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Primary Hip

Good Functional Outcomes and Low Infection Rates in Total Hip Arthroplasty in HIV-Positive Patients, Provided There Is Strict Compliance With Highly Active Antiretroviral Therapy

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ABSTRACT

Background:
Patients with HIV are more likely to require a total hip arthroplasty (THA) because of an increase in life expectancy and complications with HIV. The purpose of this study is to describe the mid-term outcomes of THA in HIV-positive patients and risk factors for postoperative infections and poor outcomes.
Methods: This is a single-center retrospective review of nonhemophiliac HIV-positive patients who underwent THA. We reviewed the short- and mid-term readmission and complication rates.
Results: Eighty-seven patients underwent 102 THAs. The average age was 58 years (24-73 years). The average body mass index was 31.6 (18-55). The average CD4+ count was 569 cells per cubic millimeter (mm^3) (51-1480), and the mean viral load was <40 copies/mL (undetectable-380 000). The mean follow-up time was 6.7 years (24 months- 8.3 years). Four patients had postoperative complications within 30 days. Seven patients had postoperative complications after 30 days; 5 of which had septic loosening of implants and had either not been initiated on or were noncompliant with their highly active antiretroviral therapy. The average postoperative Harris Hip Score was 81 (41-100) and Oxford Hip Score was 43.43 (34-48). There was no correlation the between CD4+ count and viral load with complications.
Conclusion: Low rate of complications and revision is achievable in the HIV-positive, nonhemophilic arthroplasty population contrary to published literature. An important factor ensuring good long-term outcomes in HIV-positive patients undergoing THA was the initiation of highly active antiretroviral therapy before the procedure and ensuring patient compliance with therapy after joint arthroplasty.
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Total hip arthroplasty (THA) is an effective surgical procedure for the management of end-stage hip pathology [1]. The Joint Registry reports show a steady increase in the number of primary THAs that are performed annually [2–4], and predictions are for the trend to continue over the next decade.

Annually, in the United States of America, there are more than 300,000 THAs performed and is projected to increase by 173% to 572,000 by 2030 [5]. The increasing number of elective primary procedures parallels the increased need for revision THA and associated complications [5]. The rate of revision surgery is expected to double by the year 2026 [5].

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Despite numerous surgical innovations, improved surgical technique, and patient education, the rate of prosthetic joint infections (PJI) and the need for revision THA for sequelae of infection have increased [6]. Recent literature has shown an annual incidence of PJIs of 1.17%-3.3% [6,7]. The concern about PJI has meant that perioperative interventions to optimize patients' modifiable risk factors, such as the body mass index (BMI), diabetic control, and *Staphylococcus aureus* colonization, have gained attention [8]. The HIV status is an important modifiable risk factor for PJI [8]. It is estimated that there were 37.9 million people infected with HIV at the end of 2018 and 1.7 million newly infected in 2018 alone [9]. With the introduction of highly active antiretroviral therapy (HAART), there has been a shift from HIV being a fatal diagnosis to that of a chronic disease state, which if properly managed can bring about a near-normal life expectancy, exposing them to the normal rate of hip osteoarthritis (OA). HIV and HAART are also independent risk factors for the development of avascular necrosis (AVN) of the femoral head [10–12]. Incidence of AVN in patients with HIV on HAART maybe 45-100 fold greater than that in the general population [13,14]. Subsequently, this increases the demand for THA in HIV-positive patients.

There is conflicting evidence regarding outcomes of THA in HIV-positive patients. The literature to date is made predominantly of small cohorts of heterogeneous groups including HIV-positive hemophiliacs and intravenous drug users (IVDUs). It has been shown that THA in IVDUs has the worst rate of PJI within the HIV-positive cohort [15]. In a systematic review article of more than 6 million hip and knee arthroplasties, Dimitriou et al [7] showed that the incidence of PJI is 7.3% in nonhemophiliac HIV-positive patients, which was more than double the incidence of HIV-negative patients. The current literature has been primarily devoted to the evaluation of the potential risk of complications of THA in HIV-positive patients. There are few studies investigating the functional outcomes and satisfaction rates of these patients. The aim of this study is to describe the experience of nonhemophiliac HIV-positive patients undergoing THA in a sub-Saharan academic referral institution, the short- to medium-term outcomes, and satisfaction rates of THA in HIV-positive patients and to identify risk factors for infections and poor outcomes.

Patients and Methods

A retrospective review of 87 HIV-positive patients who had undergone 102 consecutive THAs at a South African academic hospital between January 2010 and January 2018 was performed. Institutional review board approval was obtained before starting data collection. Patient charts were reviewed for complications and prospectively entered data on functional outcomes. All patients had at least 24-month follow-up. The immune status of all patients presenting for THA was documented. Patients who had not been tested for HIV in the last 6 months preceding surgery were offered the option of volunteer counseling and testing for HIV. The immune status was determined by analyzing the CD4+ count (cells/mm^3) and viral load (VL) (copies/mL).

THA was performed on patients, provided that the preoperative CD4+ was greater than 250 cells/mm^3, irrespective of the VL or HAART. Surgery was delayed if CD4+ was less than 250 cells/mm^3. These patients were referred to the Infectious Disease Unit for initiation of HAART or change of HAART regimen and returned for surgery 6 months later.

Preoperative and postoperative functional outcomes were analyzed using the Harris Hip Score (HHS) and Oxford Hip Score (OHS). Hip pathology was assessed preoperatively using standard radiographic techniques, that is, anteroposterior pelvis and lateral hip views. Images were evaluated by the senior authors, and final diagnoses were confirmed and correlated with clinical history, physical findings, and laboratory investigations. Hip pathology was categorized into HIV related, deemed to be pathophysiological process of HIV or a known adverse effect from HAART (including AVN, neck of the femur fractures, and tuberculosis of the hip), and non–HIV related (including primary OA, inflammatory arthropathy, and acetabular protrusion).

All THA procedures were performed by one of two consultants. All cases were performed in the same laminar flow theaters through a modified anterolateral surgical approach. All patients received prophylactic antibiotics at least 30 minutes before skin incision and for 24 hours postoperatively. The standard antibiotic used was a first-generation cephalosporin (cefazolin); clindamycin was used in instances of penicillin allergy. All patients received intravenous tranexamic acid 30-60 minutes before the surgical incision.

Intra-articular drains were left in situ for all THAs at the discretion of the operating surgeon, with closure in layers and clips to skin as standard practice. A compressive dressing was applied and removed on day one postoperatively.

Postoperative management involved removal of the urinary catheter and intravenous lines within 48 hours. Patients received a blood transfusion if the postoperative hemoglobin level was less than 8g/dL or 10g/dL in a symptomatic patient. A rehabilitation protocol designed by the physiotherapy department was followed for all patients. On discharge, patients were kept on low-molecular-weight heparin subcutaneously daily for 4 weeks for deep vein thrombosis prophylaxis. Skin staples were removed after 21 days.

Hospital admission data were reviewed for hospital readmissions at 30, 60, and 90 days postoperatively. All medical and surgical complications were recorded. Complications were classified as early (<4 weeks postoperatively) and late (>4 weeks). Furthermore, complications were classified according to the Clavien-Dindo-Sink Classification, which is a standardized grading system of 5 grades based on the treatment required for a complication [16–18].

Loosening of the prosthesis was evaluated by history, clinical examination, and evaluation of serial radiographs and confirmed with bone scintigraphy in all suspected cases. Decision for aspiration under an image intensifier in the theater was made by the senior authors. PJI was classified based on parameters defined in 2011 by the Musculoskeletal Infection Society. Deep PJI was confirmed by aspiration in the operating room using an alpha defensin lateral flow test kit (Synovasure, Zimmer Biomet), and samples were sent for gram stain, microscopy, culture, and sensitivity. The pathogen isolated was recorded in all cases of septic loosening of THA (Table 5).

Standard unit protocol included out-patient clinic follow-up of all postoperative patients at 6 weeks, 6 months, 1 year, and annually thereafter. Repeat anteroposterior and lateral X-rays were performed at all clinic follow-up visits. Visual analog scale pain scores and satisfaction rates using a 6-point Likert sale were performed on all patients. Dissatisfied patients were classified as such if they reported fair, poor, or terrible outcomes in this scoring system. Alternately, satisfied patients were those who reported excellent, very good, or good outcomes. HHS and OHS were assessed at each visit. CD4+ count and HIV VL were performed at six weeks and annually thereafter.

Statistical Analysis

The data were analyzed using Pearson's chi-squared test. A *P*-value <.05 was considered significant. Odds ratio (OR) and logistic regression were used to provide the relationship between two variables and to represent probability. SPSS statistics software was used.

Results

Demographic Results

One hundred and two THAs were performed in 87 HIV-positive patients. There were fifteen patients who underwent bilateral staged THA. There were 66 (75.86%) women and 21 (24.14%) men. The mean age was 58.34 years (24-73 years). The mean BMI was 31.56 kg/m^2 (18-55). The mean preoperative CD4+ count was 569 cells/mm^3 (51-1480), and the mean VL was <40 copies/mL (undetectable-380000) (Table 1). Preoperatively, 82 (94%) patients were on HAART for a mean duration of 4.7 years (0-16 years). Five patients were not initiated on HAART preoperatively or postoperatively. The mean CD4+ count and VL in this group of patients was 658 cells/mm^3 and <40 copies/mL, respectively.

Surgical Results

The indication for THA was AVN of the femoral head in 71 (69.6%) patients, primary OA in 16 (15.7%) patients, fractured neck of the femurs in 8 (7.8%) patients, inflammatory disease in 3 (2.9%) patients, tuberculosis of the hip in 1 (0.98%) patient, hip ankylosis in 1 (0.98%) patient, chondrolysis in 1 (0.98%) patient, and acetabular protrusion in 1 (0.98%) patient (Table 2).

Table 1
Demographic Data.

Demographic	N =
Age	58.34 (27-73)
Gender (women/men)	66/21
Body mass index (kg/m^2)	30.99 (16-55)
Preoperative hemoglobin (g/dL)	12.2 (7.8-15.3)
Postoperative hemoglobin (g/dL)	10.8 (6.5-13.1)
Number of perioperative blood transfusions	1
Number of comorbidities per patient	
0	11
1	36
2	30
≥3	10
Comorbidities	
Congestive cardiac failure (CCF)	5
Diabetes	13
Hypertension	24
Peripheral vascular disease (PVD)	3
Previous TB	14
Asthma	16
Rheumatoid arthritis	1
Previous TJA	
THA	15
TKA	2
On preoperative HAART	82 patients (94%)
Preoperative CD4+ T-cell count (cells/mm^3)	
<350	22
≥351	80
Preoperative RNA viral load (copies/mL)	
Viral load (VL) (>50 copies/mL)	
Detectable	6
Undetectable	96
Preoperative HHS	32.75 (12-78)
Preoperative OHS	23.62 (16-28)
Postoperative CD4+ T-cell count (cells/mm^3)	621.47 (96-1113)
Postoperative RNA viral load (copies/mL)	
Viral load (>50 copies/mL)	
Detectable	4
Undetectable	98
Postoperative Harris Hip Score	81.51 (42-100)
Postoperative Oxford Hip Score	43.43 (34-48)
Postoperative Satisfaction Rate	91.4%

TB, tuberculosis; TJA, total joint arthroplasty; THA, total hip arthroplasty; TKA, total knee arthroplasty; HHS, Harris Hip Score; OHS, Oxford Hip Score.

Table 2
Radiological Preoperative Diagnosis.

Diagnosis	Number
AVN	71 (69.6%)
Primary (1°) OA	16 (15.69%)
Fractured neck of the femur	8 (7.84%)
Inflammatory arthropathy	3 (2.94%)
Tuberculosis of the hip	1 (0.98%)
Ankylosis	1 (0.98%)
Chondrolysis	1 (0.98%)
Acetabular protrusion	1 (0.98%)

AVN, avascular necrosis; OA, osteoarthritis.

The bearing surface coupling used in this cohort was ceramic-on-ceramic bearing coupling in 57 (55.88%) patients, metal-on-polyethylene bearing coupling in 26 (25.49%) patients, and ceramic-on-polyethylene bearing coupling in 19 (18.62%) patients. Uncemented or hybrid THAs were performed with DePuy Synthes CORAIL Pinnacle prostheses. The mean total hospital stay was 9.7 (4-30) days with a mean postoperative stay of 6.4 (3-28) days. Intraoperative findings showed a mean femoral size of 9 (1-14). All patients were discharged home, and no patients were discharged to specialist care or nursing facilities.

Eighty-seven patients were followed up at with a mean follow-up duration of 81.24 (25-100) months. There were 2 deaths, and 6 patients lost to follow-up. The 2 deaths were unrelated to the THA. At the last postoperative visit, the mean CD4+ count was 621 cells/mm^3 (96-1113), and the median VL was <40 copies/mL (undetectable-52 000), respectively.

Functional Results

Preoperatively, the mean HHS was 32 (12-78) and OHS was 23.62 (16-28). Postoperatively, at the last clinic visit, the mean HHS was 81.51 (42-100) and OHS was 43.43 (34-48). All patients had improved both HHS and OHS. There were 67 (77%) patients (excluding 8 patients who underwent THA for traumatic injury) with excellent postoperative results as defined by an increase in HHS of >20 points and radiological evidence of stability (Fig. 1). There was a mean improvement of pain by 8.6 on the VAS. The average range of movement changes included (preoperative to postoperative, respectively) flexion 71° to 105°, abduction 14° to 30°, adduction 11° to 25°, internal rotation 7° to 23°, and external rotation 11° to 28°.

Satisfaction Outcomes

The overall satisfaction rate was 91.4%. Satisfaction rates were 84.6% among men and 92.5% among women ($P = <.05$). Women were 2.2 times more likely to be satisfied with postoperative outcomes than men (OR, 2.2; 95% confidence interval [CI], 5.5-12.33). With regard to age groups and satisfaction, younger patients were more likely to be satisfied; 35 of the 37 (94.6%) patients younger than 45 years were satisfied compared with 45 of 47 (95.7%) in the 45-64 year age group and 13 of 18 (72.2%) older than 65 years ($P = .015$). The satisfaction rate among those patients with HIV-related pathology (AVN, neck of femur fractures, tuberculosis of the hip) at the time of operation was 92.3% (n = 74) compared with the remaining pathologies' satisfaction rate of 86.7% (n = 19) ($P = .47$). Patients with HIV-related pathology were 1.8 times more likely to be satisfied (OR, 1.8; 95% CI, 6.5-12). The BMI in patients with HIV hip pathology was 36.52 kg/m^2 compared with 26.6 kg/m^2 in patients with non–HIV-related pathology. The satisfaction rate of patients with a BMI ≤30 kg/m^2 was 90.7% (n = 39) compared with 92% (n = 46) in patients with a BMI >30 kg/m^2 ($P = .09$).

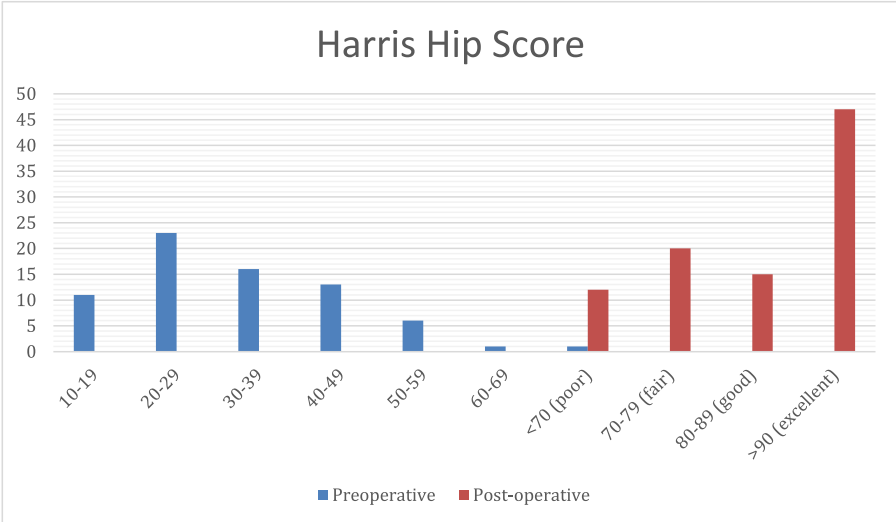


Fig. 1. Preoperative and postoperative HHS. HHS, Harris Hip Score.

Complications

The overall complication rate was 10.78% (n = 11). There were 3 (27.3%) medical and 8 (72.7%) surgical complications. There were 4 (3.9%) early (<30 days post operatively) and 7 (6.8%) late complications (>30-days postoperatively). The 0 to 30-day, 30- to 60-day, and 60- to 90-day readmission rate was 3.92%, 0%, and 6.86%, respectively. The complications are classified and detailed in Figure 2 and Table 3 respectively.

At an average follow-up of 6.41 years, there were 5 cases that were revised for late, deep PJI. One case was complicated by a Vancouver B1 periprosthetic fracture that was treated with open reduction internal fixation.

In total, there were 6 (5.88%) PJIs. This included 1 surgical site infection and 5 deep infections. All deep infections were confirmed by needle aspiration. The microscopy results are detailed in Table 4. Four of these deep infections were managed with two-stage revision THA, and 1 was treated with a debridement, antibiotics, irrigation, and retention of implant procedure.

Table 5 demonstrates the 5 patients with PJI, the preoperative VL was lower-than-detectable VLs in all patients, and the average CD4+ was 523 cells/mm^3 (238-745). HAART was never initiated on two of these patients while it was only given 1 week before index surgery in another. The other 2 patients with deep PJI reported noncompliance with HAART postoperatively. Therefore, 4 of the 5 deep PJIs were not being treated with HAART postoperatively.

The etiological indication for THA was felt to be HIV related in 80 (78.4%) cases and non–HIV related in 22 (21.6%) cases. Complications developed in 7.5% of those with HIV-related pathology and in 5 of the 22 (22.72%) of patients with non–HIV-related pathology.

There was no correlation between preoperative CD4+ count and VL with postoperative complications or outcomes ($P = .85$). The CD4+ count was ≥350 cells/mm^3 in 80 (78.4%) cases and was 250-350 cells/mm^3 in 22 (21.6%) cases. Of the 11 patients with complications, 8 (72.7%) had a CD4 count of ≥350 cells/mm^3 ($P = .62$). Of the 6 patients with septic complications, 5 (83.3%) had a CD4+ count of ≥350 cells/mm^3 (OR, 1.4; 95% CI, 3.58-4.99). No patient

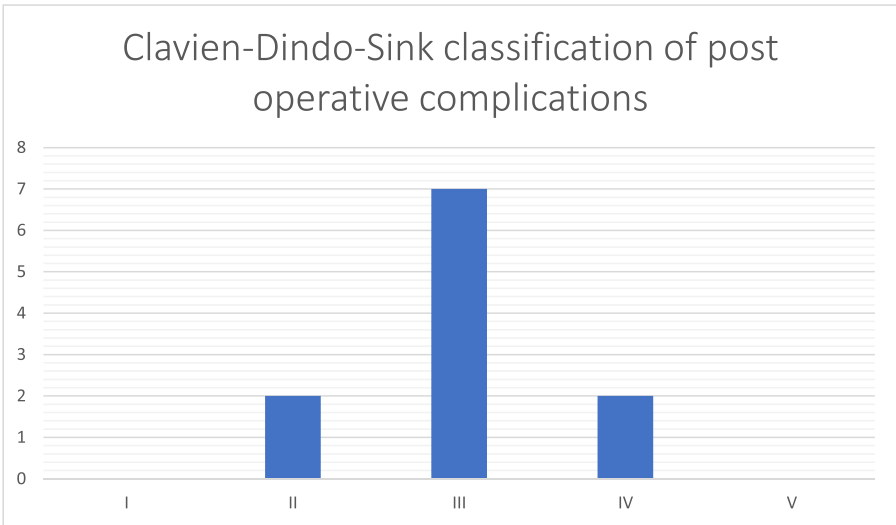


Fig. 2. Clavien-Dindo-Sink classification [18].

Table 3
Complications.

Complication	No. (%)	Early/Late	Clavien-Dindo-Sink	Management
Medical				
Nosocomial pneumonia	1 (0.98%)	Early	Grade 4	ITU and intravenous antibiotics
Atelectasis	1 (0.98%)	Early	Grade 4	ITU and pulmonologist care
Anemia	1 (0.98%)	Early	Grade 2	Blood transfusion
Surgical				
Wound dehiscence	1 (0.98%)	Early	Grade 2	Oral antibiotics, wound care
Deep PJI	5 (3.92%)	1 Early	Grade 3B	DAIR
		4 Late	Grade 3B	4 Two-stage THA Revision
Aseptic loosening	1 (0.98%)	Late	Grade 3B	Very high risk for anesthesia, conservative management
Periprosthetic fracture	1 (0.98%)	Late	Grade 3B	Single-stage THA revision

ITU, intensive therapy unit; DAIR, debridement, antibiotics, implant retention; THA, total hip arthroplasty.

with septic complications had a detectable VL of significance >100 copies/m preoperatively.

Discussion

HIV is a pandemic affecting more than 35 million people worldwide, and the numbers continue to rise [19]. HIV-positive patients are at a greater lifetime risk of requiring THA. The causative mechanism is multifactorial and is related to both the disease itself and HAART [10–12]. Despite representing a major public health concern and adding to the global burden of hip pathology, much controversy still exists regarding the outcomes of THA in HIV-positive patients.

Sub-Saharan Africa has the largest population of people living with HIV, with 7.7 million people afflicted and 240,000 new people diagnosed in 2018 alone [20]. South Africa also has the largest HAART program in the world [21]. This retrospective chart review of 102 consecutive THAs in 87 nonhemophiliac patients, non-IVDUs, HIV-positive patients evaluates complications and outcomes.

In our study, the overall complication rate was 10.78% at an average follow-up of 81 months, while the incidence of infective complications was 5.88%. HIV infection is modifiable risk factor for PJI [8]. The infection rate reported in this study is higher than the 0.76%-3.3% incidence of infection reported in the recent literature in all patients undergoing THA [7,22].

However, a paucity of data exists in the literature evaluating the mid- to long-term outcomes of THA in nonhemophiliac patients, non-IVDUs, and HIV-positive patients. Previously, outcomes were skewed by the inclusion of both HIV-positive hemophiliacs and IVDUs. The rate of infective complications was dramatically higher in these cohorts than the results of this study and similar articles subsequently, which have excluded both hemophiliacs and IVDUs [15,23]. Parvizi et al. [23] suggested a high deep infection and failure rate after total joint arthroplasty in the hemophiliac HIV-positive patients, and a paralleled rate was found by Lehman et al. [15] but was attributed to a history of incidence in IVDUs.

Recently, a systematic review by Dimitriou et al [7], of 19 articles and 6,516,186 joints that excluded hemophiliacs and IVDUs, reported an overall complication rate of 3.3% in non–HIV-positive patients and a significantly increased rate of complications of 7.3% in HIV-positive patients. This study reviewed both THA and total knee arthroplasty. Ragni et al. [24] found that there was a 15.1% incidence of infective complications within their cohort of 66 patients with a CD4+ count of less than 200. This represented a tenfold increase in infective complications in those HIV-positive patients undergoing arthroplasty as opposed to other orthopedic procedures.

Table 4
Aspiration Results.

Case	Microbiology Culture
Wound dehiscence	Mixed growth
Deep PJI	
Case 1: acute on chronic PJI	MSSA
Case 2: Late PJI	MSSA
Case 3: Late PJI	CNS
Case 4: Late PJI	MRSA
Case 5: Late PJI	MRSA

MSSA, methicillin-sensitive *Staphylococcus aureus*; CNS, coagulase-negative *Staphylococci*; MRSA, methicillin-resistant *Staphylococcus aureus*.

The relationship between PJI and HIV infection has been questioned. Lin et al. [25] suggested that HIV was not an independent risk factor for poor surgical outcome and that the HIV population without medical comorbidities or other known risk factors for poor surgical outcome had similar complication rates to the general population. This was based on the association of complication with comorbidities such as malnutrition, liver disease, and chronic kidney disease rather than as a direct result of HIV infection. In a group of 31, Snir et al. [26] also suggested that low PJI rates can be achieved in the HIV population as they had found a 2.4% incidence and was attributed to comorbidities such as IVDUs. Similarly, Bahebeck et al. [27] showed the postoperative risk of infection is almost comparable to the general population. The difference when comparing the older to more recent studies can be explained by the improving efficacy and reduction in side effects of HAART and increasing awareness of the disease [28]. This was borne out in our study too, as most late septic complications were in those patients who were not being treated on HAART by either noncompliance or noninitiation of HAART by treating surgeons.

Latest guidelines recommend starting HAART immediately in newly diagnosed HIV-positive patients [19]. This increases the uptake of the HAART, facilitates early commitment to care, improves viral suppression, prolongs life, improves quality of life, reduces the risk of transmission, and lessens the financial burden of managing HIV- and AIDS-related sequelae [29–31].

In our series, the 3 newly diagnosed patients were not initiated on HAART and remained uninitiated throughout. These 3 patients all developed late, deep PJI. The potential value of HAART therapy decreasing side effects and costs was also highlighted in that 2 patients who developed deep PJI and subsequent revision were noncompliant on HAART. We, therefore, postulate that an important risk factor for PJI is noncompliance or late initiation of HAART. Data analysis between those who have been established on HAART and those who have not showed a statistically significant difference ($P = .03$). The recommendation by Meintjes et al. [32] is that all HIV-positive patients, irrespective of CD-4+ count or VL, should be on HAART.

CD4+ counts and VL have also been used as markers to prognosticate outcomes and potentially predict adverse events, especially infective complications. In this study, however, no correlation existed between CD4+ counts and VL and poor outcomes, adverse events, and complications. This is evidenced by a small subgroup of

Table 5
Demographics of Patients Presenting With Prosthetic Loosening.

Patient	CD4 (Cell/m^3)	Viral Load (Copies/mL)	HAART Preoperative	Duration of HAART Preoperative	Noncompliant	Diagnosis	Time From Index THA (years)	Treatment
Patient 1	487	<40	No	N/A	No	Septic loosening	5	DAIR
Patient 2	738	Undetectable	No	N/A	No	Septic loosening	2	Two-stage revision
Patient 3	745	<40	Yes	<1 wk	No	Septic loosening	4	Two-stage revision
Patient 4	410	Undetectable	Yes	2 y	Yes (postoperative)	Septic loosening	5	Two-stage revision
Patient 5	238	<40	Yes	2 y	Yes (postoperative)	Septic loosening	5	Two-stage revision
Patient 6	421	Undetectable	Yes	6 y	No	Aseptic loosening	6	Unfit for anesthesia Patients decision for conservative treatment

CD4+ in cells/mm^3; VL in copies/mL.
NI, never initiated; DAIR, debridement, antibiotics, implant retention.

patients; 3 (2.94%) patients in this study with low CD4+ counts of 51, 127, 173 cells/mm^3 and 2 of the three patients with an increased VL of 2153 and 380,000 copies/mL who did not have any complications, respectively. All three were however established on HAART preoperatively and have remained compliant on treatment postoperatively. We postulate that HAART initiation and subsequent compliance may mitigate risk. Lin et al. [33] also showed that CD4+ count should not be used as a predictive indicator for adverse outcomes albeit in a small cohort of HIV-positive patients.

To our knowledge, this is the first study to evaluate medium-term satisfaction rates, functional outcomes, and pain scores in HIV-positive patients after THA. The overall satisfaction rate was 91.4% in this study. Five of the 6 patients who underwent revision THA were, however, dissatisfied at the final follow-up. Subsequent exclusion of those who were revised improves the satisfaction rate to 96.8%. This compares favorably with the literature reporting satisfaction rates of 84-97% [34,35] in THA in general. It is, therefore, imprudent to withhold THA in HIV-positive patients.

In our study, all patients improved both their HHS and OHS postoperatively. Seventy-seven percent of patients had excellent medium-term functional results. Our study demonstrated a postoperative mean HHS of 81, comparable with a mean HHS of 86 found by Graham et al. [36]; however, this was a short-term outcome in a smaller cohort of HIV-positive patients. Ng et al. found a mean HHS of approximately 80 at 6-month follow-up in the general population [37]. Pain scores in all patients also improved. We believe that comparable functional outcomes in HIV-positive patients are possible reliably and reproducibly.

This is the largest series of HIV-positive patients undergoing THA. Limitations include the fact that this is a retrospective study and follow-up is mid term. The length of follow-up is relatively short in the context of arthroplasty so may miss late complications. Although this was a consecutive series, the unit policy at the time of this study was not to test all patients for HIV and thus a proportion may have been missed.

In conclusion, THA can be performed safely in HIV-positive patients who are compliant on HAART.

References

[1] Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. Lancet 2007;370:1508–19. https://doi.org/10.1016/S0140-6736(07)60457-7.
[2] hips-all-procedures-activity n.d. https://reports.njrcentre.org.uk/hips-all-procedures-activity [accessed 11.05.20].
[3] Australian Orthopaedic Association. National Joint Replacement Registry. 2019. https://www.aoa.org.au. [accessed 11.05.20].
[4] Canadian Joint Replacement Registry metadata|CIHI n.d. https://www.cihi.ca/en/canadian-joint-replacement-registry-metadata [accessed 11.05.20].
[5] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89:780–5. https://doi.org/10.2106/JBJS.F.00222.
[6] Natsuhara KM, Shelton TJ, Meehan JP, Lum ZC. Mortality during total hip periprosthetic joint infection. J Arthroplasty 2019;34:S337–42. https://doi.org/10.1016/j.arth.2018.12.024.
[7] Dimitriou D, Ramokgopa M, Pietrzak JRT, van der Jagt D, Mokete L. Human immunodeficiency virus infection and hip and knee arthroplasty. JBJS Rev 2017;5:e8. https://doi.org/10.2106/JBJS.RVW.17.00029.
[8] Edwards PK, Mears SC, Stambough JB, Foster SE, Barnes CL. Choices, compromises, and controversies in total knee and total hip arthroplasty modifiable risk factors: what you need to know. J Arthroplasty 2018;33:3101–6. https://doi.org/10.1016/j.arth.2018.02.066.
[9] Global HIV & AIDS statistics — 2019 fact sheet|UNAIDS n.d. https://www.unaids.org/en/resources/fact-sheet [accessed 11.05.20].
[10] Allison GT, Bostrom MP, Glesby MJ. Osteonecrosis in HIV disease. Aids 2003;17:1–9. https://doi.org/10.1097/01.aids.0000042940.55529.93.
[11] Scribner AN, Troia-cancio PV, Cox BA, Marcantonio D, Hamid F, Keiser P, et al. Osteonecrosis in HIV : A Case-Control Study. J Acquir Immune Defic Syndr; 2000. p. 19–25.
[12] Glesby MJ, Hoover DR, Vaamonde CM. Osteonecrosis in patients infected with human immunodeficiency virus: a case-control study. J Infect Dis 2001;184:519–23. https://doi.org/10.1086/322779.
[13] Mehta P, Nelson M, Brand A, Boag F. Avascular necrosis in HIV. Rheumatol Int 2013;33:235–8. https://doi.org/10.1007/s00296-011-2114-5.
[14] Morse CG, Mican JM, Jones EC, Joe GO, Rick ME, Formentini E, et al. The incidence and natural history of osteonecrosis in HIV-infected Adults. Clin Infect Dis 2007;44:739–48. https://doi.org/10.1086/511683.
[15] Lehman CR, Ries MD, Paiement GD, Davidson AB. Infection after total joint arthroplasty in patients with human immunodeficiency virus or intravenous drug use. J Arthroplasty 2001;16:330–5. https://doi.org/10.1054/arth.2001.21454.
[16] Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. Surgery 1992;111:518–26.
[17] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205–13. https://doi.org/10.1097/01.sla.0000133083.54934.ae.
[18] Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J. Reliability of a complication classification system for orthopaedic surgery hip. Clin Orthop Relat Res 2012;470:2220–6. https://doi.org/10.1007/s11999-012-2343-2.
[19] Pietrzak JRT, Maharaj Z, Mokete L, Sikhauli N. Human immunodeficiency virus in total hip arthroplasty. EFORT Open Rev 2020;5:164–71. https://doi.org/10.1302/2058-5241.5.190030.
[20] South Africa|UNAIDS n.d. https://www.unaids.org/en/regionscountries/countries/southafrica [accessed 11.05.20].
[21] AIDSinfo | UNAIDS. AIDSinfo; 2019. https://aidsinfo.unaids.org. [accessed 11.05.20].
[22] Springer BD, Cahue S, Etkin CD, Lewallen DG, McGrory BJ. Infection burden in total hip and knee arthroplasties: an international registry-based perspective. Arthroplast Today 2017;3:137–40. https://doi.org/10.1016/j.artd.2017.05.003.
[23] Parvizi J, Sullivan TA, Pagnano MW, Trousdale RT, Bolander ME. Total joint arthroplasty in human immunodeficiency virus-positive patients: an alarming rate of early failure. J Arthroplasty 2003;18:259–64. https://doi.org/10.1054/arth.2003.50094.
[24] Ragni MV, Crossett LS, Herndon JH. Postoperative infection following orthopaedic surgery in human immunodeficiency virus-infected hemophiliacs with CD4 counts ≤ 200/mm3. J Arthroplasty 1995;10:716–21. https://doi.org/10.1016/S0883-5403(05)80065-8.
[25] Lin CA, Kuo AC, Takemoto S. Comorbidities and perioperative complications in HIV-positive patients undergoing primary total hip and knee arthroplasty. J Bone Joint Surg Am 2013;95:1028–36. https://doi.org/10.2106/JBJS.L.00269.
[26] Snir N, Wolfson TS, Schwarzkopf R, Swensen S, Alvarado CM, Hamula M, et al. Outcomes of total hip arthroplasty in human immunodeficiency virus-positive

patients. J Arthroplasty 2014;29:157–61. https://doi.org/10.1016/j.arth.2013.04.023.
[27] Bahebeck J, Eone DH, Nonga BN, Kingue TN, Sosso M. Implant orthopaedic surgery in HIV asymptomatic carriers: management and early outcome. Injury 2009;40:1147–50. https://doi.org/10.1016/j.injury.2008.12.012.
[28] Cheng B. Therapeutic and diagnostic advances in the HAART era. Res Initiat Treat Action 2005;11:42–5.
[29] Schackman BR, Metsch LR, Colfax GN, Leff JA, Wong A, Scott A, et al. The cost-effectiveness of rapid HIV testing in substance abuse treatment: results of a randomized trial. Drug Alcohol Depend 2013;128:90–7. https://doi.org/10.1016/j.drugalcdep.2012.08.009.
[30] Fleishman JA, Yehia BR, Moore RD, Gebo KA. The economic burden of late entry into medical care for patients with HIV infection. Med Care 2010;48:1071–9. https://doi.org/10.1097/MLR.0b013e3181f81c4a.
[31] Fauci AS, Redfield RR, Sigounas G, Weahkee MD, Giroir BP. Ending the HIV epidemic: a plan for the United States. JAMA 2019;321:844–5. https://doi.org/10.1001/jama.2019.1343.
[32] Meintjes G, Moorhouse MA, Carmona S, Davies N, Dlamini S, Van Vuuren C, et al. Adult antiretroviral therapy guidelines 2017. South Afr J HIV Med 2017;18. https://doi.org/10.4102/sajhivmed.v18i1.776.
[33] Lin CA, Takemoto S, Kandemir U, Kuo AC. Mid-term outcomes in HIV-positive patients after primary total hip or knee arthroplasty. J Arthroplasty 2014;29:277–82. https://doi.org/10.1016/j.arth.2013.06.015.
[34] Mancuso CA, Salvati EA, Johanson NA, Peterson MGE, Charlson ME. Patients' expectations and satisfaction with total hip arthroplasty. J Arthroplasty 1997;12:387–96. https://doi.org/10.1016/S0883-5403(97)90194-7.
[35] Shan L, Shan B, Graham D, Saxena A. Total hip replacement: a systematic review and meta-analysis on mid-term quality of life. Osteoarthr Cartil 2014;22:389–406. https://doi.org/10.1016/j.joca.2013.12.006.
[36] Graham SM, Lubega N, Mkandawire N, Harrison WJ. Total hip replacement in HIV-positive patients. Bone Jt J 2014;96 B:462–6. https://doi.org/10.1302/0301-620X.96B4.33213.
[37] Ng CY, Ballantyne JA, Brenkel IJ. Quality of life and functional outcome after primary total hip replacement: a five-year follow-up. J Bone Joint Surg Br 2007;89:868–73. https://doi.org/10.1302/0301-620X.89B7.18482.