova D, et al. Comparative sensitivity of the test with tuberculosis recombinant allergen, containing ESAT6-CFP10 protein, and Mantoux test with 2 TU PPD-L in newly diagnosed tuberculosis children and adolescents in Moscow. *PLoS One* 2018; 13(12): e0208705.

15. Wang Y, Wang J, Xu Z, et al. Total hip arthroplasty for active tuberculosis of the hip. *Int Orthop* 2010; 34(8): 1111–1114.

16. Barik S, Choudhury AK, Singh V, et al. Extra-spinal osteoarticular tuberculosis: a retrospective analysis of 103 cases. *Curr Health Sci J* 2019; 45(2): 142–147.

17. Guirao Arrabal E, Pérez Sola MJ, Montes Ruiz-Cabello M, et al. Osteoarticular tuberculosis of the hip and soft tissues: images of a diagnostic delay. *Rev Esp Quimioter* 2018; 31(4): 383–385.

18. Neogi DS, Yadav CS, Kumar A, et al. Total hip arthroplasty in patients with active tuberculosis of the hip with advanced arthritis. *Clin Orthop Relat Res* 2010; 468(2): 605–612.

19. Liu CS, Liu FZ, Wang XY, et al. Comparison of total curative effect between total hip arthroplasty and hip arthrodesis in treating coxotuberculosis. *Eur Rev Med Pharm Sci* 2018; 22(Suppl 1): 90–95.

20. Vogelpoel EE, Been JJ and de Gast AA. Two-stage treatment of acetabular bone defect in tuberculosis of the hip by intended ankylosis followed by total hip arthroplasty: a case report. *Cases J* 2009; 2: 6532.

21. Kim YH, Han DY and Park BM. Total hip arthroplasty for tuberculous coxarthrosis. *J Bone Joint Surg Am* 1987; 69(5): 718–727.

22. Tiwari A, Karkhur Y and Maini L. Total hip replacement in tuberculosis of hip: a systematic review. *J Clin Orthop Trauma* 2018; 9(1): 54–57.

23. Oztürkmen Y, Karamehmetoğlu M, Leblebici C, et al. Cementless total hip arthroplasty for the management of tuberculosis coxitis. *Arch Orthop Trauma Surg* 2010; 130(2): 197–203.

24. Wang Q, Shen H, Jiang Y, et al. Cementless total hip arthroplasty for the treatment of advanced tuberculosis of the hip. *Orthopedics* 2011; 34(2): 90.

25. Zeng M, Hu Y, Leng Y, et al. Cementless total hip arthroplasty in advanced tuberculosis of the hip. *Int Orthop* 2015; 39(11): 2103–2107.

26. Kashyap A, Singh PK, Satpati S, et al. Pharmacophore modeling and molecular dynamics approach to identify putative DNA gyrase B inhibitors for resistant tuberculosis. *J Cell Biochem* 2019; 120(3): 3149–3159.

27. Kim YY, Ahn JY, Sung YB, et al. Long-term results of Charnley low-friction arthroplasty in tuberculosis of the hip. *J Arthroplasty* 2001; 16(8 Suppl 1): 106–110.

28. Mediouni M, Schlatterer DR, Madry H, et al. A review of translational medicine. The future paradigm: how can we connect the orthopedic dots better? *Curr Med Res Opin* 2018; 34(7): 1217–1229.