



3-5-2018

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Sada Aschnewitz

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The Effects of Diabetes on Total Knee Arthroplasty Outcomes

Sada Aschnewitz

University of North Dakota

PERMISSION

Title: The Effects of Diabetes on Total Knee Arthroplasty Outcomes

Department Nursing

Degree Master of Science

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Abstract

Total knee arthroplasty is one of the most common orthopedic surgeries performed in the United States and is expected to continue to increase due to aging of the national population (Sirasuce, Ippolito, Gibson, Ohman-Strickland & Beebe, 2017). In addition, the prevalence of diabetes in the United States continues to increase (Brock, Shirley, Bardgett, Walker & Deehan, 2017). An individual who has been diagnosed with diabetes presents for a preoperative assessment, and she will be undergoing a total knee arthroplasty. A literature review was performed researching the effects of diabetes on total knee arthroplasty outcomes. A search was conducted using the University of North Dakota's Harley French medical library. Three different databases were used: CINAHL, PubMed and the Cochrane Library. Keywords used in the search were diabetes and total knee arthroplasty. Limitations placed on the search included that the articles were published within the last seven years and written in the English language. Fifty-three articles were initially identified; after further review eleven articles were found to be pertinent. Concluded from the literature review, diabetes is associated with increased risk of postoperative complications in total knee arthroplasty surgeries (Lopes, Reavan & Harman, 2017). As stated above, both diabetes mellitus and the rate of total knee arthroplasty surgeries are increasing; positive outcomes are essential not only to individual patient, but to the health care system.

Background

Individuals undergoing a total knee arthroplasty (TKA) are to complete a preoperative examination prior to surgery. Preoperative examinations are used to identify undiagnosed disease states, identify patient risk factors, optimize the current health status, and recognize potential complications (Cohn, 2018). A sixty-two-year-old female presents to the clinic for a preoperative examination for a left total knee arthroplasty. She has been diagnosed with several chronic diseases including type II diabetes. Further evaluation is not only needed to ensure the patient understands the impact of diabetes has on the outcome of the TKA, but also to identify if any diagnostic evaluation could be implemented to identify risk factors for complications.

A common comorbidity of osteoarthritis is diabetes mellitus type II, due to the prevalence of both type II diabetes and osteoarthritis increase with age (Brock et al., 2016). An estimated 52% of individuals with diabetes also have arthritis and may need a lower extremity joint replacement (Adams et al., 2013). Total knee arthroplasty is a common surgery to restore function and quality of life to those who have failed medical management of knee arthritis (Belmont, Goodman, Waterman Bader & Schoenfeld (2014). Oren, Sergui, Williams, Bucknell, and King (2011) report a yearly three percent failure rate due to noninfectious etiologies. As with all surgical procedures, adverse outcomes can take place; individuals with diabetes are more vulnerable to complications (Oren, Botolin, Williams, Bucknell, & King, 2011). The demand of total knee arthroplasty surgery is expected to increase to 3.48 million procedures per year by 2030 (Siracuse, Ippolito, Gibson, Ohman-Strickland & Beebe, 2017). To understand adverse total knee arthroplasty outcomes, this paper will examine the impact of diabetes on total knee arthroplasty results. The report will begin with a case report, which will be followed by a review of infection rates, mortality rates, health care demands, revision of total knee arthroplasty,

functional outcomes, and glycemic control to develop learning points about diabetes and its negative effects on total knee arthroplasty outcomes.

Case Report

A sixty-two-year-old Caucasian female presents to the clinic for a preoperative examination for left total knee arthroplasty. Surgery will be performed within thirty days from the preoperative evaluation. Significant left knee osteoarthritis has been reported since age fifty. She reports the pain and decreased range of motion has progressively worsened over the years resulting in the use of a cane for ambulation. Conservative treatments, such as physical therapy and joint injections, were utilized over the past twelve years. However, these treatments are no longer effectively managing the pain or providing increased range of motion. She rates the pain six or seven on the zero to ten pain scale and describes the pain as sharp. She uses Tylenol arthritis for pain relief. The medication lowers the pain rating to a three or four. However, the pain is always present. The patient has met with the orthopedic surgeon to discuss treatment options and has decided to proceed with a left total knee arthroplasty.

She works as a bank teller. Social history consists of one pack a day tobacco use and one to two glasses of alcohol use per day. The patient denies any drug use or abuse. She consumes about twelve cups of coffee per day. She has no known allergies. She denies any surgical history. The patient denies any past hospitalizations. She has a past medical history of hypertension, hyperlipidemia, and diabetes mellitus type II. She is currently taking lisinopril 10mg daily, metformin 1000mg twice daily, simvastatin 20mg daily and aspirin 81 mg daily. She denies any personal or family history of bleeding disorders. She also denies any history of anesthesia complications. She denies taking non-steroidal anti-inflammatory medications.

Vital signs were as follows: blood pressure 142/92, heart rate was 78, respiratory rate was 24, temperature was 98.6. The patient does appear to be anxious; she reports that she is nervous she will not be cleared for surgery. She is looking forward to having the surgery completed in hopes to increase her activity level and decrease her pain. Upon a complete physical examination, no pertinent findings to report except significant decreased range of motion and medial joint line tenderness noted to left knee. No joint effusion noted. Laboratory testing included complete blood count, comprehensive metabolic panel, liver enzymes and hemoglobin A1c. Diagnostic imaging included electrocardiogram and chest radiography. All results concluded within normal parameters. Hemoglobin A1c was 6.7 percent.

After discussion of the lab results, the patient appeared to relax and at that time her blood pressure was reevaluated. It was found to be 130/80 and respiratory rate was 18 breaths per minute. Health maintenance topics included smoking cessation, caffeine, and alcohol intake. The patient was open to trying the nicotine patch to decrease her tobacco use. Education was provided to hold aspirin and avoid non-steroidal anti-inflammatory medications for one week prior to surgery. It was also discussed that patient is to be nothing by mouth after midnight the night prior to surgery. Further instructions specific to the time of the surgery will be given to patient by the surgery department prior to the operation. The patient was cleared for the left total knee arthroplasty; however, further education could have been implemented during the preoperative assessment regarding risk factors of the surgery and existing diagnoses especially diabetes.

Literature Review

The goal of an arthroplasty is to restore function, improve mobility and reduce disability (Hogan, Bucknell & King, 2016). Education should be provided to the patient on the effects of

diabetes on outcomes of total knee arthroplasty to ensure patient understanding and to possibly increase compliance. These effects include infection, higher mortality rate, higher rates of readmission to the hospital, greater hospital charges, increased risk of revision of the surgery, or decreased function of the knee (Hogan et al., 2016). It is critical that a preoperative assessment be completed prior to surgery to identify modifiable risk factors. Hemoglobin A1c could be a tool used to identify postoperative surgical risk; although its various threshold levels have been proposed ranging from 6.5-8% (Hogan et al., 2016).

Mortality Rates

Mortality rates for unilateral total knee arthroplasty are at 0.18% within the first thirty days of surgery (Belmont Jr., Goodman, Waterman, Schoefeld & Beaumont, 2014). Diabetes and increased age are independent risk factors for mortality in patients who undergo unilateral total knee arthroplasty (Belmont Jr. et al., 2014). Belmont Jr. et al. (2014) concluded from their research of 15,321 patients “diabetes mellitus was identified in 18.2% of patients and increased the overall risk of mortality by 300%” (p.24). Brock, Shirley, Bardgett, Walker, and Deehan, (2017) state uncontrolled diabetes has shown a threefold increase in mortality rates in patients who undergo total knee arthroplasty. However, a study cited by Hogan et al. (2016) found no significant association between mortality rates and diabetes in those who underwent total knee arthroplasty. Although mixed results were found regarding mortality rates, diabetes may influence perioperative outcomes by negatively impacting morbidity (Hogan et al., 2016).

Infection

The threat of infection is always a risk when undergoing any surgery. The most common documented surgical complication related to diabetes is increased rate of infection (Hogan et al, 2016). Increased infection rates in diabetic patients are caused by immune dysfunction,

neuropathy, and greater number of medical interventions in these patients (Casqueiro, Casqueiro & Alves, 2012). Deep surgical infections following a total knee arthroplasty are infrequent, but can be a devastating occurrence (Numba, Inacio & Paxton, 2013). Complications can require prosthesis removal, prolonged antimicrobial therapy, and delay in reimplantation (Everhart et al., 2016). Studies have concluded mixed results in incident rates ranging from 0.5 to 1.8% regarding diabetes, infection, and total knee arthroplasty (Numba et al., 2013). Multifactorial influences including the patient, surgical, and hospital factors, such as infection, control influence outcomes (Numba et al., 2013).

Although statistics vary on the degree of influence diabetes has on surgical site infections, it is clear it plays a part in a multifactorial effect. Everhart et al. (2016) developed preoperative surgical site infection risk score for primary or revision knee or hip arthroplasty to identify high risk patients and allow the surgeon to provide appropriate counseling for risk modification. The surgical site infection risk score is a prediction tool for surgical site infections for within one year following primary or revision of either knee or hip; it is a point system based on the presence or absence of twelve medical comorbidities (Everhart et al., 2016). Non-insulin dependent diabetes would receive one point and insulin-dependent diabetes would receive one and a half points (Everhart et al., 2016). A possible score ranging from zero to thirty-five; the use of the cutoff of six points for primary arthroplasty and nine points for revision could be used to alert clinicians to discuss the risks of surgery and possible risk reductions (Everhart et al., 2016). Documentation regarding identification and education of risk factors would be beneficial to the preoperative examiner.

During the preoperative exam, the examiner should provide consultation regarding modifiable patient risk factors. Patient factors that were found to increase risk of infection

include increased body mass index, male sex, and diabetes (Numba et al., 2013). Modifiable risk factors include body mass index (BMI), diabetes, and tobacco use (Everhart et al., 2016).

Although BMI and diabetes are interconnected, both were found to independently contribute to surgical site infections (Everhart et al., 2016).

Health Care Demands

Health care demands push to improve quality of care and reduce spending; reducing readmission rates is a strategy to meet these demands (Siracuse et al., 2017). Financial penalties occur to the health care system when readmissions are related to procedures (Siracuse et al., 2017). Readmission after total joint arthroplasty is a “fiscal responsibility of the hospital in a bundle care payment and ‘never event’ environment” (Boraiah et al., 2015, p.1921). Patients who have an increased risk of thirty-day readmission include older than 85 years, BMI greater than 35 and diagnosed with diabetes. The most common reason for readmission is surgical site infection; as discussed previously, the infection rates increases in patient who have been diagnosed with diabetes (Boraiah et al., 2015). Overall, patients with diabetes can face higher health care cost when undergoing a total knee arthroplasty (Hogan et al., 2016).

Restoration of function and pain relief are the main goals when undergoing a total knee arthroplasty. An indicator of quality of life is if the patient can return home and resume activities of daily living (Hogan et al., 2016). Patients with diabetes had significantly higher rate of non-home discharge following either a primary or revision of total knee arthroplasty (Hogan et al., 2016). Not only does a non-home discharge possibly effect quality of life but increases the cost of health care (Hogan et al., 2016).

Functional Outcomes

Patients with diabetes demonstrated significantly poorer outcomes related to functionality than the control group (Hogan et al., 2016). Impaired mobility and gait were associated with patients who had poor glycemic control and longer duration of diabetes due to impaired muscle quality (Brock et al, 2017). The patients who were followed for five years after surgery, diabetes and joint stiffness were found to have significant correlation at the one year follow up (Hogan et al., 2016).

Poor functional outcomes are related to diabetes due to a molecular impact. Bone mineral density is affected by diabetes due to decreased qualities in the bone matrix (Oren et al., 2011).

Cadaveric studies have shown that increased concentration of nonenzymatic glycation products (also called advanced glycation end products [AGEs]) within the collagen network of bone correlate with many bone mechanical properties, including ultimate strength, yield strength, and fracture toughness (Oren et al., 2011, p. 1196).

These end products lead to “increase stiffness and brittleness of articular cartilage” (Oren et al., 2011, p. 1196). Authors of a pilot study found

detrimental effects of pentosidine and other AGEs for bone repair may indicate that control of glycemia before surgery would be beneficial not only to increase perioperative safety but also to avoid impairment of bone remodeling following arthroplasty. Clinicians should be aware that with regard to bone healing, current blood glucose levels may be less important than long-term glycemic control (Oren et al., 2011, p. 2011).

Due to these findings further studies involving molecular and tissue involvement are warranted, as this may lead to improved outcomes.

Revision of Total Knee Arthroplasty

Poor functional outcomes can lead to limitations in activities of daily living and lead to revision of the knee (Hogan et al., 2016). Total knee arthroplasty revision is not only another surgical procedure the patient would have to endure but revisions are associated with higher cost than the initial surgery and longer hospital stays (Oren et al., 2011). Diabetes is one of several factors associated with high rates of total knee arthroplasty revisions; revision rates among diabetics are up to nine times higher (Oren et al., 2011). Causes of revisions include surgical infections, joint stiffness, septic loosening and alterations in bone density (Oren et al., 2011). However, other studies demonstrated no correlation between diabetes and total knee revisions, but this could be related to shorter length of follow-up observations (Hogan et al., 2016).

Glycemic Control

Although diabetes mellitus is associated with the above complications, it is not clearly understood whether average levels of glycemic control measured by hemoglobin A1c levels (HbA1c), perioperative glucose levels, chronic long-term effects of diabetes, or a combination of these factors contribute to increased risks of complications (Lopez, Reaven & Harman, 2017). In the primary care setting, where most of preoperative assessments are preformed, hemoglobin A1c is used as a meter for glycemic control because it is routinely available and consistently applied (Hogan et al., 2016). Adequate glycemic control is associated with HbA1c of less than 7% and has been demonstrated to decrease the rate of infections across a variety of surgical procedures (Shaw, Saleem & Gahtan, 2015). However, hemoglobin A1c cannot be applied to predict the risk of complications in total knee arthroplasty (Lopez et al., 2017). Delays in elective surgery due to elevated hemoglobin A1c can have negative impacts (Lopez et al., 2017). Limited exercise and mobility due to pain and restrictions of daily living would promote obesity and

insulin resistance; the longer the surgery is delayed the more difficult it could be to improve glycemic control (Lopez et al., 2017).

Authors of a systematic review concluded there is insufficient evidence to use hemoglobin A1c levels as a predictor of postoperative complications (Lopez et al., 2017). A meta-analysis could not be performed on studies addressing preoperative HbA1c, threshold levels of HbA1c, and incidence of complications due to retrospective and variations in design of the studies and difference in HbA1c threshold levels (Lopez et al., 2017).

The lack of convincing evidence supporting a relationship of HbA1c levels with postoperative complications, such as infections, has important clinical implications. Elective surgeries, particularly joint replacement procedures, are often delayed due to elevated HbA1c levels and concern about poor control. Patients and their care providers are often advised to optimize glucose control prior to surgery, in hope of decreasing postoperative complication risk...it does not seem that this is a logical approach for several reasons. First, evidence that HbA1c predicts risk is weak; second, many patients are unable to achieve the advised HbA1c goals; and third there are currently no evidence that intervention to reduce HbA1c, even if successful, mitigate risk... To delay or prevent these patients from having these procedures because of “poor” glycemic control (usually defined as an HbA1c of > 6.5 % or 7%) may in fact promote worsening hyperglycemia, as the patient s are unable to optimize lifestyle management, which is the first and most effective step in achieving diabetes control (Lopez et al., 2017, p. 1717).

Future prospective cohort studies and trials are needed to address the association of HbA1c preoperative levels and the occurrence of postoperative complications (Lopez et al., 2017).

Future studies should control confounding factors in the data analysis and use the HbA1c as continuous variable (Hogan et al., 2016).

Conclusion

Increasing safety and positive outcomes in patients with diabetes is the responsibility of both the patient and the health care system (Hogan et al., 2016). The patient discussed in the case study did demonstrate good glycemic control, however, it would be beneficial to discuss the impact of diabetes on total knee arthroplasty outcomes. Possible complications include infection, higher mortality rate, higher rates of readmission to the hospital, greater hospital charges, and increased risk of revision of the surgery or decreased function of the knee (Hogan et al., 2016). Discussing the potential implications allows the clinician to individualize the teaching and provide patient centered care.

Learning points

- Diabetes has a negative effect on total knee arthroplasty outcomes. These effects include increase risk of infection, higher rates of readmission, decreased function, increased revision rates and higher cost of the surgery.
- Consultation of the modifiable risk factors should be discussed at the preoperative evaluation. It may be beneficial to review the risk score performed by the orthopedic surgeon with the patient.
- Poor functional outcomes in total knee arthroplasty are related to diabetes due to a molecular impact. Diabetes effects the quality of the bone matrix and increases brittleness of articular cartilage.
- HbA1c cannot be used as a predictor of postoperative complications in total knee arthroplasty. At this time, no threshold HbA1c levels have been identified to decrease the incidence of complications. Future studies are needed to find if there

is a correlation regarding HbA1c levels and incidence of complications. Delaying total knee arthroplasty surgery due to elevated HbA1c should not be taken lightly due to possible worsening of hyperglycemia.

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