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Implementation of Preoperative Screening Criteria Lowers Infection and Complication Rates Following Elective Total Hip Arthroplasty and Total Knee Arthroplasty in a Veteran Population

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ABSTRACT

Background: Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are common procedures with a risk of complications. Attempting to minimize complications, our institution implemented preoperative screening criteria for patients undergoing elective total joint replacement. Our study aimed to determine if screening criteria lowered total complications and/or surgical site infections (SSI).
Methods: Two groups of consecutive patients undergoing TKA and THA at a single Veterans Affairs facility were evaluated prior to and after implementation of screening criteria, 520 and 475 respectively. Screening criteria included hemoglobin A1c ≤7, hemoglobin ≥11, body mass index ≤35, and albumin ≥3.5. Groups were analyzed for demographics, preoperative comorbidities, and postoperative complications. Rates of total complications and SSI were compared. Average follow-up was at least 2 years with minimum of 1 year.
Results: Demographics and comorbidities outside the screening criteria were similar. Total complication rate was reduced from 35.4% to 14.8% ($P < .01$) after implementation of screening criteria. For TKA, total complications were reduced from 33.1% to 15.0% ($P < .01$) and for THA they were reduced from 42.4% to 14.2% ($P < .01$). SSI rates for combined TKA and THA were reduced from 4.4% to 1.3% ($P < .01$). For knees, SSI was reduced from 4.6% to 1.3% ($P = .01$) and was statistically significant. For THA, SSI decreased from 3.8% to 1.2% ($P < .05$).
Conclusion: Our institution saw a statistically significant decrease in both SSI and total complications following implementation of preoperative screening criteria for elective TKA and THA.
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The number of total knee arthroplasties (TKAs) and total hip arthroplasties (THAs) performed in the United States continues to grow annually. The most recent data from the Centers for Disease Control approximate that 720,000 TKAs and over 332,000 THAs are performed yearly [1] and these procedures are predicted to increase over the next decade [2]. Although both procedures provide excellent improvement in quality of life and function, they can be associated with complications that adversely affect the outcome, increase costs, and cause long-term disability or death [3–5]. With this in mind, many groups have investigated patient-related factors that can influence morbidity and mortality in total joint arthroplasty (TJA).

One such factor, diabetes, is a common comorbidity within the US THA and TKA patient population with a prevalence of 22% in the veteran population [6]. The use of hemoglobin A1c as a marker of glucose control prior to elective orthopedic surgery has increased over time. A value of 7.0 is often used to differentiate poorly versus well-controlled diabetics. Results of using glucose control as a predictive risk factor for complications after elective arthroplasties have support [7].

Obesity, a second factor, defined as body mass index (BMI) over 30, and its role in total joint replacement is also an important

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preclinical consideration. Recent data show that 35.4% of Americans over 60 are obese [8]. Despite a clear connection between increasing BMI and osteoarthritis [9], evidence concerning BMI's effect on complications following joint replacement surgery is contradictory but suggests that increasing BMI leads to increased adverse events [10–13].

Malnutrition in the surgical patient has also been associated with several postoperative complications. Values below 3.5 for albumin, 200 for transferrin, and 1500 for lymphocyte count are commonly used as objective markers to measure malnutrition [14,15]. Several authors have demonstrated an increased risk of delayed wound healing after joint arthroplasty with suboptimal nutrition [14,16].

A prospective study recently observed that another variable, low preoperative hemoglobin concentrations, was independently associated with postoperative red blood cell transfusions [17]. Allogenic blood transfusions after arthroplasty have been shown to be an independent risk factor for surgical site infections (SSIs) [18].

Attempting to reduce complications, our institution implemented preoperative screening criteria for patients undergoing elective total joint replacement. Screening criteria included hemoglobin A1c ≤7, BMI ≤35, hemoglobin ≥11, and albumin ≥3.5. This study sought to determine if implementation of these criteria lowered total complications and/or SSI rates.

Methods

A retrospective review of 520 consecutive primary TKA and THA patients at one Veterans Affairs facility between 2005 and 2008 was compared to 475 consecutive primary TKA and THA patients between 2013 and 2015, representing cohorts before and after screening criteria for elective TJA were implemented. Between 2008 and 2013, some screening began but adherence was not required and all criteria were not used by all surgeons so this group was excluded from analysis. Prior to 2009 surgery clearance was left to the discretion of each individual surgeon. After 2013 screening criteria were established and adherence was accepted and implemented by all faculties.

Between 3 and 5 surgeons performed TJA during each time period and 3 were constant between groups. Other exclusion criteria for the analysis included revision surgeries and arthroplasty completed secondary to acute trauma.

Consultations for TKA and THA were requested by the patient's primary care physician (PCP). Patients were not excluded from initial consultation based on screening criteria. If patients were deemed candidates for TKA or THA based on severity of disease, symptoms, and failure of conservative management they were scheduled for surgery if they met screening criteria. Adherence to the screening protocol was achieved with the use of initial screening forms followed by subsequent checkpoints. Once a patient was approved for surgery by an attending, a physician assistant reviewed their signed screening form prior to scheduling preop appointments. Labs and weights were then reassessed for any changes at their preop visit.

Screening criteria included hemoglobin A1c ≤7, hemoglobin ≥11, BMI ≤35, and albumin ≥3.5. Hemoglobin A1c and albumin were hard cutoffs. Hemoglobin A1c was optimized by the patient's PCP and low albumins were addressed with nutrition consultation. Anemia was treated by the PCP, and if the patient was unable to achieve a value of 11 a hematology consultation was obtained for further evaluation prior to scheduling. For BMI, exceptions were made at the discretion of the surgeon for patients who had a BMI under 38 who had demonstrated extensive weight loss. Thirteen patients had BMI over 35 and 1 patient had a BMI over 38 in the screening group. The patient with a BMI of 41 was approved by an attending and agreed upon by the chief of the service after review as part of a plan for compassionate care.

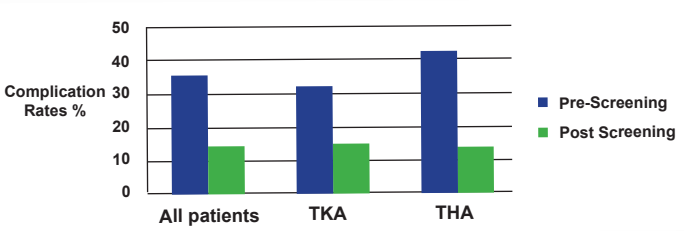

Fig. 1. Complication rates before and after screening criteria.

Perioperative protocols did not change in regard to closure, antibiotic administration, deep venous thrombosis (DVT) prophylaxis, or transfusion criteria between the 2 time periods. Criteria to transfuse during both periods were a hemoglobin of 7 or symptomatic acute blood loss anemia. However, regular administration of tranexamic acid began in 2013 at our institution and therefore it represents a change between our 2 groups. Anesthesia protocols did not differ except that adductor canal blocks became favored over femoral nerve blocks in the second cohort. Spinal anesthesia was at the discretion of the anesthesiologist and was 9% and 14% respectively in the 2 groups, which was not statistically significant.

The groups were analyzed for demographics, preoperative comorbidities, American Society of Anesthesiologists (ASA) scores, and postoperative complications. Rates of total complications and SSI were compared. Average follow-up was at least 2 years for each group with a minimum follow-up of 1 year. Data were analyzed using Student's *t* and chi-square test by a clinical statistician.

All complications, minor and major, were recorded including intraoperative complications, SSI, return to operating room, superficial skin infection, readmission to the hospital within 90 days, DVT, pulmonary embolism, myocardial infarction, pressure ulcers, acute blood loss anemia requiring transfusion, urinary tract infection, and death. SSI was defined using the Musculoskeletal Infection Society criteria for periprosthetic joint infection.

Results

Demographics and comorbidities of the patient population between the 2 groups were similar. The average age in the earlier group was 63.1 versus 63.5 years in the latter group; 94.4% were men in the earlier group and 92.7% in the latter cohort. Tobacco use was 29.4% in the earlier cohort versus 27.1% in the latter. None of these were found to be statistically significant. The ASA score was nearly identical between the 2 groups at 2.75 in the early cohort versus 2.74 in the latter cohort. There were no statistically significant differences in heart disease, liver disease, chronic kidney disease, coronary artery disease, history of myocardial infarction or strokes, coagulopathic or peripheral vascular diseases.

Total complication rate (Fig. 1) was reduced from 35.4% to 14.8% ($P < .01$) after implementation of screening criteria. For TKA, total complications were reduced from 33.1% to 15.0% ($P < .01$) and for THA they were reduced from 42.4% to 14.2% ($P < .01$). SSI rates for combined TKA and THA were reduced from 4.4% to 1.3% ($P < .01$) (Fig. 2). For knees, SSI was reduced from 4.6% to 1.3% ($P < .01$) and was statistically significant. For THA, SSI decreased from 3.8% to 1.2% ($P < .05$). No single criterion was found to individually predict the complication and infection reductions.

Discussion

THA and TKA are common elective procedures with potential complications. The drive for improvement has led many

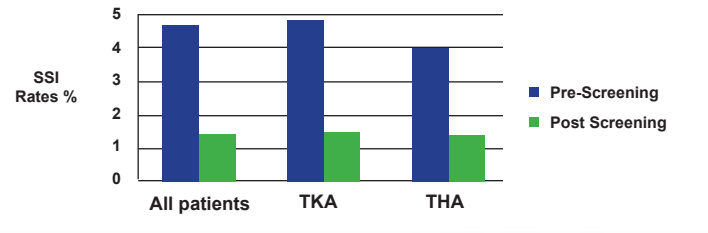

Fig. 2. Surgical site infection rates before and after screening criteria.

researchers to look at optimizing patient's preoperative health prior to undertaking elective surgical procedures. Many previous studies have looked at individual screening markers and compared results but few have looked at implementing several criteria at once.

Our institution was an early adopter of screening criteria due to the ease of obtaining the information given the structure of the Veterans Affairs system. For nutritional status, several markers are used in the literature but albumin was chosen because it can be easily obtained during the preoperative workup and does not add additional cost. Height and weight were measured at each orthopedic clinic visit and other laboratory values were readily available for most patients at the time of their initial consultation.

Several authors have researched individual criteria as they relate to complications after THA and TKA. One of the most studied is diabetes and preoperative hemoglobin A1c control. Values over 7 have been associated with increased complications including stroke, pulmonary embolism, wound infection, transfusion requirements, length of stay, and mortality [7,19–21]. Another study showed a linear increase in overall complications as hemoglobin A1c increased [22]. Increased return to the operating room for both manipulation and postoperative infections has also been noted [23–25]. We utilized a cutoff value of 7 with success supporting the existing literature.

Research on BMI and its impact on arthroplasty has also been looked at by several different groups. Obesity has been associated with SSIs and complications such as DVT and pulmonary embolism by several groups [10–13]. In addition, morbid obesity (BMI >40) and super morbid obesity (BMI >50) have been associated with both SSI and complications including wound problems, unplanned readmissions, DVTs, and postop mortality [26–28]. Although there is no clearly defined cutoff value for a safe BMI, a cutoff of 35 did show success as part of a comprehensive screening protocol in our study.

One of our criteria, albumin, is just one option for screening of adequate healing potential. Malnutrition should be highly considered for screening preoperatively as it has been associated with wound complications [29,30], infection [31], and longer hospital stays in previous studies [32,33]. Other options for screening including transferrin and lymphocyte count may also be effective, but an albumin level at our institution proved to be readily accessible without additional cost.

Our study found a statistically significant drop in SSI and complications after we adopted our combined preoperative screening criteria for elective arthroplasty. Total complications dropped from over 35% to approximately 15%. The screening cohort in the study also had a large, statistically significant decrease in SSI. Total SSI dropped from 4.4% to 1.3%. It is possible that the large decrease we saw was due to the multifactorial effect of the screening criteria. Each individual criteria may make a small difference; however, when they are used as a group the effect becomes magnified.

Some limitations to the study include the retrospective nature. We did attempt to ensure that age, gender, and medical comorbidities were matched between the 2 groups. Additionally, the population at the Veterans Administration hospital may not be typical of the overall population. There is a much higher proportion of men who undergo surgery at the Veterans Affairs, while in the general population women undergo TJA in greater numbers [34]. In addition, our population appeared to have a higher ASA score than the average elective arthroplasty performed [35,36].

An additional limitation of our study is that we cannot say how many consultations initially failed screening criteria due to the retrospective nature of our work. Given that the veteran population has inherently less mobility between healthcare systems, they may be more motivated to participate in their optimization as their options for surgery elsewhere are limited. Our study therefore may not be applicable to all patient populations.

Our results open the door to future prospective analysis of patients who pass or fail initial screening and their eventual outcome differences. Specifically, we are interested in determining if patients really do become optimized and if they do, are their results equivalent to patients who pass on initial presentation.

Conclusion

Our data support the use of combined criteria in a comprehensive screening process for elective TKA and THA. Our institution saw a statistically significant decrease in both SSI and total complications following implementation of preoperative screening criteria. Application of a screening protocol should be considered at any institution, particularly if their rates of complications and SSIs are higher than average.

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