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Comparative Randomized Study of The Outcome of Single versus Two Stage Revision for Prosthetic Hip Infection

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ABSTRACT

Background: Continuous debates persist on the gold standard approach for managing periprosthetic joint infection (PJI) following total hip arthroplasty (THA).

Objective: This study aimed to compare the outcomes of single-stage revision versus two-stage revision for PJI after THA.

Patients and methods: 40 patients were included in this study with minimum duration of follow-up of 12 months. The patients were divided into two equal groups. **Group A** (n=20): Single-stage revision THA. **Group B** (n=20): Two-stage revision THA. Infection eradication, Harris hip score (HHS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, radiological evaluation and complications were compared between the two groups.

Results: There was one case of reinfection, which occurred in group B. In group A, the mean HHS was 91.70 ± 3.79 and mean WOMAC score 9.95 ± 3.78. In group B, scores were lower with mean HHS of 88.85 ± 5.31 and mean WOMAC score 15.90 ± 7.32 and complication rates were higher. There were no significant differences in radiographic outcome between the groups.

Conclusion: The single-stage revision was associated with several advantages, including shorter hospital stays, reduced duration of antibiotic therapy and superior functional outcomes as well as more efficient recovery.

Keywords: Prosthetic hip infection, PJI, THA.

INTRODUCTION

Periprosthetic joint infection (PJI) is one of the common complications following primary Total Hip Arthroplasty (THA) and is associated with a high morbidity and mortality [(1)]. The incidence of PJI ranges between 0.5% and 2% following THA [(2)].

Revision THA is a complex surgical procedure because it has longer duration of surgery, requires more expensive prosthesis, carries higher complication rates and longer hospital stays [(3)]. Presentation of infection vary from acute periprosthetic infection with draining sinuses and septicemia to chronic late loosening of implants that might have lasted for many years [(4)].

Accurate diagnosis is required for proper management of PJI as several factors must be taken into consideration when determining treatment options as the duration of symptoms, patient's general condition, presence of septic focus, local soft tissue condition, bone defects and functional expectations [(5)].

The Musculoskeletal Infection Society (MSIS) working group presented diagnostic criteria for PJI in 2018 based on clinical findings, hematological tests and preoperative cultures [(6)]. Successful management of PJI doesn't involve infection eradication only but also restoring patient mobility and functional activities, which are essential for patient satisfaction [(7)].

Ideal evaluation of any treatment algorithm for PJI should be from a multidisciplinary perspective, including infection eradication, radiographic and functional outcome [(8)]. The management of PJIs post THA varies either debridement antibiotics and implant retention (DAIR) with or without exchange of bearings; single-stage revision arthroplasty or two-stage revision arthroplasty, or excisional arthroplasty [(9)].

A two-stage revision arthroplasty has been considered the gold standard for management of PJIs, however a single stage revision approach can serve as a good alternative for carefully selected patient groups [(10)].

PATIENTS AND METHODS

General: Forty patients with periprosthetic hip infection according to criteria of Philadelphia consensus of periprosthetic joint infection 2018 [(6)] were included in this prospective study that was conducted between February 2022 to July 2024.

Inclusion criteria: Age more than 18 years, no history of prior surgical debridement or failed revision surgeries and with minimum duration of follow-up of 12 months.

Exclusion criteria: Severely immunocompromised patients, patients with active systemic infection or sepsis at the time of surgery and patients with failed previous revisions (either single-stage or two-stage).

Patients included in study were randomized into two groups: Group A [Single stage group (SSG) that included twenty patients and group B [Two stage group (TSG) that included twenty patients].

All patients included in the study were subjected to preoperative hip aspirations in the operative theater with sterile precautions under fluoroscopic guidance. All patients received thorough preoperative counseling

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regarding the surgical plan, required investigations, anticipated rehabilitation timelines and possible postoperative complications and consent to be included in the study. Clinical evaluation was performed preoperatively through Harris Hip Score (HHS) [(11)] and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC score) [(12)]. Also, bone defects were assessed and classified according to Paprosky classification of acetabular bone loss.

Single stage revision (SS): All procedures were performed through posterior approach in lateral decubitus position utilizing previous skin incisions with proximal and distal extensions for adequate exposure. Aggressive mechanical debridement with gentle acetabular components removal to preserve bone stock as much as possible. Extended trochanteric osteotomy was done whenever needed to safely extract femoral implants and remove cement mantles. Five deep tissue specimens at least were obtained and sent for standard and deep cultures. Chemical debridement using 3% hydrogen peroxide, povidone-iodine (0.3%) and pulsatile saline lavage (total 6–9 liters) till reaching fresh bone bed with gentle bleeding and bone defect after debridement was carefully assessed.

Following debridement surgical site was re-sterilized and re-draped with the surgical team changing gloves, gowns, and instruments and intravenous antibiotics were administered

Intraoperative assessment of acetabular bony defects was performed and impaction grafting for acetabular defects was performed using a fresh frozen femoral head allograft divided into bone chips 8-12 mm mixed with antibiotics that was impacted gently in layers until the defects were filled and fully seated.

High acetabular defects grades were augmented by reconstruction rings (Kerboull Cross ring) or Tantalum augments.

Regarding the femoral side long cementless Wagner SL stem or long distal femoral locked stem SAGITTA EVL R stems (in cases with significant proximal bone loss that can't tolerate standard implants) were inserted (Figure 1).

Local antibiotics were poured all over the implanted implants in majority of cases relying on the previous culture results by preoperative hip aspiration. Osteotomies were closed using cerclage wires and external rotators were repaired using non-absorbable sutures.

Figure (1-A): left image (a): Preoperative PXR of infected cementless THA with loosening of the acetabular cup and proximal migration and loosening around the femoral stem were noted. Staphylococcus aureus organism was identified by preoperative hip aspiration.

Right and middle images (b): Postoperative PXR of cemented dual mobility cup and acetabular reconstruction with tantalum augment and long cementless distal femoral locked stem.

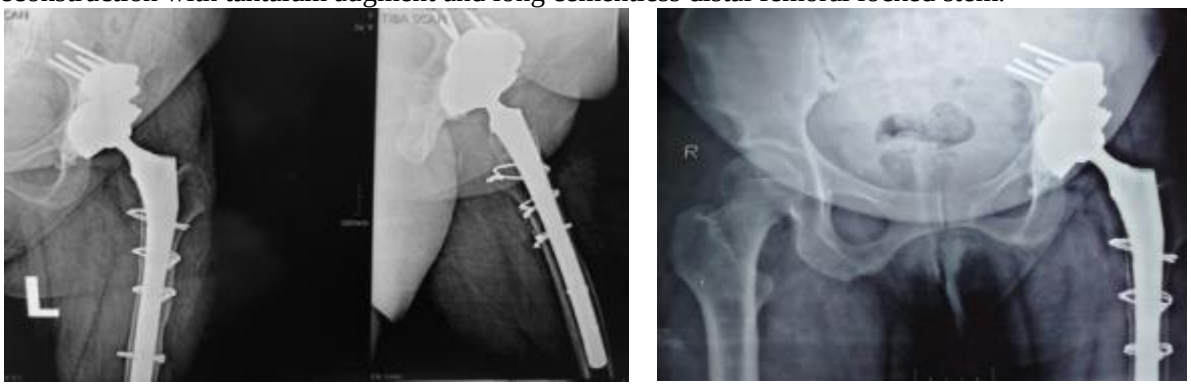

Figure (1-B): Left and middle images (c): 6 months follow up revealed well-fitting acetabular and femoral components and full union in osteotomy site.
Right image (d): Final 37 follow up months revealing stable acetabular and femoral components.

Two stage revision (TS)

A) First stage:

All technical intraoperative steps performed in the single stage were followed with additional attention for preserving acetabular bone stock and minimizing segmental defects to reduce spacer instability till antibiotic infusion and intraoperatively hand-made spacers were molded from 2 packs of antibiotic-loaded bone cement around a reshaped rush pin to restore proximal femoral anatomy and ensure stability. Articulating spacer (KIWI Hip) was done in two cases, which were poorly cemented THR in two active ambulatory patients with high functional demands to prevent soft tissues contractures and to provide good joint mobility (Figure 2).

Figure (2): left image (a): Static antibiotic loaded cement handmade spacer around rush pin. Right image (b): Articulating spacer (KIWI hip) with poor cementation technique.

B) Interval period between two stages:

Antibiotic standard regimen for majority of cases IV antibiotics were continued for 4–6 weeks based on culture and clinical status followed by 4-6 weeks of oral antibiotics. Continuous monitoring of clinical and radiological signs in addition to laboratory investigations (CBC, ESR, CRP) to ensure infection subsidence. Two weeks of antibiotic holiday period before second stage were allowed in all patients.

C) Second stage:

Spacers were carefully removed and additional aggressive debridement was performed. Bone stock and surrounding soft tissue landmarks were preserved as much as possible and deep specimens from the medullary canal, the acetabulum and the membrane around spacer were taken**.** Acetabular reconstruction to address bone defects if needed by both augments, reconstruction ring & impaction of bone graft and acetabular components either cemented or cementless were chosen based on bone quality. Femoral stems reimplantation in the TSG were the same as SSG relying on proximal bone loss and osteolysis. Antibiotics were continued after the second stage for 6-8 weeks according to previous culture results (Figure 3).

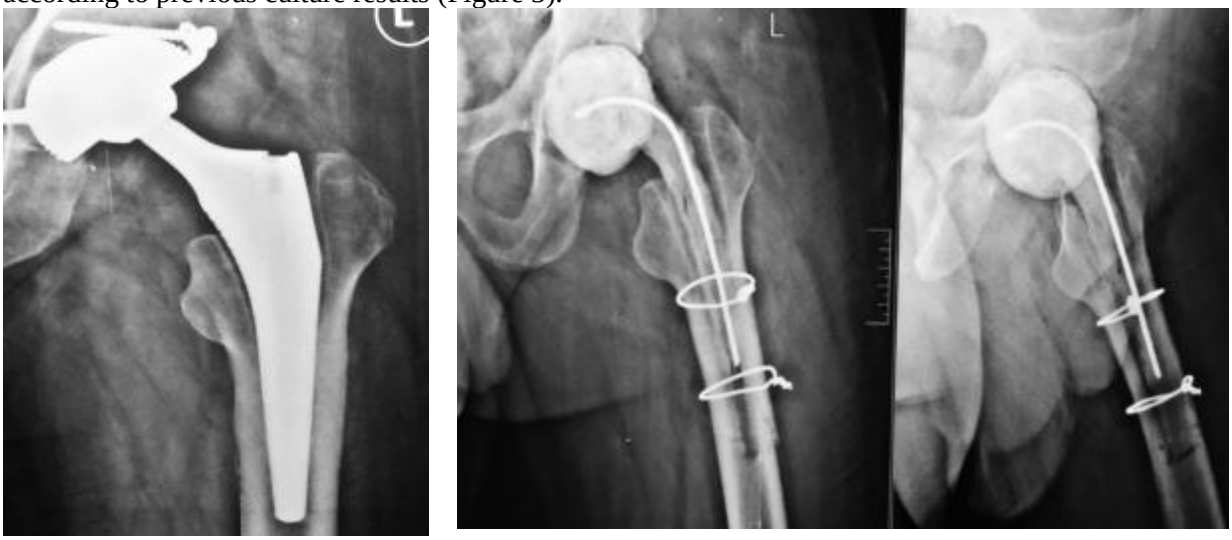

Figure (3 A) left image (a): Preoperative cementless THA showed progressive radiolucent lines around the femoral stem and acetabular cup. **Right and middle images (b):** X-ray after first stage revision with stable static handmade cement spacer.

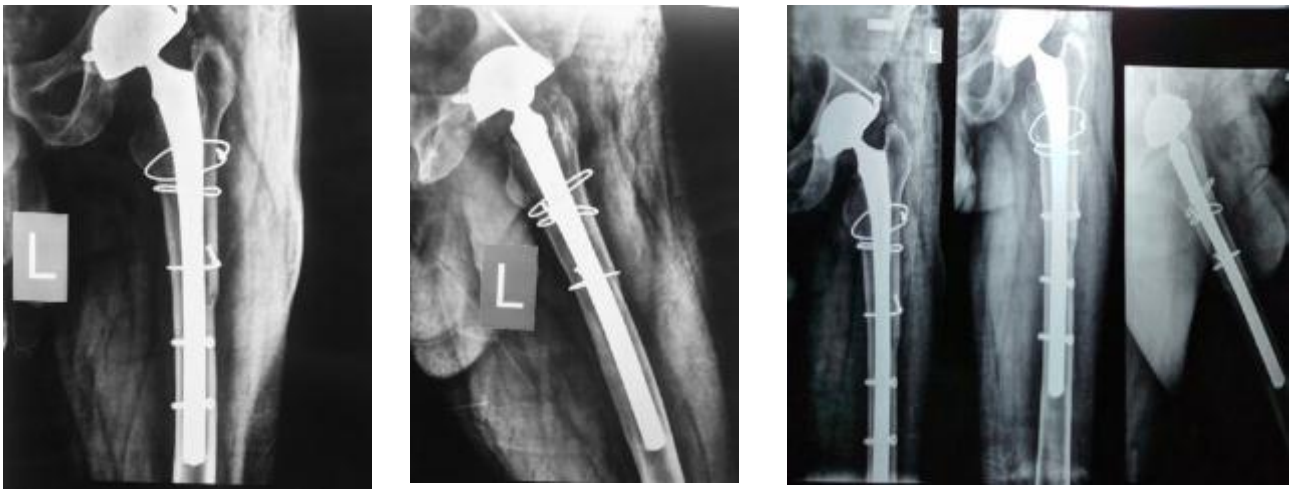

Figure (3 B): Left two images (c): 6 months follow up X-ray with full union in osteotomy site and signs of bone ingrowth around the prosthesis and stable implants. **Right two images (d):** Final follow up 24 months with no radiological signs of loosening or implant migration and stable implants.

Postoperative Follow up protocol: Infection profile markers (ESR, CRP ,WBC) were assessed at 2 weeks, 4 weeks, and 6 weeks postoperatively to monitor early signs of infection and then at 6 and 12 months from surgery. Touch weight-bearing (WB) was encouraged initially and gradually progressed to partial WB according to implant stability and ETO site union until reaching full WB. Immediate postoperative radiographs were taken and then at 3, 6, and 12 months then annually follow up X-rays. Functional scores (HHS) and (WOMAC) score were recorded at 6 and 12 months, and then annually till last visit.

Ethical approval: This study has been approved by Menoufia Faculty of Medicine's Ethics Committee. Following receipt of all information, signed consent was provided by each participant. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis:
SPSS version 22.0 for Windows® was used to code, process and analyze the collected data. To find out if the data had a normal distribution, Shapiro-Walk test was employed. Relative percentages and frequencies were used to present the qualitative data. When comparing qualitative traits amongst several groups, the X^2-test is utilized. The mean ± SD was used to display quantitative data. Two sets of normally distributed variables were compared using the independent samples t-test (parametric data). A p-value that is equal to or less than 0.05 was considered significant.

RESULTS
Forty patients included in the study with mean age of 55.15 ± 11.05 years (range: 31.0 – 70.0) in SS group and mean age of 53.85 ± 9.13 years (range: 40.0 – 72.0) in TS group. Nine males and eleven females in SSG while fourteen males and six females in TSG group. Mean follow up period was (24.15 ± 6.66) months in SSG, while was 19.85 ± 3.73 months in the TSG group.

Organisms identified by preoperative hip aspiration and intraoperative sampling: Nine patients were culture negative in the SSG (45%) while two patients were culture negative in TSG (10%). No patients were identified with polymicrobial organisms in SSG, while seven patients (35%) were identified with polymicrobial organisms in the TSG (Table 1).

Table (1): Organisms identified by aspirations and cultures.

Organism identified at Hip Aspiration				
Negative	9	45.0	2	10.0
E Coli	1	5.0	2	10.0
Klebsiella	0	0.0	6	30.0
MRSA	2	10.0	4	20.0
Polymicrobial (staphylococcus aureus+E. coli)	0	0.0	1	5.0
Proteus	0	0.0	1	5.0
Pseudomonas	1	5.0	1	5.0
Staphylococcus Aureus	4	20.0	2	10.0
Staphylococcus saprophyticus	1	5.0	0	0.0
Streptococcus pyogenous	2	10.0	1	5.0
Organism identified by intraoperative cultures				
Negative	7	35.0	0	0.0
Coagulase negative staphylococcus	1	5.0	0	0.0
E. coli	1	5.0	1	5.0
Klebsiella	0	0.0	3	15.0
MRSA	2	10.0	3	15.0
Poly microbial (MRSA, Candida albicans)	0	0.0	1	5.0
Polymicrobial (Klebsiella + Candida albicans)	0	0.0	1	5.0
Polymicrobial (staphylococcus aureus + E. coli)	0	0.0	1	5.0
Polymicrobial (MRSA and Acinetobacter)	0	0.0	1	5.0
Polymicrobial (Klebsiella, E. coli)	0	0.0	2	10.0
Polymicrobial (Klebsiella, Pseudomonas)	0	0.0	2	10.0
Polymicrobial (Staphylococcus aureus + Acinetobacter)	0	0.0	1	5.0
Proteus	0	0.0	1	5.0
Pseudomonas	1	5.0	0	0.0
Staphylococcus Epidermidis	1	5.0	0	0.0
Staphylococcus Saprophyticus	1	5.0	1	5.0
Staphylococcus Aureus	4	20.0	0	0.0
Streptococcus Pyogenous	2	10.0	2	10.0

Acetabular defects and reconstruction: Bone defects were noticed in SSG and TSG and were addressed by either antibiotic loaded impaction bone graft or impaction graft and reconstruction ring or tantalum augments. No signs of graft resorption or lysis were observed in these patients. One case in TSG had progressive radiolucent lines in acetabular cup.

Table (2): Acetabular bone loss and reconstruction in both groups

	Stage			
	SSG (n = 20)		**TSG (n = 20)**	
	No.	**%**	**No.**	**%**
Acetabular bone loss (Paprosky)				
1	3	15.0	5	25.0
2a	7	35.0	5	25.0
2b	1	5.0	4	20.0
2c	4	20.0	2	10.0
3a	3	15.0	4	20.0
3b	2	10.0	0	0.0
Acetabular reconstruction				
Kerboul cross ring, impaction graft	6 (30%)		3 (15%)	
Augment	3 (15%)		5 (25%)	
Antibiotic loaded Impaction bone graft	2 (10%)		2 (10%)	
No	9 (45%)		10 (50%)	

Trochanteric osteotomy union: ETO was done in sixteen patients in SSG and done in fourteen cases in TSG. All cases underwent ETO had complete radiological union.

Hospital stay: The hospital stay ranged from 3 to 11 days with a mean value of 5.05 ± 1.93 days in SSG and ranged from 7 to 23 days with a mean value of 10.94 ± 3.45 days in TSG (P =0.001).

Local antibiotics and antibiotic duration: Local antibiotics were poured intraoperatively around implanted prothesis according to organisms identified by hip aspiration (Table 3).

Table (3): Local Antibiotics poured around implants

	Stage			
	SSG (n = 20)		TSG (n = 20)	
	No.	%	No.	%
Local Antibiotics				
No	3	15.0	4	20.0
Vancomycin	11	55.0	2	10.0
Gentacoll	1	5.0	9	45.0
Amphotericin B	0	0.0	2	10.0
Vancomycin + Meronem	5	25.0	3	15.0

The antibiotic durations ranged from 8 to 12 weeks with a mean value of 10.85 ± 1.5 weeks in SSG and ranged from 12 to 36 weeks with a mean value of 23.10 ± 5.52 weeks in TSG (P<0.001).

Infection Eradication: Infection in SSG was eradicated in twenty patients and one patient had DAIR after 3 weeks and infection was eradicated. Infection in TSG was eradicated in nineteen patients and one patient revealed laboratory investigations of increasing inflammatory markers and clinical signs of infection at the last follow up was previously identified by polymicrobial organisms (klebsiella multidrug resistant and candida albicans) with general health deterioration from megaloblastic syndrome and generalized immunocompromised state.

Functional outcome: The mean (HHS) was significantly improved from a preoperative value of 46.10 ± 10.22 to a postoperative value of 91.70 ± 3.79 in SSG and improved from preoperative value of 37.65 ± 7.68 to a postoperative value of 88.85 ± 5.31 in TSG. (P = 0.033). WOMAC score significantly improved from a preoperative value of 50.05 ± 11.42 to a postoperative value of 9.95 ± 3.78 in SSG and improved from preoperative value of 58.30 ± 9.57 to a postoperative value of 15.90 ± 7.32in TSG. (P = 0.319) (Figure 4).

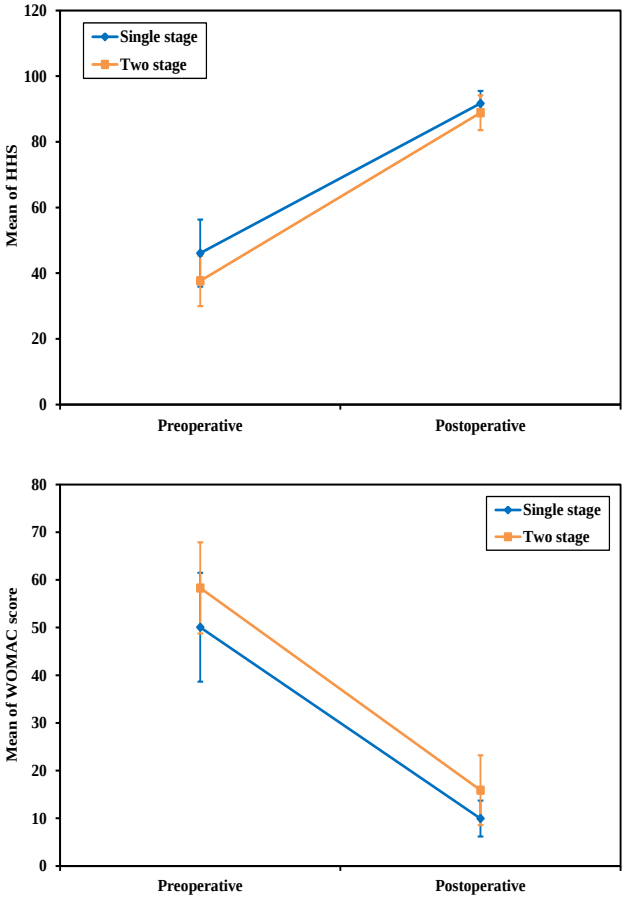

Figure (4): Comparison of functional outcomes between SSG and TSG in terms of HHS (left graph) and WOMAC score (right graph) at preoperative and postoperative evaluations.

Significance difference in the results of functional scores between the preoperative and postoperative scores.

Complications: In SSG, there were one patient had greater trochanter reconstruction by cerclage wiring and another patient had long femoral plate augmentation and proximal femoral reconstruction, while in TSG there were two patients had greater trochanter reconstruction by cerclage wiring, one patient had postoperative periprosthetic fracture in stem fixed by broad DCP plate, two patients had spacer dislocation, one patient had late postoperative periprosthetic fracture left distal femur fixed by distal femoral locked plate. Two patients in the SSG dead accidently 14 and 16 months postoperatively due to general medical issues unrelated to revision surgery.

DISCUSSION

PJI is one of the most complicated challenges that can face orthopedic surgeons following THA and has impact on the patient's functional activities and quality of life. A lot of debates were discussed related to appropriate management choice either single stage surgery or staged surgery.

In our study, infection eradication was insignificantly different between the two groups. **Zhao *et al.*** [13] showed no difference between single- and two-stage revision in the rates of reinfection and reoperation.

Although preoperative aspiration in both groups identified negative cultures and seven cases of SSG didn't reveal organism growth either by aspiration or deep tissue cultures but final results revealed successful infection eradication**. Van den Kieboom *et al.*** [14] reported similar reinfection rate after both SS revision and TS revision for chronic culture-negative PJI. Other case series reported successful infection eradication with SS revision, even in patients with culture-negative PJI [15, 16].

The antibiotic durations period was significantly lower in SSG than TSG (P<0.001). **Ohlmeier *et al.*** [17] revealed that the single stage revision offers significant advantages for patients, including a decreased duration of antibiotic therapy.

Although high doses of local antibiotics were used in our study most commonly vancomycin powder in SSG and gentacoll (collagen sponge highly impregnated with gentamycin) in TSG. **Lange *et al.*** [16] showed 91.1% infection free period of follow up duration 48 months in 56 patients using local Gentamicin collagen fleece. **Ji *et al.*** [18] revealed 89.2% infection free success rate in 111 patients in 5 years follow up using local vancomycin and imipenem powder.

Our findings reported that HHS and WOMAC score significantly improved postoperatively in SSG than TSG which was consistent with **Qin *et al.*** [19] who reported better hip function score in SSG. Several studies reported better functional outcome in SSG regarding pain, stiffness and functional daily activities [20-22].

LIMITATIONS: This study was conducted on a relatively small sample size and follow-up period, though adequate to detect early outcomes, may not fully capture long-term recurrence rates or prosthesis survival.

CONCLUSION

Both single-stage and two-stage revision THA were effective procedures for managing periprosthetic hip infections with comparable infection eradication rates. The single-stage was associated with several advantages, including shorter hospital stays, reduced duration of antibiotic therapy and superior functional outcomes as well as more efficient recovery and lower healthcare burden. Single-stage revision is a good option for carefully selected patients.

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No conflict of interest.

REFERENCES

1. **Zmistowski B, Karam J, Durinka J *et al.* (2013):** Periprosthetic joint infection increases the risk of one year mortality. J Bone Joint Surg Am., 95: 2177-84.
2. **Engesæter L, Dale H, Schrama J *et al.* (2011):** Surgical procedures in the treatment of 784 infected THAs reported to the Norwegian Arthroplasty Register. Acta Orthop., 82: 530-37.
3. **Jafari S, Coyle C, Mortazavi S (2010):** Revision hip arthroplasty : Infection is the most common cause of failure. Clin Orthop Relat Res., 468 (8): 2046-52.
4. **Parvizi J, Suh D, Jafari S *et al.* (2011):** Aseptic loosening of total hip arthroplasty: infection always should be ruled out. Cli Orthop Related Res., 469: 1401-5.
5. **Cooper H, Della Valle C (2013):** The two-stage standard in revision total hip replacement. Bone Joint J., 95 (11): 84–87.
6. **Parvizi J, Tan T, Goswami K *et al.* (2018):** The 2018 Definition of Periprosthetic Hip and Knee Infection: An Evidence-Based and Validated Criteria. J Arthroplasty, 33 (5): 1309-1314.
7. **Britton A, Murray D, Bulstrode C *et al.* (1997):** Pain levels after total hip replacement: their use as endpoints for survival analysis. J Bone Joint Surg., 79: 93-98.
8. **Saleh K, Celebrezze M, Kassim R *et al.* (2003):** Functional outcome after revision hip arthroplasty: a metaanalysis. Clin Orthop., 416: 254-64.
9. **Lee H, Prashant K, Shon W (2015):** Management of periprosthetic hip joint infection. Hip Pelvis, 27 (2): 63–71.
10. **Negus J, Gifford P, Haddad F (2017):** Single-stage revision arthroplasty for infection-an underutilized treatment strategy. Journal of Arthroplasty, 32 (7): 2051–2055
11. **Parsons N, De Souza R, Oni T *et al.* (2010):** A comparison of Harris and Oxford hip scores for assessing outcome after resurfacing arthroplasty of the hip: can the patient tell us everything we need to know? Hip Int., 20: 453-459.
12. **da Silva Júnior J, Dibai-Filho A, Santos I *et al.* (2023):** Measurement properties of the short version of the Western Ontario and McMaster Universities Arthritis Index (WOMAC) for individuals with knee osteoarthritis. BMC Musculoskelet Disord., 24: 574-589.
13. **Zhao Y, Fan S, Wang Z *et al.* (2024):** Systematic review and meta-analysis of single-stage vs two-stage revision for periprosthetic joint infection: a call for a prospective randomized trial. BMC Musculoskelet Disord., 25 (1): 153. doi: 10.1186/s12891-024-07229-z.
14. **van den Kieboom J, Tirumala V *et al.* (2021):** One-stage revision is as effective as two-stage revision for chronic culture-negative periprosthetic joint infection after total hip and knee arthroplasty. Bone Joint J., 103-B (3): 515-21.
15. **Ilchmann T, Zimmerli W, Ochsner P *et al.* (2021):** One-stage revision of infected hip arthroplasty: outcome of 39 consecutive hips. Int Orthop., 40 (5): 913-18.
16. **Lange J, Troelsen A, Solgaard S *et al.* (2021):** Cementless One-Stage Revision in Chronic

Periprosthetic Hip Joint Infection. Ninety-One Percent Infection Free Survival in 56 Patients at Minimum 2-Year Follow-Up. J Arthroplasty, 33 (4): 1160-65.

17. **Ohlmeier M, Jachczik I, Citak M *et al.* (2022):** High re-revision rate following one-stage exchange for streptococcal periprosthetic joint infection of the hip. Hip Int., 32 (4): 488-92.
18. **Ji B, Wahafu T, Li G *et al.* (2019):** Single-stage treatment of chronically infected total hip arthroplasty with cementless reconstruction: results in 126 patients with broad inclusion criteria. Bone Joint J., 101-B (4): 396-402.
19. **Qin Y, Liu Z, Li L *et al.* (2024):** Comparative reinfection rate of one-stage versus two-stage revision in the management of periprosthetic joint infection following total hip arthroplasty: a meta-analysis. BMC Musculoskelet Disord., 25: 1056. doi: 10.1186/s12891-024-08199-y
20. **Oussedik S, Dodd M, Haddad F (2010):** Outcomes of revision total hip replacement for infection after grading according to a standard protocol. J Bone Joint Surg Br., 92 (9): 1222-26.
21. **Kuiper J, Rustenburg C, Willems J *et al.* (2018):** Results and Patient Reported Outcome Measures (PROMs) after One-Stage Revision for Periprosthetic Joint Infection of the Hip: A Single-centre Retrospective Study. J Bone Jt Infect., 3 (3): 143-49.
22. **Blom A, Lenguerrand E, Strange S *et al.* (2022):** Clinical and cost effectiveness of single stage compared with two stage revision for hip prosthetic joint infection (INFORM): pragmatic, parallel group, open label, randomised controlled trial. BMJ., 379: e071281. doi: 10.1136/bmj-2022-071281.