

# Modifiable Risk Factors in Total Joint Arthroplasty: A Pilot Study

STEVEN F. DEFRODA, MD, ME; LEE E. RUBIN, MD; DEREK R. JENKINS, MD

## ABSTRACT

Strong evidence exists to suggest that morbid obesity, smoking, and poorly controlled diabetes mellitus are associated with poorer outcomes after total joint arthroplasty. To our knowledge, no study has reported the effect of the implementation of a risk reduction strategy. Risk factors, based on published data, were defined as Body Mass Index (BMI) >40, Hemoglobin A1c (HbA1c) >8.0, and use of any tobacco product. A retrospective pilot review was done of a 3-month period using this protocol in the practice of a single fellowship-trained academic arthroplasty surgeon (DRJ). Outcomes were evaluated in the subsequent 3-month period. Overall 19/29 (65.5%) patients identified to be “at risk” and offered support for modification followed up under the care of their index surgeon. 11/19 (57.9%) improved their risk factors and 8/19 (42.1%) ultimately met the specific goals set for surgery with 4 (21%) ultimately undergoing their replacement procedure during the 6-month study period. These initial results suggest that a significant proportion of our patients were willing and able to modify their risk before surgery.

**LEVEL OF EVIDENCE:** Level III retrospective study.

**KEYWORDS:** Total Knee Arthroplasty, Total Hip Arthroplasty, Obesity, Diabetes Mellitus, Tobacco use, Risk Factor

## INTRODUCTION

It is estimated that over 200,000 primary hip and 400,000 primary knee replacements are performed annually in the United States, with substantial increases forecast by 2030.<sup>1</sup> Multiple studies have reported the success of total joint arthroplasty (TJA) in improving pain and mobility.<sup>2-5</sup> While there may be many risk factors that can have an adverse effect on postoperative outcomes, three key risk factors suggested in the literature include obesity, poorly-controlled diabetes, and smoking.<sup>6-9</sup>

While rates of primary TJA continue to increase, so too does the incidence of obesity. It is projected that 42% of Americans will be obese by 2030.<sup>10</sup> This unfortunate statistic may

have real consequences in TJA outcomes. According to Ward et al., BMI >40 kg/m<sup>2</sup> led to increased post-operative complications including acute kidney injury, cardiac arrest, reintubation, reoperation, and infection.<sup>11</sup> Additionally, acetabular component malposition has been shown to be associated with BMI >35 kg/m<sup>2</sup>, which may necessitate revision surgery.<sup>12</sup>

Patients with poorly controlled diabetes mellitus are also at risk for poorer outcomes after TJA. A Veterans Health administration study found that elevated hemoglobin A1c (HbA1c) values (>7%) led to an increased risk of post-operative infection in non-cardiac surgery with an odds ratio of 2.13.<sup>13</sup> Another study of TKA patients found that HbA1c >8 resulted in an increased risk of superficial surgical site infection, with an odds ratio of 6.14, identifying poor glycemic control as a risk factor for infection.<sup>14</sup>

Tobacco use has also been linked to less favorable outcomes in TJA surgery. Kapadia et al. found that at a mean follow-up of 47 months, smokers had 90% survivorship of their primary joint replacement, as opposed to 99% in non smokers.<sup>15</sup> A large study of 78,191 patients who underwent primary TJA found that 1.8% of current smokers experienced wound complications compared with 1.3% and 1.1% of former and non-smokers respectively.<sup>16</sup> This study also found that both current and former smokers were at increased total complication risk with odds ratios of 1.18 and 1.20 respectively, with an increased pack-year history of smoking being related to the total complication risk.<sup>16</sup>

The purpose of this study was to determine the effect of implementation of an evidence-based risk reduction strategy whereby patients were identified at risk for poorer outcomes after joint replacement surgery and support given to modify their risk in an effort to improve surgical outcome. Specifically, this study assesses the willingness of patients to continue to follow up in the care of their surgeon and their success in the pursuit of risk factor modification after it was decided to delay surgical intervention to mitigate risk of TJA.

## MATERIALS AND METHODS

A set of risk factor goals was defined based on published studies<sup>9,12,17-19</sup> and is currently being used in the practices of fellowship-trained academic arthroplasty surgeons at our institution. IRB approval was granted and charts from one participating surgeon (DRJ) were retrospectively reviewed

during the 6-month period from February 16, 2015 through July 27, 2015. Patients were included if they were evaluated in the office during the 3-month period from February 16 to May 4. If the patient met surgical indications for primary TJA based on history, examination, and imaging studies, but was identified as having one or more medical risk factors felt to elevate the risk of surgery, they were included as candidates for this pilot study. The following key risk factors were used to identify patients: BMI > 40 kg/m<sup>2</sup>, tobacco use, active oral or other infection, and HbA1c > 8.0. Outcomes were evaluated over the subsequent three months, and descriptive statistics applied.

At the initial office visit, after risk factors were identified, a conversation between surgeon and patient occurred discussing elevated risk for poorer surgical outcomes based on medical evidence. Patients were advised that definitive TJA would be delayed, and their arthritis treated conservatively during a period of time whereby interventions would be offered to improve their operative risk. Support was offered via contact with the patients' PCP to help mitigate risk by optimizing risk factors. Obese patients were counseled regarding the importance of understanding their own body weight and BMI, and also directed to our institution's weight-loss program which includes dietitian counseling, physical exercise advice and bariatric surgery referral if indicated. Patients were also offered consultation with a psychologist, social worker, and exercise physiologist to best optimize physical, nutritional and functional capabilities.<sup>20</sup> Tobacco users were given information about our institution's tobacco cessation programs. Poorly controlled diabetic patients were counseled and referred back to their primary care provider or their endocrinologist for tighter glucose control. Following this initial discussion, a 3-month or earlier follow-up appointment was made to evaluate progress toward risk factor goals. It was expected that some patients would decide to not follow up. Various reasons may motivate patients to seek an easier path to surgical intervention at a surgical practice without a risk factor optimization protocol. Whether this mechanism of patient self-selection for motivated compliant individuals yields a patient population with a greater chance of clinical success was not evaluated.

Patients who chose to follow up continued to be surveilled at 3-month, or more frequent, intervals. When risk factor goals were achieved, surgery was scheduled. Obese patients were re-weighed, smokers were asked about nicotine and tobacco use, diabetics had new HbA1c results evaluated, infection status was reassessed, and oral health status was queried and examined. Patients who met risk factor goals were indicated for surgery while those who did not were given encouragement and counseling and continued to undergo routine follow-up with the attending surgeon (DRJ) as needed or in three months, whichever came first.

Patient information and data was compiled and analyzed using Microsoft Excel 2007 (Microsoft Corp, Redmond, WA).

## RESULTS

Twenty-nine (29) patients met inclusion criteria for the study and 19 (65.5%) followed up (Table 1). Ten (10) patients were males, 19 were females. 21 patients had a chief complaint of knee arthritis while 8 presented with hip arthritis (Table 2). Of the patients that followed up, 11 (57.8%) improved their risk factors, 8 (42%) met criteria for surgery, and 4 (21%) either underwent or had their surgery scheduled within the study period (Table 3, Figure 1). Sixteen patients (84.2%) elected for corticosteroid injections at some point in their treatment course. Ten patients did not follow up within the study period and their outcome is unknown.

Overall 4/15 (36.4%) tobacco users quit; 1/6 (16.67%) obese patients lowered their BMI below 40, and 1/2 (50%) of diabetics lowered their HbA1c below 8.0. Morbidly obese (N=7) patients' average BMI decreased from 44.4 to 42.9 ( $P=0.21$ ). These patients were most likely to be lost to follow-up with 6/13 (46.2%) following up. Tobacco users followed up at a rate of 73.3% (11/15).

Table 1. Patient Demographics

	N	Percent*
<b>Patients Meeting Inclusion Criteria</b>	29	
<b>Patients Who Followed Up</b>	19	65.5%
<b>Overweight</b>	<b>13</b>	
Average BMI at Presentation	47.3	
Average BMI at Follow-Up	43.3	
Patients who Followed Up	6	46.2%
BMI < 40 at Follow-Up	1	16.7%
<b>Smokers</b>	<b>15</b>	
Patients who Followed Up	11	73.3%
Patients who Quit Smoking	4	36.4%
<b>Diabetics HbA1c &gt; 8.0</b>	<b>3</b>	
Average Initial HbA1c at Presentation	9.6	
Patients who Followed Up	2	66.7%
Average HbA1c at Follow-Up	9.1	
HbA1c < 8.0 at Follow-Up	1	50.0%
<b>Active Infection</b>	<b>2</b>	
Patients who Followed Up	1	50.0%
Cleared Infection at Follow-Up	1	50.0%
<b>Poor Dentition</b>	<b>4</b>	
Patients who Followed Up	4	100.0%
Dental Clearance Achieved at Follow-Up	4	100.0%
<b>&gt;2 Risk Factors</b>	<b>6</b>	
Patients who Followed Up	4	66.7%
Modified Risk Factors at Follow-Up	2	50.0%

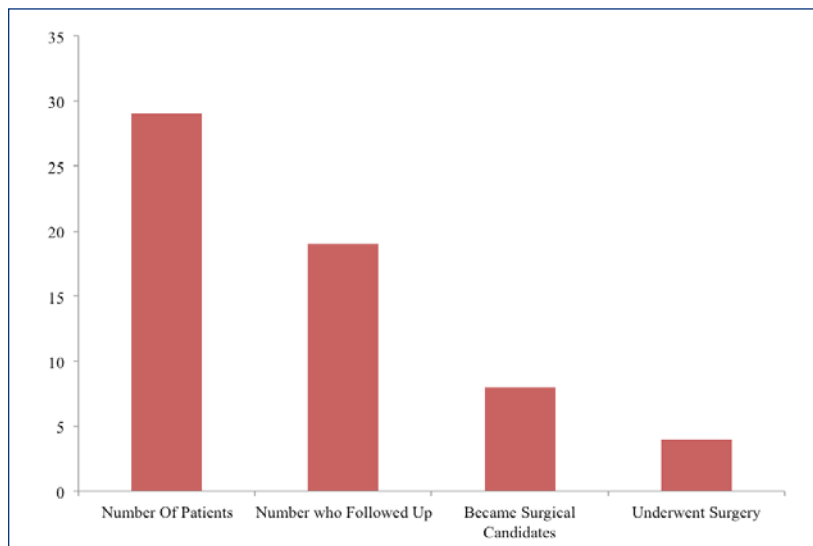
\*Percent for Risk Modifications is of Patients Who Followed Up

**Table 2.** Patient Presentation

Total Patients	29
Average Age	56.8
Male	10
Female	19
Knee OA	21
Hip OA	8

**Table 3.** Follow-up visit statistics during 6-month study period

	N	%
Number of patients who followed up	19	
Average number of follow-up visits per patient	1.8	
Average time elapsed before follow-up visit	3.9 mo	
Number of patients who modified risk factors at follow-up	11	57.9%
Number of patients who opted for joint injections	16	84.2%
Number of patients who met risk factor goals at follow-up	8	42.1%
Number of patients who scheduled or underwent surgery after meeting goals during study period	4	21.1%

**Figure 1.** Risk Factor Modification Results

## DISCUSSION

For primary TJA, payer policies are now trending toward bundled payment models that may either withhold compensation for the treatment of complications after surgeries, or penalize both hospital and surgeon for observed complication rates that are higher than expected. Awareness of this issue may motivate surgeons and total joint replacement centers to reduce risk by attempting to modify patient factors before proceeding with elective TJA. Arthroplasty surgeons in competitive markets may be hesitant to incorporate strategies that delay surgery to improve risk factors out of concern for losing patients to other less selective surgeons. In our study, a majority of patients not only continued under the care of their surgeon following initial consultation, but also successfully worked towards modifying their risk factors.

The most frequent modified risk factor encountered in our study was tobacco use (N=15).

Our study shows that educating patients about the risks of tobacco and encouraging them to quit preoperatively is successful. Tobacco use turned out to be one of the most

modified risk factors, with 4 patients ultimately quitting. Obesity was a more difficult risk factor to overcome. Six (6) of 13 morbidly obese patients followed up with only 1 reaching their goal BMI. While the relatively short study period is a contributing factor, this also highlights the particular difficulty patients have with obesity and weight loss. It is our practice to refer patients to our institution's weight loss center which includes specialty dietitian and nutrition support as well as bariatric surgery consultation. One diabetic patient was able to lower his/her HbA1c appropriately. HbA1c requires a period of time with altered average blood glucose to affect a change, and our brief follow-up

period was likely too short to allow for this.

The modification of risk factors is likely to lead to improved patient outcomes, and the potential benefit of implementation of a risk reduction strategy is supported by literature evidence. Paxton et. al. in their study of 12,030 patients found a 3.6% 30-day readmission rate following elective THA.<sup>9</sup> Morbid obesity, medical comorbidities and system-related hospital problems were found to be risk factors associated with readmission.<sup>9</sup> Maoz et. al. reviewed 3,672 primary and 406 revision arthroplasties and reported modifiable risk factors associated with periprosthetic joint infection.<sup>21</sup> Obesity (BMI > 40 mg/k<sup>2</sup>) was found to have an odds ratio of 4.13 while tobacco use and colonization with *Staphylococcus aureus* were additive risk factors with an odds ratio of 12.76 when combined with other risk factors.<sup>21</sup> Kapadia et al compared the outcomes of 110 smokers to 220 non-smokers who underwent total hip arthroplasty and found a 92%

survivorship in smokers compared to 99% in non-smokers at an average of 51 months post-operatively.<sup>19</sup>

The two key limitations of this pilot study are its small sample size and brief study duration. Patients were enrolled over just a 3-month period and followed for an additional 3 months. It is the goal of the investigators to use the data generated by this study as a pilot to support a longer-term study with increased patient numbers. Additionally, patient drop-out was expected after patients were advised that they were not immediately surgical candidates, and due to the retrospective design of this study, information is not available for the 10 patients who did not follow up with the study surgeon. Future studies could be directed at determining whether these patients sought care elsewhere, and if offered surgery, their outcomes.

In conclusion, we report a set of modifiable risk factors and goals that can be used in an effort to improve results after elective arthroplasty surgery. Our study shows that with proper support, counseling, and guidance, some arthroplasty

candidates are willing to “buy in” to a shared-decision making model. This model empowers patients to become partners in their healthcare with their medical doctor and surgeon and therefore work to meet goals in a mutual effort to improve their own likelihood of a good surgical outcome. While some preoperative risk factors cannot be altered, the factors we investigated are ultimately within the control of the patient and physicians and desired goals can often be achieved, as has been the clinical observation in our practice. The results of our initial study are encouraging both with regards to retaining patients in follow-up and also in terms of meeting defined evidence-based goals to effect improved surgical outcomes. A majority of patients continued in the care of the study surgeon despite the difficulties of risk factor modification and surgical time delay, and actually improved their modifiable risk factors, with a number of patients meeting these goals and having surgery scheduled within the three months after risk factor modification was initiated.

## References

- 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(4):780-785. doi:10.2106/JBJS.F.00222.
- Jones CA, Beaupre LA, Johnston DWC, Suarez-Almazor ME. Total joint arthroplasties: current concepts of patient outcomes after surgery. *Clin Geriatr Med.* 2005;21(3):527-541. vi. doi:10.1016/j.cger.2005.02.005.
- Klit J. Results of total joint arthroplasty and joint preserving surgery in younger patients evaluated by alternative outcome measures. *Dan Med J.* 2014;61(4):B4836. <http://www.ncbi.nlm.nih.gov/pubmed/24814600>. Accessed January 4, 2016.
- Mainard D, Guillemin F, Cuny C, Mejat-Adler E, Galois L, Delagoutte J. [Quality of life assessment one year after total hip or knee arthroplasty]. *Rev Chir orthopédique réparatrice l'appareil Mot.* 2000;86(5):464-473. <http://www.ncbi.nlm.nih.gov/pubmed/10970970>. Accessed January 4, 2016.
- O'Brien S, Bennett D, Doran E, Beverland DE. Comparison of hip and knee arthroplasty outcomes at early and intermediate follow-up. *Orthopedics.* 2009;32(3):168. <http://www.ncbi.nlm.nih.gov/pubmed/19309063>. Accessed January 4, 2016.
- Arsoy D, Woodcock JA, Lewallen DG, Trousdale RT. Outcomes and complications following total hip arthroplasty in the super-obese patient, BMI > 50. *J Arthroplasty.* 2014;29(10):1899-1905. doi:10.1016/j.arth.2014.06.022.
- D'Apuzzo MR, Novicoff WM, Browne JA. The John Insall Award: Morbid obesity independently impacts complications, mortality, and resource use after TKA. *Clin Orthop Relat Res.* 2015;473(1):57-63. doi:10.1007/s11999-014-3668-9.
- Harris AHS, Bowe TR, Gupta S, Ellerbe LS, Giori NJ. Hemoglobin A1C as a marker for surgical risk in diabetic patients undergoing total joint arthroplasty. *J Arthroplasty.* 2013;28(8 Suppl):25-29. doi:10.1016/j.arth.2013.03.033.
- Paxton EW, Inacio MCS, Singh JA, Love R, Bini SA, Namba RS. Are There Modifiable Risk Factors for Hospital Readmission After Total Hip Arthroplasty in a US Healthcare System? *Clin Orthop Relat Res.* 2015. doi:10.1007/s11999-015-4278-x.
- Finkelstein EA, Khavjou OA, Thompson H, et al. Obesity and severe obesity forecasts through 2030. *Am J Prev Med.* 2012;42(6):563-570. doi:10.1016/j.amepre.2011.10.026.
- Ward DT, Metz LN, Horst PK, Kim HT, Kuo AC. Complications of Morbid Obesity in Total Joint Arthroplasty: Risk Stratification Based on BMI. *J Arthroplasty.* 2015;30(9 Suppl):42-46. doi:10.1016/j.arth.2015.03.045.
- Elson LC, Barr CJ, Chandran SE, Hansen VJ, Malchau H, Kwon Y-M. Are morbidly obese patients undergoing total hip arthroplasty at an increased risk for component malpositioning? *J Arthroplasty.* 2013;28(8 Suppl):41-44. doi:10.1016/j.arth.2013.05.035.
- Dronge AS, Perkal MF, Kancir S, Concato J, Aslan M, Rosenthal RA. Long-term glycemic control and postoperative infectious complications. *Arch Surg.* 2006;141(4):375-380; discussion 380. doi:10.1001/archsurg.141.4.375.
- Hwang JS, Kim SJ, Bamne AB, Na YG, Kim TK. Do glycemic markers predict occurrence of complications after total knee arthroplasty in patients with diabetes? *Clin Orthop Relat Res.* 2015;473(5):1726-1731. doi:10.1007/s11999-014-4056-1.
- Kapadia BH, Johnson AJ, Naziri Q, Mont MA, Delanois RE, Bonutti PM. Increased revision rates after total knee arthroplasty in patients who smoke. *J Arthroplasty.* 2012;27(9):1690-1695.e1. doi:10.1016/j.arth.2012.03.057.
- Duchman KR, Gao Y, Pugely AJ, Martin CT, Noiseux NO, Callaghan JJ. The Effect of Smoking on Short-Term Complications Following Total Hip and Knee Arthroplasty. *J Bone Joint Surg Am.* 2015;97(13):1049-1058. doi:10.2106/JBJS.N.01016.
- Maradit Kremers H, Kremers WK, Berry DJ, Lewallen DG. Social and Behavioral Factors in Total Knee and Hip Arthroplasty. *J Arthroplasty.* 2015. doi:10.1016/j.arth.2015.04.032.
- Stryker LS, Abdel MP, Morrey ME, Morrow MM, Kor DJ, Morrey BF. Elevated postoperative blood glucose and preoperative hemoglobin A1C are associated with increased wound complications following total joint arthroplasty. *J Bone Joint Surg Am.* 2013;95(9):808-814, S1-S2. doi:10.2106/JBJS.L.00494.
- Kapadia BH, Issa K, Pivec R, Bonutti PM, Mont MA. Tobacco use may be associated with increased revision and complication rates following total hip arthroplasty. *J Arthroplasty.* 2014;29(4):777-780. doi:10.1016/j.arth.2013.08.023.
- About the Program. <http://www.miriamhospital.org/centers-and-services/behavioral-and-preventive-medicine/weight-management-program/about-the-program.html>. Accessed January 4, 2016.
- Maoz G, Phillips M, Bosco J, et al. The Otto Aufranc Award: Modifiable versus nonmodifiable risk factors for infection after hip arthroplasty. *Clin Orthop Relat Res.* 2015;473(2):453-459. doi:10.1007/s11999-014-3780-x.

## Authors

Steven F. DeFroda, MD, ME, Resident Physician, Department of Orthopedic Surgery, Alpert Medical School of Brown University, Providence, RI. Rhode Island Hospital, Miriam Hospital.

Lee E. Rubin, MD, Assistant Professor, Department of Orthopedic Surgery, Division of Adult Reconstruction, Alpert Medical School of Brown University, Providence, RI. Attending Surgeon, Rhode Island Hospital, Miriam Hospital. University Orthopedics, Inc., Providence, RI.

Derek R. Jenkins, MD, Assistant Professor, Department of Orthopedic Surgery, Division of Adult Reconstruction, Alpert Medical School of Brown University, Providence, RI. Attending Surgeon, Rhode Island Hospital, Miriam Hospital. University Orthopedics, Inc., Providence, RI.

## Disclosures

The views expressed herein are those of the authors and do not necessarily reflect the views of the authors' participating institutions. The authors report no conflict of interest pertinent to this study.

## Correspondence

Derek R. Jenkins, MD  
Assistant Professor of Orthopedics  
Alpert Medical School of Brown University  
University Orthopedics, Inc.  
100 Butler Drive, Providence, RI 02906  
401-453-9032, Fax 401-861-5812  
[derek\\_jenkins@brown.edu](mailto:derek_jenkins@brown.edu)