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Ankylosing spondylitis substantially increases health-care costs and length of hospital stay following total hip arthroplasty – National in-patient database study

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A R T I C L E I N F O

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A B S T R A C T

Introduction: The outcome following major arthroplasty surgeries in patients with ankylosing spondylitis (AS) has tremendously improved over the past decades, due to substantial amelioration in the medical therapies and sophistication of available surgical modalities. Although various studies have already demonstrated the complication rates and challenges faced in AS patients undergoing THA, there is a substantial paucity of data on the actual healthcare burden associated with this disease, and the diverse factors which may affect it.
Methods: Using the National Inpatient Sample (NIS) database (on the basis of ICD-10 CMP codes), patients undergoing THA between the years 2016 and 2019 were identified. These patients were then classified into two categories: group A: patients with a known diagnosis of AS; and group N: those without. The details regarding demographical information, associated co-morbidities, data pertaining to patients' hospital admissions including expenditure incurred, length of stay and complications encountered, were compared. In addition, propensity-score matching was performed to identify a 1:1 matched sample of THA patients without AS.
Results: Overall, 367,890 patients underwent THA; among whom, 501 (0.14%) were known AS patients (group A). Group A included a substantially higher proportion of patients belonging to younger age group (58.6 ± 13.4 versus 65.9 ± 11.4 years; **p < 0.001**), male sex (67.1% in group A vs 44.1% in group N; **p < 0.001**), and Asian ethnicity (**p < 0.001**). Group A patients had a substantially higher risk for longer duration of hospital stay **(p < 0.03)** and higher overall healthcare expenditure incurred **(p < 0.001)**. As compared to group N, AS patients had a significantly higher risk for developing post-operative anemia [21.8% (group A) vs 11.8% (group N); **p < 0.02]**; and higher rate of periprosthetic infections [2.4% (group A) vs 1.0% (group N); **p < 0.007].**
Conclusion: Patients with AS require a significantly longer duration of hospital stay and higher admission-related expenditure following THA, as compared to the general population. These enhanced early health care-associated costs can be attributed to higher complication rates in AS patients. AS patients are prone to higher rates of anemia and peri-prosthetic infections during the early post-THA period.

1. Introduction

Ankylosing spondylitis (AS) is a relatively common seronegative spondyloarthropathy (SSA), which is characterized by inflammatory arthritis primarily affecting the axial skeleton.[1,2] The mean prevalence of AS is estimated to range between 0.3% and 1.3% in

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North America, with some studies suggesting that spondyloarthropathies may be more prevalent than rheumatoid arthritis (RA) in the United States (US).[3,4] AS primarily affects young males; and typically manifests between the second and fourth decades of life.[5] The prevalence of hip involvement in AS is around 30−50%, with a majority of these patients presenting with bilateral disease.[6] Overall annual prevalence of THA in AS population is estimated to be between 1.73 and 2.24 per 1000 total THAs.[7] Patients with AS tend to be younger at time of THA and most studies show an improvement in pain and mobility following THA.[1,5,6]

Previous studies have demonstrated an increased risk of perioperative complications in AS patients undergoing THA.[1,6] Due to the escalating health care costs, bundled payment models for total joint arthroplasty (TJA) procedures are becoming increasingly common.[8] To effectively implement these payment models while maintaining economic viability and quality of patient care, it is crucial to recognize conditions, which may predispose patients to increased perioperative complications, longer hospitalizations, and potentially higher hospital charges.[9,10] While some previous studies have reported on these outcomes in patients with AS undergoing THA, majority of these reports have been relative smaller case series involving limited sample populations.[9,10] The substantial paucity of large-scale research regarding the actual health care-related expenditure and other logistic-related data for AS patients undergoing THA has also been well-acknowledged.[11−13] Such data can potentially aid in the amelioration of health care delivery in these complicated scenarios.

The purpose of the current study was thus to examine the Nationwide Inpatient Sample (NIS) database to critically analyze the cost of medical care and challenges in the perioperative management following THA in patients with AS. Being the largest available data of hospital admissions, NIS database provides the ideal patient sample for evaluating such a complex problem.

2. Methods

2.1. Database description

This study was completed using the NIS Database [a component of the Healthcare Cost and Utilization Project (HCUP)] (appendix 1). NIS is the largest all-payer inpatient database within the US and includes data from greater than 7 million hospital stays. The data is verified using a quality assessment evaluation comparing datapoints to standardized normative values by an independent contractor; and broadly encompasses details from 20% of the hospitals within the US.

The 2018 version of NIS utilizes the International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS). The data elements within the NIS database include details regarding patient demographics, associated comorbidities, in-hospital complications, details regarding hospital admission and health care-related expenditure.[14]

2.2. Data acquisition

This study was exempt from Institutional Review Board (IRB) approval, since the data were de-identified and available publicly. The patients, who underwent THA (both primary and revision THAs), were identified using the ICD-10 procedural codes OSRB and OSR9. From this cohort, patients with AS, were identified using the ICD-10 codes (appendix 1). The patients were then classified as a. Group A - patients with AS and B. Group N - those without.

The details regarding preoperative variables including age, sex, race, comorbidities [diabetes, chronic kidney disease (CKD), obesity]; and associated tobacco- or alcohol-related disorders were identified (Tables 1 and 2). Data regarding postoperative medical/systemic (anemia, acute renal failure, hypotension, pulmonary embolism, deep vein thrombosis, myocardial infarction, pneumonia, and need for blood transfusion), or local surgical complications [like wound dehiscence, superficial surgical site infection (SSI), deep SSI, prosthetic joint infection, prosthetic dislocations and peri-prosthetic fractures] and other intraoperative adversities were aggregated from the NIS database (Table 3). Additionally, admission-related details [including duration of hospital stay, discharge-related details (including the facilities of patient disposition following discharge), costs incurred, and mortality rates were procured for all included patients. ICD-10 codes were used to procure all the aforementioned data.

2.3. Statistical analysis

All statistical analyses were conducted using SPSS version 27.0 (IBM; Armonk, NY, USA). Originally, descriptive statistics were used to aggregate patients' demographic data. T-tests and chi-squared tests were utilized for analyzing numerical and binomial variables, respectively. Fischer Exact tests were used when the incidence values were <5. For all tests, a p-value ≤0.05 was considered as statistically significant. Odds ratios and their corresponding 95% confidence intervals (CI) for the surgical outcomes and associated complications were measured as ratios between AS and non-AS patient cohorts. In addition, propensity-score matching was performed to identify a 1:1 matched sample of THA patients without AS. The patients were matched for age, sex, obesity, diabetic status and tobacco-use disorder.

3. Results

Overall, 367,890 patients who underwent THA between 2016 and 2019 were identified from the NIS database. Among these patients, 501 (0.14%) were known AS patients (group A); and the remaining 367,389 (99.86%) were considered as controls (Non-AS: group N). The demographic details of these groups were compared and presented in Table 1.

There was a statistically significant difference in the age of patients undergoing THA between the two groups (58.6 ± 13.4 years in group A versus 65.9 ± 11.4 years in group N; **p < 0.001**; Table 1). Group A included a significantly greater proportion of male patients (32.9% females in group A vs 55.9% in group N; **p < 0.001**); and the distribution of ethnicity was substantially different between groups A and N (**p < 0.001)**. There was no substantially significant difference in the distribution of co-morbidities [obesity (20.5% vs 21.7%, p = 0.53), uncomplicated diabetes (8.2% vs 10%, p = 0.17), tobacco use disorders (15.2% vs 17.3%, p = 0.20)] between the two groups. There was no statistically significant difference in the rate of emergent admissions between groups A and N (7.6% in group A vs 8.7% in group N, p = 0.40). The findings have been presented in Table 2.

3.1. Details pertaining to the patients' admissions

Based on our data, AS patients had a significantly longer duration of hospital stay [2.5 ± 3.2 days group A) vs 2.3 ± 2.5 days (group B); **p = 0.03**), as compared to the control population. The total costs incurred during the admission of patients following THA were substantially higher in group A (72,950.4 ± 56,968.9 USD in group A) in comparison with non-AS patients (66,871.6 ± 47,828.2 USD in group N; **p < 0.001**). However, there was no statistically significant difference between the two groups with regard to the type of facility, the patients were transferred to following their discharge (**p = 0.59**). All observations have been presented in Table 2.

Table 1
Comparison of demographic profile of patients in groups A [Ankylosing Spondylitis (AS)] and N (Non-AS).

Parameter	Group A (AS; n = 501)	Group N (Non-AS; n = 367,389)	p value
Age (Mean ± SD years)	58.6 ± 13.4	65.9 ± 11.4	**<0.001**
No of males	165 (32.9%)	205,577 (55.9%)	**<0.001**
Patient ethnicity			
Caucasian	407 (81.3%)	314,485 (85.6%)	**<0.001**
African American	30 (5.9%)	28,656 (7.8%)	
Hispanic	30 (5.9%)	13,593 (3.7%)	
Asian or Pacific Islander	21 (4.2%)	3527 (0.9%)	
Native Indian	[a] (0.8%)	882 (0.3%)	
Not available	[a] (1.9%)	6246 (1.7%)	

[a] - Numbers between 1 and 10 were not reported as per Healthcare cost and utilization project (HCUP) data use agreement.

Table 2
Details regarding the patient admission (Groups A and B).

	Group A (AS; n = 501)	Group N (Non-AS; n = 367,389)	p value
Length of stay (days; Mean ± SD)	2.5 ± 3.2	2.3 ± 2.5	0.03
Cost of care (USD)	72,950.4 ± 56,968.9	66,871.6 ± 47,828.2	0.001
Patient disposition			
Home/Routine	209 (41.7%)	143,066 (38.9%)	0.59
Short-term hospital	[a] (0.4%)	877 (0.2%)	
Another type of facility	77 (15.4%)	67,456 (18.4%)	
Home health care (HHC)	213 (42.5%)	155,387 (42.3%)	
Left Against Medical Advice (LAMA)	0	262 (0.1%)	
Died	0	341 (0.1%)	
Emergent admissions [N(%)]	38 (7.6%)	31,796 (8.7%)	0.47

[a] - Numbers between 1 and 10 were not reported as per Healthcare cost and utilization project (HCUP) data use agreement.

Table 3
Comparison of complications and adverse events between groups A [Ankylosing Spondylitis (AS)] and B (Non-AS).

	Group A (AS; n = 501)	Group N (Non-AS; n = 367,389)	Odds Ratio	95% Confidence Interval	p value
Acute Renal Failure	15 (2.9%)	9115 (2.5%)	1.21	0.73; 2.03	0.47
Myocardial Infarction	**	141 (0.01%)	5.21	0.73, 37.30	0.18
Anemia	**109 (21.8%)**	**43,352 (11.8%)**	**1.47**	**1.06, 2.04**	**0.020**
Pneumonia	**	972 (0.3%)	0.75	0.10, 5.37	1.00
Need for blood transfusions	16 (3.2%)	12,886 (3.5%)	0.91	0.55, 1.49	0.79
Pulmonary Embolism	0	475 (0.1%)	0.99	0.99, 0.99	1.00
Deep Venous Thrombosis	**	560 (0.2%)	2.62	0.65, 10.55	0.18
Peri-prosthetic fracture	**	4420 (1.2%)	0.83	0.34, 1.99	0.84
Prosthetic dislocation	**	5145 (1.4%)	0.85	0.38, 1.91	0.85
Peri-prosthestic mechanical complications	**	2850 (0.8%)	1.55	0.69, 3.47	0.29
Peri-prosthetic infection	**12 (2.4%)**	**3819 (1%)**	**2.34**	**1.32, 4.15**	**0.007**
Mortality during hospitalisation	0	332 (0.1%)	0.99	0.99, 0.99	1.00

**- Numbers between 1 and 10 were not reported as per Healthcare cost and utilization project (HCUP) data use agreement.

3.2. Complications during hospital admission

The overall complication rate was substantially higher in group A, as compared with group N. Patients in group A had a significantly higher risk for developing post-operative anemia, in comparison with non-AS patients (21.8% in group A vs 11.8% in group N; **$p < 0.02$**). There was no statistically significant difference in terms of the other medical complications (ARF: $p = 0.47$, MI: $p = 0.18$, need for blood transfusion: $p = 0.79$, pneumonia: $p = 1.00$, DVT: 0.18, PE: $p = 1.00$) between groups A and N.

There was a significantly higher rate of periprosthetic infections in group A (2.4% in group A vs 1.0% in group N; **$p < 0.007$).** However, there was no significant difference in the incidence of other local complications between groups A and N (peri-prosthetic fractures: $p = 0.84$, prosthetic dislocations: $p = 0.85$, peri-prosthetic mechanical complications: $p = 0.29$). The two groups were statistically similar with regard to the early mortality rates ($p = 1.00$).

3.3. Propensity-matching analysis

When the patients in the two groups were matched for preoperative variables including age, sex, obesity, diabetic status and tobacco-use disorders, patients with AS had significantly higher rates of blood loss anemia as compared to patients without AS [21.76% in group A vs 15.89% in group N, $p = 0.02$). The most common local complication in the AS group was peri-prosthetic infection. The rate for peri-prosthetic infection was 2.4% in group A, which was higher than the matched non-AS group (0.84%). However, this difference was not statistically significant ($p = 0.05$). There were no statistically significant differences in prevalence rates of other systemic or local complications between the two groups (based on matched analysis; $p > 0.05$).

4. Discussion

AS is an autoimmune disease; which initially affects the sacroiliac (SI) joint, followed by the progressive involvement of spinal column and other peripheral joints.[15] The prevalence of AS varies across different geographic domains, with a mean prevalence per 10,000 of 23.8, 16.7, 31.9, 10.2 and 7.4 in Europe, Asia, North America, Latin America and Africa, respectively.[3] Among the peripheral joints, hip is the most commonly involved joint, resulting in a wide range of functional disabilities due to progressive ankylosis and deformities.[16] Since these patients require THA at a much younger age as compared to the general population, studies on AS patients have mainly focused on evaluating the complication rates (especially mechanical, prosthesis-related adversities), implant longevity, revision procedures, and long-term postoperative functional outcome.[15] Recent studies have demonstrated excellent long-term survival and functional outcome following THA in AS patients; and have attributed the improved clinical outcome to the advancements in bearing surfaces and precisions in reconstruction technology.[5,6,17]

With the progressively aging population in the US, the overall rates of THA have been projected to substantially increase to an estimated 572,000 patients by the year 2030.[18] Additionally, the rising healthcare costs and the overall economic burden associated with it have resulted in a shift in the reimbursement model from the traditional fee-for-service reimbursements to value-based care.[19] The value-based reimbursement model typically establishes a single-time payment for the entire episode of patient care or treatment.[20,21] With the background of these shifts in healthcare delivery, the significance of identifying patient-specific factors potentially affecting the overall cost-of-care for patients undergoing THA, cannot be understated. In this context, the current study was planned to comprehensively evaluate the NIS database; and evaluate the demographic information, complication rates, mortality and hospital-associated expenditure in AS patients undergoing THA. Such a large-scale study can aid us to clearly understand the root-cause of the problem; thereby enabling us to address the relevant concerns as well as provide us with the direction to meliorate health-care delivery in these challenging scenarios.[22] To the best of our knowledge, no previous study with such large-scale patient sample evaluating the cost-of-care in AS patients undergoing THA has been published heretofore.

We could clearly observe that the AS patients were substantially younger than the control group. The early development of severe inflammatory arthritis in this patient cohort enhances the need for requiring joint reconstruction surgeries at a relatively younger age.[1,11,15,21,23] This in turn, puts them at a significantly higher risk for delayed complications and revision surgeries, as compared to the general population.[17] In this context, lifespan of prostheses and longevity of implants have remained central issues of discussion in the context of THA in AS patients.[10,15,17] Previous studies have demonstrated a substantial difference in gender distribution of AS patients, with relatively higher prevalence of the disease among males. In our study too, we could clearly observe a higher distribution of male patients in the AS group undergoing THA. Bremander et al.[12] concluded that AS patients had relatively higher prevalence of cardiovascular and pulmonary (restrictive lung disease) pre-operative comorbidities. There was no statistically significant difference in the distribution of comorbidities between the two groups.

The most crucial findings in our study were that the patients with AS were significantly more prone to relatively longer and more expensive hospital stays during the initial perioperative days. Although such findings have been previously demonstrated in patients with other inflammatory arthritis [rheumatoid arthritis (RA) or systemic lupus erythematosus (SLE)] following THA and TKA, the health care expenditure in AS has not been widely examined hitherto.[9,10,22] In a large-scale, population-based study involving US Medicare beneficiaries (younger than 75 years of age) undergoing THA between 1999 and 2013, it was concluded that AS patients had a greater likelihood for longer length of hospital stay and discharge to a care facility.[17] They also observed a statistically significant correlation between a longer length of hospital stay and the volume of THAs performed at the particular hospital (≥100 THAs per year). In our patient cohort, there was no statistically significant difference between the two groups with regard to the proportion of emergent admissions and the facility to which the patients were transferred following their discharge from hospital. Ward et al.[17] did not observe any substantial difference in the mortality rates between AS and control populations undergoing THA. Even in our study, we did not observe any statistically significant difference in the mortality rates between the two groups.

In the study of AS patients undergoing primary THA, Bukoswki et al.[13] demonstrated substantial improvements in clinical outcome and excellent survivorship free of revision at 20 years. Similar studies published by Li et al.[21] and Joshi et al.[6] also demonstrated significant long-term improvement in hip functions in AS patients undergoing THA. Therefore, with the available evidence, the long-term benefits of THA in AS have been well established. However, as well observed in our study, the concerns regarding the enhanced health care spending in these patients has been correlated with the overall higher complication rates and adverse events in these patients. A majority of reports hitherto published on THA in AS patients have mainly focused on the survival rate of prosthesis and postoperative range of motion.[21] The current large-scale study was thus planned to evaluate the early outcome measures and possible factors contributing to enhanced expenditure in AS patients undergoing THA.

We could observe a clear evidence of higher complication rates in AS group in our patient cohort. The major systemic complication observed in our study was the significantly higher perioperative blood losses resulting in post-operative anemia (even after propensity-matched analysis). Based on a retrospective study, Li et al.[21] demonstrated that THA in AS patients was associated with substantially higher amounts of blood losses, which could be attributable to the greater difficulty and longer durations of surgery. Therefore, they recommended that these patients required strict perioperative measures and appropriate strategies for preoperative optimization in order to curtail blood losses and restrict the need for blood transfusions. It has also been well-acknowledged in the literature that the magnitude of blood loss in these patients tends to correlate with the degree or severity of bony ankylosis. With this background, the need for considering various preoperative (optimization of hemoglobin levels, autologous transfusion, iron or erythropoietin supplements etc.), intraoperative (good surgical technique, ensuring adequate hemostasis, antifibrinolytic agents etc.) and postoperative (blood product transfusions, appropriate monitoring of clinical and laboratory data) strategies to ascertain good outcome in these patients cannot be understated.

With regard to the other systemic complications in AS patients undergoing THA, there is no clear evidence in the existing literature. Blizzard et al.,[1] in an analysis of THA complications among Medicare patients, concluded that AS patients substantially greater risk of developing perioperative pneumonia and other pulmonary complications. In another large-scale analysis of NIS sample, Schnaser et al.[11] concluded that the risks of in-hospital mortality; and systemic complications like cardiac, peripheral vascular, thrombotic, central nervous system, and gastrointestinal complications were substantially higher in the AS patients. On the other hand, Ward et al.[17] did not observe any significant increase in the early systemic or local complication rates in the AS population following THA. In our study also, we did not observe any significant difference in the incidence of other early systemic complications between the AS and non-AS patients.

We did observe a significantly higher incidence of postoperative wound infection (although the difference was not statistically significant after propensity matching) in AS group. Broadly, a majority of the previously published studies in the literature have demonstrated substantially greater incidence of local complications (especially infections or wound dehiscence). Blizzard et al.[1] showed that AS patients presented with higher rates of local complications including wound complications within 90 days of surgery, hip dislocation, prosthesis failure, revision arthroplasty; and wound complications over 2 years following THA. In a large-scale analysis of NIS sample, Schnaser et al.[11] concluded that the rates of wound dehiscence were substantially higher in the AS patients. Some of the possible reasons underlying higher infection rates in AS patients include associated comorbidities, long-term use of immunosuppressive medications, poorer systemic condition including restricted ambulatory status, longer surgical duration due to more complicated surgeries, higher intraoperative blood losses, and need for undergoing revision or multiple surgical procedures. These factors need to be borne in mind prior to planning surgery, in order to obviate avoidable complications and ensure acceptable outcome in these patients.

Various past studies have foregrounded the higher prevalence of long-term local complication rates; and widely discussed diverse factors which can potentially determine such adverse outcome in AS patients. In a large-scale, retrospective study with a mean follow-up of 16 years, the 20-year cumulative incidence of revision surgery and dislocation were 17.5% and 2.9%, respectively.[13] In their cohort, aseptic loosening, polyethylene wear, osteolysis and femoral component fracture were the most common reasons for revision surgery. In a recently published metaanalysis, it was concluded that patients with stiff spine were potentially at higher risk for mechanical complications including aseptic loosening, dislocations and infections.[23] Patients with AS present with altered spinopelvic biomechanics due to progressive spinal fusion and kyphosis, which can in turn place substantially increased demands on the hip joints. To avoid mechanical implant-related complications, the component selection and implant position need to be clearly planned so as to accommodate for such altered spino-pelvic biomechanics.[1] Our study was a retrospective analysis of the NIS database involving in-hospital admission data of patients. Therefore, the determination of long-term outcome was beyond the scope of our current study.

5. Limitations

The current study has some limitations. Since NIS database only includes data of patients collected during their hospital stay, the details regarding the clinical, functional or radiological outcome following their discharge from hospital are beyond the scope of this study. the records on post-operative adverse events are limited to their in-hospital stay only. The database also relies substantially on the availability of accurate coding and precise documentations. Nevertheless, we believe that the large size of our patient sample provides highly reliable information for the surgeons as well as policy makers about the issues which require appropriate attention and scrutiny in order to ameliorate the health-care delivery available for this complicated patient cohort.

6. Conclusion

Patients with AS require longer duration of hospital stay and higher admission-related expenditure following THA, in comparison with the general population. These enhanced early health care-associated costs can be attributed to relatively higher complication rates in AS patients. These patients are highly prone to increased rates of anemia and peri-prosthetic infections during the early post-THA period.

Authorship credit statement

Akshay Goel Methodology, Formal analysis and investigation, Writing - original draft preparation.

Vibhu Krishnan Viswanathan Conceptualization, Methodology, Writing - review and editing, Resources, Supervision.

Philip Serbin Conceptualization, Methodology, Formal analysis and investigation, Resources.

Tyler Youngman Conceptualization, Methodology, Formal analysis and investigation, Resources.

Varatharaj Mounasamy Conceptualization, Methodology, Writing - review and editing.

Senthil Sambandam Conceptualization, Methodology, Writing - review and editing.

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Competing/conflict of interest

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Ethical approval

Waived by IRB.

Consent to participate

No patient included (database-based study).

Consent to publish

Yes.

Availability of data and materials

Yes (NIS database-based study).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcot.2023.102151.

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