ARTICLE IN PRESS

The Journal of Arthroplasty xxx (2016) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Comparing In-Hospital Total Joint Arthroplasty Outcomes and Resource Consumption Among Underweight and Morbidly Obese Patients

Zain Sayeed, MSc, MHA [a], Afshin A. Anoushiravani, BSc [b], Monique C. Chambers, MD, MSL [b], Theodore J. Gilbert, MSc [b], Steven L. Scaife, MSc [c], Mouhanad M. El-Othmani, MD [b], Khaled J. Saleh, MD, MHCM, CPE [d], *

[a] *Chicago Medical School, Rosalind Franklin University, North Chicago, Illinois*
[b] *Division of Orthopaedics and Rehabilitation, Department of Surgery, Southern Illinois University School of Medicine, Springfield, Illinois*
[c] *Center for Clinical Research, Southern Illinois University School of Medicine, Springfield, Illinois*
[d] *Orthopaedic Education Inc., Springfield, Illinois*

ARTICLE INFO

Article history:
Received 19 December 2015
Received in revised form
24 February 2016
Accepted 8 March 2016
Available online xxx

Level of Study:
level III. Retrospective cohort analysis

Keywords:
underweight
morbidly obese
nutritional status
resource consumption
body mass index
total joint arthroplasty

ABSTRACT

Background: As orthopedic surgeons search for objective measures that predict total joint arthroplasty (TJA) outcomes, body mass index may aid in risk stratification. The purpose of this study was to compare in-hospital TJA outcomes and resource consumption amongst underweight (body mass index ≤19 kg/m^2) and morbidly obese patients (≥40 kg/m^2).

Methods: Discharge data from 2006 to 2012 National Inpatient Sample were used for this study. A total of 1503 total hip arthroplasty (THA) and 956 total knee arthroplasty (TKA) patients were divided into 2 cohorts, underweight (≤19 kg/m^2) and morbidly obese (≥40 kg/m^2). Patients were matched by gender and 27 comorbidities by use of Elixhauser Comorbidity Index. Patients were compared for 13 in-hospital postoperative complications, length of stay, total hospital charge, and disposition. Multivariate analyses were generated by SAS software. Significance was assigned at *P* value <.05.

Results: Underweight patients undergoing primary TJA had higher risk for developing postoperative anemia compared with morbidly obese patients (TKA: odds ratio [OR], 3.1; 95% CI, 2.3-4.1; THA: OR, 1.8; 95% CI, 1.5-2.3). Underweight THA candidates displayed greater risk for deep venous thrombosis (75.36% vs 24.64%; OR, 3.1; 95% CI, 1.1-8.4). Underweight TJA patients were charged more (TKA: USD 51,368.90 vs USD 40,128.80, *P* = .001, THA: USD 57,451.8 vs USD 42,776.9, *P* < .001) compared to the morbidly obese patients. Length of stay was significantly longer for underweight THA patients (4.6 days vs 3.5 days, *P* = .008) compared to morbidly obese counterparts.

Conclusion: Our results indicate underweight, compared to morbidly obese, TJA patients are at a greater risk for postoperative anemia and consume more resources.

Total knee arthroplasty (TKA) and total hip arthroplasty (THA) are common surgeries that improve function and quality of life of patients with severe degenerative changes [1-4]. In the United States, the number of primary TKA procedures performed annually is projected to increase from 719,000 in 2010 to 3.48 million by 2030 [5]. Whereas the number of primary THA procedures is also expected to follow a similar trend and rise from 470,000 procedures in 2012 to 700,000 procedures in 2030 [5,6]. As the health care environment moves from a volume-based to value-based system, orthopedic surgeons are in search of methods to improve quality of care. Observing the increased incidence of total joint arthroplasties (TJAs) being performed, assessment of preoperative nutritional status has gained interest in the role of predicting postoperative complication after TJA.

An internationally well-documented nutritional indicator, body mass index (BMI), aids in the assessment of nutritional status to

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to doi: http://dx.doi.org/10.1016/j.arth.2016.03.015.

* Reprint requests: Khaled J. Saleh, MD, MHCM, CPE, Orthopaedic Education Inc., 5304 Cromwell Place, Springfield, IL 62711.

http://dx.doi.org/10.1016/j.arth.2016.03.015
0883-5403/

predict postoperative outcomes [7]. Furthermore, excessively high or low BMI have been suggested to be indicators of malnourishment that may adversely affect arthroplasty outcomes [7]. A more comprehensive understanding of the correlation between BMI and postoperative TJA outcomes will enable orthopedic surgeons to enhance clinical quality while optimizing resource consumption globally [8]. As the prevalence of obesity (≥30 kg/m^2) worldwide, and in the United States, is approximated to be 13% and 35%, respectively [9], orthopedic literature is replete in assessing the relationship of high BMI with regard to TJA outcomes [10-17]. Morbid obesity (≥40 kg/m^2) accounts for 6% of the national population [9], whereas 1.8% is comprised of underweight (≤19 kg/m^2) individuals [18]. Although lesser in prevalence, both populations of orthopedic patients represent individuals that bare greater risk for suboptimal clinical outcomes and increased resource consumption compared with normal BMI patients. As osteoarthritis is the most common indication for elective TJA, adult reconstruction specialists must be cognizant that the combined prevalence (8%) of underweight and morbidly obese patients provides a significant contribution to elective TJA candidates [19,20]. Both patient populations serve as outliers in TJA, therefore, their direct comparison may offer insight on the prognostic value of BMI in TJA outcomes.

A BMI ≥40 kg/m^2 has been reported to be an objective predictor of postoperative complications [10-15], however, few studies report similar findings for low BMI. To our knowledge, a matched comparison between underweight and morbidly obese TJA patients has yet to be conducted. As morbidly obese patients are heavily studied in the field of orthopedics, they serve as the comparative baseline for the purposes of our analysis. Therefore, we compare in-hospital postoperative outcomes and resource utilization trends after primary TJA between underweight and morbidly obese patients.

Materials and Methods

Materials

Data were obtained using the National Inpatient Sample (NIS) database from 2006 to 2012. The NIS is a database developed by the Healthcare Cost and Utilization Project and offers a stratified representation that approximates 20% of all community hospitals [16]. Discharges are recorded annually, and these data can be weighted to produce statistically valid national estimates. This tool allows researchers to investigate health care–related costs, medical practice trends, and perioperative outcomes at a national level. [21] The NIS database uses the *International Classification of Disease, Ninth Revision, Clinical Modification* (ICD-9-CM) codes to standardize the reporting of diagnoses, procedures, and complications.

Data Collection

ICD-9-CM codes were used to identify 401,152 and 858,091 patients who underwent THA (81.51) and TKA (81.54). We then further stratified each cohort corresponding to low and high BMI matching for gender alongside 27 comorbidities after modified Elixhauser Comorbidity Index (Fig. 1) [22]. We excluded weight loss and obesity from our matching criteria because of the nature of this study. Our analysis isolated 1503 THA (both low and high BMI) and 956 TKA (both low and high BMI) patient samples. We examined comorbidity profiles between cohorts and confirmed comparable baseline characteristics (Table 1). To identify in-hospital postoperative outcomes, ICD-9-CM diagnosis codes were used for 13 secondary diagnoses (Fig. 2) [22]. To evaluate resource utilization, we assessed length of stay (LOS), total hospital charge, and disposition (home vs rehabilitation facility). Our data were weighted to allow each cohort to statistically represent a nationally validated sample.

ELIXHAUSER COMORBIDITY INDEX
AIDS
042-044.9
Alcohol abuse
291.1, 291.2, 291.5, 291.8, 291.9, 303.90-303.93, 305.00-305.03, v11.3
Deficiency anemia
291.1, 291.2, 291.5, 291.8, 291.9, 303.90-303.93, 305.00-305.03, v11.3
Rheumatoid arthritis/collagen vascular disease
701.0, 710.0-710.9, 714.0-714.9, 720.0-720.9, 725
Chronic blood loss anemia
280.0
Peripheral vascular disorders
440.0-440.9, 441.2, 441.4, 441.7, 441.9, 443.1-443.9, 447.1, 557.1, 557.9, v43.4
CHF
398.91, 402.11, 402.91, 404.11, 404.13, 404.91, 404.93, 428.0-428.9
Chronic Pulmonary Disease
490-492.8, 493.00-493.91, 494, 495.0-505, 506.4
Coagulopathy
286.0-286.9, 287.1, 287.3-287.5
Depression
300.4, 301.12, 309.0, 309.1, 311
Diabetes (uncomplicated)
250.00-250.33
Diabetes (complicated)
250.40-250.73, 250.90-250.93
Drug abuse
292.0, 292.82-292.89, 292.9, 304.00-304.93, 305.20-305.93
HTN
401.1, 401.9, 402.10, 402.90, 404.10, 404.90, 405.11, 405.19, 405.91, 405.99
Hypothyroidism
243-244.2, 244.8, 244.9
Liver disease
070.32, 070.33, 070.54, 456.0, 456.1, 456.20, 456.21, 571.0, 571.2, 571.3, 571.40-571.49, 571.5, 571.6, 571.8, 571.9, 572.3, 572.8, v42.7
Lymphoma
200.00-202.38, 202.50-203.01, 203.8-203.81, 238.6, 273.3, v10.71, v10.72, v10.79
Fluid and electrolyte disorder
276.0-276.9
Metastatic cancer
196.0-199.1
Other neurologic disorder
331.9, 332.0, 333.4, 333.5, 334.0-335.9, 340, 341.1-341.9, 345.00-345.11, 345.40-345.51. 345.80-345.91, 348.1, 348.3, 780.3, 784.3
Paralysis
342.0-342.12,342.9-344.9
Psychosis
295.00-298.9, 299.10-299.11
Pulmonary acirculation disorder
416.0-416.9, 417.9
Renal failure
403.11, 403.91, 404.12, 404.92, 585, 586, v42.0, v45.1, v56.0, v56.8
Solid Tumor w/o metastasis
140.0-172.9, 174.0-175.9, 179-195.8, v10.00-v10.9
Peptic ulcer disease excluding bleeding
531.70, 531.90, 532.70, 532.90, 533.70. 533.90, 534.70, 534.90, v12.71
Valvular Disease
093.20-093.24, 394.0-397.1, 424.0-424.91, 746.3-746.6, v42.2, v43.3

Fig. 1. Elixhauser Comorbidity Index with corresponding ICD-9-CM codes. ICD-9-CM, *International Classification of Disease, Ninth Revision, Clinical Modification*.