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Clinical Studies

# Degenerative cervical myelopathy in HIV: Rates of postoperative complications and revision following decompression surgery

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ABSTRACT

***Background:*** HIV has been associated with cervical myelopathy, but it is unclear if HIV leads to earlier presentation of DCM and need for decompression surgery. Furthermore, long-term rates of postoperative complications and revision following decompression surgery have not been investigated in this patient population. The aim of this study was to identify the age of surgery for degenerative cervical myelopathy (DCM) in patients with human immunodeficiency virus (HIV) and investigate postoperative revision and complication rates.

***Methods:*** Patients who underwent decompression surgery for DCM were identified in a national database and stratified by preexisting diagnosis of HIV. Demographic characteristics were identified. The 2-year rates of revision surgery, 2-year rates of postoperative surgical complications, and 90-day rates of postoperative medical complications were calculated.

***Results:*** 1,014 patients with HIV and 153,974 patients without HIV were identified. The HIV group was younger at the time of decompression (53.6 ± 8.8; Non-HIV: 57.1 ± 11.0; p<.0001). There were no statistically significant differences in 2-year rates of revision (HIV: 7.6 %; Non-HIV 7.72 %; p=.88), removal of implants (HIV: 0.99 %; Non-HIV 1.06 %; p=.82), or I&D (HIV: 1.78 %; Non-HIV 1.31 %; p=.19). There were significant differences in the 2-year rates of infection diagnosis (HIV 4.93 %, non-HIV 3.59 %; p=.022) and neurological deficit (HIV 6.02 %, non-HIV 4.20 %; p<.001). 90-day medical complications of pneumonia, UTI, and renal failure were higher in the HIV group.

***Conclusions:*** Patients with HIV who develop cervical myelopathy undergo decompression at a younger age; this age difference may not be clinically significant. While patients with HIV are more likely to have higher rates of short-term medical complications, they do not experience higher 2-year rates of revision or surgical complications requiring reoperation.

## Introduction

Human immunodeficiency virus (HIV) affects over 1.1 million people in the United States [1]. Improved diagnosis and treatment of HIV has increased the life expectancy for individuals with HIV [2–5]. As the HIV population ages, some non-communicable, age-related comorbidities may occur at earlier time points [6–9]. It remains unclear how HIV may accelerate or accentuate aging and the onset of degenerative conditions, such as degenerative cervical myelopathy (DCM) [10–11].

Prior literature has associated HIV with cervical myelopathy, often related to sequelae from the pathophysiology of the disease—such as opportunistic infections, vascular lesions, and neoplasms—or as HIV-associated vacuolar myelopathy [12–15]. However, there have been few studies investigating the association of HIV with DCM. Similar to other non-communicable comorbid conditions, the aging population living with HIV may potentially experience DCM at earlier time points. From our clinical observations, patients with HIV appear to require decompression at younger ages compared to non-HIV populations. Furthermore, long-term outcomes after decompression surgery for DCM have not been examined in HIV patients as compared to the general population. These outcomes are important for patient education and surgical risk stratification.

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This study aims to investigate the long-term surgical outcomes following decompression for degenerative cervical myelopathy in HIV patients. Additionally, we aim to identify the demographics and comorbidities of patients with HIV who undergo decompression surgery and compare this to non-HIV populations to further explore whether these patients require decompression at younger ages. We hypothesized that patients living with HIV who received decompression for DCM may differ demographically and experience worse long-term outcomes than those living without HIV.

## Materials and Methods

### *Database*

The PearlDiver national insurance claims database was used in this retrospective study. Data was collected from the Mariner data subset, which consists of billing data from 2010 to 2018 of 122 million patients and includes self-pay, private insurance, and Medicare payors. Current Procedural Technology (CPT) and International Classification of Diseases (ICD) diagnostic and procedural codes are recorded in the database and all records are anonymized. The database is Health Insurance Portability and Accountability Act (HIPAA) compliant, and this study was exempt from further review by our Institutional Review Board (IRB).

### *Patient selection*

We identified patients who underwent decompression surgery for degenerative cervical myelopathy using CPT and ICD billing codes (Appendix). Patients were included if they had a diagnostic code for degenerative cervical disc disease with myelopathy prior to a procedural code for a decompression surgery. Both anterior cervical discectomy and fusion (ACDF) and posterior laminectomy procedures were included. Patients were excluded if they did not have active records in the database for 2-years following the index surgery. This was done to account for patients who left the database due to insurance changes. We then stratified patients by preexisting diagnosis of HIV, defined as an ICD-9 or ICD-10 diagnostic code for HIV prior to decompression surgery. Demographics and comorbidities were recorded for both patient groups, including age, gender, tobacco use, obesity, and diabetes. The Elixhauser Comorbidity Index (ECI) was calculated for both groups, as well as the percentage who underwent ACDF versus posterior approaches.

### *Outcomes*

The 2-years rates of revision surgery and surgical complications were calculated. Surgical complications included diagnosis of superficial or deep infection, irrigation and debridement procedure (I&D), removal of implants procedure, and neurological deficit. The 90-day rates of the postoperative medical complications of pulmonary embolism or deep vein thrombosis (PE/DVT), renal failure, urinary tract infection (UTI), and pneumonia were identified. A subanalysis was then conducted based on the index decompression surgery: the HIV and non-HIV patient groups were further stratified by ACDF or posterior decompression. Subgroups were created for the ACDF and posterior laminectomy procedure groups, comparing HIV patients to non-HIV patients who had the same index surgery approach. The 2-year revision and surgical complication rates were identified for each subgroup.

### *Statistical analysis*

The rates of revision, surgical complication, and medical complications of the HIV and non-HIV groups were compared with Pearson chi squared tests to evaluate univariate differences between the 2 groups. An alpha of 0.05 was used to determine significance. For outcomes that were statistically significant, a multivariate analysis was performed. Multivariate logistic regression analysis was employed to account for demographic and comorbidity covariates between the HIV and non-HIV patient populations. The R statistical package available through the PearlDiver database software was used for all statistical analysis.

**Table 1**
Demographics and comorbidities of HIV* and non-HIV patients who underwent surgical decompression for degenerative cervical myelopathy.

| Characteristics | HIV ($n$ = 1,014) | Non-HIV ($n$ = 153,974) | p |
|---|---|---|---|
| Age, mean ± SD | 53.6 ± 8.8 | 57.1 ± 11.0 | <.001 |
| Sex, % (n) | | | |
| Female | 31.5 % (319) | 51.8 % (79,727) | <.001 |
| Male | 68.5 % (695) | 48.2 % (74,247) | <.001 |
| Comorbidity, % (n) | | | |
| Tobacco Use | 65.1 % (660) | 51.2 % (78,903) | <.001 |
| Obesity | 40.6 % (412) | 41.2 % (63,361) | .70 |
| Diabetes | 56.1 % (569) | 45.5 % (70,135) | <.001 |
| Elixhauser Comorbidity Index | 5.96 ± 4.23 | 3.65 ± 3.17 | <.001 |
| Index Surgery, % (n) | | | |
| ACDF† | 78.1 % (792) | 81.6 % (125,616) | <.001 |
| Posterior Laminectomy | 21.9 % (222) | 18.4 % (28,358) | <.001 |

* Human immunodeficiency virus.
† Anterior cervical discectomy and fusion.

## Results

### *Patients*

154,988 patients who underwent decompression surgery for degenerative cervical myelopathy were identified in the database. Of those patients, 1,014 had HIV diagnosis and 153,974 did not have a diagnosis of HIV. There were significant differences in age, sex, tobacco use, diabetes, ECI, and index surgery compared between the HIV and non-HIV groups (Table 1).

### *Outcome Measures*

The 2-year rates of revision were similar between the HIV and non-HIV groups (HIV 7.59 %, non-HIV 7.72 %; p=.88; Fig. 1). The 2 groups had similar 2-year rates of the surgical complications of I&D (HIV 1.78 %, non-HIV 1.31 %; p=.19) and removal of implants procedure (HIV 0.99 %, non-HIV 1.06 %; p=.82). There were significant differences in the 2-year rates of infection diagnosis (HIV 4.93 %, non-HIV 3.59 %; p=.022) and neurological deficit (HIV 6.02 %, non-HIV 4.20 %; p<.001).

Significant differences existed between the 2 groups for the 90-day medical complication rates of pneumonia (HIV 4.14 %, non-HIV 2.19 %; p<.001), UTI (HIV 6.41 %, non-HIV 4.18 %; p<.001), and renal failure (HIV 3.06 %, non-HIV 1.48 %; p<.001; Fig. 2). No difference in rates of PE/DVT was observed (HIV 1.08 %, non-HIV 0.90 %; p=.55).

In multivariate analysis, after accounting for demographic and comorbidity covariates, HIV was found to be independently associated with 2-year rates of infection diagnosis (OR 1.55, 95 % CI 1.43-1.67; p<.001) and neurologic deficit (OR 1.24, 95 % CI 1.14-1.36; p<.001).

### *Index Surgery Subanalysis*

After stratification of the HIV patients by index surgery, 792 (78.1 %) had ACDF and 222 (21.9 %) had posterior laminectomy. For the non-HIV patients, 125,616 (81.6 %) had ACDF and 28,358 (18.4 %) had posterior laminectomy. When comparing the HIV and non-HIV patients who had ACDF as index surgery, no difference in 2-year rates of revision was observed (HIV 7.95 %, non-HIV 7.87 %; p=.93). Of the surgical complications, there was a significant difference only in rates of infection

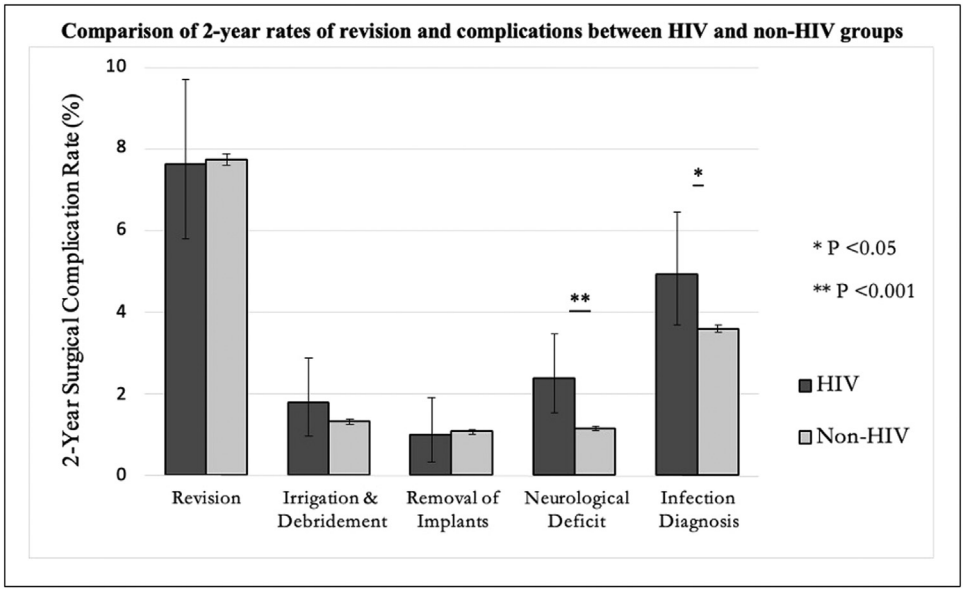


**Fig. 1.** Two-year rates of revision and surgical complications compared between the HIV and non-HIV groups.

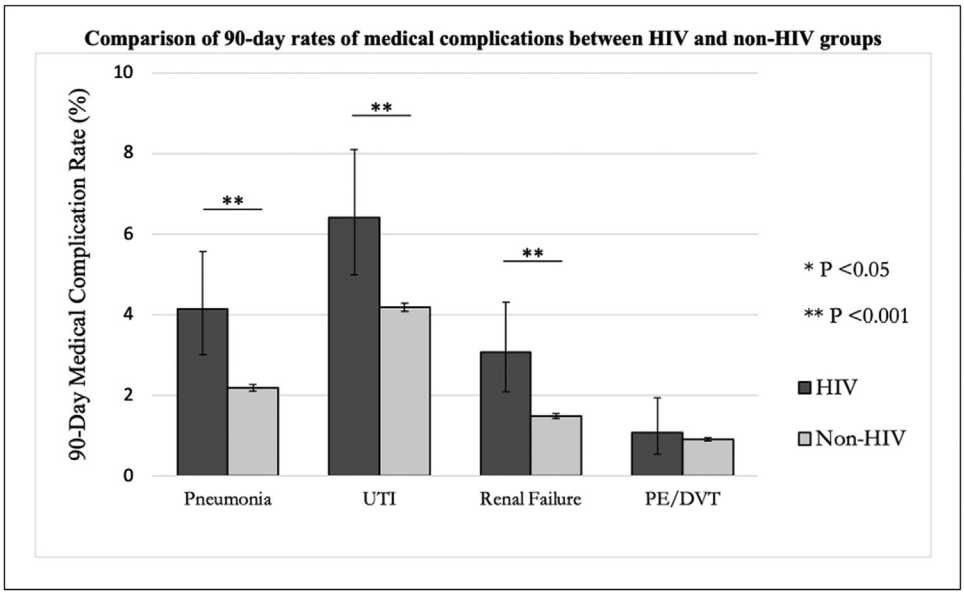


**Fig. 2.** Ninety-day rates of medical complications compared between the HIV and non-HIV groups.

**Table 2**
Subanalysis of 2-year rates of revision and surgical complications for patients with ACDF* as index surgery.

| Complication, % (n) | HIV† (*n* = 792) | Non-HIV (*n* = 125,616) | p |
|---|---|---|---|
| Revision | 7.95 % (63) | 7.87 % (9,882) | .93 |
| Infection Diagnosis | 4.67 % (37) | 3.12 % (3,920) | .013 |
| I&D Procedure | 1.52 % (12) | 1.14 % (1,426) | .32 |
| Removal of Implants | 1.26 % (10) | 1.14 % (1,434) | .75 |
| Neurological Deficit | 4.29 % (34) | 3.21 % (4,035) | .086 |

* Anterior cervical discectomy and fusion.
† Human immunodeficiency virus.

**Table 3**
Subanalysis of 2-year rates of revision and surgical complications for patients with posterior laminectomy as index surgery.

| Complication, % (n) | HIV* (*n* = 222) | Non-HIV (*n* = 28,358) | p |
|---|---|---|---|
| Revision | 6.30 % (14) | 7.08 % (2,007) | .65 |
| Infection Diagnosis | 5.86 % (13) | 5.66 % (1,606) | .90 |
| I&D† Procedure | 2.70 % (6) | 2.06 % (585) | .50 |
| Removal of Implants | 0 % (0) | 0.68 % (192) | .22 |
| Neurological Deficit | 12.2 % (27) | 8.57 % (2430) | .054 |

* Human immunodeficiency virus.
† Irrigation and debridement.

diagnosis (HIV 4.67 %, non-HIV 3.12 %; p=.013; Table 2). When comparing the subgroups who had posterior laminectomy, no differences in revision (HIV 6.30 %, non-HIV 7.08 %; p=.65) or any surgical complications were found (Table 3).

## Discussion

Highly active antiretroviral therapy has significantly altered the natural history of HIV, resulting in affected patients living long enough

to develop age-related orthopaedic conditions, including degenerative spine conditions. The prevalence of HIV-positive patients undergoing surgery for cervical degenerative disease is increasing—a recent systematic review noting an incidence of 0.094 per 100,000 in 2000 compared to 0.303 per 100,000 in 2009 [16,17]. Despite the rising incidence, there have been few studies examining the long-term surgical outcomes of HIV positive patients undergoing spine surgery. Given the paucity of available data, there is conflicting evidence regarding postoperative outcomes and complications in HIV-positive patients undergoing cervical spine surgery [16–19]. It is imperative that surgeons understand potential long-term complications in this growing patient population in order to optimize patient outcomes.

Our study aimed to investigate the long-term surgical outcomes following decompression for degenerative cervical myelopathy in HIV-positive patients. To our knowledge, there are no prior studies evaluating the impact of HIV on long-term revision and complication rates following cervical spine surgery. We found no significant difference in 2-year revision rates. Despite this, we found that HIV was independently associated with a small but statistically significant increased risk of diagnosed surgical site infection (OR 1.55, 95 % CI 1.43-1.67; p<.001) and postoperative neurologic deficit (OR 1.24, 95 % CI 1.14-1.36; p<.001).

These findings are consistent with prior lumbar spine literature. Donnally et al. evaluated 1-year outcomes after lumbar fusion showing HIV positive patients are at increased risk for neurologic complications (OR 1.96; 95 % CI 1.04-3.73; p=.039), wound complications (OR 2.60; 95 % CI 1.37-4.96; p<.001), and respiratory complications (OR 5.43; 95 % CI 3.40-8.67; p<.001) [20]. Ifarraguerri et al. performed a similar study to ours evaluating the impact of HIV on long term revision rates and 90-day postoperative complication rates following lumbar fusion [21]. They found no difference in infectious complications or 2-year revision rates between HIV-positive and HIV-negative groups.

Several studies have demonstrated an association between HIV and a host of comorbid conditions including tobacco use, chronic kidney disease, diabetes, and COPD [17,20,21]. HIV positive patients in our study were more likely to have diabetes (56.1 % vs. 45.5 %, p<.001) and use tobacco (65.1 % vs 51.2 %, p<.001). These demographic factors may be associated with our findings of an increased rate of postoperative pneumonia, UTI, and renal failure among HIV positive patients compared to the HIV negative patients within the 90-day postoperative period. After multivariate analysis, Lovey et al. found that a diagnosis of HIV was not associated with an increased risk of acute postoperative complications after cervical spine surgery [17]. However, prior studies have consistently noted that the presence of HIV was associated with a significantly increased cost and length of stay [17]. This has been attributed to the increased prevalence of medical comorbidities that require peri-operative medical management.

Lovy et al. similarly found that HIV-positive patients undergoing degenerative cervical spine surgery were more likely to be younger (48.6 vs. 53.4 years, p<.001) and more likely to be male (81.8 % vs. 49.5 % male, p<.001) [17]. Compared to the Lovy et al. study, our study has an older population in both the HIV (53.6 years) and non-HIV groups (57.1 years). The age difference between studies may be reflective of the broader inclusion criteria of all degenerative conditions of the spine compared to our study being limited to patients with cervical myelopathy attributable to degenerative cervical disc disease.

Similar to the preoperative management of any chronic disease, a thorough understanding of a patient's disease severity allows the opportunity to mitigate potential complication with preoperative optimization. Preoperative assessment for HIV-positive patients undergoing elective spine surgery should include CD4 count, absolute neutrophil count, platelet count, nutritional status, history of AIDS-related disease, and response to intradermal skin test antigens (anergy) [22]. Savoiz et al. demonstrated that patients with a CD4 count higher than 500 had similar rates of complications as patients without HIV [23]. CD4 count has been demonstrated to have a direct relationship with postoperative viral, bacterial and fungal infections; in addition to being important in postoperative wound healing [22].

Our study has several limitations that should be considered when interpreting its findings. Most notably, this is a database study that relies on billing codes; therefore, any coding errors may impact the study accuracy. Additionally, utilizing diagnostic codes does not allow us to account for disease severity—specific to our study would be important measures of HIV status such as CD4 count, viral load, and use or adherence to antiretroviral medications. Laboratory values are not readily available in the database. While it is possible to query the PearlDiver database for medication prescriptions using National Drug Codes (NDCs), the authors have found that this function lacks granularity and provides limited data on medication adherence. Therefore, in this study we investigate the HIV population as a whole without significant means to stratify patients by disease severity. With advances in highly active antiretroviral therapy (HAART), the natural course of HIV and the sequala of disease may differ greatly between patients, and our results may not be generalizable to all patients, particularly those with undetectable viral load. A third limitation was the significant demographic and comorbidity differences between the HIV and non-HIV groups. We did utilize a multivariate analysis to control for demographic and comorbidity variances; however, it is not possible to control statistically for all differences between groups which may have impacted our outcomes. In particular, controlling for the number of spinal levels decompressed would better account for differences in disease severity among patients receiving multilevel as opposed to single-level decompressions, however we were unable to modify our methodology to implement this control prior to losing access to the dataset. Lastly, patients may have developed surgical complications or underwent revision surgery beyond the 2-year postoperative period included in our analysis.

## Conclusions

Our results demonstrate that HIV positive status does not affect 2-year revision rates following operative management of degenerative cervical myelopathy. Based on our review of the literature, this is the only large database study to evaluate the impact of HIV status on long-term revision and complication rates following cervical spine surgery. These findings provide surgeons with high powered data demonstrating that HIV status has no significant effect on revision rate and no major effect on surgical complications. However, there are expected short term differences in medical complication rates as previous studies have similarly shown. As the prevalence of HIV-positive patients undergoing spine surgery continues to increase, surgeons should incorporate these findings into their treatment algorithm while continuing to ensure preoperative optimization to minimize early medical complications.

## Declarations of competing interest

One or more authors declare potential competing financial interests or personal relationships as specified on required ICMJE-NASSJ Disclosure Forms.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2024.100577.

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